MACON WATER AUTHORITY

CONTRACT FOR

Amerson Water Treatment Plant
Generator Fueling System Replacement

Issue for Construction
June 1, 2026

Designed by

CLARKNEXSEN
A JMT Company

PROPRIETARY NOTICE

This document is prepared by the Macon Water Authority for the sole purpose of communicating to our vendors. The proprietary information contained herein is based on the requirements of the project. None of the information in this document is to be shared with any third parties without the expressed written consent of the Macon Water Authority.

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INVITATION TO BID

THE MACON WATER AUTHORITY
MACON, GEORGIA

Sealed Bids for furnishing all materials, labor, tools, equipment and appurtenances necessary for the installation of Amerson Water Treatment Plant Generator Fueling System Replacement (the "Project") will be received by the Macon Water Authority (the "Owner"), at the Macon Water Authority, 537 Hemlock Street, Human Resources Training Room, Macon, Georgia 31201 until **2:00 P. M., local time, August 11, 2026,** and then at said office publicly opened and read aloud.

All bidders must attend a **mandatory pre-bid meeting** at the **Amerson Water Treatment Plant**, **703 Riverbend Drive, Macon, GA 31211** at **10:00 A.M. on July 28, 2026** in the second floor conference room. All bid questions must be submitted to the Owner by **10:00A.M. on August 04, 2026**. The Bidder should attend the pre-bid meeting in its entirety.

The Project consists of replacing the existing underground fuel oil system with a new above-ground system.

The Project will be awarded in one Contract. Fifty-one percent (51%) of the Work under the Contract Documents must be self-performed by the General Contractor. The Project will be awarded by base bid on a lump sum basis for the performance and completion of all Work required by the Contract Documents.

The Contract Documents include, but may not be limited to, the Instructions to Bidders, the Contract Agreement, the General Conditions, the Drawings, the Specifications (Divisions 01 through 46, inclusive, where applicable), and the forms of Bid Bond, Performance Bond, and Payment Bond. These and any other Contract Documents may be examined at the following location:

Engineering Department
Macon Water Authority
537 Hemlock Street
Macon, GA 31201

Copies of Contract Documents may be obtained at ARC Document Solutions, (152 Spring St. Macon, GA 3121, Phone: (478)-746-3331, email: macon.jobs@e-arc.com) upon a **non-refundable** payment of **$150.00** for each set, payable to Clark Nexsen at 3920 Arkwright Rd, Ste. 385, Macon, GA 31210. A street address must be provided to ensure prompt delivery. No partial sets of bidding documents shall be issued. **Bidders must purchase the Contract Documents in order to be eligible to submit a bid.** Bid documents on the MWA website are for informational purposes only.

Each Bid must be accompanied by a Bid Bond in the amount of **5%** of the Bid, prepared on the form of Bid Bond that is part of the Contract Documents, duly executed by the Bidder as principal and having as surety thereon a surety company licensed to do business in the State of Georgia and

listed in the latest issue of U.S. Treasury Circular 570.

Bidders must comply with the Disadvantaged Business Enterprise Participation Requirements specified in the Instructions to Bidders.

The Bidder shall affix to the outside of its Bid envelope the Bidder's Georgia Utility Contractor License Number. A license number of a Utility Manager or a subcontractor is insufficient, and any Bid that fails to affix to the outside of its Bid envelope the Bidder's Georgia Utility Contractor License Number may be rejected.

The successful Bidder for this Project shall be required to furnish a Performance Bond and Payment Bond, satisfactory to the Owner, each in the amount of 100 % of the Contract Price.

Employment of Local Businesses and Contractors: It is the desire of the Owner that local businesses--including disadvantaged, minority, and women enterprise subcontractors-- be given the opportunity to participate on the various parts of the Work.

The Owner's encouragement of participation of disadvantaged, minority, and women enterprises and of locally owned businesses and contractors is not intended to restrict or limit competitive bidding or to increase the cost of the Work. The Owner supports a healthy, free market system that seeks to include responsible local businesses and provide ample opportunities for local business growth and development.

In an effort to assist minority-owned businesses, Georgia law permits an income tax adjustment on the state tax return of any company that subcontracts with a certified minority-owned firm to furnish goods, property or services to the State of Georgia pursuant to O.C.G.A. §48-7-38. Suppliers should consult with their tax advisors to find out how to take advantage of these tax credits.

The Owner reserves the right to reject any or all Bids. The Owner reserves the right to waive informalities and technicalities.

The Macon Water Authority
Michel Wanna
Interim Executive Director & President

END OF SECTION

SECTION 00100

INSTRUCTIONS TO BIDDERS

1.01 CONTRACT DOCUMENTS

A. The Bidder's attention is directed to the General Conditions and other Contract Documents, all of which should be reviewed and studied by the Bidders before submitting a Bid.

B. The Contract Documents shall define and describe the complete Work to which they relate.

1.02 DEFINITIONS

The Bidder's attention is called to the definitions set forth in Article 41 of the General Conditions.

1.03 PREPARATION AND EXECUTION OF BID

A. Each Bid must be prepared to represent that it is based solely upon the materials and equipment specified in the Contract Documents.

1. *Trade Names.*— When reference is made in the Contract Documents to trade names, brand names, or to the names of manufacturers, such references are made solely to indicate that products of that description may be furnished and are not intended to restrict competitive bidding. Unless requests for approvals of other products have been received and approvals have been published by addendum in accordance with the procedure described below in this Section, the successful Bidder may furnish no products of any trade names, brand names, or manufacturers' names except those designated in the Contract Documents.
2. *Use of other products.*—If a Bidder desires to use products of trade or brand names or of manufacturers' names which are different from those specified in the Contract Documents, application for the approval of the use of such products must be received by the Engineer at least ten (10) days prior to the date set for the opening of Bids. The application to the Engineer for approval of a proposed product must be accompanied by:
    a. a schedule setting forth in which respects the materials or equipment submitted for consideration differ from the materials or equipment designated in the Contract Documents; and
    b. a copy of the published recommendations of the manufacturer for the installation of the product together with a complete schedule of changes in the drawings and specifications, if any, which must be made in other work in order to permit the use and installation of the proposed product in accordance with the recommendations of the manufacturer of the product.

In addition, the Engineer will give consideration to reports from reputable independent testing laboratories, verified experience records showing the reputation

of the proposed product with previous users, evidence of reputation of the manufacturer for prompt delivery, evidence of reputation of the manufacturer for efficiency in servicing its products, or any other written information that is helpful in the circumstances. To be approved, a proposed product must also meet or exceed all express requirements of the Contract Documents.

3. *Burden of proof.*— The degree of proof required for approval of a proposed product as acceptable for use in place of a named product or products is that amount of proof necessary to convince a reasonable person beyond all doubt.
4. *Request for conference.*—Any Bidder who alleges that rejection of a submittal is the result of bias, prejudice, caprice, or error on the part of the Engineer may request a conference with a representative of the Owner: PROVIDED, that the request for said conference, submitted in writing, shall be received by the Owner at least five (5) days prior to the date set for the opening of Bids, time being of the essence.
5. *Issuance of addenda.*— If the submittal is approved by the Engineer, an addendum will be issued to all prospective Bidders. Issuance of an addendum is a representation to all Bidders that the Engineer, in the exercise of its professional judgment and discretion, established that the product submitted for approval is acceptable and meets or exceeds all express requirements.

B. Each Bid must be submitted on the Bid forms which are a part of the Contract Documents. **All blank spaces for Bid prices, both words and figures, must be filled in and completed in ink.** In case of discrepancy, the amount shown in words will govern. All required enclosed certifications or other documents must be fully completed and executed when submitted.

C. In case of discrepancies between the figures shown in the unit prices and the totals, the unit prices shall apply and the totals shall be corrected to correspond with the unit prices. In case of discrepancies between written amounts and figures, written amounts shall take precedence over figures and the sum of all Bid extensions (of unit prices) plus lump sum items shall take precedence over the Bidders input of the Bid Total.

D. Each Bid must be submitted in a sealed envelope, addressed to the Macon Water Authority (the "Owner"). Each sealed envelope containing a Bid must be plainly marked on the outside as, "**Amerson Water Treatment Plant Generator Fueling System Replacement".**

E. The Bidder shall provide on the outside of the sealed envelope the following information:
   1. Bidder's Name;
   2. Bidder's Georgia Utility Contractor License Number (if applicable); and,
   3. The words, "SEALED BID"

F. Any Bid submitted which does not contain the above information on the outside of the sealed envelope will not be opened and will be returned to the Bidder.

G. If forwarded by mail, the sealed envelope containing the Bid must be enclosed in another envelope addressed as follows:

THE MACON WATER AUTHORITY
Attn: Heather Veal
790 Second Street
Post Office Box 108
Macon, Georgia 31202-0108

H. Any and all Bids not meeting the aforementioned criteria for Bid submittal may be declared non-responsive, and subsequently returned to the Bidder unopened.

I. The Bidder, in signing a Bid on the whole or any portion of the Project, shall conform to the following requirements:

1. Bids which are not signed by individuals making the Bid shall have attached thereto a power of attorney evidencing authority to sign the Bid in the name of the person for whom it is signed.

2. Bids which are signed for a partnership shall be signed by all of the partners or by an attorney-in-fact. If a Bid is signed by an attorney-in-fact, there should be attached to the Bid a power of attorney executed by the partners evidencing authority to sign the Bid.

3. Bids which are signed for a corporation shall have the correct, legal corporate name thereof, as reflected in the records of the Georgia Secretary of State, and the signature of the president or other authorized officer of the corporation manually written below the corporate name following the wording "By _____." If applicable, the corporate seal shall be affixed to the Bid.

4. The Bidder shall complete, execute and submit the following documents, (if applicable to the Bidder) which are a part of the Contract Documents:

a. The Bid;
b. The Bid Bond;
c. Statement of Bidder's Qualifications;
d. Statement of Equipment;
e. Corporate Certificate, if the Bidder is a corporation;
f. Statement of Disadvantaged Business Enterprise ("DBE") compliance;
g. Contractor's License Certification;
h. Photocopy of State of Georgia Utility Contractor's License;
i. Photocopy of Certificate of Authority from Georgia Secretary of State's Office to do work in Georgia (if out of state contractor);
j. Non-Collusion Affidavit of Prime Bidder;
k. Any and all forms, certifications or other documentation required by the Georgia Department of Natural Resources Environmental Protection Division.

1.04 METHOD OF BIDDING

The unit or lump sum price for each of the several items in the Bid of each Bidder shall include its pro rata share of overhead and profit so that the sum of the products, obtained by multiplying the quantity shown for each item by the unit price, represents the total Bid. Any Bid not conforming to this requirement may be rejected. Additionally, unbalanced Bids (including unbalanced unit prices) may be rejected. Conditional Bids shall not be accepted. ***The special attention of all Bidders is called to this provision, for should conditions make it necessary to revise the quantities, no limit will be fixed for such increased or decreased quantities, nor extra compensation allowed.***

1.05 ADDENDA AND INTERPRETATIONS

A. No interpretation of the meaning of the Drawings, Specifications or other pre-bid documents or Contract Documents shall be made to any Bidder orally.

B. Any and all such interpretations and any supplemental instructions will be in the form of written Addenda to the Contract Documents which, if issued, will be mailed, shipped or faxed to all prospective Bidders (at the respective addresses furnished) at least seventy-two (72) hours (exclusive of weekends and holidays) prior to the date fixed for the opening of Bids.

C. Failure of Bidders to receive or acknowledge any Addendum shall not relieve them of any obligation under the Bid or the Contract Documents. All Addenda shall become part of the Contract Documents and obligations there under binding.

1.06 BID MODIFICATIONS

Bidders may modify their Bid by facsimile communication at any time prior to the scheduled closing time for receipt of Bids, provided such facsimile communication is received by the Owner prior to the time Bids are required, and provided further that the Owner is satisfied that a written confirmation of the facsimile modification over the signature of the Bidder was mailed by the Bidder to the Owner prior to the time Bids are required. The facsimile communication should not reveal the Bid price but should provide the addition or subtraction or other modification so that the final prices or terms will not be known by the Owner until the sealed Bid is opened. If written confirmation from the Bidder is not received by the Owner within two business days from the time Bids are required, no consideration will be given to the facsimile modification and the facsimile modification shall be rejected.

1.07 BID SECURITY

A. Each Bid must be accompanied by a Bid Bond, prepared on the form of Bid Bond included herein, duly executed by the Bidder as principal and having as surety thereon a surety company authorized to do business in the State of Georgia and listed in the latest issue of U.S. Treasury Circular 570, in the amount of **five (5%)** percent of the

Bid. Attorneys-in-fact who sign Bonds must file with each Bond a currently dated and valid original of their power of attorney. Where validity and currentness of a power of attorney are established by certification executed by a corporate officer, the certification shall be made and executed by a corporate officer of record, as reflected in the records of the Georgia Secretary of State, or by valid corporate resolution or authorization identifying such corporate officer.

B. Except as provided in O.C.G.A. §§ 36-91-52 and 36-91-53, if for any reason whatsoever the successful Bidder withdraws from the competition after opening of the Bids, or if Bidder refuses to execute and deliver the Contract and Bonds required in Article 2 of the General Conditions, the provisions of the Bid Bond may be enforced.

C. Except as provided in O.C.G.A. §§ 36-91-52 and 36-91-53, a Bid may not be revoked or withdrawn until sixty (60) days after the time set for opening the Bids. Upon expiration of this time period, the Bid will cease to be valid, unless the Bidder provides written notice to the Owner prior to the scheduled expiration date that the Bid will be extended for a time period specified by the Owner.

1.08 RECEIPT AND OPENING OF BIDS

The Owner may consider a technicality and informality in any Bid not prepared and submitted in strict accordance with the provisions hereof and may waive any technicality and informality or reject any and all Bids. Any Bid may be withdrawn prior to the above scheduled time for the opening of Bids or authorized postponement thereof. Any Bid received after the time and date specified shall not be opened.

1.09 CONDITIONS OF THE PROJECT

A. Each Bidder must be informed fully of the conditions relating to the construction of the Project and the employment of labor thereon. Failure to do so will not relieve a successful Bidder of the obligation to furnish all material and labor necessary to carry out the provisions of the Contract Documents. Insofar as possible, the Bidder, in carrying out the Work, must employ such methods or means as will not cause any interruption of or interference with the work of any other contractor.

B. The Bidder is advised to examine the location of the Project and to be informed fully as to its conditions; access requirements, the conformation of the ground; the character, quality and quantity of the products needed preliminary to and during the prosecution of the work; the general and local conditions and all other matters which can in any way affect the work to be done under the Contract Documents. Failure to examine the site will not relieve the successful Bidder of an obligation to furnish all products and labor necessary to carry out the provisions of the Contract Documents.

C. The Bidder shall notify the Owner of the date and time Bidder proposes to examine the location of the Project. The Bidder shall confine examination to the specific areas designated for the proposed construction, including easements and public right-of-ways. If, due to some unforeseen reason, the proceedings for obtaining the proposed construction site (including easements), have not been completed, the Bidder may enter

the site only with the express consent of the property owner. The Bidder is solely responsible for any damages caused by examination of the site.

C. All anticipated federal, state and local permits required for the Project __shall be obtained before the start of construction.

D. All rights of way and easements anticipated for the Project NA been obtained.

E.

1.10 EQUAL EMPLOYMENT OPPORTUNITY

A. During the performance of the Contract, the Bidder agrees as follows:

1. The Bidder shall not discriminate against any employee or applicant for employment, or in any employment action during employment, based upon any applicable, legally-recognized and protected basis, including, but not limited to, veteran status, uniformed service member status, race, color, religion, sex, sexual orientation, gender identity, age (40 and over), pregnancy (including childbirth, lactation and related medical conditions), national origin or ancestry, citizenship status, physical or mental disability, genetic information (including testing and characteristics), or any other consideration protected by federal, state, or local law.

2. The Bidder shall, in all solicitation or advertisement for employees placed by or on behalf of Bidder, state that all qualified applicants will receive consideration for employment without regard to any applicable, legally-recognized and protected consideration, including, but not limited to veteran status, uniformed service member status, race, color, religion, sex, sexual orientation, gender identity, age (40 and over), pregnancy (including childbirth, lactation and related medical conditions), national origin or ancestry, citizenship status, physical or mental disability, genetic information (including testing and characteristics), or any other characteristic or basis protected by federal, state, or local law.

3. The Bidder shall send to each labor union or representative of the workers, with which the Bidder has a collective bargaining agreement or other contract or understanding, a notice advising the labor union or worker's representative of the Bidder's commitments under the Equal Employment Opportunity Program of the Owner and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

4. The Bidder and its subcontractors, if any, shall file compliance reports at reasonable times and intervals with the Owner in the form and to the extent prescribed by the Owner or the Georgia Department of Natural Resources. Compliance reports filed at such times as directed shall contain information as to the employment practices, policies, programs and statistics of the Bidder and its subcontractors.

5. The Bidder shall demonstrate by the documentation required in Paragraph C, below, that a "Good Faith Effort" has been made to achieve compliance with the Owner's goal that a minimum of ten percent (10%) of the Contract Price shall be

subcontracted to a Disadvantaged Business Enterprise (DBE). "DBE" shall have the meaning as is defined in applicable federal law, including the current rules and regulations of the United States Department of Transportation More specifically, the term "DBE" means a firm or business which is at least fifty-one percent (51%) owned, operated, capitalized, and controlled by one or more United States citizens or lawfully admitted residents who are socially and economically disadvantaged.

As used herein, the term "subcontracted" means providing subcontracting services or furnishing products or materials to be utilized in the performance of the Work.

6. The Bidder shall include the provisions of paragraphs 1 through 6 of this Section 1.10.A in every subcontract or purchase order so that such provisions will be binding upon each subcontractor or vendor.

B. In determining whether a Bidder has made "Good Faith Efforts", the Owner will look effort that a Bidder has made.

C. The following list of kinds of efforts is provided for consideration, but this is not an exhaustive list of efforts that may be considered by the Owner:

1. Whether the Bidder attended any pre-solicitation or pre-bid meetings that were scheduled by the Agent to inform DBEs of contracting and subcontracting opportunities;

2. Whether the Bidder advertised in general circulation, trade association, and DBE-focus media concerning the sub-contracting opportunities;

3. Whether the Bidder provided written notice to DBEs that their interest in the Contract was being solicited, in sufficient time to allow the DBEs to participate effectively;

4. Whether the Bidder followed up initial solicitations of interest by contacting DBEs to determine with certainty whether the DBEs were interested;

5. Whether the Bidder selected portions of the Work to be performed by DBEs in order to increase the likelihood of meeting the DBE goals (including, where appropriate, breaking down contracts into economically feasible units to facilitate DBE participation);

6. Whether the Bidder provided interested DBEs with adequate information about the Drawings, Specifications and requirements of the Contract Documents;

7. Whether the Bidder negotiated in good faith with interested DBEs, not rejecting DBEs as unqualified without sound reasons based on a thorough investigation of their capabilities;

8. Whether the Bidder made efforts to assist interested DBEs in obtaining bonding, lines of credit, or insurance required by the Contract Documents or Contractor; and

D. Each Bidder shall include with his or her Bid a Statement of Disadvantaged Firm Utilization. Such statement shall include, as a minimum, the names and addresses of all DBE firms providing subcontracting services, furnishing products or materials, etc., the nature of the work to be contracted; and the anticipated cost of the services by each named firm as a percentage of the total Contract Price set forth in the Bid. The percentage participation should be calculated on the basis of the proportion of total dollar value of the Bid, including bulk purchase materials supplied by DBEs.

E. It is the desire of the Owner that DBEs be given the opportunity to bid on the various parts of the Work, and that to the extent feasible, DBE firms in the Middle Georgia area will be solicited and used. However, this desire is not intended to restrict or limit competitive bidding or to increase the cost of the Work. The Owner supports a healthy, free market system that seeks to include responsible businesses and provide ample opportunities for business growth and development.

In an effort to assist minority-owned businesses, Georgia law permits an income tax adjustment on the state tax return of any company that subcontracts with a certified minority-owned firm to furnish goods, property or services to the State of Georgia pursuant to O.C.G.A. § 48-7-38. Suppliers should consult with their tax advisors to find out how to take advantage of these tax credits.

1.11 NOTICE OF SPECIAL CONDITIONS

If any special federal, state, county or city laws, municipal ordinances, and the rules and regulations of any authorities having jurisdiction over construction of the Project, enclosed, herein referred to, or applicable by law to the Project, conflict with requirements of the Contract Documents, then the federal, state, county or city laws, municipal ordinances, and the rules and regulations of any authorities having jurisdiction over construction of the Project shall prevail and supersede the conflicting requirements of the Contract Documents.

1.12 OBLIGATION OF BIDDER

A. By submission of a Bid, each Bidder warrants that Bidder has inspected the site and has read and is thoroughly familiar with the Contract Documents (including all addenda). The failure or omission of any Bidder to examine any form, instrument or document shall in no way relieve any Bidder from any obligation in respect to the Bid.

C. Special attention is directed to Article 4, "Insurance" contained at pages 00700-3 through 00700-6 in the General Conditions. The Owner requires (1) "Worker's Compensation and Employer's Liability Insurance," (2) "Commercial General and Umbrella Liability Insurance," (3) "Business Auto and Umbrella Liability Insurance," and (4) "Materials and Floater" Insurance. For each of the required policies, the Owner requires a certificate of insurance at least quarterly, a copy of the endorsement of the insurance company showing the Owner as an additional insured, and a copy of the insurance policy declaration and any necessary endorsements.

D. Attention is further directed to Paragraph 6 of 00500, Contract Agreement and Article 9 of 00700, General Conditions regarding assignments. Prior written consent of the Owner is required for any assignment of any portion of this Contract, including any assignment due to "buyout" of Bidder or other acquisition of Bidder where the Bidder is a corporation or where Bidder is 50 percent or more owned by a corporation, firm, or person.

1.13 METHOD OF AWARD

A. The Contract, if awarded, will be awarded to the lowest responsible and responsive Bidder whose Bid meets the requirements and criteria set forth in the Contract Documents. The Contract, if awarded, will be awarded by base bid comprised of unit prices, for the performance and completion of all Work required by the Contract Documents.

B. The Bidder to whom the award is made will be notified. The Owner reserves the right to reject any and all Bids and to waive any technicalities and informalities in Bids received whenever such rejection or waiver is in the Owner's interest.

C. A responsive Bidder shall be one who submits a Bid in the proper form without qualification or intent other than as called for in the Contract Documents, and who binds itself on behalf of the Bid to the Owner with the proper Bid Bond completed and attached, and who properly completes all forms required to be completed and submitted at the time of the Bidding. The Bidder shall furnish all data, documents, forms, and certifications required by the Contract Documents. Failure to do so may result in the Bid being declared non-responsive.

D. A responsible Bidder shall be one who can fulfill the following requirements:

1. The Bidder shall maintain a permanent place of business. This requirement applies to the Bidder where the Bidder is a division of a corporation, or where the Bidder is 50 percent or more owned by a person, corporation or firm.

2. The Bidder shall demonstrate adequate construction experience and sufficient equipment resources to properly perform the work under and in conformance with the Contract Documents. This evaluation will be based upon a list of completed or active projects and a list of construction equipment available to the Bidder to perform the work. The Owner may make such investigations as deemed necessary to determine the ability of the Bidder to perform the Work, and

the Bidder shall furnish to the Owner all such information and data for this purpose as the Owner may reasonably request. The Owner reserves the right to reject any Bid if the evidence submitted by, or investigation of, such Bidder fails to satisfy the Owner that such Bidder is properly qualified to carry out the obligations of the Contract Documents and to complete the Project contemplated therein.

3. The Bidder shall demonstrate financial resources of sufficient strength to meet the obligations incident to the performance of the Work covered by the Contract Documents. The ability to obtain the required Performance and Payment Bonds will not alone demonstrate adequate financial capability.

1.14 EMPLOYMENT OF LOCAL LABOR

Preference in employment on the Project shall, insofar as practical, be given to qualified local labor.

END OF SECTION

FEDERAL WORK AUTHORIZATION PROGRAM AFFIDAVITS

EACH BIDDER MUST PROVIDE THE OWNER WITH THE PROPERLY COMPLETED AND PROPERLY SIGNED FEDERAL WORK AUTHORIZATION PROGRAM AFFIDAVITS AS REQUIRED BY O.C.G.A. § 13-10-91

THIS FORM MUST BE COMPLETED BY ALL CONTRACTORS, ALL SUBCONTRACTORS AND ALL SUB-SUBCONTRACTORS

THE FORMS ARE ATTACHED HERETO.

Contractor Affidavit under O.C.G.A. § 13-10-91(b)(1)

By executing this affidavit, the undersigned contractor verifies its compliance with O.C.G.A. § 13-10-91, stating affirmatively that the individual, firm or corporation which is engaged in the physical performance of services on behalf of the Macon Water Authority has registered with, is authorized to use and uses the federal work authorization program commonly known as E-Verify, or any subsequent replacement program, in accordance with the applicable provisions and deadlines established in O.C.G.A. § 13-10-91. Furthermore, the undersigned contractor will continue to use the federal work authorization program throughout the contract period and the undersigned contractor will contract for the physical performance of services in satisfaction of such contract only with subcontractors who present an affidavit to the contractor with the information required by O.C.G.A. § 13-10-91(b). Contractor hereby attests that its federal work authorization user identification number and date of authorization are as follows:

_____
Federal Work Authorization User Identification Number

_____
Date of Authorization

_____
Name of Contractor

_____
Name of Project

Name of Public Employer: the Macon Water Authority

I hereby declare under penalty of perjury that the foregoing is true and correct.

Executed on _____, ___, 20___ in _____ (city), _____ (state).

_____
Signature of Authorized Officer or Agent

_____
Printed Name and Title of Authorized Officer or Agent

SUBSCRIBED AND SWORN BEFORE ME
ON THIS THE _____ DAY OF _____, 20___.

_____
NOTARY PUBLIC

My Commission Expires: _____, 20___.

Subcontractor Affidavit under O.C.G.A. § 13-10-91(b)(3)

By executing this affidavit, the undersigned subcontractor verifies its compliance with O.C.G.A. § 13-10-91, stating affirmatively that the individual, firm or corporation which is engaged in the physical performance of services under a contract with _____ _____ [insert name of contractor] on behalf of the Macon Water Authority has registered with, is authorized to use and uses the federal work authorization program commonly known as E-Verify, or any subsequent replacement program, in accordance with the applicable provisions and deadlines established in O.C.G.A. § 13-10-91. Furthermore, the undersigned subcontractor will continue to use the federal work authorization program throughout the contract period and the undersigned subcontractor will contract for the physical performance of services in satisfaction of such contract only with sub-subcontractors who present an affidavit to the subcontractor with the information required by O.C.G.A. § 13-10-91(b). Additionally, the undersigned subcontractor will forward notice of the receipt of an affidavit from a sub-subcontractor to the contractor within five business days of receipt. If the undersigned subcontractor receives notice that a sub-subcontractor has received an affidavit from any other contracted sub-subcontractor, the undersigned subcontractor must forward, within five business days of receipt, a copy of the notice to the contractor. Subcontractor hereby attests that its federal work authorization user identification number and date of authorization are as follows:

_____
Federal Work Authorization User Identification Number

_____
Date of Authorization

_____
Name of Subcontractor

_____
Name of Project

Name of Public Employer: Macon Water Authority

I hereby declare under penalty of perjury that the foregoing is true and correct.

Executed on _____, ___, 20___ in _____ (city), _____ (state).

_____
Signature of Authorized Officer or Agent

_____
Printed Name and Title of Authorized Officer or Agent

SUBSCRIBED AND SWORN BEFORE ME
ON THIS THE _____ DAY OF _____, 20____.

_____
NOTARY PUBLIC

My Commission Expires: _____, 20____.

Sub-subcontractor Affidavit under O.C.G.A. § 13-10-91(b)(4)

By executing this affidavit, the undersigned sub-subcontractor verifies its compliance with O.C.G.A. § 13-10-91, stating affirmatively that the individual, firm or corporation which is engaged in the physical performance of services under a contract for _____ [insert name of subcontractor or sub-subcontractor with whom such sub-subcontractor has privity of contract] and _____ [insert name of contractor] on behalf of the Macon Water Authority has registered with, is authorized to use and uses the federal work authorization program commonly known as E-Verify, or any subsequent replacement program, in accordance with the applicable provisions and deadlines established in O.C.G.A. § 13-10-91. Furthermore, the undersigned sub-subcontractor will continue to use the federal work authorization program throughout the contract period and the undersigned sub-subcontractor will contract for the physical performance of services in satisfaction of such contract only with sub-subcontractors who present an affidavit to the sub-subcontractor with the information required by O.C.G.A. § 13-10-91(b). The undersigned sub-subcontractor shall submit, at the time of such contract, this affidavit to _____ [insert name of subcontractor or sub-subcontractor with whom such sub-subcontractor has privity of contract]. Additionally, the undersigned sub-subcontractor will forward notice of the receipt of any affidavit from a sub-subcontractor to _____ [insert name of subcontractor or sub-subcontractor with whom such sub-subcontractor has privity of contract]. Sub-subcontractor hereby attests that its federal work authorization user identification number and date of authorization are as follows:

_____
Federal Work Authorization User Identification Number

_____
Date of Authorization

_____
Name of Sub-subcontractor

_____
Name of Project

_____
Name of Public Employer

I hereby declare under penalty of perjury that the foregoing is true and correct.

Executed on _____, ___, 20___ in _____ (city), _____ (state).

_____
Signature of Authorized Officer or Agent

_____
Printed Name and Title of Authorized Officer or Agent

SUBSCRIBED AND SWORN BEFORE ME
ON THIS THE _____ DAY OF _____, 20___.

_____
NOTARY PUBLIC

My Commission Expires: _____, 20___.

SECTION 00300

BID

TO: MACON WATER AUTHORITY

FROM:_____
(Bidder's Name)

FOR: Amerson Water Treatment Plant Generator Fueling System Replacement

Submitted: _____, 20__

The undersigned Bidder, in compliance with your Invitation to Bid for the construction of this Project, having examined the Contract Documents and the site of the proposed Work, and being familiar with all of the conditions surrounding the construction of the proposed Project, including the availability of materials and labor, hereby proposes to construct the Project in accordance with the Contract Documents.

The Bidder proposes and agrees, if this Bid is accepted, to contract with the Macon Water Authority, in the form of Contract Agreement specified, and to furnish all necessary products, machinery, tools, apparatus, means of transportation and labor necessary to complete the construction of the Work in full and complete accordance with the reasonably intended requirements of the Contract Documents to the full and entire satisfaction of the Macon Water Authority with a definite understanding that no money will be allowed for extra work except as set forth in the Contract Documents, for the following prices:

Item No.	Quantity	Unit	Description	Unit Price	Total Price
1	**BASE BID: For furnishing all products, materials, and equipment and performing all labor necessary to complete the Amerson Water Treatment Plant Generator Fuel System Replacement; including all work shown on the drawings and documents for the total amount of:**				
a.	1	LS	a. Civil b. Structural c. Plumbing d. Electrical e. Controls f. Contingency		

Total Bid inclusive in the amount of

_____ Dollars

($_____) which sum hereinafter is called the "Base Bid".

The Bidder agrees hereby to commence Work under this Contract, with adequate personnel and equipment, on a date to be specified in a written order of the Engineer, and to fully complete all Work under this Contract within One Year (365) consecutive calendar days from and including said date specified in the written order of the Engineer. Bidder understands that time is of the essence for the work under this Contract, and timely completion of the Work is important for MWA's operations. Therefore, Bidder further agrees to pay as damages, the sum of $250.00 for each calendar day thereafter required to achieve substantial completion of all Work which Bidder agrees is a reasonable and good faith estimate of the damages that MWA would incur as a result in Bidder's delay in achieving substantial completion of the Work.

The Bidder declares an understanding that the quantities shown for unit price items are subject to either increase or decrease, and that should the quantities of any of the items of Work be increased, the Bidder proposes to do the additional Work at the unit prices stated herein; and should the quantities be decreased, the Bidder also understands that payment will be made on the basis of actual quantities at the unit price bid and will make no claim for additional costs or anticipated profits for any decrease in

quantities; and that actual quantities will be determined upon completion of Work, at which time adjustment will be made to the Contract Price by direct increase or decrease.

In case of discrepancies between the figures shown in the unit prices and the totals, the unit prices shall apply and the totals shall be corrected to agree with the unit prices. In case of discrepancies between written amounts and figures, written amounts shall take precedence over figures and the sum of all Bid extensions (of unit prices) plus lump sum items shall take precedence over the Bidder's represented BID TOTAL.

The Bidder furthermore agrees that, in the case of a failure to execute the Contract Agreement and Bonds within ten days after receipt of conformed Contract Documents for execution, the attached Bid Bond accompanying this Bid and the monies payable thereon shall be paid into the funds of the Macon Water Authority as damages for such failure.

Attached hereto is a Bid Bond for the sum of _____

_____ Dollars ($_____) according to the conditions of "Instructions to Bidders" and provisions thereof.

Bidder acknowledges receipt of the Following Addenda:

Addendum No. 1, dated:_____

Addendum No. 2, dated:_____

Addendum No. 3, dated:_____

Addendum No. 4, dated:_____

Remainder of Page Left Blank
[Signatures, attestations, and seal on following page]

BIDDER: _____

By: _____

Name: _____
(Print or Type)

Title: _____

Address: _____

_____

Phone: _____

Attest: _____

Name: _____
(Print or Type)

Title: _____

(SEAL)

Note: Attest for a corporation must be by the secretary of record for the corporation, as reflected in the records of the Georgia Secretary of State; for a partnership by another partner; for an individual by a notary.

Note: If the Bidder is a corporation, the Bid shall be signed by an officer of the corporation; if a partnership, it shall be signed by a partner. If signed by others, authority for signature shall be attached.

The full names and addresses of persons or parties interested in the foregoing Bid, as principals, are as follows:

{PRIVATE }Name	Address

END OF SECTION

SECTION 00410

BID BOND

STATE OF GEORGIA

COUNTY OF MACON-BIBB

KNOW ALL MEN BY THESE PRESENTS, that we, _____, as Principal, and _____, as Surety, are held and firmly bound unto the Owner, the Macon Water Authority, in the sum of _____ Dollars ($_____) lawful money of the United States of America, for the payment of which sum well and truly to be made, we bind ourselves, our heirs, personal representatives, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has submitted to the Owner a Bid for the **Amerson Water Treatment Plant Generator Fueling System Replacement**.

NOW THEREFORE, the conditions of this obligation are such that if the Bid be accepted, the Principal shall, within ten days after receipt of conformed Contract Documents, execute a Contract in accordance with the Bid upon the terms, conditions and prices set forth therein, and in the form and manner required by the Contract Documents and execute sufficient and satisfactory separate Performance and Payment Bonds payable to the Owner, each in an amount of 100 percent of the total Contract Price, in form satisfactory to the Owner , then this obligation shall be void; otherwise, it shall be and remain in full force and effect in law; and the Surety shall, upon failure of the Principal to comply with any or all of the foregoing requirements within the time specified above, immediately pay to the aforesaid Owner, upon demand, the amount hereof in good and lawful money of the United States of America, not as a penalty, but as delay damages.

This bond is given pursuant to and in accordance with the provisions of the Georgia Procurement Manual and Georgia Local Government Public Works Construction Law, O.C.G.A. § 36-91-1 et. seq. All the provisions of the law referring to this character of bond as set forth in said Manual or Code Sections or as may be hereinafter enacted and these are hereby made a part hereof to the same extent as if set out herein in full.

Remainder of Page Left Blank
[Signatures, attestations, and seals on following page]

IN WITNESS WHEREOF, the said Principal has hereunder affixed its signature and seal, and said Surety has hereunto caused to be affixed its corporate signature and seal, by its duly authorized officers, on this _____ day of _____, 20___.

CONTRACTOR - PRINCIPAL:_____

By:_____

Name:_____
(Print or Type)

Address:_____

_____

Phone:_____

Attest:_____

Name:_____
(Print or Type)

Title:_____

(SEAL)

Note: Attest for a corporation must be by the secretary of record for the corporation, as reflected in the records of the Georgia Secretary of State; for a partnership by another partner; for an individual by a notary.

SURETY:_____

By:_____

Name:_____
(Print or Type)

Title:_____

Phone:_____

Attest:_____

Name:_____
(Print or Type)

Title:_____

(SEAL)

Note: Surety companies executing bonds must appear on the Treasury Department's most current list (Circular 570 as amended) and be authorized to transact business in the state where the Project is located.

END OF SECTION

SECTION 00420

STATEMENT OF BIDDER'S QUALIFICATIONS

All questions must be answered and the data given must be clear and comprehensive. This statement must be notarized. If necessary, questions may be answered on separate attached sheets. The Bidder may submit any additional information desired. Attach all additional sheets to this statement.

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 description of type of work performed by your company:_____
_____

8. Have you ever failed to complete any work awarded to you? If so, where and why?
_____

9. Have you ever defaulted on a contract? If so, where and why?
_____

10. Attach a list of the most important projects recently completed by your company which are similar in scope to this Project. For each project, list its: official name and owner, a contact person's name, company and position, address and phone number; completion date; and contract amount.

11. Names, background and experience of the principal members of your organization, including officers:_____
_____

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

Dated this _____ day of _____, 20___.

BIDDER:_____

By:_____

Title:_____

State of _____

County of _____

_____ being duly sworn deposes and says that he or she is _____ of _____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 _____, 20___.

Notary Public:_____

(SEAL)

My Commission Expires:_____
(Date)

END OF SECTION

SECTION 00421

STATEMENT OF EQUIPMENT

Show machinery and other equipment available to the Bidder for prosecuting the Work required by the Contract Documents. (To be filled in by Bidder and submitted with Bid.)

Available Machinery and Other Equipment Kind - Size - Capacity	Location	Ownership	Date Proposed To Be Placed On Work

The above is a true statement of the equipment available to the undersigned Bidder for prosecuting the Work required by the Contract Documents. Where it is shown that the equipment is not owned by the Bidder, arrangements have been made with the owners to furnish the equipment.

Signed:_____

Name:_____

Title:_____

END OF SECTION

SECTION 00422

CORPORATE CERTIFICATE

I, _____, certify that I am the Secretary of the Corporation named as Bidder in the foregoing Bid; that _____, who signed said Bid on behalf of the Bidder was then _____ of said Corporation; that said Bid was duly signed for and on behalf of said Corporation by authority of its Board of Directors, and is within the scope of its corporate powers; that said Corporation is organized under the laws of the State of _____.

This _____ day of _____, 20___.

(Corporate Secretary) _____

(SEAL)

END OF SECTION

SECTION 00423

STATEMENT OF DISADVANTAGED FIRM UTILIZATION

The Bidder shall list all disadvantaged firms, as are defined in the Instructions to Bidders, providing subcontracting services, furnishing products or materials, etc., to be utilized in the performance of the work. This list shall be submitted in the following format:

Subcontractor (Name & Address)	**Nature of Work to be Contracted**	**Group (Local, DBE)**	**Anticipated Cost of Services ($ Value, %)**
			$
			%
			$
			%
			$
			%
			$
			%
			$
			%
			$
			%
			$
			%
			$
			%

NOTE: Any proposed changes from the above list shall be submitted in writing to the Macon Water Authority prior to initiation of the action, with the reason for the proposed deviation.

END OF SECTION

SECTION 00425

CONTRACTOR'S LICENSE CERTIFICATION

Contractor's Name:_____

Georgia Contractor's License Number:_____

Expiration Date of License:_____

I certify that the above information is true and correct and that the classification noted is applicable to the Bid for this Project.

Signed:_____

Printed:_____

Date:_____

END OF SECTION

CONTRACTOR'S CERTIFICATION OF AUTHORITY

(IF OUT OF STATE CONTRACTOR)

Contractor's Name:_____

Georgia Certificate of Authority Number:_____

Expiration Date of Certificate:_____

I certify that the above information is true and correct and that the classification noted is applicable to the Bid for this Project.

Signed:_____

Printed:_____

Date:_____

END OF SECTION

SECTION 00480

NON-COLLUSION AFFIDAVIT OF PRIME BIDDER

STATE OF GEORGIA COUNTY OF _____

_____, being first duly sworn, deposes and says that:

He or she is _____

(Owner, Partner, Officer, Representative or Agent)

of _____, the Bidder that has submitted the attached Bid;

He or she is fully informed respecting the preparation and contents of the attached Bid and of all pertinent circumstances respecting such Bid;

He or she understands that collusive bidding is a violation of State and Federal law and can result in fines, prison sentences, and civil damages awards;

Such Bid is genuine and is not a collusive or sham Bid;

Neither the said Bidder nor any of its officers, partners, owners, agents, representatives, employees or parties in interest, including this Affiant, has in any way colluded, conspired, connived or agreed, directly or indirectly with any other Bidder, firm or person to submit a collusive or sham Bid in connection with the Contract for which the attached Bid has been submitted or to refrain from bidding in connection with such Contract, or has in any manner, directly or indirectly, sought by agreement or collusion or communication or conference with any other Bidder, firm or person to fix the price or prices in the attached Bid or of any other Bidder, or to fix any overhead, profit or cost element of the Bid price or the Bid price of any other Bidder, or to secure through any collusion, conspiracy, connivance or unlawful agreement any advantage against the Owner, the Macon Water Authority, or any person interested in the proposed Contract; and

The price or prices quoted in the attached Bid are fair and proper and are not tainted by any collusion, conspiracy, connivance or unlawful agreement on the part of the Bidder or any of its agents, representatives, owners, employees, or parties in interest, including this Affiant. Affiant agrees to abide by all conditions of this Bid, and certifies that he or she is authorized to sign this Bid for the Bidder.

(Signed) _____

(Title) _____

Subscribed and Sworn to before me this _____ day of _____, 20___.

_____ My Commission Expires:_____

(Notary Public)
(SEAL)

Note: If the Bidder is a partnership, all of the partners and any officer, agent or other person who may have represented or acted for the partnership shall also make the foregoing oath. If the Bidder is a corporation, all officers, agents, or other persons who may have acted for or represented the corporation shall also make the oath.

END OF SECTION

SECTION 00500

CONTRACT AGREEMENT

AGREEMENT BETWEEN CONTRACTOR AND OWNER

THIS AGREEMENT is made and entered into on the __ day of _____ in the year Two Thousand and _____ (20___) by and between _____, hereinafter referred to as the "Contractor", and THE MACON WATER AUTHORITY, hereinafter (the "Owner") (collectively, "the Parties").

WITNESSETH, that the Contractor and the Owner, for the consideration hereinafter named, agree as follows:

1. SCOPE OF WORK. - That the Contractor will furnish all products, tools, construction equipment, materials, skill and labor of every description necessary to carry out and to complete in a good, firm, substantial workman like manner perform the Amerson Water Treatment Plant Generator Fueling System Replacement project and will complete the Work in strict conformity with the Drawings and the Specifications (Divisions 01 through 46, inclusive, together with the foregoing Bid made by the Contractor, the Invitation to Bid, Instructions to Bidders, General and Supplementary Conditions, Special Conditions, Performance and Payment Bonds and all Addenda hereto incorporated (if applicable) which form essential parts of this Contract Agreement, as if fully contained herein, the same collectively referred to as the "Contract Documents."

2. TIME OF COMPLETION.-The Contractor shall commence the Work to be performed under this Contract Agreement on a date to be specified in a written Notice to Proceed and shall achieve substantial completion of all Work required by the Contract Documents within 1 year (365) consecutive calendar days (the "Contract Time"). Time is of the essence and is an essential element of this Contract, and the Contractor shall pay to the Owner, not as a penalty, but as damages, the sum of two hundred Dollars ($250.00) for each calendar day for which there is an unexcused delay in achieving substantial completion of the Work within the time limit set forth herein. These damages are not established as a penalty but are reasonably calculated in good faith and agreed upon in advance by the Owner and the Contractor due to the uncertainty and impossibility of determining the actual and consequential damages that will be incurred by the Owner and the general public of Macon-Bibb County, Georgia as a result of the failure on the part of the Contractor to achieve substantial completion of the Work on time. Such damages referred to herein are intended to be and are cumulative and shall be in addition to every other remedy now or hereafter enforceable at law, in equity, by statute, or under the Contract Documents.

3. THE CONTRACT PRICE.-The Owner shall pay to the Contractor for the faithful performance of the Contract Agreement, subject to additions and deductions as provided for in the Contract Documents, in current funds a sum of _____ Dollars ($_____.00) (the "Contract Price") which sum shall also pay for loss or damage arising out of the nature of the Work aforesaid, or from the action of the elements, or from unforeseen obstructions or difficulties encountered in the prosecution of the Work, and for all expenses incurred by, or in consequence of the Work, its suspension or discontinuance and for well

and faithfully completing the Work and the whole thereof, as herein provided, and for replacing defective Work or products for a period of one year after completion.

4. PROGRESS PAYMENTS The Owner shall make progress payments on account of the Contract Price as follows: On or about the 20th day of each month, ninety-five percent (95%) of the value, based on the contract prices, of labor and materials incorporated in the Work and of materials suitably stored at the site thereof up to the twenty-fifth day of the month preceding, as estimated by the Engineer, less the aggregate of previous payments. Application for Payment must be made on the standard Owner's form to be provided by the Owner to the Contractor. No form of collateral in lieu of cash will be acceptable as retainage. At the discretion of the Owner, the retainage of each Subcontractor may be released separately as each Subcontractor completes its work. An application for release of a Subcontractor's retainage shall bear the certificates of the Subcontractor, the Contractor, and the Engineer that the Subcontractor's work has been fully performed and that the sum for which payment is requested is due by the Contractor to the Subcontractor. Checks releasing a Subcontractor's retainage shall be made payable to the Contractor, the Contractor's surety, and the Subcontractor, and shall be mailed to the Contractor's surety. This Article does not create any contractual relationship between the Owner and the Subcontractor or any duty of the Owner to any Subcontractor. Payments pursuant to this Article shall in no way diminish, change, alter or affect the rights of the Owner under the Contract Documents.

5. FINAL PAYMENT.-(a)-Final payment including retainage, shall be due 30 days after the date of notice from the Owner of the final acceptance of the Work, provided that all other requirements of the Contract Documents shall have been met in full. Final payment shall be made by a check payable jointly to the Contractor and surety and shall be mailed to the surety.

(b)-Upon receipt of written notice from the Contractor pursuant to Article 30 of the General Conditions that the Work is ready for final inspection, the Engineer shall promptly make such inspection, and when he/she finds the Work complies with the Contract Documents, and when the Contract shall have been fully performed the Engineer shall promptly issue a final certificate of recommendation to the Owner, over the Engineer's signature, stating that the Work required by the Contract Documents has been completed under the terms and conditions thereof, and that the entire balance of the Contract Price found to be due to the Contractor and noted in said final certificate, is due and payable.

(c)-Before issuance of a final certificate of recommendation, the Contractor shall submit evidence satisfactory to the Engineer that all payrolls, material bills, and all other indebtedness in connection with the Work has been paid in full.

(d)-If full completion of the Work is materially delayed through no fault of the Contractor, and the Engineer so certifies same, the Owner shall, upon certificate of the Engineer, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed. Such payment shall be made under the terms and conditions of the General Conditions governing final payment, except that it shall not constitute a waiver of claims.

6. NO ASSIGNMENT.- This Contract and the proceeds of this Contract may not be assigned nor may the performance thereunder be assigned, except with the prior written consent of

the Owner.

7. BONDS. – The Contractor shall furnish both a performance bond and a payment bond and shall pay the premium thereon. The performance bond shall guarantee the full performance of the Contract.

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[Signatures, attestations, and seals on following page]

IN WITNESS WHEREOF, the parties hereto have executed this Contract Agreement under their respective seals on the day and date first above written in six counterparts, each of which shall, without proof or accounting for the other counterparts, be deemed an original Contract.

Signed, sealed, and delivered
in the presence of:

THE MACON WATER AUTHORITY

1._____ By:_____
Gary Bechtel, Chairman

2._____

Attest:_____
Michel Wanna, Interim Executive Director & President

(Official Seal)

Signed, sealed, and delivered
in the presence of:

CONTRACTOR:_____

1._____ By: (Signed) _____

2._____ (Printed) _____

Attest: (Signed) _____

(Printed) _____
(Secretary)

(Corporate Seal)

APPROVED AS TO FORM

_____

_____
(Printed Name)
Attorney for the Macon Water Authority

END OF SECTION

SECTION 00550

PRE-AWARD OATH

STATE OF GEORGIA
COUNTY OF _____

In accordance with O.C.G.A. 36-91-21(e), we, the undersigned of _____

being first duly sworn, depose and say that:

We have not directly or indirectly violated O.C.G.A. 36-91-21(d), and more specifically, we have not

- prevented or attempted to prevent competition in such bidding or proposals by any means whatever,
- prevented or endeavored to prevent anyone from making a bid or proposal thereof by any means whatever, nor
- caused or induced another to withdraw a bid or proposal for the work.

We, the undersigned, to the best of our knowledge, affirm that no other officers, agents or other persons acted for or represented the Contractor in the bidding for and procurement of this Contract.

Signature	Printed Name	Title	Date

_____ My Commission Expires: _____
(Notary Public)

(SEAL)

END OF SECTION

SECTION 00600

PERFORMANCE BOND

Bond No. _____

KNOW ALL MEN BY THESE PRESENTS:

That

_____

(Legal title and address of the Contractor)

as Principal (hereinafter referred to as "Contractor"), and _____

_____

(Legal title and address of Surety)

as Surety (hereinafter referred to as "Surety"), do hereby acknowledge ourselves indebted and firmly bound and held unto the Macon Water Authority (the "Owner") in the amount of _____ Dollars ($_____.00) to which payment Contractor and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the above bound Principal has entered into a Contract with Owner bearing date of _____ for construction of _____ Project in accordance with Contract Documents prepared by Owner all of which said Contract Documents are incorporated herein by reference and made a part hereof, and are hereinafter collectively referred to as the "Contract."

NOW THEREFORE, THE CONDITION OF THIS OBLIGATION is such that, if the Contractor shall promptly and faithfully perform and comply with the terms and conditions of said Contract; and shall indemnify and save harmless the Owner against and from all costs, expenses, damages, injury or loss to which said Owner may be subjected by reason of any wrongdoing, including patent infringement, misconduct, want of care or skill, default or failure of performance on the part of said Principal, his agents, subcontractors of employees, in the execution or performance of said Contract, and shall fully reimburse and repay the said Owner any and all outlay, costs, and expense which it may incur in making good any such default and shall guarantee all products and workmanship against defects, as provided in the Contract Documents which comprise and constitute the Contract, for a period of one year and shall replace all defective work and products for such period of one year then this obligation shall be null and void; otherwise it shall remain in full force and effect.

1. The said Surety to this bond, for value received, hereby stipulates and agrees that no change or changes, extension of time or extensions of time, alteration or alterations or addition or additions to the terms of the Contract or to the Work to be performed thereunder, or the

specifications or drawings accompanying same shall in any wise affect its obligations on this bond, and it does hereby waive notice of any such change or changes, extension of time or extensions of time, alteration or alterations or addition or additions to the terms of the Contract or to the Work or to the specifications or drawings.

2. It is expressly agreed that this bond shall be amended automatically and immediately, without formal and separate amendments hereto, upon amendment to the Contract not increasing the Contract Price more than 20 percent in excess of the original Contract Price, so as to bind the Principal and Surety to the full and faithful performance of the Contract as so amended. The term "amendment" shall include any alteration, addition, extension, or modification of any character whatsoever.

3. If pursuant to the Contract Documents the Contractor shall be declared in default by the Owner under the aforesaid Contract, the Owner shall take possession of the Project and finish the Work by whatever method the Owner may deem expedient, in accordance with Article 7 of the General Conditions.

4. Supplementary to and in addition to the foregoing, whenever the Owner shall notify the Surety that the Owner has notice that the Contractor has failed to pay any subcontractor, materialman, or laborer for labor or materials certified by the Contractor as having been paid for by the Contractor, the Surety shall, within thirty (30) days of receipt of such notice, cause to be paid any unpaid amount for such labor or materials.

5. It is expressly agreed by the Principal and the Surety that the Owner, if it desires to do so, is at liberty to make inquiries at any time of subcontractors, laborers, materialmen, or other parties concerning the status of payments for labor, materials, or services furnished in the prosecution of the work.

6. The Surety agrees that other than as is provided in this bond it may not demand of the Owner that the Owner shall (a) perform any thing or act, (b) give any notice, (c) furnish any clerical assistance, (d) render any service, (e) furnish any papers or documents, or (f) take any action of any nature or description which is not required of the Owner to be done under the Contract Documents.

7. No right of action shall accrue on this bond to or for the use of any person or corporation other than the Owner named herein or the legal successors of the Owner.

This bond is given pursuant to and in accordance with the provisions of the Georgia Procurement Manual and of Title 36, Chapter 91 of the Official Code of Georgia Annotated, as may be amended or modified from time to time, and all the provisions of the law referring to this character of bond as set forth in said sections or as may be hereafter enacted or amended and these are hereby made a part hereof to the same extent as if set out in full herein.

Remainder of Page Left Blank

[Signatures, attestations, and seals on following Page]

Signed and sealed this _____ day of _____, 20___.

Signed, sealed and delivered
in the presence of:

_____
(Insert Name of Contractor)

By: (Signed)_____

1. _____

(Printed)_____

2. _____ Attest :(Signed) _____

(Printed)_____

(CORPORATE SEAL)

Signed, sealed and delivered
in the presence of:

_____
(Insert Name of Surety)

By: (Signed)_____

1. _____

(Printed)_____

2. _____ Attest :(Signed) _____

(Printed)_____

(CORPORATE SEAL)

APPROVED AS TO FORM:

_____

_____
(Printed Name)
Attorney for the Macon Water Authority

END OF SECTION

PLACE SURETY FOR PERFORMANCE BOND HERE

SECTION 00610

PAYMENT BOND

Bond No. _____

KNOW ALL MEN BY THESE PRESENTS:

That

_____

(Legal title and address of the Contractor)

as Principal (hereinafter referred to as "Contractor"), and _____

_____

(Legal title and address of Surety)

as Surety (hereinafter referred to as "Surety"), do hereby acknowledge ourselves indebted and firmly bound and held unto the Macon Water Authority (the "Owner"), in the amount of _____ Dollars ($_____.00) to which payment Contractor and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the above bounden Principal has entered into a Contract with Owner bearing date of _____ for construction of _____ Project in accordance with the Contract Documents prepared by Owner, all of which said Contract Documents are incorporated herein by reference and made a part hereof, and are hereinafter collectively referred to as the "Contract."

NOW THEREFORE, THE CONDITION OF THIS OBLIGATION is such that if the Contractor shall promptly make payment to all claimants as hereinafter defined for all labor and material supplied in the prosecution of the work provided for in said Contract Documents, then this obligation shall be void; otherwise it shall remain in full force and effect, subject, however, to the following conditions:

1. The said Surety to this bond, for value received, hereby stipulates and agrees that no change or changes, extension of time or extensions of time, alteration or alterations or addition or additions to the terms of the Contract or to the Work to be performed thereunder, or the specifications or drawings accompanying same shall in any wise affect its obligations on this bond, and it does hereby waive notice of any such change or changes, extension of time or extensions of time, alteration or alterations or addition or additions to the terms of the Contract or to the work or to the specifications or drawings.

2. It is expressly agreed that this bond shall be amended automatically and immediately, without formal and separate amendments hereto, upon amendment to the Contract Documents not increasing the Contract Price more than 20 percent in excess of the original Contract Price, so as to bind the Contractor and Surety to the full and faithful performance of the Contract as so amended. The term "amendment" shall include any alteration, addition, extension, or modification of any character whatsoever.

3. A Claimant is defined as any subcontractor and any person supplying labor, materials, machinery, or equipment in the prosecution of the Work provided for in said Contract.

4. Every person or entity entitled to the protection hereunder and that has not been paid in full for labor or materials furnished in the prosecution of the Work referred to in said bond before the expiration of a period of ninety days after the day on which the last of the labor was done or performed by them, or materials or equipment or machinery was furnished or supplied by them for which such claim is made, or when they have completed its subcontract for which claim is made, shall have the right to sue on such payment bond for the amount, or the balance thereof, unpaid at the time of the commencement of such action and to prosecute such action to final execution and judgment for the sum or sums due them; provided, however, that any person or entity having direct contractual relationship with a subcontractor, but no contractual relationship, express or implied, with the Contractor, shall have the right of action upon this bond upon giving written notice to said Contractor within ninety days from the day on which such person or entity did or performed the last of the labor, or furnished the last of the materials or machinery or equipment for which such claim is made, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were furnished or supplied or for whom the labor was performed or done; provided further that nothing contained herein shall limit the right of action to said 90-day period. Notice may be served by depositing a notice, registered mail, postage prepaid, duly addressed to the Contractor at any place the Contractor maintains an office or conducts business, including any post office or branch post office or any letter box under the control of the United States Postal Service, or notice may be served in any manner in which the sheriffs of Georgia are authorized by law to serve summons or process.

5. Every suit instituted under this section shall be brought in the name of the claimant without the Owner being made a party thereto. The official who has the custody of said bond is authorized and directed to furnish, to any person or entity making application therefor who submits an affidavit that it has supplied labor or material for such work and payment therefor has not been made, or that it is being sued on any such bond, a copy of such bond and the Contract for which it was given, certified by the official who has custody of said bond; this copy shall be primary evidence of this bond and Contract and shall be admitted as evidence without further proof. Applicants shall pay for such certified copies and such certified statements such as fees as the official fixes to cover the cost of preparation thereof, but in no case shall the fee exceed the fees which the clerks of the superior courts are permitted to charge for similar copies.

6. No action can be instituted on this bond after one year from the date of the final acceptance of the Owner.

This bond is given pursuant to and in accordance with the provisions of the Georgia Procurement Manual and of Title 36, Chapter 91 of the Official Code of Georgia Annotated, as may be amended or modified from time to time, and all the provisions of the law referring to this character of bond as set forth in said sections or as may be hereafter enacted or amended and these are hereby made a part hereof to the same extent as if set out in full herein.

[Signatures, attestations, and seals on following Page]

Signed and sealed this _____day of _____, 20___

Signed, sealed and delivered
in the presence of:

_____
(Insert Name of Contractor)

By: (Signed)_____

(Printed)_____

1. _____

2. _____ Attest: (Signed) _____

(Printed)_____

(CORPORATE SEAL)

Signed, sealed and delivered
in the presence of:

_____
(Insert Name of Surety)

By: (Signed)_____

(Printed)_____

1. _____

2. _____ Attest: (Signed) _____

(Printed)_____

(CORPORATE SEAL)

APPROVED AS TO FORM:

_____

_____
(Printed Name)
Attorney for the Macon Water Authority

END OF SECTION

PLACE SURETY FOR PAYMENT BOND HERE

SECTION 00700
GENERAL CONDITIONS

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Article 1. - Notice of Award of Contract. Within sixty (60) days after receipt of Bids, the Owner will notify the successful Bidder of the award of the Contract. Should the Owner require additional time to award a Contract, the time may be extended by the mutual agreement between the Owner and the successful Bidder. If an award of Contract has not been made within 60 days from the Bid date or within the extension mutually agreed upon, the Bidder may withdraw the Bid without further liability on the part of either party.

Article 2. - Execution of Contract Documents. (a) *Time Limits.*—Within fifteen (15) days of notification of Award of Contract, the Owner will furnish the Contractor with conformed copies of Contract Documents for execution by the Contractor and the surety. The Contractor and its surety must execute the bond forms contained in the conformed Contract Documents without any changes. Within ten (10) days after receipt, the Contractor shall return all the Contract Documents properly executed by the Contractor and the surety. Attached to each set of Contract Documents shall be original powers-of-attorney for the person executing the Bonds for the surety and certificates, endorsements, and declarations of insurance for the required insurance coverages, all as required by Article 3 and Article 4. Within thirty (30) days after receipt of the conformed Contract Documents properly completed and executed by the Contractor and the surety together with the power-of-attorney, and the proper certificates, endorsements and declarations of insurance, the Owner will complete the execution of the Contract Documents. Distribution of the completed Documents will be made upon execution by the Owner.

(b) *Failure of Contractor or Surety to Execute Documents.*—Should the Contractor or the surety fail to properly execute the Documents within the specified time the Owner will have the right to proceed on the Bid Bond accompanying the Bid.

(c) *Failure of Owner to Execute Documents.*—If the Owner fails to execute the Documents within the time limit specified, the Contractor will have the right to withdraw the Bid without penalty. In such event the Owner will have no liability to the Contractor under these Documents or otherwise.

(d) *Extensions of Time.*—Should either party require an extension of any of the time limits stated above, this shall be done only by mutual agreement between both parties.

(e) Changes to Documents.-- Insertion, addition, alteration, modification, revision, or deletion of any text, verbiage, provision, statement, term, condition, or other component of the Contract Documents, whether textual, numerical, or pictorial, is prohibited and no such unilateral change to the Contract Documents shall be binding. In the event the Owner discovers any attempt by the Contractor to modify the Contract Documents by insertion, addition, alteration, revision, or deletion

of any text, verbiage, provision, statement, term, condition, or other portion of the Contract Documents without the written assent and approval of the Owner, the Owner shall have grounds to withdraw the contract award, terminate all proceedings related to contractual relationship with the Contractor for the subject Project, and to award the contract to the next bidder which met the requirements of the invitation to bid.

(f) *Incorporation of Prior Agreements*. — All agreements between the parties are incorporated into this Agreement. In the event of any conflict or inconsistency between this Agreement and any provisions, terms or conditions of any other prior agreement, the provisions, terms and conditions of this Agreement shall supersede, control and prevail over the conflicting or inconsistent provisions of the prior agreement.

Article 3. - Contract Security.—The Contractor shall furnish separate Performance and Payment Bonds each in a sum equal to the amount of the Contract Price on the Owner's forms. Such Bonds shall be executed by the Contractor and a bonding company licensed to transact such business in Georgia and named on the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds" as published in the Treasury Department Circular Number 570. The expense of these Bonds shall be borne by the Contractor.

If at any time a surety on any such Bond is declared bankrupt, becomes insolvent, loses its right to do business in Georgia or is removed from the list of Surety Companies accepted on Federal Bonds, the Contractor shall, within ten (10) days after notice from the Owner to do so, substitute acceptable Bonds in such form and sum and signed by such other surety as may be satisfactory to the Owner. The premium on such substitute Bonds shall be paid by the Contractor. No further progress payments shall be deemed due, nor shall any be made, until the new surety furnishes acceptable Bonds to the Owner. The person executing the substitute Bonds on behalf of the surety shall submit with the Bonds valid powers-of-attorney certified to by an official of said surety company.

Article 4. - Insurance—Proof of insurance coverage and furnishing of insurance policies acceptable to the Owner shall be as set forth in this Article.

(a) *Policies, Certificates, Limits and Disposition of Documents.*—The Contractor shall obtain at his expense insurance with limits as shown hereinbelow, unless the Contractor desires to broaden the limits and obtain more protection. The Contractor shall provide the Owner with all insurance documentation and evidence of insurance as required herein, and updated certificates of all insurance required herein must be provided to the Owner at least quarterly until Final Payment.

(1) WORKER'S COMPENSATION AND EMPLOYER'S LIABILITY INSURANCE.—The Contractor shall procure and maintain Worker's Compensation and Employers Liability Insurance for all of his employees to be engaged in Work on the project under this contract, and in case any such Work is sublet, the Contractor shall require the Subcontractor similarly to provide Worker's Compensation and Employer's Liability Insurance for all of the latter's employees to be

engaged in such work unless such employees are covered by the protection afforded by the Contractor's insurance. Worker's Compensation insurance policies shall include GEORGIA under Section 3A and shall include Other States coverage and Voluntary Compensation.

Worker's Compensation Limits:	Statutory
Employers Liability Limits:	
Each Accident	$1,000,000
Disease - Policy Limit	$1,000,000
Disease - Each Employee	$1,000,000

Contractor waives all rights against Owner and its agents, officers, directors, and employees for recovery of damages to the extent these damages are covered by the worker's compensation and employer's liability or commercial umbrella liability insurance obtained by Contractor pursuant to Article 4 of this agreement. The Waiver of Our right To Recover From Others Endorsement, ISO Form SC 00 03 13 shall be attached to the policy showing the Owner listed in the Schedule.

Disposition: Certificate(s) of insurance showing the required coverage and copy of declaration page must be returned to the Owner with properly executed Contract Documents. If requested by the Owner, Contractor shall also provide a certified copy of the policy(ies) required by Article 4(a)(1).

(2) COMMERCIAL GENERAL AND UMBRELLA LIABILITY INSURANCE.—The Contractor shall procure and shall maintain commercial general liability (CGL) and if necessary, commercial umbrella insurance with a limit of not less than $2,000,000 each occurrence, as shall protect him and any Subcontractor performing Work covered by this Contract from claims for damages for bodily injury, including accidental death, as well as from claims for property damages, which may arise from operations under the Contract Agreement, whether such operations are by himself or by any Subcontractor or by anyone directly or indirectly employed by either of them.

CGL insurance shall be written on ISO occurrence form CG 00 01 10 93 (or substitute form providing equivalent coverage) and shall cover liability arising from premises, operations, independent contractors, products-completed operations, personal injury and advertising injury, and liability assumed under an insured contract (including the tort liability of another assumed in a business contract). If such CGL insurance contains a general aggregate limit, it shall apply separately to this project, (Per Project Aggregate Endorsement). Each policy shall be indorsed with ISO Form CG 25 03 11 85 or equivalent form with wording satisfactory to Owner.

The Owner shall be included as an additional insured under the CGL, using ISO additional insured endorsement CG 20 33 or a substitute providing equivalent coverage, and under the commercial umbrella, if any. This insurance shall apply as primary insurance with respect to any

other insurance or self-insurance programs afforded to the Owner.

There shall be no endorsement or modification of the CGL limiting the scope of coverage for liability arising from explosion, collapse, or underground property damage.

Contractor waives all rights against the Owner and its agents, officers, directors, and employees for recovery of damages to the extent these damages are covered by commercial general liability or commercial umbrella liability insurance maintained pursuant to Article 4 of this agreement.

Disposition: Certificate(s) of insurance showing the required coverage and copy of declaration page must be returned to the Owner with properly executed Contract Documents. If requested by the Owner, Contractor shall also provide a certified copy of the policy(ies) required by Article 4(a)(2).

(3) BUSINESS AUTO AND UMBRELLA LIABILITY INSURANCE.—The Contractor shall procure and shall maintain business automobile liability, and if necessary, commercial umbrella liability insurance with a limit of not less than $2,000,000 each occurrence.

Such insurance shall cover liability arising out of any auto (including owned, hired, and non-owned autos).

Business auto coverage shall be written on ISO form CA 00 01, CA 00 05, CA 00 12, CA 00 20 or a substitute form providing equivalent liability coverage. If necessary, the policy shall be endorsed to provide contractual liability coverage equivalent to that provided in the 1990 and later editions of ISO form CA 00 01. This insurance shall apply as primary insurance with respect to any other insurance or self-insurance programs afforded to the Owner. Owner is named as additional insured.

Contractor waives all rights against the Owner and its agents, officers, directors, and employees for recovery of damages to the extent these damages are covered by the business auto liability or commercial umbrella liability insurance obtained by Contractor pursuant to Article 4 of this agreement or under any applicable auto coverage.

Disposition: Certificate(s) of insurance showing the required coverage and copy of declaration page must be returned to the Owner with properly executed Contract Documents. If requested by the Owner, Contractor shall also provide a certified copy of the policy(ies) required by Article 4(a)(2).

Cross-Liability Coverage.—If Contractor's liability policies do not provide the standard ISO separation of insureds provision, or a substantially similar clause, they shall be endorsed to

provide cross-liability coverage.

(3) By proper endorsement, the policy must name

MACON WATER AUTHORITY
790 Second Street
P. O. Box 108
Macon, GA 31202

as an additional insured and shall provide for not less than thirty (30) days prior written notice before cancellation or any material change in the policy, except for non-payment of premium which shall require ten (10) days prior written notice of cancellation, to the Owner.

(4) Commercial Umbrella/Excess Policy:

Contractor shall procure a commercial umbrella or excess policy with a limit of no less than $5,000,000. Coverage must follow form over underlying policies including GL, Auto and Employer's Liability insurance.

(5) MATERIALS AND EQUIPMENT FLOATER. - The Contractor shall procure, and shall maintain during the performance of the Contract Agreement, Materials and Equipment Floater (May be labeled as *Equipment Floater* or Installation Floater or Builders Risk) Insurance to protect the interests of the Owner, the Contractor and Subcontractors against loss by vandalism, malicious mischief, and all hazards included in a standard All Risk Endorsement. The amount of insurance shall at all times equal or exceed the amount of the materials in the Contract + *$30k for Owner furnished materials.* The policies shall be in the names of the Owner and the Contractor.

Disposition: Original policy must be returned to the Owner with properly executed Contract Documents. Owner may accept with returned, executed Contract Documents in lieu of an original policy, an insurance binder evidencing the policy coverage, but Contractor shall not be relieved of the obligation to furnish the actual policy.

Endorsement on Materials and Equipment Floater Policy.—There shall be attached to and made a part of the insurance policy for MATERIALS AND EQUIPMENT FLOATER an endorsement of the insurance company in accordance with the specimen shown in preceding Paragraph (a)(3).

Article 5. - Hazards and Indemnification. (a) *Hazards.* —The Contractor shall be responsible from the time of his execution of the Contract Documents or from the time of the beginning of the first work, whichever shall be earlier, for all injury or damage of any kind resulting from the Work to persons or property regardless of who may be the owner of the property. It is the intention of this paragraph to shift the full and complete risk of all such loss to the Contractor for the period of construction and until notice from the Owner of the final acceptance of the Work is made in

accordance with Article 30, regardless of whether or not any particular hazard shall be insured against.

(b) *Indemnification.*—In addition to the liability imposed upon the Contractor on account of bodily injury (including death) or property damage, which liability is not impaired or otherwise affected hereby, the Contractor assumes the obligation to save the Owner harmless and to indemnify and defend the Owner, the Engineer and their agents and employees from and against all claims, damages, losses and expenses including claims consultant's and attorney's fees arising out of or through bodily injury, sickness, disease or death of any person or persons or damage to property (regardless of who may be the owner of the property) including the loss of use resulting therefrom arising out of or suffered through any act or omission of the Contractor or any Subcontractor, or anyone either

(1) directly or indirectly employed by the Contractor, or
(2) under the supervision of the Contractor or any subcontractor in the prosecution of the Work required by the Contract Documents.

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, this indemnification obligation shall not be limited in any way by any limitation on the amount or type of damages, compensation or benefits payable by or for the Contractor or any Subcontractor under workers' compensation acts, disability benefit acts or other employee benefits acts.

(c) *Sole Negligence Exception.* —The Contractor shall not be liable or responsible for loss or damage, and the indemnity obligation set forth above will not apply if the incident from which the loss or damage arose was the result of the sole negligence or sole cause of the Owner, the Engineer, or their agents, servants and employees.

Article 6. - Notice to Proceed. The Notice to Proceed will be issued, following the pre-construction conference, within thirty (30) days of the execution of the Contract Agreement by the Owner. The time may be extended by mutual agreement between the Owner and the Contractor. If the Notice to Proceed has not been issued within the thirty (30) day period or within the period mutually agreed upon, the Contractor may terminate the Contract Agreement without further liability on the part of either party.

Within ten (10) days of receiving the Notice to Proceed, the Contractor must initiate on-site construction activity. If on-site construction activity is not initiated within this time period, the Owner may begin proceedings for Termination of Work for Default.

Article 7. - Termination of Work for Default. —(a) *Definition.*—The Work may be terminated for default if any one of the following events or circumstances occurs:

(1) The Contractor is adjudged bankrupt or becomes insolvent;

(2) The Contractor makes a general assignment for the benefit of creditors;

(3) A trustee or receiver is appointed for the Contractor or for any of Contractor's property;

(4) The Contractor files a petition to take advantage of any debtor's act, or to reorganize under the bankruptcy or applicable laws;

(5) The Contractor fails to supply sufficient skilled workmen, materials or equipment;

(6) The Contractor fails to make satisfactory progress toward timely completion of the Work;

(7) The Contractor fails to make prompt payments to Subcontractors or material suppliers for labor, materials or equipment;

(8) The Contractor disregards laws, ordinances, rules, regulations, or orders of any public body having jurisdiction of the Work;

(9) The Contractor fails to comply with directives of the Engineer; or,

(10) The Contractor otherwise violates any provision of the Contract Documents.

(b) *Grounds for Issuance of Notice of Declaration of Default.* —It shall be a sufficient ground for the issuance of a notice of declaration of default that the Contractor has been unfaithful or delinquent in the performance of the Contract or any part of it in any respect. The Engineer does not have authority to declare the Contractor in default.

(c) *Termination of Services and Possession of the Project.* —The Owner may, without prejudice to any other right or remedy and after giving the Contractor and surety written notice ten (10) days in advance, terminate the services of the Contractor and take possession of the Project, the Work and of all products thereon owned by the Contractor, and finish the Work by whatever method the Owner 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 and all Work, including compensation for additional professional services, such excess shall be paid to the Contractor. If such costs exceed such unpaid balance, the Contractor or surety shall pay the difference to the Owner. Such costs incurred by the Owner will be determined by the Engineer and incorporated in a Change Order.

(d) *Effect of Termination.* —Where the Contractor's services have been so terminated by the Owner, said termination will 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.

Article 8. - Termination for Convenience of Owner. (a) *General.* —If, for any reason other than those provided for under Article 7, the Owner elects to discontinue, in whole or in part, the Work under this Contract, the Owner may, ten (10) days after delivery of a written notice to the Contractor and the Engineer, terminate, in whole or in part, the Contractor's performance of the Work under this Contract. The notice of termination shall specify the extent to which performance of the Work under the Contract is terminated.

(b) *Entitlement to Payment.* —In the event of such termination by the Owner, the Contractor shall be entitled to payment for the Work properly performed up to the time of the termination and reimbursement for such actual costs as are reasonably incurred by the Contractor due to the termination and not otherwise compensated. The Contractor shall also be entitled to profit on the amounts payable to the Contractor, but such profit shall be limited to six (6%) percent of such amounts. The Contractor shall not be entitled to any payment, including any anticipated profit, on Work not performed, and the Contractor shall not be entitled to any compensation or recovery of damages for any other costs, losses, or damages of any nature.

Article 9. - Assignments. The Contractor shall not assign the whole or any part of this Contract or any monies due or to become due hereunder without prior written consent of the Owner.

Should the Owner consent, in writing, to Contractor's assigning of all or any part of any monies due, or to become due, under this Contract, the instrument of assignment shall contain a clause substantially to the effect that it is agreed that the right of any assignee in and to any monies due or to become due to the Contractor shall be subject to any set-offs then due to the Owner and to prior liens of all persons, firms, and corporations for services rendered or materials supplied for the performance of the Work called for under this Contract.

Article 10. - Subcontractors, Materialmen, Suppliers and Employees. —(a) *Submission of List*. -As soon as possible after notice of award of the Contract and in any event not later than the time fixed in the Contract for delivery of the executed Contract Documents to the Owner, the Contractor shall submit in writing to the Engineer a list of the names of Subcontractors that the Contractor will engage for the Work. The list of Subcontractors is not submitted for approval, but is for the purpose of establishing:

(1) What trades and portions of the Work are to be performed under subcontract; and,

(2) The names of the entities selected by the Contractor to perform work by subcontract, the aforesaid selection being a matter lying solely within the discretion of the Contractor.

The Contractor shall utilize the services of specialty Subcontractors on those parts of the Work which, under normal construction practices, are best performed by specialty Subcontractors and as may be required by the Engineer in the Engineer's sole discretion, at no additional cost to the Owner. If the Contractor desires to self-perform specialty Work, the Contractor shall submit a notice to the Owner accompanied by evidence that the Contractor's own organization has successfully performed the type of work, and the performance of the Work by specialty Subcontractors will result in materially increased costs or inordinate delays.

(b) *No Approval of Subcontractors*.—Neither the Owner nor the Engineer undertakes to pass upon or approve any Subcontractor.

(c) *Warranty of Contractor.*—The Contractor warrants that the Subcontractors selected by the Contractor are reputable, skilled, reliable, competent, qualified in the trade or field in which such Subcontractors are to perform Work on the Project, and that all Subcontractors are thoroughly familiar with applicable codes.

(d) *Certification on account of.*—The Engineer shall, upon written request, furnish to any Subcontractor, wherever practicable, evidence of the amounts certified as payable or paid on the Subcontractor's account. Furnishing any such evidence shall not establish any relationship between the Engineer and any Subcontractor.

(e) *Contractor Responsible for Acts and Omissions of Subcontractors, Materialmen, Suppliers and Employees*.—The Contractor agrees that it is as fully responsible for the acts and omissions of its Subcontractors, materialmen, suppliers, and employees (and of entities either directly or indirectly employed by any of them) as the Contractor is for the acts and omissions of entities directly employed or engaged by the Contractor. The failure of a Subcontractor, materialman, supplier, or employee to timely and properly perform any Work shall not be asserted by the Contractor as an excuse for any omission from, or noncompliance with, the requirements of the Contract Documents; nor shall the Contractor be entitled to an extension of the Contract Time because of any failure of a Subcontractor, materialman, supplier, or employee to timely perform the Work unless such failure was a direct result of some critical delay to the Subcontractor, materialman, supplier or employee of the kind and character described under Article 28 of the General Conditions for which the Contractor shall have requested and received an extension of time under the terms of Article 28 of the General Conditions. The subcontracting of work does not relieve the Contractor of the full responsibility for the execution of the Work and for compliance with all requirements of the Contract Documents. The Contractor may not assert negligence, inefficiency, insolvency, bankruptcy, or incompetence of any Subcontractor, materialman, supplier, or employee as excuse for any noncompliance with methods and material designated in the Contract

Documents. As to Subcontractors, materialmen, suppliers and employees of the Contractor, the doctrine that a principal is liable for acts and omissions of his agent shall be binding on the Contractor, and the Contractor may not reverse the aforesaid doctrine by serving as a conduit or agent for its Subcontractors, materialmen, suppliers and employees. Any provision in any Contract between the Contractor and any Subcontractor pursuant to which the Contractor is obliged to present to the Owner any claim of any Subcontractor shall be invalid, null and void.

(f) *No Contract Between Owner and Any Subcontractor, Materialman, Supplier, or Employee*.—Nothing contained in the Contract Documents shall create any contractual relationship between the Owner and any Subcontractor or between the Owner and any materialman, supplier or employee of the Contractor or its Subcontractors.

(g) *Relationship of Contractor and Subcontractors*.—The Contractor agrees to bind every Subcontractor to, and every Subcontractor agrees to be bound by, the terms of the Contract Documents, including the following provisions of this Article:

The Subcontractor agrees

(1) To be bound to the Contractor by the terms of the Contract Documents and to assume toward the Contractor all the obligations and responsibilities that the Contractor by the Contract Documents assumes toward the Owner.

(2) To submit to the Contractor applications for payment in such reasonable time as to enable the Contractor to apply for payment under Article 30 of the General Conditions.

(3) To make claims for extras, for extensions of time or for damages to the Contractor in the manner provided in the General Conditions for like claims by the Contractor upon the Owner.

The Contractor agrees

(1) To be bound to the Subcontractor by all the obligations that the Owner assumes to the Contractor under the Contract Documents.

(2) To pay the Subcontractor upon the payment of certificates issued under the schedule of values described in Article 24 of the General Conditions the amount allowed to the Contractor on account of the Subcontractor's work to the extent of the Subcontractor's interest therein; amounts retained by the Contractor from payments due to Subcontractors (expressed as a percentage) shall not exceed that being retained by the Owner.

(3) To pay the Subcontractor as required by the Contract Documents.

(4) To pay the Subcontractor on demand for its work or materials as far as executed and fixed in place, less the retained percentage, even though the Engineer fails to approve payment to the Contractor for any cause not the fault of the Subcontractor.

(5) To pay the Subcontractor a just share of any fire insurance money received by the Contractor.

(6) To make no demand for delay damages or penalty for delay in any sum in excess of such amount as may be specifically identified in the subcontract.

(7) That no claim for services rendered or materials furnished by the Contractor to the Subcontractor shall be valid unless written notice thereof is given by the Contractor to the Subcontractor during the first ten days of the calendar month following that in which the claim originated.

(8) To give the Subcontractor an opportunity to be present and to submit evidence in any dispute involving rights of the Subcontractor.

(b) *Owner Not Obligated to any Subcontractor*.—There is no obligation on the part of the Owner to pay, or to see to the payment of, any sums to any (1) Subcontractor, (2) materialman, (3) supplier, (4) laborer, (5) employee, or (6) claimant as defined in the Payment Bond.

(c) *Incorporation of Terms in Subcontracts*.—The Contractor agrees that failure on its part to incorporate in all subcontracts an express provision in accordance with this Article shall be deemed to be and is a breach of an essential covenant, and that, in the event of such breach, that Contractor shall, within five (5) days after demand of the Owner, furnish proof in writing that the deficiency has been remedied and that (1) the Contractor may not maintain that it is beyond the Contractor's right or ability to require performance of terms of the Contract Documents by a Subcontractor and (2) no Subcontractor may maintain that it has not assumed toward the Contractor all the obligations and responsibilities that the Contractor has assumed toward the Owner.

Article 11 - Engineer.—(a) *Supervision.*—The Engineer shall have general supervision and direction of the Work except in respect to safety and except as qualified by Articles 27 and 36 of the General Conditions. He/she shall make visits to the Project site and make determination as to whether the Work is proceeding in accordance with the Contract Documents. Except for projects on which the Macon Water Authority itself serves in the capacity of engineer by use of its employees, which shall be indicated in the Contract Documents, the Engineer is an independent contractor and acts as the agent of the Owner only when in special instances he/she is authorized in writing by the Owner so to act, and in such instances he/she shall, upon request, show the Contractor written authority. The Engineer has authority to stop the Work whenever such stoppage may be necessary to ensure the proper execution of the Contract.

(b) *Interpreter and Impartial Judge.*—As the Engineer is the interpreter of the conditions of the Contract and the judge of its performance, the Engineer shall side neither with the Owner nor with the Contractor but shall use the Engineer's powers to enforce the faithful performance of the Contract by both the Owner and the Contractor.

(c) *Succession.*—In case of the termination of the employment of the Engineer, the Owner shall appoint a capable and reputable Engineer against whom the Contractor shall make no objection and whose status under the Contract shall be that of the former Engineer.

(d) *Promptness.*—The Engineer shall make decisions with reasonable promptness after presentation of evidence on (i) any claim of the Owner or Contractor, (ii) a demand of the Owner or Contractor for a decision on any matter relating to the execution, or progress, of the Work, or (iii) a demand of the Contractor or Owner for interpretation of or additional instructions ("Request for Information" or "RFI") with respect to the Contract Documents.

(e) *Engineer's Authority.*—The Engineer shall be vested with the authority to judge, determine and direct the following:

(1) Whether products furnished are of the quality, type and kind called for by the Contract Documents and are otherwise acceptable for the Work as provided in the Contract Documents, and if not, to reject those not so qualifying or otherwise unacceptable;

(2) Whether products incorporated in the Work comply with the standards and requirements of the Contract Documents as to installation and operation and, if not, to require their removal and replacement, at the expense of the Contractor, with products which do meet the qualifications and operating ability, requirements, performance and standards as provided in said Contract Documents;

(3) The accuracy of quantities, amount of Work performed and all other submittals by the Contractor submitted in partial or periodic payment estimates, and whether all or any part of such quantities and other submittals are acceptable and comply with the Contract Documents, and to disallow any submittals not approved by the Engineer until the deficiencies causing such disallowance have been eliminated and rectified;

(4) The validity and merit of any and all claims for additional compensation or extension of the Contract Time;

(5) All matters relating to artistic effect;

(6) The validity and reasonableness of any notice of facility interruption given under

Article 20 of the General Conditions; and,

(7) All other matters relating to the proper execution of the Work in conformity with the Contract Documents, including workmanship.

The determination and decision, and any resulting approval, non-approval, condemnation, rejection, requirements of removal or replacement in all the foregoing matters of or by the Engineer shall be final and conclusive and binding upon the Contractor, all Subcontractors and all suppliers of products materials and equipment.

(f) *Claims for alleged procrastination.*—No claim for delay to the Contractor or for additional expense to the Contractor shall commence to accrue on account of failure of the Engineer to render decisions, make interpretations, or furnish additional instructions until ten (10) days after receipt of written claim for additional compensation, damages, or extension of time served upon the Engineer and the Owner and not then unless such claim be reasonable and otherwise permitted under the Contract Documents.

Article 12. - Separate Contracts.—(a) *Cooperation of Contractor.*—The Owner reserves the right to let other contracts in connection with, or related to, this Project. The Contractor shall afford other contractors reasonable opportunity for the introduction and storage of their products and the execution of their work, and the Contractor and other contractors shall properly connect and coordinate their respective work with each other. 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 other contractor's work that render it unsuitable for such proper execution and results.

(b) *Performance of Work by Owner.*—The Owner may perform additional work related to the Project with Owner's own forces. The Contractor shall afford the Owner reasonable opportunity for the introduction and storage of products and the execution of such work and shall properly connect and coordinate Contractor's work with work performed by Owner's own forces.

(c) *Claims for Extra Expense.*—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 will 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 causes the Contractor any additional expense or entitles the Contractor to an extension of the Contract Time, the Contractor may make a claim therefor as provided in Article 29 of the General Conditions.

Article 13. - Laws and Regulations. (a) *General.*—The Contractor acknowledges and agrees that all applicable federal, state, county and city laws, municipal ordinances, and the codes, rules, and regulations of all authorities having jurisdiction over construction of the Project shall apply to the Contract as though written out in full herein. The Contractor shall keep fully informed of all laws,

ordinances and regulations of the federal, state, county, city and municipal governments or authorities in any manner affecting those engaged or employed in the Work or the material used in the Work or in any way affecting the conduct of the Work and of all orders and decrees of bodies or tribunals having any jurisdiction or authority over same. If any discrepancy or inconsistency should be discovered in these Contract Documents herein referred to, in relation to any such law, ordinance, regulation, order or decree, the Contractor shall herewith report the same, in writing, to the Owner and the Engineer.

(b) *Expense for Violation of Laws, Ordinances, etc.*—If the Contractor performs any work knowing or reasonably knowing it to be contrary to such laws, ordinances, rules or regulations without such notice to the Owner, the Contractor shall bear all costs arising therefrom.

(c) *Indemnification.*—The Contractor shall at all times observe and comply with all such existing and future laws, ordinances, and regulations, and shall protect and indemnify the Owner, the Engineer and their agents against the violation of any such law, ordinance regulation, order or decree, whether by the Contractor or by the Contractor's employees or Subcontractors.

(d) *Drug Free Workplace Act.*—The Contractor certifies that the provisions of O.C.G.A. §§ 50-24-1 through 50-24-6 (as may be amended or re-numbered) relating to the "Drug Free Workplace Act" will be complied with in full. The Contractor further certifies that: (i) A Drug Free Workplace will be provided for employees during the performance of the Contract, and (ii) that if a Subcontractor is engaged by the Contractor to work in a Drug Free Workplace, the Contractor shall secure from the Subcontractor the following written certification:

"As part of the subcontracting agreement with _____ (Contractor's name), _____ (Subcontractor's name) certifies to the Contractor that a drug-free workplace will be provided for the Subcontractor's employees during the performance of this Contract pursuant to the 'Drug Free Workplace Act'". Contractor also certifies to the Owner and the Engineer that the Contractor and its employees will not engage in the unlawful manufacture, sale, distribution, dispensation, possession, or use of any controlled substance or marijuana during the performance of the Contract.

(e) *Alcoholic Beverages on the Jobsite.*—The Contractor will strictly enforce a policy prohibiting the possession and consumption of alcoholic beverages on the jobsite before, during or after working hours for duration of the Work.

Article 14. - Taxes. (a) *General.*—The Contractor shall pay all sales, consumer, use and other similar taxes required by the law of the place where the Work is performed. The Owner will be responsible for any sales or use tax due on products furnished by the Owner to the Contractor to be incorporated into the Work.

(b) *Tabulation.*—The Contractor shall provide a written tabulation, plus other documentation

as may be required, of all taxes, including sales tax, paid by the Contractor to assist the Owner in obtaining sales or use tax refunds for eligible machinery and equipment used for the primary purpose of reducing or eliminating air or water pollution as provided for in Chapter 48-8-3 (36) and (37) of the Official Code of Georgia (as may be amended). Such written tabulation shall be included with each partial payment request. Additionally, the tabulation shall be documented with copies of invoices indicating the amount of tax paid, with all blanks completed on the invoice, and with a description of the function of the item included in the tabulation. All taxes will be paid by the Contractor. All refunds will accrue to the Owner.

(c) *Tariffs* – "Tariffs" includes applicable tariffs, duties, customs fees, import taxes, or similar charges imposed by a governmental authority. "Tariffs" does not include sales, consumer, use, and similar taxes that are legally enacted by a governmental entity as outlined in subsection (a) above. If the cost of materials and/or equipment increases by more than 10% over the amount estimated in calculating the Contract Price, which increase is directly attributable to Tariffs, Contractor shall promptly provide to Owner or Owner's representative with a written request for an equitable adjustment for an amount above the 10% increase. Prior to Contractor making such a request, Contractor shall determine whether substantially similar materials and/or equipment may be utilized that is not subject to Tariffs. If no substantially similar materials are available, Contractor may request a Change Order to increase the Contract Price by the difference between the original cost plus the 10% increase due to Tariffs and the actual costs to be paid by the Contractor, without markup or overhead. In no event shall the Contract Price be adjusted by more than 10% over the original Contract Price for the aggregate of all such increases due to Tariffs. Any adjustment of the Contract Price under this provision shall not be duplicated in any contingency amounts established under the terms of the Contract, or by any allowance.

Article 15. - Notice and Service Thereof. (a) *General.*—All notices, demands, requests, instructions, approvals, and claims shall be in writing.

(b) *Notice to Contractor.*—Any notice to or demand upon the Contractor will be sufficiently given if delivered at the office of the Contractor specified in the Bid (or at such other office as the Contractor may from time to time designate to the Owner in writing), or if delivered by the United States Mail in a sealed, postage-prepaid envelope, or delivered by facsimile transmission, followed by written confirmation, in each case addressed to such office.

(c) *Notice to Owner.*—All papers required to be delivered to the Owner shall, unless otherwise specified in writing to the Contractor, be delivered to:

Macon Water Authority
790 Second Street
Macon, GA 31201

FAX (478) 750-2007

Any notice to or demand upon the Owner shall be sufficiently given if delivered to the Office of the Executive Director or if delivered by the United States Mail in a sealed, postage-prepaid envelope, or delivered by facsimile addressed to said Executive Director or to such other representative of the Owner or to such other address as the Owner may subsequently specify in writing to the Contractor for such purposes. Any such notice or demand shall be deemed to have been given to the Owner or made only as of the time of actual delivery to Owner.

(d) *Delivery to Engineer or Resident Inspector.*—Notice in writing or orally to the Engineer or to the resident inspector is not notice to the Owner unless a copy of the aforesaid notice in writing shall have been properly served upon the Owner as provided in this Article.

Article 16. - Patents and Royalties. (a) *General.*—If the Contractor uses any patented, trademarked or copyrighted design, process, device, material or other item, the Contractor shall provide for such use by suitable agreement between the Owner and the holder of such patented, trademarked or copyrighted design, device or material. The Contract Prices shall include royalties or costs arising from the use of such design, device, or materials, in any way involved in the Work.

(b) *Indemnification.*—The Contractor and the Contractor's surety shall indemnify and save harmless the Owner, the Engineer and their agents from claims for infringement by reason of the use of such patented, trademarked or copyrighted design, process, device or materials in connection with Work agreed to be performed under this Contract, and shall indemnify the Owner, the Engineer and their agents for any cost, expense, damage and reasonable attorneys' fees which the Owner, the Engineer or their agents may be obliged to pay by reason of such infringement, at any time during the prosecution of the Work or after completion of the Work.

Article 17. - Land and Rights-of-Way. (a) *Project Site.*—The Owner will provide, as indicated in the Contract Documents and prior to the Notice to Proceed, the lands upon which the Work is to be performed, rights-of-way for access thereto, and such other lands which are designated for the use of the Contractor. The Contractor shall confine all Work and all associated activities to the easements and other areas designated for the Contractor's use. The Contractor shall comply with any limits on construction methods and practices which may be required by easement agreements.

(b) *Delays in Providing Access.*—If, due to some unforeseen reason, the necessary easements are not obtained, the Contractor shall receive an equitable extension of Contract Time or an equitable increase in the Contract Price, or both, to cover the Contractor's additional costs as a result thereof, provided the Owner is notified in writing of the claim. The Contractor's claim therefor shall be made as provided for in Article 29 of the General Conditions.

(c) *Additional Easements.*—Should additional temporary easements for ingress or egress be required by the Contractor for access to the Work, these easements shall be obtained by the

Contractor, at no additional cost to the Owner.

Article 18. - Products. (a) *Storage.*—Products shall be stored in accordance with the manufacturer's recommendations to insure the preservation of their quality and fitness for the Work. Stored products to be incorporated in the Work shall be located so as to facilitate prompt inspection by the Owner or the Engineer.

(b) *Installation.*—Manufactured products shall be applied, installed, connected, erected, used, cleaned, and conditioned as directed by the manufacturer.

(c) *Conformance with Shop Drawings.*—Products shall be furnished in accordance with shop drawings or samples submitted by the Contractor and approved by the Engineer.

(d) *Quality and Ownership.*—Unless otherwise specified, all products incorporated into the Work shall be new, and both workmanship and materials shall be of good quality. The Contractor shall, if required, furnish satisfactory evidence as to the kind and quality of products. The burden of proof is on the Contractor. Products to be incorporated into the Work shall not be purchased by the Contractor or Subcontractor subject to a chattel mortgage or under a conditional sale contract or other agreement by which an interest is retained by the seller.

Article 19. - Supervision of Work. (a) *Supervision by Contractor.*—The Contractor shall give efficient supervision to the Work, using its best skill and attention. The Contractor shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction.

(b) *Superintendent of Contractor.*—The Contractor shall employ and maintain on the Work a qualified superintendent and any necessary assistants, all satisfactory to the Owner and Engineer, who shall have been designated in writing by the Contractor as the Contractor's representative at the site. The superintendent shall not be changed except with the consent of the Owner and Engineer unless the superintendent proves to be unsatisfactory to the Contractor and ceases to be in the Contractor's employ. The superintendent shall represent the Contractor and shall be present on the site at all times as required to perform adequate supervision and coordination of the Work. The superintendent's sole responsibility shall be to superintend the construction of the Project; he shall not be a "working foreman." The superintendent shall have full authority to act on behalf of the Contractor and to execute orders or directions of the Engineer without delay. The superintendent shall have full authority to promptly supply products, tools, plant equipment and labor as may be required. The superintendent's authority shall be such that all communication given to the supervisor shall be as binding as if given to the Contractor.

(c) *Contractor's Personnel.*—The Contractor shall employ only competent and skilled personnel. The Contractor shall at all times enforce strict discipline and good order among its employees and shall not employ on the Work any unfit person or anyone not skilled in the work assigned to him. The Contractor shall, upon demand from the Engineer, immediately remove any

superintendent, foreman, or worker whom the Engineer or Owner may consider incompetent or undesirable.

Article 20. - Interruption of Facility Operations. (a) *General.*—The Contractor shall provide the Owner with written notice at least five (5) days prior to any interruption in facility operations required by any construction activity. The notice shall include the date and time of the scheduled interruption; the length of time the interruption will be in effect; the procedures to be followed in effecting the interruption; a complete identification of all those processes, equipment and operations to be affected; and all other information the Owner may require. The Contractor shall provide any and all equipment, piping, auxiliary power or other means necessary to sustain facility operations or function for interruptions which have not been identified by the Contract Documents, or when interruptions must exceed the time allowed by the Contract Documents.

(b) *Damages and Fines.*—Any damages resulting from surcharging, overflow or back-up caused by the Contractor's operations shall be the Contractor's responsibility. Any fines levied against the Owner resulting from a surcharge, overflow or backup caused by the Contractor shall be paid by the Contractor.

Article 21. - Protection of Work, Property and Persons. (a) *Duty to Protect Persons and Property.*—The Contractor shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. The Contractor shall take all necessary precautions for the safety of, and shall provide necessary protection to prevent damage, injury or loss to all employees on the Work and other persons who may be affected thereby, all the Work and all products to be incorporated therein, whether in storage on or off the site, and other property at the site and adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures and utilities not designated for removal, relocation or replacement in the course of construction. The Contractor shall pay for any such damage, injury, or loss except such as may be directly the result of errors in the Contract Documents or such as shall be caused directly by agents or employees of the Owner.

(b) *Safety Precautions.*—The Contractor shall comply with the Occupational Safety and Health Act, the Contract Work Hours and Safety Standards Act, and all rules and regulations relating thereto. Contractor warrants and represents that it is thoroughly familiar with the safety requirements with regard to scaffolding set forth in O.C.G.A. § 25-15-110, the requirements concerning blasting or excavating near underground gas pipes and utility facilities contained in O.C.G.A. § 25-9-1, *et seq.*, and the High Voltage Safety Act, O.C.G.A. § 46-3-30, *et seq.*, and that the Work shall be prosecuted in complete accord with all limitations and requirements set forth in these, and other applicable, laws. The contractor's operation of the jobsite shall be consistent with the provisions of the "Manual of Accident Prevention in Construction" issued by the Associated General Contractors of America, Inc., and shall maintain an accurate record of all cases of death, occupational disease, and injury requiring medical attention or causing loss of time from work arising out of and in the course of employment on the Work. The Contractor alone shall be

responsible for the safety, efficiency, and adequacy of its plant, appliances, and methods and for any damage which may result from their improper construction, maintenance, or operation. The Contractor shall erect and properly maintain at all times as required by the conditions and progress of the work proper safeguards for the protection of workers and the public and shall post danger warnings against any hazards created by the construction operations. The Contractor shall designate a responsible member of its organization on the Work whose duty shall be the prevention of accidents. In the absence of notice to the contrary filed with the Engineer in writing with a copy to the Owner, this person shall be the superintendent of the Contractor.

(c) *Emergencies.*—In an emergency affecting the safety of life or the Work or adjoining property, the Contractor, without special instruction or authorization from the Engineer or Owner, is hereby permitted to act, at its discretion, to prevent such threatened loss or injury. Any remuneration claimed by the Contractor on account of emergency work shall be determined in accordance with allowances permitted on force account under section (c), Case(c) of Article 29 of the General Conditions.

(d) *Injury or Loss to Persons or Property.*—The Contractor shall remedy all damage, injury or loss to any property, improvements or facilities caused, directly or indirectly, in whole or in part, by the Contractor or any of the Contractor's Subcontractors or anyone directly or indirectly employed by and of them or anyone for whose acts any of them may be liable. The property, improvements or facilities shall be replaced or restored to a condition as good as when the Contractor entered upon the Work. In case of failure on the part of the Contractor to restore such property, or pay for such damages or injury, the Owner may, after 48 hours written notice, proceed to repair, rebuild, or otherwise restore such property, improvements or facilities as may be deemed necessary. The cost thereof will be deducted from any monies due or which may become due to the Contractor under this Contract.

(e) *Blasting.*—In the absence of an express provision in the Contract Documents permitting blasting, there shall be no blasting. If blasting is permitted under the Contract Documents and under the law which is applicable to the Project site, such blasting shall be done in such manner as to prevent all damage and injury.

(f) *Rain Water, Surface Water, and Backup.*—The Contractor shall protect all Work, including but not limited to excavations and trenches, from rain water, surface water, and back-up of drains and sewers. The Contractor shall furnish all labor, pumps, shoring, enclosures, and equipment necessary to protect and keep the Work free of water. Completed Work and stored products shall be suitably protected during inclement weather to allow Work to proceed in a timely fashion. Work planned, or in progress, should be performed to minimize impact of adverse weather conditions.

Article 22. - Protection of the Environment. (a) *General.*—The Contractor shall be responsible for taking all measures required to minimize all types of pollution associated with the undertaking

of the proposed Work, and shall abide by the requirements of all governmental agencies having jurisdiction over the Work or Contractor's Project operations.

(b) *Restoration.*—Any area used or involved in the Project that is disturbed by the Contractor, shall be restored to original or better condition, even though such area is outside the limits of that specified for grading, grassing or landscaping.

Article 23. - Protection, Location and Relocation of Utilities. (a) *Notification and Protection.*—The Contractor shall notify owners of adjacent utilities when prosecution of the Work may affect them. The Contractor shall protect from damage all existing improvements or utilities at, or in proximity to, the site of the Work, and shall repair or restore any damage to such facilities resulting from the performance of the Work. If the Contractor fails or refuses to repair any such damage promptly, the Owner may have the Work performed and charge the cost thereof to the Contractor.

(b) *Relocation.*—Prior to the construction or installation of any proposed facility or pipeline, the Contractor shall expose all existing utilities true to their vertical and horizontal location, within the vicinity of the Work. In order to avoid conflicts between existing and proposed facilities or utilities, the Contractor shall either relocate the existing or proposed utility on a temporary or permanent basis, or shall take whatever means necessary to protect the existing facilities or utilities during the installation of proposed utilities, as approved by the Engineer. No separate or additional payment will be made for the relocation of existing utilities or for any work associated with the protection of existing facilities or utilities.

Article 24. - Schedules, Reports and Records.—(a) *Progress Reports.*—Within such reasonable time as the Owner shall designate in writing, the Contractor shall submit to the Owner such schedule of quantities and costs, construction progress schedules, payrolls, bills, vouchers, correct copies of all subcontracts, statements, reports, correct copies of all agreements, correspondence, and written transactions with the surety that have any relevance to the Work, estimates, records, and other data as the Owner may request concerning Work performed or to be performed under this Contract. When requested by the Owner, the Contractor shall give the Owner access to accounts relating to the foregoing. The above reports shall include but are not limited to (i) written notice of dates by which specified Work will have been completed, (ii) written notice of dates by which condemned Work shall have been remedied, (iii) written notice that condemned Work has been remedied, (iv) written notice as to the date or dates by which Work that has not been performed with equal steps and at the same rate required by the construction progress schedule shall have been brought into conformity with the schedule, (v) written notice of the date by which any undisputed claim of a Subcontractor, materialman, or laborer shall have been paid, (vi) written advice regarding the nature and amount of any disputed claim of a Subcontractor, materialman, or laborer, and (vii) information regarding work performed under Sections (c), Case (b) and Case (c) of Article 29 of the General Conditions.

(b) *Construction Progress Schedule.*—Within ten (10) days of the Notice to Proceed, the

Contractor shall submit to the Engineer a Preliminary Progress Schedule ("PPS") and a Near Term Schedule ("NTS") in the form and with the content required by the Specifications. Within forty-five (45) days of the Notice to Proceed, the Contractor shall submit to the Engineer the Overall Project Schedule ("OPS") as required in the Specifications.

(c) *Schedule of Values.*—The Contractor shall, within ten (10) days of the Notice to Proceed, submit to the Engineer a Schedule of Values of the various parts of the Work, including quantities, aggregating the total Contract Price, divided in such manner as to facilitate payments to Subcontractors in accordance with Article 10, with a complete breakdown of the Contract Price so arranged and so itemized in accordance with the Specifications as to meet the approval of the Engineer, and, if requested, supported by such evidence as to its correctness as the Engineer may direct. This schedule, designated herein as the Schedule of Values, when approved by the Engineer shall be used as a basis for certificates of payment.

(d) *Shop Drawings.*—The Contractor shall prepare, execute, and submit shop drawings as required by the Specifications. No shop drawings shall be submitted which do not comply with the Contract Documents.

(e) *Schedule of Submittals.*—Within ten (10) days of the Notice to Proceed, the Contractor shall prepare and submit for the approval of the Engineer a Schedule of Submittals showing the estimated date of submittal of all shop drawings and the desired approval date for each shop drawing anticipated. The Contractor shall submit in accordance with the schedule and the Engineer shall furnish approval in accordance with the schedule. The schedule must be consistent with the construction progress schedules.

(f) *Submitting Updated Schedules.*—An updated OPS and NTS together with an updated Schedule of Submittals shall be presented with each periodical payment request. Failure to timely submit such schedules will delay processing of the pay request until receipt of the updated schedules.

(g) *Float in the Schedule.*—If the OPS reflects a completion date prior to the completion date established in the Contract Agreement, or as extended by Change Order, this shall afford no basis for a claim of delay should the Contractor not complete the Work prior to the projected date set forth in the OPS. All "float" between the completion date in the OPS and the completion date established in the Contract Agreement shall belong to and be exclusively available to the Owner. Should a Change Order be executed with a revised completion date, the progress schedule shall be revised to reflect the new completion date.

(h) *Record Drawings.*—The Contractor shall maintain on the Project site throughout the Contract Time an up-to-date set of records and drawings as required by the Specifications.

(i) Project Coordination Meetings.—The Contractor shall participate in Project Coordination

Meetings to be held on the site monthly, or more often if conditions warrant, to establish the current state of completion and revise the schedule as necessary. The Project Coordination Meeting will be conducted by the Owner and the Engineer.

(j) *Maintenance of Project Scheduling System.*—The Contractor shall take the following steps to ensure that the Project stays on schedule:

(1) The Contractor shall implement the detailed NTS of activities to the fullest extent possible between Project Coordination Meetings.

(2) The Contractor shall provide a copy of the Contractor's Daily Report to the Resident Inspector by 10:00 a.m. of the day following the Report date. This Daily Report will contain, as a minimum, the weather conditions; number of workers by craft, including supervision and management personnel on site; active and inactive equipment on site; Work accomplished by Critical Path Method activity item; problems; and visitors to the jobsite.

(3) If a current activity or series of activities on the OPS is behind schedule and if the late status is not due to an excusable delay for which an extension of the Contract Time would be forthcoming, the Contractor shall attempt to reschedule the activity to be consistent with the OPS so as not to delay completion of the Contract. The Contractor agrees that:

a. The Contractor shall attempt to expedite the activity to completion so as to have it agree with the OPS. Such measures as the Contractor may choose shall be made explicit during the Project Coordination Meeting;
b. If, within two weeks of identification of such behind-schedule activity, the Contractor is not successful in restoring the activity to an on-schedule status, the Contractor shall:
    1. Carry out the activity with the scheduled crew on an overtime basis until the activity is complete or back on schedule;
    2. Increase the crew size or add shifts so the activity can be completed as scheduled; or,
    3. Commit to overtime or increased crew sizes for subsequent activities, or some combination of the above as deemed suitable by the Engineer.

    These actions shall be taken at no increase in the Contract Price.

(4) Maintain a current copy of all construction schedules on prominent display in the Contractor's field office at the Project site; and,

(5) Cooperate with the Owner or Owner's representative in all aspects of the Project

Scheduling System. Failure to implement the Project Scheduling System or to provide specified schedules, diagrams, and reports, or to implement actions to re-establish progress consistent with the OPS may be causes for withholding of payment.

Article 25. - Drawings and Specifications.

(a) *Identification.*— The Contract Documents shall be as defined in Article 41(e) of the General Conditions. They are intended to define, describe, and provide for all Work necessary to complete the Project in an acceptable manner, ready for use, occupancy, or operation by the Owner. Insertion, addition, alteration, modification, revision, or deletion of any text, verbiage, provision, statement, term, condition, or other component of the Contract Documents, whether textual, numerical, or pictorial, is prohibited and no such unilateral change to the Contract Documents shall be binding.

(b) *Number of Copies.*—The Engineer will furnish the Contractor two copies of the Contract Documents, one copy of which the Contractor shall have available at all times on the Project site. Any additional copies will be furnished at additional cost.

(c) *Correlation and Intent.*—The Contract Documents are complementary, and what is called for by one shall be as binding as if called for by all. The intention of the documents is to include all labor and materials, equipment, and transportation necessary for the proper execution of the Work. It is not intended, however, that materials or work not covered by or properly inferable from any heading, branch, class, or trade of the Specifications shall be supplied unless distinctly noted on the drawings. Materials or Work described in words which so applied have a well-known technical or trade meaning shall be held to refer to such recognized standards. In the event the Engineer shall have used such phrases anywhere in the Specifications as: "work indicated on the drawings and herein specified", "work shown and specified", "in accordance with the drawings and Specifications", "indicated on the drawings and Specifications", "in accordance with Specifications and applicable drawings", "these Specifications and the accompanying drawings", "as indicated on the drawings and as specified herein", or similar expressions, they shall not be deemed to be and are not a defeasance of the provisions under this Article of the General Conditions, and they are not to be construed as requiring Work to be called for both in the Specifications and in the drawings in order to be a requirement under the Contract. Any of the aforesaid conjunctive expressions and phrases or any cross-references between drawings and Specifications, between Specifications and Specifications, or between drawings and drawings to the contrary notwithstanding, the Contract Documents are complementary, and what is called for by one shall be as binding as if called for by all.

(d) *Refinement of Documents.*—The Contractor shall do no Work without complete, definite, and clear Drawings and Specifications. In the event the Contract Documents are not complete, definite, and clear, the Contractor shall make demand upon the Engineer, in writing, for a Request for Instructions (RFI) in accordance with Section (d) (iii) of Article 11 of the General Conditions. A copy of such demand shall be served upon the Owner. With reasonable promptness the Engineer

shall furnish complete, definite, and clear instructions in writing, or by means of drawings, or in writing and by means of drawings. Such additional instructions if given orally shall be confirmed in writing or by drawings or both within a reasonable time. All such additional instructions shall be consistent with the Contract Documents, true developments thereof, and reasonably inferable therefrom. The Work shall be executed in conformity with the aforesaid instructions. The Engineer shall furnish the Owner a copy of all additional instructions issued to the Contractor. No clarification of the Drawings and Specifications hereunder by the Engineer will entitle the Contractor to any additional monies unless a Change Order has been processed as provided by Article 29 of the General Conditions.

(e) *Conflicts.*—The following principles shall govern the settlement of disputes which may arise over conflicts in the Contract Documents:

(i) as between figures given on drawings and the scaled measurements, the figures shall govern;

(ii) as between large-scale drawings and small-scale drawings, the larger scale shall govern;

(iii) As between Drawings and Specifications, the requirements of the Specifications shall govern;

(iv) as between the form of the Contract Agreement, General Conditions or agency funding documents, the requirements of the agency funding documents shall govern; and,

(v) in cases where products or quantities are omitted from the Specifications, the description and quantities on the Drawings shall govern.

Conflicts noted shall be reported to the Engineer. The principles set forth herein shall not alter the provisions of subsection (c) herein. Schedules, lists, indexes, tables, inventories, written instructions, written descriptions, summaries, statements, classifications, specifications, written selections, or written designations although appearing on the drawings are deemed to be and are "Specifications" within the meaning of this Article.

(f) *Materially Differing Site Conditions.*—Any materially differing site condition as between what is shown on the Drawings and Specifications and actually found on site shall be immediately reported to the Engineer and Owner, in writing, prior to the continuance of Work at the site. Failure of the Contractor to notify the Engineer, in writing, of the differing site condition prior to performance of Work at the site shall constitute a waiver of any claim for additional monies. Any Change Order necessitated by the differing site condition shall be processed as provided under Article 29 of the General Conditions. Any Work done by the Contractor following a discovery of such differing site condition or ambiguity or need for clarification in the Contract Drawings and Specifications, prior to a written report to the Engineer, shall not entitle the Contractor to additional monies and shall be done at the Contractor's risk.

Article 26. - Surveys and Permits.—(a) *Surveys.*—The Owner will furnish a land survey to establish a base line for locating the principal component parts of the Work, as shown in the Contract Documents. A bench mark will be otherwise specified in the Contract Documents; the Contractor shall develop and make all detailed surveys needed for construction, such as alignment, slope stakes, batter boards, stakes for pile location and other working points, lines, elevations and cut sheets.

(b) *Permits.*—Permits and licenses of a temporary nature necessary for the prosecution of the Work shall be obtained and paid for by the Contractor. Permits, licenses and easements for permanent structures or permanent changes in existing facilities shall be obtained and paid for by the Owner unless otherwise specified.

Article 27. - Testing, Inspection and Rejection of Work.—(a) *Testing of Materials.*—Unless otherwise specifically provided for in the Specifications, the inspection and testing of materials and products to be incorporated in the Work at the site shall be made by bureaus, laboratories, or agencies approved by the Owner; the cost of such inspection and testing shall be paid by the Contractor. The Contractor shall furnish evidence, satisfactory to the Owner and Engineer, that the materials and products have passed the required tests prior to their incorporation into the Work. The Contractor shall promptly segregate and remove rejected materials and products from the site of the Work.

(b) *Access to Work.*—The Owner and Engineer and their representatives shall at all times have access to the Work wherever it is in preparation or progress, and the Contractor shall provide proper facilities for such access and for inspection.

(c) *Notice to Engineer from Contractor Prior to Covering Work.*—If the Specifications, the Engineer's instructions (either in the Specifications or issued later in writing), laws, ordinances or any public authority require any Work to be specially tested or approved, the Contractor shall give the Engineer timely notice in writing of its readiness for inspection, and if the inspection is by any authority other than the Engineer, of the date fixed for such inspection. Inspections by the Engineer shall be made promptly and where practicable at the source of supply. If any Work should be covered without approval or consent of the Engineer, it must, if required by the Engineer, be uncovered for examination at the Contractor’s expense.

(d) *Re-examination or Re-testing of Work Covered pursuant to Consent of Engineer.*—Re-examination or re-testing of questioned work covered pursuant to consent of the Engineer may be ordered by the Engineer, and if so ordered the Work must be uncovered by the Contractor. If such Work is found in accordance with the Contract Documents the Owner shall pay the cost of re-examination and replacement or of re-testing. If such Work is found not in accordance with the Contract Documents the Contractor shall pay such cost unless he shall show that the defect in the Work was caused by another contractor of the Owner, and in that event the Owner shall pay such

cost. Re-examination or re-testing under the terms of this section applies only to Work which has been covered with consent of the Engineer. Work covered without consent of the Engineer must be uncovered for examination as provided under Article 27(c) of the General Conditions.

(e) *Inspection Does Not Relieve Contractor.*—Under the Contract Documents, the Contractor has assumed the responsibility of furnishing all services, labor, and materials for the entire Work in accordance with such documents. No provisions of this Article or any inspection of the Work by the Owner, representatives of the Owner, resident inspector, clerk-of-the-works, architects employed by the Engineer, representatives of the Engineer, or the Engineer shall in any way diminish, relieve, or alter said responsibility and undertaking of the Contractor; nor shall the omission of any of the foregoing to discover or to bring to the attention of the Contractor the existence of any Work or materials injured or done not in accordance with said Contract Documents in any way diminish, relieve, or alter such obligation of the Contractor nor shall the aforesaid omission diminish or alter the rights or remedies of the Owner as set forth in the Contract Documents. Subject to the provisions of Section (g) herein, the resident inspector has no power to make decisions, to accept or reject Work, or to consent to the covering of Work. The resident inspector owes no duty to the Contractor.

(f) *False Start.*-In the event notice of readiness pursuant to Article 30(g) of the General Conditions shall have been issued prematurely by the Contractor, the Contractor's action shall be deemed to be a "false start", and the Contractor shall be liable for the damage resulting from the aforesaid false start, including but not limited to the salary, professional fees, and travel and living expenses of the person or parties inconvenienced by the aforesaid false start.

(g) *Authority and Duties of the Resident Inspector.*—The Resident Inspector will be authorized to inspect all Work done and all products furnished, including preparation, fabrication and manufacture of the products to be used, but the Resident Inspector is not authorized to alter or waive any requirements of the Contract Documents. The Resident Inspector may temporarily reject products or suspend the Work until any question at issue can be referred to and decided by the Engineer. The responsibility of the Contractor is not lessened by the presence of the Resident Inspector.

(h) *Rejection of Work; Orders of Condemnation.*—The Contractor shall remove from the premises within the time designated in orders of condemnation all Work condemned by the Engineer as failing to conform to the Contract Documents, whether incorporated in the Work 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 by such removal or replacement. The Contractor shall supply any omitted Work and perform all unexecuted Work within the time fixed by the Engineer in orders of condemnation.

(i) *Remedy of the Owner for Breach of Order of Condemnation.*—If the Contractor does not

make good a deficiency within the time fixed in an Order of Condemnation, the Owner may:

(1) Remove the condemned Work and store it at the expense of the Contractor. If the Contractor does not pay the expenses of such removal and storing within ten (10) days after receipt of written demand of the Owner, the Owner may upon three (3) days' notice in writing to the Contractor sell such materials at private sale or at auction and shall account for the net proceeds thereof after deducting all proper costs incurred by the Owner; or

(2) Supply omitted Work, perform unexecuted Work, or replace and re-execute Work not done in accordance with the methods and materials designated in the Contract Documents and deduct the cost thereof from any payment then or thereafter due the Contractor; or,

(3) Accept the condemned Work and deduct the reasonable value of such Work from the Contract Price.

The remedies stated in this Article are in addition to the remedies otherwise available to the Owner, do not exclude such other remedies, and are without prejudice to any other remedies. Time limits stated in orders of condemnation are of the essence of the Contract. Unless otherwise agreed to by the Owner in writing, the making good of condemned Work shall physically commence at the site in not more than seven (7) days after receipt of the Order of Condemnation except that in case of emergency correction shall physically commence immediately and except that the Contractor shall in any event physically commence the correction at the site early enough to complete within the time allowed in the Order of Condemnation. The Owner shall give prompt consideration to reasonable requests for delay in commencement of the making good of orders of condemnation. The making good of condemned Work shall be completed within the time allowed in the Order of Condemnation unless the Contractor shall have requested from the Engineer an increase in the amount of time allowed and the Engineer shall have given notice to the Contractor in writing, with copy to the Owner, stating the additional time, if any, allowed. An extension of the time allowed to correct condemned Work shall not extend the Contract Time.

(j) *Notice of Correction from Contractor.*—The Contractor shall give prompt notice in writing to the Engineer, with copy to the Owner, upon completion of the correction of any Work, the supplying of any omission of any Work or materials or the performance of any unexecuted Work condemned by the Engineer. In the absence of such notice, it shall be and is presumed under this Contract that there has been no correction, supplying remedy, or performance of unexecuted Work.

Article 28. - Contract Time and Damages. (a) *Rate of Progress.*—The Contractor shall proceed with the Work at a rate of progress which will insure substantial completion of the Project within the Contract Time. It is expressly understood and agreed by and between the Contractor and the Owner that the Contract Time for the Work is a reasonable time, taking into consideration the

average climatic and economic conditions, and other factors prevailing in the locality of the Work. It is understood that the Contractor's proposed construction schedule is based on a normal 40-hour work week, less recognized holidays. If the Contractor desires to work in excess of a normal 40-hour work week, the Contractor shall submit a written request to the Owner and Engineer a minimum of two (2) days prior to the desired work date. The Contractor shall be responsible for any additional expenses incurred by the Owner as a result of any extended work hours, including resident inspection overtime. The cost associated with resident inspector overtime will be deducted from the Contractor's monthly progress payment request.

(b) *Grounds for Delays and Extensions of Time.*—If the Contractor be delayed at any time in the progress of the Work by any act or neglect of the Owner or the Engineer, or of any employee of either, or by any separate contractor of the Owner, or by changes ordered in the Work, or by strikes, lockouts, pickets, abnormal and unforeseeable weather, unforeseeable subsurface conditions, fire, unusual delay in transportation, unavoidable casualties, or any causes beyond the Contractor's control, or by any cause which the Engineer shall decide to justify the delay, then the Contract Time may be extended for such reasonable time as the Engineer may decide.

(c) *Filing of Claims.*—No extension of the Contract Time shall be made for delay occurring more than ten (10) days before claim therefor is made in writing to the Engineer with a copy to the Owner. In the case of a continuing cause of delay, only one claim is necessary, but no claim for a continuing delay shall be valid unless the Contractor, within ten (10) days of the commencement of the delay, shall have given notice in writing to the Engineer, with copy to the Owner.

(d) *Weather Delays.*—The Contractor is held to be familiar with weather conditions in the Macon-Bibb County area. When a claim for extension of the Contract Time is based on abnormal and unforeseeable weather conditions the request must be accompanied by U.S. Weather Bureau data for the past ten (10) years for the Macon/Macon-Bibb County, Georgia area that substantiates the claim of abnormal and unforeseeable weather conditions. Each day of inclement weather is not, by itself, reason for an extension of the Contract Time. Extensions of the Contract Time will be based solely on the number of rain days in a monthly period that are in excess of the ten (10) year average as established for the Macon/Macon-Bibb County area. A rain day, for purposes of calculating the ten (10) year average, is defined as a day in which 0.10 inch of rain or more was measured by the Weather Bureau.

(e) *Delay in Furnishing Drawings.*—If no Schedule of Submittals or agreement stating the dates upon which drawings or approval of shop drawings shall be furnished is made, then no claim for delay shall be allowed on account of failure of the Engineer to furnish drawings or approval of shop drawings until fourteen (14) days after demand therefor and not then unless such claim be reasonable.

(f) *No Damages for Delay.*—In the event of any delay as set forth in Section (b) herein, the Contractor may be entitled to an extension of the Contract Time only, and shall not be entitled to

any additional payment on account of such delay. Without limiting the foregoing, except as otherwise specifically provided under Article 29, the Contractor shall not be entitled to payment or compensation of any kind from the Owner for direct, indirect or impact damages, including but not limited to costs of acceleration or extended home office overhead arising because of hindrance or delay from any cause whatsoever, whether such hindrances or delays be reasonable or unreasonable, foreseeable or unforeseeable, or avoidable or unavoidable.

(g) *Damages from Contractor for Delay.*—If the Contractor shall fail to perform the Work required within the Contract Time, or extended Contract Time if authorized by Change Order, then the Contractor shall pay Owner the full amount of damages specified in the Contract Documents for each calendar day that the Contractor shall be in default after the time stipulated in the Contract Documents shall have expired, and the Owner shall deduct such damages from the Contractor's monthly progress payment request.

Article 29. - Changes in the Work.—(a) *Owner's Right to Make Changes.*—The Owner without invalidating the Contract may authorize or order extra work or may authorize or order changes by altering, adding to, or deducting from the Work, the Contract Price or the Contract Time, or both, being adjusted accordingly. The Contractor hereby expressly agrees that the Contractor shall have no right to a claim for damages or extended overhead of any nature because of changes made by the Owner. Such Work is hereinafter designated "change" or "changes".

(b) *Field Orders.*—The Engineer may at any time, by issuing a field order, make changes in the details of the Work. These changes by field order will not affect Contract Time or Contract Price. The Contractor shall proceed with the performance of any such changes in the Work so ordered by the Engineer, unless the Contractor believes that such field order entitles Contractor to a change in Contract Price or Contract Time, or both, in which event Contractor shall give the Engineer immediate, written notice thereof and if required by the Owner, an immediate estimate of the direct cost of Work as outlined in Case (b) below, 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 written instruction from the Owner.

(c) *Cost to Owner for Changes.*—The cost to the Owner of any change shall be determined in one or more of the following ways:

CASE (a) By estimate and acceptance in a lump sum.

CASE (b) By unit prices identified in the Contract or subsequently agreed upon. Unit prices are net including overhead and profit. Neither establishment of unit prices in the Contract or later agreement to unit prices shall entitle the Contractor to execute any change under Case (b) prior to issuance of an authorization or order of the Owner in writing.

CASE (c) By force account, which is defined as expenditures allowed under Article 29(i) plus a percentage or percentages as stated under Article 29(i).

(d) *Changes Forbidden without Consent of Owner.*—Neither the Engineer or the Contractor shall make any change whatsoever in the Work without authorization or order of the Owner in writing except in emergency as described hereinbelow. The making of any change without authorization or order of the Owner in writing is a breach of contract except in emergency as referred to under Article 21 of the General Conditions. In the absence of authorization or order of the Owner given in advance in writing (except in emergency as referred to under Article 21 of the General Conditions) the Contractor shall have no claim for payment, repayment, reimbursement, remittance, remuneration, compensation, profit, cost, overhead, expense, loss, expenditure, allowance, charge, demand, hire, wages, salary, tax, cash, assessment, price, money, bill, statement, dues, recovery, restitution, benefit, recoupment, exaction, injury, damages or time based upon or resulting from any change.

(e) *Notice of demand of Contractor for extraordinary remuneration or for damages.*—For a change in the Work, the Contractor shall be entitled to no claim other than or in excess of allowances permitted under Article 29(i) unless prior to commencement of execution of the change (a) the Contractor shall have notified the Owner in writing of the nature of the claim and (b) the Owner shall have agreed in writing to the claim. Commencement of execution of a change authorized by the Owner in the absence of the aforesaid written notice from the Contractor and written agreement to the claim by the Owner shall be deemed to be and is conclusive proof that the Contractor acknowledges that it makes no claim other than or in excess of allowances permitted under Article 29(i).

(f) *Subsurface Conditions.*—Material below the surface of the ground is assumed to be earth and other material that can be removed by a backhoe or similar equipment. Should conditions encountered below the surface of the ground be at variance to conditions indicated by Drawings, Specifications, or geotechnical reports, and subject to Article 23 of the General Conditions, the Contract Price may be adjusted as provided in this Article for changes in the Work upon claim by either party made in writing within a reasonable time after the first observance of the conditions; PROVIDED, however, that the Contractor shall in any event give written notice to the Owner before proceeding to execute any change resulting from subsurface conditions; and PROVIDED FURTHER; that the Owner shall not be liable to the Contractor for any claim occasioned by the aforesaid subsurface conditions except in accordance with and pursuant to authorization of the Owner issued in writing prior to commencement of execution of the aforesaid change to which authorization the Contractor shall have taken no exception. If exception to the authorization be taken by the Contractor, the Owner may issue an order pursuant to Article 29(i). Commencement of execution of work pursuant to Article 29(i) shall not exclude the recovery of damages by the Contractor under other Articles of the General Conditions, but the cost to the Owner for the changes executed pursuant to the aforesaid order shall not exceed the "net allowable expenditures" permitted to the Contractor under Article 29(i) plus the "allowance for overhead and profit" permitted under

Article 29(i).

(g) *Rock.*—If rock, as hereinafter defined, is encountered, no claim for additional compensation for changes shall lie against the Owner in the absence of previous authorization by the Owner in writing, and the cost to the Owner for any changes shall be determined as provided in this Article. ***CAUTION: No rock for which extra compensation is expected to be received shall be removed except pursuant to and in conformity with a written authorization or order of the Owner.*** Shale, rotten stone, or stratified rock that can be loosened with a pick or removed by a backhoe or similar equipment shall not be classified as rock. Rock is defined as follows: any material which cannot be excavated with conventional equipment, and must be removed by drilling, chemical cracking, or blasting, and occupies an original volume of at lease one-half cubic yard.

(h) *Existing Conditions.*—The Contractor in undertaking the Work under this Contract is assumed to have visited the premises and to have taken into consideration all conditions which might affect the Work. No consideration will be given any claim based on lack of knowledge of existing conditions except where existing conditions are such as cannot be readily ascertained. Any claims relating to conditions which were not readily ascertainable shall be adjusted as provided in this Article for changes in the Work.

(i) *Cost to Owner, Allowances for Contractor, and Allowable Expenditures.*—In Cases (a) and (c), above, the "allowance for overhead and profit" combined, included in the total cost to the Owner, shall be based upon the following schedule:

(1) For the Contractor an allowance for Work which it performs with its own forces, not to exceed 16% of its "net additional allowable expenditures", if any, for changes.

(2) For a Subcontractor an allowance for Work which it performs with its own forces, not to exceed 16% of its "net additional allowable expenditures", if any, for changes. A Subcontractor shall receive no allowance for overhead and profit on Work not performed by its own forces. Under these Contract Documents, the forces of a Sub-subcontractor of a Subcontractor are deemed to be and are the forces of the Subcontractor.

(3) For the Contractor an allowance for Work performed by its Subcontractor, not to exceed 10% of the amount, if any, due the Subcontractor for changes.

The above percentages shall be applied to the "net additional allowable expenditures", if any, as limited and defined herein. If the net difference between "allowable expenditures" and savings results in a decrease in expenditures, the amount of credit allowed the Owner shall be the net decrease without any credit for profit and overhead. "Net additional allowable expenditures" as used herein shall mean the difference between all "allowable expenditures" and savings. The term

"allowable expenditures" is limited to and defined as items of:

(1) Labor which is defined as the specific labor wages including a thirty percent (30%) markup on the cost of direct payroll wages. The Contractor shall furnish, if required by the Owner, certified payrolls to verify wages.

(2) Material delivered and used on the designated Work, including sales tax, if paid for by the Contractor and as verified by original invoices or otherwise verifiable to the Engineer's acceptance.

(3) Rental, or Ownership cost of equipment, including necessary transportation of equipment, having a purchase value in excess of $300.00. Rental or Ownership cost will be allowed for only those hours during which the equipment is required on the Project site. Cost allowances will not exceed the rates defined as follows: the hourly rate, for equipment not used exclusively in the change to the scope of Work, will be the monthly rate, as printed in the current Rental Blue Book for Construction Equipment published by Dataquest, divided by 176; the rate, for equipment used exclusively for those tasks identified in the change to the scope of Work, will be the daily, weekly or monthly rate, used singularly or in combination, which will provide the lowest total cost. The rates will be modified by the Rate Adjustment Table factors to reflect a depreciation allowance indexed to the year a machine was originally manufactured and sold. The rates will be adjusted to account for regional differences in annual use hours, cost of labor, freight, taxes, etc. The amount by which basic rates will be increased or decreased is shown on the adjustment maps included in the "Blue Book". The equipment use period will begin only at the time equipment is unloaded at the site of the changed Work; will include each day that the equipment is required at the site of the changed Work; and will terminate at the end of the day on which the use of such equipment becomes unnecessary, plus reasonable transportation time. The maximum time to be paid per day will not exceed eight hours unless the equipment is in operation for a longer time. The time which will be paid for per day for equipment not used exclusively in the change to the scope of Work, will be the hours which the equipment was actually in operation on the changed Work.

(4) In cases where there is an extension of the Contract Time, *pro rata* expenditures for time of foremen employed in the direct superintendence of productive labor in execution of changes.

All expenditures not included in the term "allowable expenditures" as limited and defined in this Article shall be considered as overhead, including, but not limited to, bond premiums, supervision, travel (meals, transportation, and lodging), superintendence [except *pro rata* time of foremen as referred to herein], timekeepers, clerks, watchmen, hand tools, small tools, incidental job burdens, engineering, drafting, and office expense. Any other provisions in the Contract Documents to the

contrary notwithstanding, only demonstrable, direct, out-of-pocket expenditures for the changes plus percentages as set forth hereinabove shall be allowable for changes. No wages of a foreman shall be allowable for a change carried on concurrently with contract Work unless the claim includes a demand for extension of time caused by the authorizing or ordering of the change.

(j) *Execution of Changes Pursuant to Order.*—In the event neither Case (a) nor Case (b) can be mutually agreed upon as the method of determining the cost to the Owner for a change, the Contractor, provided it receives a written order from the Owner, shall proceed on force account under Case (c), and he shall keep and present in such form as the Engineer may direct a correct account of the expenditures together with vouchers. Allowable expenditures shall in no event exceed current costs for like services and materials, the burden of proof being on the Contractor.

(k) *Stipulated Maximum Sum.*—Under Case (b) and Case (c), the Owner shall prescribe the limits of any authorization or order for a change by means of an authorization or order in writing stipulating the maximum sum of money committed toward execution of the said change, and the Contractor shall have no authority to perform any change which will cost the Owner in excess of the stipulated maximum sum. It shall be solely the Contractor's responsibility ***to apply in writing to the Owner, NOT [repeat NOT] to the Engineer***, for an enlargement of the scope of the authorization or order by an increase in the said stipulated maximum sum if during the course of the performance of a change on force account under Case (c) the additional cost of the change to the Owner as established in accordance with allowable expenditures and allowances for profit and overhead permitted under Article 29(i) is approaching, or may exceed, the said stipulated maximum sum. It shall likewise be the responsibility of the Contractor to apply for an enlargement of the scope of the authorization or order if the total value of units at any agreed unit price under Case (b) is approaching the said stipulated maximum sum. For changes in the Work no claim for payment, repayment, reimbursement, remittance, remuneration, compensation, profit, cost, overhead, expense, loss, expenditure, allowance, charge, demand, hire, wages, salary, tax, cash, assessment, price, money, bill, statement, dues, recovery, restitution, benefit, recoupment, exaction, injury or damages shall lie against the Owner for any amount in excess of such amount as shall have been mutually agreed to under Case (a) or in excess of such amount as shall have been established as the stipulated maximum sum under Case (b) or Case (c). The cost to the Owner for any change in the Work, except a change based upon agreed unit prices under Case (b), shall be established in accordance with the schedule of allowances and percentages stipulated under Article 29(i).

(l) *Breakdown of Expenditures.*-To accompany all Change Orders, the Contractor shall furnish a breakdown of expenditures for labor and materials by units and quantities in the form prescribed by the Owner, and the breakdown shall be accompanied by the following declaration: "I do solemnly swear, under criminal penalty, that the costs shown hereinabove do not exceed current costs for like services or materials and do not exceed the actual costs to the Contractor therefor, and that the quantities shown do not exceed actual requirements." For all force account changes, the Contractor shall promptly, and in no event later than thirty (30) days after receipt of written demand therefor, pursuant to Article 29(i) submit to the Engineer a complete, accurate, and final breakdown

and account together with vouchers, showing all expenditures and percentages allowable under Case (c). For all unit price changes, the Contractor shall promptly, and in no event later than thirty (30) days after receipt of written demand therefor, pursuant to Article 29(i) submit to the Engineer an accurate account of the quantity of Work performed under Case (b). In any case, the Engineer shall certify to the amount [including under Case (a) and Case (c) the allowance prescribed in the Contract for overhead and profit] due the Contractor. The Contractor shall obtain and furnish as back-up to the Contractor's breakdown a separate breakdown for each Subcontractor's charges prepared by each Subcontractor on the letterhead of the Subcontractor and properly signed by the Subcontractor.

(m) *Payment on Account.*—If the Contractor desires to obtain payment on account before any change in the Work has been completed, a Change Order certified by the Engineer and signed by the Contractor and the Owner must have been executed for so much of the change as has been completed at the time of the filing of the request for payment on account.

(n) *Form and Execution of Change Orders.*—Change Orders shall be recommended by the Engineer and signed by the Contractor and the Owner in accordance with the form of change order prescribed by the Owner. No request for payment of the Contractor for account of a change shall be due, nor shall any such request appear on a progress payment request or demand for final payment until (1) the Change Order shall have been certified by the Engineer and (2) a Change Order shall have been executed by the Contractor and the Owner.

(o) *Claims Distinguished from Changes.*— Claims for damages arising out of alleged negligence of the Engineer or Owner as provided for under Article 37 of the General Conditions are distinguished from claims for allowances for changes as provided for under Article 29. Claims for damages must be filed entirely separately pursuant to Article 37 of the General Conditions and claims for allowances for changes must be filed entirely separately pursuant to Article 29 unless the Contractor and Owner agree in writing otherwise.

(p) *Conditions Different from Those Indicated in Contract Documents.*—The parties contemplate delays necessary to complete tests, to redesign, and to perform change order Work in the event conditions encountered at the site are different from those indicated in the Contract Documents, or to perform change order Work to correct errors and omissions in the Drawings and Specifications. Execution of any change must be authorized. In such event there shall be an adjustment in the Contract Price as provided in the Contract for changes in the Work, but no claim for damages shall lie against the Owner for the aforesaid delays. Such delays are not a breach of contract because the parties contemplate such delays as a natural and probable consequence of construction operations. The parties agree that such delays constitute no wrong or injury, create no right to a claim for damages, and are not a ground for claiming extraordinary remuneration.

(q) *Unit Prices.*— The term "net" as used in reference to "unit prices" means in respect to Change Orders performed in accordance with Case (b) of Article 29 of the General Conditions that

the unit prices offered by the Contractor and accepted by the Owner shall be inclusive of all sums for payment, repayment, reimbursement, remittance, remuneration, compensation, profit, cost, overhead, expense, loss, expenditure, allowance, charge, demand, hire, wages, salary, tax, cash, assessment, price, money, bill, statement, dues, recovery, restitution, benefit, recoupment, exaction, or injury. Upon request of the Owner in writing and within such reasonable space of time as the Owner shall designate in writing, the Contractor shall submit for consideration of the Owner proposals in writing for unit prices to be applied in the event Work is authorized by the Owner to be performed under Case (b) of Article 29. Under penalty of false swearing, a principal of the contracting firm shall certify that the unit prices submitted do not exceed current costs for like services or materials.

(r) *Combining Small Change Orders.*—The Owner may, with the Contractor's concurrence, elect to postpone the issuance of a Change Order until such time that a single Change Order of substantial importance can be issued incorporating several changes. In such cases, the Owner will indicate this intent for each change in the Contract in a written notice to the Contractor, following agreement by the Owner and Contractor on the scope, price and time, if any, of the change.

(s) *Changes in the Contract Time.*—The Contract Time may be changed only by a Change Order. Changes in the Work described in section (a) of this Article and any other claim made by the Contractor for a change in the Contract Time will be evaluated by the Engineer and if the conditions warrant, an appropriate adjustment of the Contract Time will be made. The Engineer, when making these evaluations will take into consideration the amount and scope of Work which has been changed and will evaluate if the change in Work has affected the Critical Path as currently accepted on the Progress Schedule such that it would delay the completion of the Project. If after these evaluations have been made, and in the sole opinion of the Engineer the Contractor is due an extension of the Contract Time, then it will be granted by a Change Order. Extensions of the Contract Time granted as a result of weather will not result in a change in Contract Price.

(t) *Effect of Executed Change Order.*-The execution of a Change Order by the Contractor shall constitute conclusive evidence of the Contractor's agreement to the ordered changes in the Work, the Contract as thus amended, the Contract Price and the Contract Time. The Contractor, by executing the Change Order, waives and forever releases any claim against the Owner for additional time or compensation for matters relating to or arising out of or resulting from the Work included within or affected by the executed Change Order. The foregoing waiver and release expressly includes, without limitation, claims for additional compensation or time based on the theory that the Contractor has suffered so-called "impact" damage attributable to the effect of change order Work on other change orders Work or on unchanged Work.

Article 30. - Payments and Completion.—(a) *Contract Price.*— The Contract Price is either a lump sum or the sum of the unit prices stated in the Contract Agreement, for each item multiplied by the actual quantities installed of each item, and is the total amount payable by the Owner to the Contractor for the performance of the Work set forth in the Contract Documents. It is understood

that the Contractor shall provide and pay for all products, labor, (including labor performed after regular working hours, on Sundays, or on legal holidays), equipment, tools, water, light, power, sewer, transportation, supervision, temporary construction of any nature, and all other services and facilities of any nature whatsoever necessary to execute, complete, place into operation, and deliver the Work.

(b) *Application for Payment and Receipts.*—The Contractor shall submit to the Engineer in accordance with a form to be supplied by the Owner an application for each monthly progress payment, and, if requested by the Owner or Engineer, receipts or other vouchers, showing his payments for materials and labor, including payments to Subcontractors as required by Article 10 of the General Conditions.

(c) *Progress Payments.*—If progress payments are made on valuation of Work done, such complete application shall be submitted to the Engineer at least twenty (20) days before payment falls due. In applying for payments, the Contractor shall submit a statement based upon the Schedule of Values on a progress payment form to be supplied by the Owner, and, if requested by the Engineer or Owner, itemized in such form and supported by such evidence as the Engineer or Owner may direct showing the Contractor's right to the payment claimed.

(d) *Materials stored.*—Application for payment may include, at the Contractor's option, the cost of products not yet incorporated into the Work which have been delivered to the site or to other storage locations authorized and approved by the Engineer. The Owner reserves the right to accept or reject pay requests for stored materials, and to limit payments to those stored materials which, in the Engineer's judgment, are necessary for continuing satisfactory Project progress.

Payment for stored products will be subject to the following conditions being met or satisfied:

(1) The products shall be received in a condition satisfactory for incorporation in the Work, including manufacturer's storage and installation instructions;

(2) The products shall be stored in accordance with the manufacturer's recommendations and in such manner that any and all manufacturer's warranties will be maintained and that they will not be damaged due to weather, construction operation, or any other cause;

(3) An invoice from the manufacturer shall be furnished for each item on which payment is requested. The request may include reimbursement for cost of delivery, limited to common carrier rates, to the site, but will not include the Contractor handling, on or off site, or for storage expense;

(4) The Contractor shall, on request of the Engineer, furnish written proof from the supplier of payment (less retention equal in percentage to that being retained by the Owner) for

the products no later than 30 days after receipt of payment for same from the Owner. The Owner will have the right to deduct from the next payment estimate an amount equal to the payment for products if reasonable and adequate proof is not submitted; and,

(5) Shop drawings, product data and samples, showing "No Exceptions Taken", have been received from the Contractor for that specific equipment or material.

(e) *Operating Test Period.*—Upon receipt of written notice from the Contractor that the Work is ready to be placed into service for the operating test period, the Engineer will, within a reasonable time, inspect the Work. Prior to initiating the operating test, Work required by the Contract Documents must be in place and operable as determined by the Engineer, which includes, but is not limited to the following:

(1) Pressure testing all lines as required in the Specifications;

(2) Making adjustments of manhole rims;

(3) Performing functional tests and providing manufacturers' required certification as specified;

(4) Removing temporary plugs, bulkheads, bypasses, etc., and diverting flow into the facility when directed by the Engineer; and,

(5) All painting, grassing and restoration of the Work area, provided the Work area is not part of another segment not yet in the 30-day operating test period.

When the Engineer finds the Work of the Contractor ready for initiation of the operating test period, the Engineer will recommend to the Owner that the operating test period begin.

Certain segments of the Work, whether new or existing to be modified, may need to be placed in service prior to completion of the entire Project. Prior to placing these segments in operation, the requirements above, which pertain to the operating test period, must be complete for each segment.

The operating test period begins upon written notification from the Owner and runs for a period of 30 days. During this period, the Contractor shall complete all remaining items of Work, make adjustments found to be necessary, and ensure that all equipment and systems are functioning properly, and continue to function properly. The beginning of the operating test period initiates the Owner's responsibility for providing chemicals, power, and operating personnel. The Contractor retains responsibility for maintaining equipment until acceptance by the Owner. The segments to be placed into service prior to completion of the entire Project will be determined solely by the Engineer or the Owner.

(f) *Conditions Precedent to Application for Final Payment.*—ALL WORK REQUIRED BY THE CONTRACT DOCUMENTS MUST BE COMPLETED BEFORE THE FINAL INSPECTION IS PERFORMED. This includes, but is not limited to, the following:

(1) Performing infiltration and pressure tests as described in the detailed Specifications;

(2) Removing temporary plugs, bulkheads, bypasses, etc.;

(3) Flushing all lines with potable water furnished by Contractor;

(4) Pressure testing all lines as required in the Specifications;

(5) Demonstrating the operation of all valves;

(6) Providing specified instruction for the Owner's personnel;

(7) Disinfecting all water mains as required in the Specifications; and,

(8) Grassing and restoration of the Work area.

(g) *Notification of Readiness for Final Inspection.*—When all conditions precedent for the application have been completed, the Contractor shall submit completed Record Drawings to the Engineer and give notice to the Engineer in accordance with Article 5 of the Contract Agreement with a copy to the Owner in the following words:

The work on the Contract for the Amerson Water Treatment Plant Generator Fueling System Replacement having been fully completed except as stipulated hereinbelow, it is requested that a final inspection be made promptly by the Engineer in accordance with Article 5 of the Contract Agreement. The following Work is incomplete through no fault of the Contractor:

No final inspection shall be made until such time as the Engineer has received a letter in the exact form indicated above and a copy thereof has been received by the Owner. In the event the Contractor shall have issued the "Notice of Readiness for Final Inspection" prematurely [hereinafter referred to as "false start"] he shall be liable for the damage resulting from the aforesaid false start including but not limited to the salaries, professional fees, and travel and living expenses of the persons or parties inconvenienced by the aforesaid false start. The Contractor acknowledges and agrees that he has an indivisible, non-delegable, and non-transferable contractual obligation to the Owner to make its own inspections of the Work at all stages of construction; and the Contractor shall supervise and superintend performance of the Contract in such manner as to enable it to confirm and corroborate at all times that all Work has been executed strictly, literally, rigidly, and inflexibly in accordance with the methods and materials designated in the Contract Documents so

that (a) its certifications on periodical estimates shall be true and correct and (b) its notice of readiness for final inspection shall be true and correct. Accordingly, the Contractor agrees that it may not defend or excuse any deviation from the Contract Documents on the ground (a) that the deviation was not brought to its attention by another person or party or other persons or parties or (b) that a Subcontractor is, or Subcontractors are, at fault.

(h) *Final Acceptance.*—If the Engineer finds the Work of the Contractor complete and acceptable in accordance with the provisions of the Contract Documents and that the Record Drawings accurately depict the complete Work, the Engineer will recommend to the Owner that the Project be accepted and that final payment be made. In the event that the final inspection reveals deficiencies in meeting the Contract requirements, the Contractor shall complete all remaining items of Work, and make adjustments found to be necessary. Upon receipt of written notice from the Contractor that the Work is complete and ready for re-inspection, the Engineer will make another final inspection. The Contractor will be notified, in writing, by the Owner of the final acceptance of the Work. The date of final acceptance shall be the beginning of the warranty period.

(i) *Liens.*—Neither the final payment or any part of the retained percentage shall become due until the Contractor has furnished the Owner proper and satisfactory evidence (under oath if required) that all claims for labor employed and materials used in the construction of the Work under this Contract have been paid, satisfied or waived, and that no claims can be filed against the Owner for such labor or materials. If required, the Contractor shall deliver to the Owner a complete release of all liens or claims arising out of this Contract, and an affidavit that so far as it has knowledge or information the releases include all labor and materials for which a lien or claim could be filed; provided, however, that the Contractor may, if any Subcontractor or claimant refuses to furnish a release, furnish a bond satisfactory to the Owner to indemnify the Owner against any lien or claim. If any lien or claim remains unsatisfied after all payments are made, the Contractor shall refund to the Owner all moneys that the Owner may be compelled to pay in discharging such lien or claim, including all costs and a reasonable attorneys' fees.

(j) *Compliance with O.C.G.A. §§ 13-10-80 and 13-10-81.*—For purposes of O.C.G.A. § 13-10-80(b) the term "substantial completion of the Work" shall mean that "the Work has been satisfactorily completed and is accepted in accordance with the Contract Documents." If upon completion of the second "final" inspection provided for in subsection (g) of this Article there are still remaining (i) any disputed indebtedness or (ii) if there are liens upon the property, or (iii) there are any items of Work uncompleted which in the opinion of the Engineer are "incomplete items" within the meaning of O.C.G.A. §§ 13-10-80(b)(2)(B) and/or 13-10-81(c), an amount equal to two hundred percent (200%) of each such item of indebtedness, lien or uncompleted Work as determined by the Engineer shall be withheld until such item or items are paid, settled or completed and the remaining retainage shall be paid to the Contractor.

Article 31. - Certificates of Payment.—(a) *Issuance.*—If the Contractor has made application for payment as provided under Article 30, the Engineer shall not later than the date when each payment

falls due issue to the Owner a certificate for such amounts as he decides to be properly due or state in writing his reasons for withholding a certificate.

(b) *Warranty of Title.*—The Contractor warrants that title to all Work and products covered by a Certificate of Payment, whether incorporated into the Project or not, will pass to the Owner upon the receipt of such payment by the Contractor, free and clear of all liens, claims, security interests or encumbrances except retention equal in percentage to that being retained by the Owner.

(c) *Effect.*—No Certificate issued, or payment made to the Contractor, or partial or entire use of occupancy of the Project by the Owner shall be an acceptance of any Work or materials not in accordance with the Contract Documents. The making of the final payment shall constitute a waiver of all claims by the Owner other than those arising from unsettled liens, from faulty work appearing after final payment, or from the requirements of the Contract Documents, including but not limited to the provisions of Article 5, Hazards and Indemnification, of these General Conditions. Acceptance of the final payment shall operate as and shall be a release by the Contractor to the Owner from all claims of any kind or character arising out of or related to the Contract except for such specific amount or amounts as may have been withheld to cover the fair value of any incomplete Work which has been certified by the Engineer under the provision of Paragraph (d) of Article 5 of the Contract Agreement as incomplete through no fault on the part of the Contractor.

(d) *Date and Rate of Payment.*—Progress payments will be made by the Owner to the Contractor in accordance with Article 4 of the Contract Agreement. Final payment will be made in accordance with Article 5 of the Contract Agreement. The date and rate of payment are subject to Article 32 of the General Conditions. Sums retained pursuant to this Article are and remain the property of the Owner until such time as the Contractor shall have become entitled to receive payment of such retainage by complying with the full terms of the Contract Documents.

(e) *Delays in Making Payments.*—The date on which any progress payment is due shall be extended for such period of time as may be necessary in the determination of the Engineer for the Contractor to remedy any incorrect or incomplete application for payment.

(f) *Interest.*—Should the Owner fail to pay the sum named in any certificate of the Engineer when due, the Contractor shall receive, in addition to the sum approved in the certificate, simple interest thereon at the legal rate; PROVIDED, however, that the Contractor shall have given the Owner written notice of the date on which payment was properly due, and no interest shall be payable if the Owner makes payment when due or within three days after receipt of the aforesaid notice from the contractor. Such notice shall be in writing, and shall set forth:

(1)— A short and concise statement that interest is due pursuant to this Article;
(2)— The principal amount of the progress or final payment which is allegedly due to the Contractor; and,
(3)— The first day and date upon which the Contractor alleges that interest will begin to

accrue, pursuant to this Article.

(g) *Integration with the Prompt Pay Act (O.C.G.A. § 13-11-1, et seq.).*—The provisions of the Contract Documents with respect to time limits for payments, grounds for withholding payment, conditions authorizing payments, and interest on late payments shall supersede all provisions of the Georgia Prompt Pay Act, as originally enacted or as amended, and any dispute arising between the parties hereto as to whether or not the provisions of this Contract or the Georgia Prompt Pay Act control will be resolved in favor of the terms of these Contract Documents.

Article 32. - Payments Withheld.—The Engineer may withhold or, on account of subsequently discovered evidence, nullify the whole or a part of any certificate to such extent as may be necessary to protect the Owner from loss on account of:

(a)—Defective work not remedied;

(b)—Claims filed or reasonable evidence indicating probable filing of claims;

(c)—Failure of the Contractor to make payments properly to Subcontractors or for materials or labor;

(d)—A reasonable doubt that the Project can be completed for the unpaid balance of the Contract Price.

(e)—Damage to another Contractor or to some third party;

(f)—Failure to maintain a rate of progress in accordance with the currently approved construction progress schedule;

(g)—Failure to supply enough skilled workers or proper materials; or,

(h)—Failure to complete all Work within the Contract Time.

When the above grounds are removed, the Engineer shall issue to the Owner a certificate for such withheld amounts as he determines to be properly due, and the Owner shall pay such amounts within ten (10) days. At the option of the Owner adherence to the construction progress schedule shall be a condition precedent to the right of the Contractor to demand payment of a progress payment. No omission on the part of the Owner to exercise the aforesaid option shall be construed to be a waiver of breach of the construction progress schedule or acquiescence therein, and the Owner may exercise its option from time to time as often as may, in its judgment, be expedient.

Article 33. - Notice of Commencement.—See Notice to Proceed, as used throughout these General Conditions.

Article 34. - Correction of Work after Final Payment.—Neither (1) the final certificate, (2) or any decision of the Engineer, (3) nor payment, (4) nor any provision in the Contract shall relieve the Contractor of responsibility for faulty materials, faulty workmanship, or omission of Work required by the Contract Documents, and the Contractor shall remedy any defects or supply any omissions resulting therefrom and pay for any damage to other Work resulting therefrom. The Owner shall give notice of observed defects or omissions with reasonable promptness. The Contractor shall within the time designated in orders of condemnation and without expense to the Owner, correct, remedy, replace, re-execute, supply omitted Work, or remove from the premises all Work condemned by the Engineer. The Contractor shall give prompt notice in writing to the Engineer, with copy to the Owner, upon completion of the supplying of any omitted Work or the correction of any Work condemned by the Engineer. In the absence of said notice, it shall be and is presumed under this Contract that there has been no correction of the condemned Work or supplying of omitted Work. If the Contractor does not remove, make good the deficiency, correct, or remedy faulty Work, or supply any omitted Work within the time designated in orders of condemnation without expense to the Owner, the Owner, after ten (10) days' notice in writing to the Contractor, may remove the Work, correct the Work, remedy the Work or supply omitted Work at the expense of the Contractor. In case of emergency involving health, safety of property, or safety of life the Owner may proceed at once. Correction of defective Work executed under the Contract Documents or supplying of omitted Work, whether or not covered by warranty of a Subcontractor or materialmen, remains the primary, direct responsibility of the Contractor. The foregoing obligation of the Contractor shall remain in effect until the same shall have been extinguished by operation of the statute of limitations.

As additional security for the fulfillment of such obligation, but in no way limiting the same, the Contractor warrants and guarantees (1) that all work executed under the Contract Documents shall be free from defects of materials or workmanship for a period of one year from the notice of final acceptance of the Work by the Owner, and (2) that for not less than one year from such final acceptance, or for such greater time as may have been designated in the Contract Documents, products of manufacturers shall be free from defects of materials and workmanship. Whenever written guaranties or warranties are called for, the Contractor shall furnish the aforesaid for such period of time as may be required. The aforesaid instruments shall be in such form as to permit direct enforcement by the Owner against any Subcontractor, materialmen, or manufacturer whose guaranty or warranty is called for, and the Contractor agrees that:

(a) The Contractor is jointly and severally liable with such Subcontractors, materialmen, or manufacturers;

(b) The said Subcontractors, materialmen, or manufacturers are agents of the Contractor for purposes of performance under this Article, and the Contractor, as principal, ratifies the warranties or guaranties of his aforesaid agents by the filing of the aforesaid instruments with the Owner. The Contractor as principal is liable

for the acts or omissions of his agents;

(c) Service of notice on the Contractor that there has been breach of any warranty or guaranty will be sufficient to invoke the terms of the instrument; provided, however, that the Owner shall have furnished the Contractor with a copy of notice served on the Subcontractor, materialmen, or manufacturer; and,

(d) The Contractor will bind his Subcontractor, materialmen, and manufacturers to the terms of this Article.

The calling for or the furnishing of written warranties shall in no way limit the contractual obligation of the Contractor as set forth hereinabove. The remedies stated in this Article are in addition to the remedies otherwise available to the Owner, do not exclude such other remedies, and are without prejudice to any other remedies.

Article 35. - Cash Allowances.—The Contractor shall include in the Contract Price all cash allowances named in the Contract Documents and shall cause the Work thus covered to be done by such contractors or firms and for such sums as the Engineer may direct, the Contract Price being adjusted in conformity therewith. The Contractor declares that the Contract Price includes such sums for overhead and profit on account of cash allowances as he deems proper. No demand for overhead and profit other than those included in the Contract Price shall be allowed. The Contractor shall not be required to employ for any such Work persons against whom he has a reasonable objection.

Article 36. – Contractor's Warranty as to Performance.—The Contractor warrants that it is familiar with the codes applicable to the Work and that it has the skill, knowledge, competence, organization, and plan to execute the Work promptly and efficiently in compliance with the requirements of the Contract Documents. The Contractor having the obligation to keep a competent superintendent engaged on the Work during its progress, to employ only skilled mechanics, and to enforce strict discipline and good order among its employees, the Contractor, itself, is responsible for seeing that the Work is installed in accordance with the Contract Documents. Failure or omission on the part of the Owner, representatives of the Owner, agents of the Owner, resident engineer inspector, clerk-of-the-works, engineers employed by the Engineer, representatives of the Engineer, or the Engineer either to discover or to bring to the attention of the Contractor any deviation from, omission from, or noncompliance with the Contract Documents shall not be asserted by the Contractor as a defense for failure on the Contractor's part to install the Work in accordance with the Contract Documents or for any other neglect to fulfill requirements of the Contract; nor shall the presence of any one, or all, or any of the foregoing at the site or the fact that any one, or all, or any of the foregoing may have examined the Work or any part of it be asserted as a defense by the Contractor against a claim for failure on its part to install the Work in accordance with the Contact Documents or for any neglect to fulfill requirements of the Contract. No requirement of this Contract may be altered or waived except in pursuance of a written order of the

Owner and in strict accordance with the provisions in the Contract for changes in the Work.

Article 37. - Claims.—(a) *Extra Cost.*—If the Contractor maintains that any instructions by drawings or otherwise involve extra cost to the Owner under this Contract, the Contractor shall give the Owner and the Engineer written notice thereof within a reasonable time after the receipt of such instructions, and in any event before proceeding to execute any change except in emergency endangering life or property. The allowances to the Contractor shall then be as provided under Article 29 of the General Conditions. No claim for extra cost shall be valid unless so made.

(b) *Protest.*—All references to arbitration are deleted from the Contract Documents. Decisions of the Engineer shall be rendered in all cases as provided for under the General Conditions of the Contract, but no decision of the Engineer shall deprive the Owner or the Contractor of any form of redress which may be available under the laws of the State of Georgia to contracting parties. Any decision of the Engineer shall be final and binding on the Contractor in the absence of written notice of protest from the Contractor received by the Owner by registered mail within twelve (12) days of the date of the decision of the Engineer. The Owner shall have twelve (12) days from the date of receipt of a protest within which to investigate and make a reply. There is no provision under the Contract for execution of work "under protest". A protest must contain (1) the date of the decision of the Engineer to which exception is taken, (2) a statement of the issue or issues, (3) a citation of the provision or provisions of the Contract Documents which govern the issue or issues, (4) a summary of the logical principle or principles on which the protest is based, and (5) a summary of the legal grounds for taking exception. Filing a written notice of protest shall not be grounds for an extension of the Contract Time.

(c) *Shall be Based on the Legal Assertions of the Contractor.*—The Contractor shall assert claims solely on the basis of (a) principles of logic and (b) principles of law to which the Contractor, itself, has prescribed. The Contractor shall not protest a decision or request a conference on the ground merely that a Subcontractor, materialmen, or supplier has protested to the Contractor. Accordingly, the Contractor shall neither file a claim or make a request for a conference with the Owner regarding a claim except as it shall be for the purpose of asserting in the exercise of the Contractor's best judgment such views, requests, and legal propositions as he deems the Contractor is entitled to maintain independently of any right of any Subcontractor, materialmen, or supplier against the Contractor.

(d) *Conference with the Owner.*—

(1) *Effect of.*—The Owner has no legal obligation to confer orally with the Contractor about the terms of the Contract or its performance and may insist that all transactions and all intercourse shall be in writing. Agreement of the Owner to confer with a Contractor shall not be construed as an offer of the Owner to reconsider or alter the Owner's policies, practices, procedures, or prior position, and no such agreement shall constitute a waiver of any right or defense of the

Owner. Such a conference is without prejudice to any rights or defense of the Owner. After the conference there will be nothing to confirm since the Owner does not engage itself to do or not to do a thing by agreeing to confer with the Contractor. It is expressly agreed that no conference between the Contractor and the Owner shall cure any failure of the Contractor to give any notice nor shall it cure any breach of any time limit or revive any right in the Contract.

(2) *Conditions precedent to.*—A proposal from the Contractor for a conference in respect to (a) a dispute, (b) a controversy, or (c) an interpretation or construction of any provision of the Contract Documents shall contain (a) a statement of the issue or issues, (b) a citation of the provisions of the Contract Documents which govern the issue or issues, (c) a precise summary of the logical principle or principles on which the issue or issues are based, and (d) a summary of the legal grounds which the Contractor takes with respect to the issue or issues.

(3) *Basis for and Terms of.*—All conferences between the Owner and the Contractor shall be pursuant to, under the terms of, and in accordance with this Article of the General Conditions.

Article 38. - Use of Premises.—The Contractor shall confine its equipment, apparatus, the staging and storage of materials, the operations of its forces, and the Work to limits indicated by law, ordinances, permits, or the Contract Documents and shall not unreasonably encumber the premises with materials. The Contractor shall not load or permit any part of the Work to be loaded with weight that will endanger its safety. The Contractor shall enforce the Engineer's instructions regarding signs, advertisements, fires, and smoking.

Article 39. - Specification Arrangement.—The Specifications are separated into numbered and titled divisions for convenience of reference. Neither the Owner nor the Engineer assumes any responsibility for defining the limits of any subcontracts on account of the arrangement of the Specifications. Notwithstanding the appearance of such language in the various divisions of the Specifications as, "The Mechanical Contractor", "The Electrical Contractor", "The Roofing Contractor", etc., the Contractor is responsible to the Owner for the entire Contract and the execution of all of the Work referred to in the Contract Documents.

Article 40. - Valuable Material, Geological Specimens.—If during the execution of the Work the Contractor, any Subcontractor, or any servant, employee, or agent of either should uncover any valuable material or materials such as, but not limited to, treasure, geological specimen or specimens, archival material or materials, or ore, the Contractor acknowledges that title to the foregoing is vested in the Owner. The Contractor shall notify the Owner upon discovery of any of the foregoing, shall guard it, and shall deliver it promptly to the Owner. The Contractor agrees that the Geologic and Water Resources Division of the Georgia Department of Natural Resources may inspect the Work at reasonable times consistent with the convenience of the Contractor.

Article 41. - Definitions.—(a) *Applicable Law.*—This Contract shall be governed by the law of Georgia.

(b) *Article Not Plenary.*—This Article is not entire, plenary, or exhaustive of all terms used in the General Conditions which require definition. There are definitions of other terms under Articles to which the terms are related.

(c) *Balanced Bid.*—Balanced Bid shall mean a Bid in which each of the unit prices and total amount bid for each of the listed items reasonably reflects the value of that item with regard to the entire Project considering the prevailing cost of labor, material and equipment in the relevant market. A Bid is unbalanced when, in the opinion of the Owner, any unit prices or total amounts Bid on any of the listed items do not reasonably reflect such actual values.

(d) *Change Order Form.*—The Change Order Form is the instrument by which adjustments in the Contract Price and Contract Time are effected pursuant to changes made in accordance with Case (a), Case (b) or Case (c) of Article 29 of the General Conditions or in accordance with Subparagraph (i) of Article 29 of the General Conditions. The Change Order Form shall be accompanied by a breakdown in the form prescribed in a specimen, which the Owner will supply to the Contractor. The Engineer shall certify to the amount of the adjustment. The Change Order Form shall be signed by the Contractor and the Owner. The breakdown is only for the purpose of enabling the Engineer and the Owner to make a judgment on the dollar amount of the adjustment in the Contract Price. No condition, term, qualification, limitation, exception, exemption, modification, or proviso shall appear in the breakdown. The breakdown shall be in the exact form and language of the above-mentioned specimen. In the event any condition, term, qualification, limitation, exception, exemption, modification, or proviso shall appear in a breakdown, it shall be invalid.

(e) *Contract; Contract Documents.*—The terms Contract and Contract Documents include the Invitation to Bid, Instructions to Bidders, Contractor's Bid (including all documentation accompanying the Bid and any post-Bid documentation required by the Owner prior to the Notice of Award), the Contract Agreement, Bonds, all Special Conditions, General Conditions, Supplementary Conditions, Specifications (Divisions 01 through 46, inclusive), Drawings, and Addenda, together with written amendments, Change Orders, field orders and the Engineer's written interpretations and clarifications issued in accordance with the General Conditions on or after the date of the Contract Agreement. Shop drawing submittals reviewed in accordance with the General Conditions, geotechnical investigations and soils reports, and drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the site are not Contract Documents.

(f) *Contract Time.*—Contract Time shall mean the number of consecutive calendar days as provided in the Contract Agreement for substantial completion of the Project, to be computed from

and including the date of the Notice to Proceed. All time limits stated in the Contract Documents or shown on the construction progress schedule are of the essence of the Contract.

(g) *Contractor.*—The Contractor shall mean the party identified in the Contract Agreement and its authorized and legal representatives.

(h) *Cross-reference and Citations of Articles and Paragraphs of the General Conditions.*—Cross-references and citations of Articles and paragraphs of the General Conditions are for the convenience of the Contractor, Engineer and the Owner, and are not intended to be plenary or exhaustive nor are they to be considered in interpreting the Contract Documents or any part of the Contract Documents.

(i) *Engineer.*—The Engineer shall mean _____(if no Engineer, put Macon Water Authority).

(j) *Furnished by Owner.*—Furnished by Owner shall mean that the Owner shall pre-purchase specific products and have them delivered to a place mutually agreed upon by the supplier, the Owner and the Contractor, at no cost to the Contractor. In connection with an item furnished by the Owner, "Install" shall mean to take delivery of the item, off-load and transport to the job site, store as necessary and install according to the Drawings and Specifications.

(k) *Install, Deliver, Furnish, Supply, Provide.*—Such words mean the work in question shall be put in place by the Contractor ready for occupancy and use, unless expressly provided to the contrary.

(l) *Damages for Delay by Contractor.*—Damages for Delay by Contractor shall mean the good faith, reasonable estimate of damages stated in the Contract Agreement which the Contractor agrees to pay for each consecutive calendar day beyond the Contract Time required to achieve substantial completion of the Project. Such Damages will end upon written notification from the Owner that the Project is ready for initiation of the Operating Test Period for the total Project.

(m) *Meaning of words and phrases.*—Unless the context or the Contract Documents taken as a whole indicate to the contrary, words used in the Contract Documents that have usual and common meanings shall be given their usual and common meanings and words having technical or trade meanings shall be given their customary meaning in the subject business, trade or profession.

(n) *Notices.*—Unless otherwise provided in the Contract Documents, written notice shall be deemed to have been duly served if delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended, or if delivered or sent by certified mail to the last business address known to the party that gives notice.

(o) *Notice to Proceed.*—The Notice to Proceed is a written notice from the Owner pursuant to which the Contractor shall commence physical work on the Project site. A Notice to Proceed is a condition precedent to the execution of any Work on the site by the Contractor.

(p) *Order of Condemnation.*—An Order of Condemnation shall be in writing, shall be dated, shall be signed by the Engineer, shall be addressed to the Contractor with a copy to the Owner, and shall contain three elements as follows:

FIRST ELEMENT: Description of Work

(1) which has been omitted or
(2) which is unexecuted as of the date of the Order of Condemnation, the time for its incorporation into the Work under the construction progress schedule having expired, or
(3) which has not been executed in accordance with the methods and materials designated in the Contract Documents.

SECOND ELEMENT: Citation of the provision or provisions of the Contract Documents which has or have been violated.

THIRD ELEMENT: Fixing of a reasonable time within which the Contractor shall have made good or remedied the deficiency which said time shall not be deemed to be an extension of Contract Time or deemed to be authorization for amendment to the construction progress schedule.

An Order of Condemnation may be issued for failure of the Contractor to supply enough workers or enough materials or proper materials, the Order of Condemnation in such event being based on Article 28 of the General Conditions and upon the definition of Work as set forth under Article 41(u).

(q) *Owner.*—The Owner shall mean THE MACON WATER AUTHORITY or its authorized and legal representatives.

(r) *Products.*—Products shall mean materials or equipment permanently incorporated into the Work.

(s) *Specifications.*—The term "Specifications" shall include all written matter in the bound volume (Divisions 01 through 46, inclusive) or on the drawings and any addenda or modifications thereto.

(t) *Subcontractor.*—The term Subcontractor as employed herein includes only those having a direct contract with the Contractor. It includes one who furnishes labor and materials

which are incorporated into the Work but does not include one who merely furnished materials incorporated into the Work by the labor of others.

(u) *Work; Project.*—The terms Work and Project shall mean the entire completed construction required to be furnished under the Contract Documents.

END OF SECTION

SECTION 00800

SUPPLEMENTARY CONDITIONS

GENERAL (Example, if any conditions exist)

The provisions in these Supplementary Conditions shall govern in the event of any conflict between the General Conditions and the provisions herein.

Policy "A". – Compaction Tests and Shop Drawing Submittals

Please contact Mr. Joel Herndon, the Macon Water Authority's (the "Owner's) Chief Inspector, at 478.464.5639 before commencing the construction activity. Compaction tests, where required, shall be performed in accordance with Macon Water Authority's policy. The Contractor and the soil testing laboratory shall contact Mr. Herndon before the testing. The location at which the tests are performed will be decided by our inspection crew. The test report shall be submitted to the Engineering Division before the Owner can accept the Project for operation and maintenance. The Contractor shall submit five (5) copies of the shop drawings (ductile iron pipe, gate valve, valve box, ductile iron fittings, fire hydrant, manholes, manhole frames and covers, gravity sewer pipe, support structures, appurtenances, etc.) before installation. The Contractor will not be permitted to install materials and appurtenances until all the shop drawings are approved. The Contractor shall submit two copies of as-built drawings after the completion of construction but before the Project is accepted for operation and maintenance. The as-built drawings shall include the following for water/sewer portion of the Project: location of water main, valves, fire hydrants, fittings, water services to each lot, location of sewer mains, manholes (including rim and invert elevations), distance and angle between manholes, distance and length of each lateral from manholes, location of water main, gate valves, fire hydrants and fittings, width of easements and any other pertinent information.

Note: See Section 01720 for additional requirements.

Policy "**B".** – Televising: NOT USED

Policy "C". – As-Builts: Produce and submit "AS-BUILT" survey of the generator, electrical lines to and from transfer switch, and any other underground utilities that were encountered during the installation. As-Builts shall be prepared by a licensed Professional Engineer or Georgia Registered Land Surveyor, as appropriate for the project, and shall be submitted before the project is accepted by the Owner for operation and maintenance and before any project plat is signed.

The As-Built drawings shall be submitted in either the (.dxf) or the (.dwg) version DWG 2010 or later on a USB Flash Drive, along with two (2) sets of plans in the same format as shown on the drive. The As-Built drawings shall be submitted on a (24" x 36") sheet. The vertical and horizontal accuracy of the as-builts shall be within 0.1-foot accuracy.

All relative information such as right-of-way, property corners, state plane monuments, etc. shall be located and tied to Georgia State Plane Coordinates.

Policy "D" – Payment Estimate Form – The Contractor shall generate an EXCEL spreadsheet listing all items in the Proposal and columns for quantities this period, total this period, total quantities to date, and total amount to date for a detail backup for the attached pay estimate summary sheet.

MWA PAY ESTIMATE FORM – FOLLOWS ON SEPARATE PAGE

- **Project Milestone & Scheduling**- It is the desire of the Owner to complete this Project within the Contract Time allocated in the Contract Documents.

END OF SECTION

Macon Water Authority

Material Pick-up Acknowledgement

Macon Water Authority
790 Second Street P.O. Box 108
Macon GA 31202
Phone: (478) 464–5600
Fax: (478) 738-3864

Project Name: Amerson Water Treatment Plant Generator Fueling System Replacement
Project Engineer: _____
Project Manager: _____

Itemized List of the Materials:

Material Description	Size (if applicable)	Length (if applicable)	Quantity
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

I understand and acknowledge by receipt of the Materials listed, that:

These Materials furnished by the Macon Water Authority have been inspected thoroughly by me prior to transport to the project location; and that Materials in transport to the project location become the sole responsibility of my company.

_____
(Print Contractor's Company Name)

By:_____
(**Signature** of Authorized Representative - *person picking up the materials*)

Date: _____

Print Name: _____

By: _____ Date: _____
MWA-Warehouse Manager or MWA-Authorized Representative

Macon Water Authority

PAY ESTIMATE

Summary Sheet

Macon Water Authority
790 Second Street P.O. Box 108
Macon GA 31202
Phone: (478) 464–5600
Fax: (478) 738-3864

Project Name: Amerson Water Treatment Plant Generator Fueling System Replacement
MWA's Project Number: _____

Pay Estimate Number: _____ Partial: _____

Final: _____

Pay Period: _____

Original Contract Amount: $_____

Total Change Orders to Date: _____

Current Contract Amount: $_____

Original contract Work Performed to Date: _____

Change Order Work Performed to Date: _____

Materials Stored on Job Site: _____

Subtotal: _____

Less (5 %) Previous Retainage: _____

Subtotal: _____

Less Previous Payments: _____

Current Invoice Amount: _____

Less (5 %) Current Retainage: _____

Balance Due This Payment: _____

According to the best of my knowledge and belief, all items and amounts shown on the face of this Pay Estimate are correct; that all Work has been performed or materials supplied, or both, in full accordance with the requirements of the Contract Documents, or duly authorized deviations or additions thereto; that the foregoing is a true and correct statement of the Contract Price account up to and including the last day of the period covered by this Pay Estimate; that none of the "Balance Due This Payment" has been received, and that the undersigned and its Subcontractors have complied with all the labor provisions of the Contract Documents.

The Contractor further certifies that on those items of Work not disputed that all payables, materials, bills, and other indebtedness connected with the Work have been paid (less retention equal to that being retained by the Owner) for Work covered by previous payments. Quantities on request for partial payment are estimated only. Final quantities are by a final survey and "as built" drawings by Contractor.

_____ By:_____
(Contractor's Company Name-PRINT) (Signature of Contractor's Authorized Representative)

Date: _____ Title: _____

By: _____ By: _____ By: _____
MWA-Inspector Project Engineer MWA-Project Manager

Date: _____ Date: _____ Date: _____

Submittals Report

Generated: November 24, 2025

Section	Action Submittals	Information Submittals		
	Product Data	Material/Product Certificates	Warranty	Manufacturer Certificates
031000 - CONCRETE FORMING AND ACCESSORIES	✓			
032000 - CONCRETE REINFORCING	✓			
033000 - CAST-IN-PLACE CONCRETE	✓			
055000 - METAL FABRICATIONS	✓			
099113 - EXTERIOR PAINTING	✓			
099123 - INTERIOR PAINTING	✓			
220500 - COMMON WORK RESULTS FOR PLUMBING	✓			
220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING	✓			
220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT	✓			
220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT	✓			

Section	Action Submittals	Information Submittals		
	Product Data	Material/Product Certificates	Warranty	Manufacturer Certificates
230923 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC	✓		✓	
230923.11 - CONTROL VALVES	✓		✓	
230923.14 - FLOW INSTRUMENTS	✓		✓	
230923.17 - LEVEL INSTRUMENTS	✓		✓	
230923.18 - LEAK DETECTION INSTRUMENTS	✓		✓	
230923.23 - PRESSURE INSTRUMENTS	✓		✓	
231113 - FACILITY FUEL-OIL PIPING	✓		✓	
231213 - FACILITY FUEL-OIL PUMPS	✓		✓	
231323 - FACILITY ABOVEGROUND FUEL-OIL STORAGE TANKS	✓		✓	
260010 - SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL				
260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES	✓			
260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS	✓			
260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS	✓			

Section	Action Submittals	Information Submittals		
	Product Data	Material/Product Certificates	Warranty	Manufacturer Certificates
260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS	✓			
262213 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS	✓			
262416 - PANELBOARDS	✓		✓	
262716 - ELECTRICAL CABINETS AND ENCLOSURES	✓			
262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS	✓		✓	
262913.03 - MANUAL AND MAGNETIC MOTOR CONTROLLERS	✓			
263213.13 - DIESEL-ENGINE-DRIVEN GENERATOR SETS	✓		✓	
271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING	✓			
271523 - COMMUNICATIONS OPTICAL FIBER HORIZONTAL CABLING	✓			
312000 - EARTH MOVING				
321723 - PAVEMENT MARKINGS	✓			

SECTION 031000 - CONCRETE FORMING AND ACCESSORIES PART 1 -

GENERAL

1.1 SUMMARY

A. Section Includes:

1. Form-facing materials.
2. Form liners.
3. Waterstops.

B. Related Requirements:

1. Section 321313 "Concrete Paving" for formwork related to concrete pavement and walks.

1.2 DEFINITIONS

A. Form-Facing Material: The temporary form materials that come in direct contact with the concrete as part of the formwork components in supporting the concrete while the concrete is setting and gaining sufficient strength to be self-supporting. The most common materials are steel, aluminum, and wood.

B. Form Lining: Materials used to line the concreting face of formwork to impart a smooth or patterned finish to the concrete surface, to absorb moisture from the concrete, or to apply a set-retarding chemical to the formed surface of the concrete.

C. Formwork: The total system of support of freshly placed concrete, including the mold or sheathing that contacts the concrete, as well as supporting members, hardware, and necessary bracing.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction, movement, contraction, and isolation joints
c. Forms and form-removal limitations.
d. Shoring and reshoring procedures.
e. Anchor rod and anchorage device installation tolerances.

1.4 ACTION SUBMITTALS

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A. Product Data: For each type of product.

B. Shop Drawings: Prepared by, and signed and sealed by, a qualified professional engineer responsible for their preparation, detailing fabrication, assembly, and support of forms.

1. For exposed vertical concrete walls, indicate dimensions and form tie locations.
2. Indicate dimension and locations of construction and movement joints required to construct the structure in accordance with ACI 301.

a. Location of construction joints is subject to approval of Architect.

3. Indicate location of waterstops.

4. Indicate form liner layout and form line termination details.
5. Indicate proposed schedule and sequence of stripping of forms, shoring removal, and reshoring installation and removal.

C. Samples:

1. For waterstops.
2. For Form Liners: 12- by 12-inch sample, indicating texture.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Minutes of preinstallation conference.

C. Qualification Statements: For testing and inspection agency.

1.6 QUALITY ASSURANCE

A. Testing and Inspection Agency Qualifications: An independent agency qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Form Liners: Store form liners under cover to protect from sunlight.

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

PART 2 – PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Concrete Formwork: Design, engineer, erect, shore, brace, and maintain formwork, shores, and reshores in accordance with ACI 301, to support vertical, lateral, static,

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and dynamic loads, and construction loads that might be applied, until structure can support such loads, so that resulting concrete conforms to the required shapes, lines, and dimensions.

1. Design wood panel forms in accordance with APA's "Concrete Forming Design/Construction Guide."
2. Design formwork to limit deflection of form-facing material to 1/240 of center-to-center spacing of supports.
    a. For architectural concrete specified in Section 033300 "Architectural Concrete," limit deflection of form-facing material, studs, and walers to 0.0025 times their respective clear spans (L/400).

2.2 FORM-FACING MATERIALS

A. As-Cast Surface Form-Facing Material:

1. Provide continuous, true, and smooth concrete surfaces.
2. Furnish in largest practicable sizes to minimize number of joints.
3. Acceptable Materials: As required to comply with Surface Finish designations specified in Section 033000 "Cast-in-Place Concrete, and as follows:
    a. Plywood, metal, or other approved panel materials.
    b. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
        1) APA HDO (high-density overlay).

B. Concealed Surface Form-Facing Material: Lumber, plywood, metal, plastic, or another approved material.

1. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that produce surfaces not exceeding specified formwork surface class.

1. Provide forms with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

2.3 RELATED MATERIALS

A. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4-inch, minimum.

B. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

2. Form release agent for form liners to be acceptable to form liner manufacturer.

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C. Form Ties: Factory-fabricated, removable or snap-off, glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

D. Sealant: One-part moisture cure silicone sealant used with form liners.

PART 3 - EXECUTION

3.1 INSTALLATION OF FORMWORK

A. Comply with ACI 301.

B. Construct formwork, so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117 and to comply with the Surface Finish designations specified in Section 033000 "Cast-in-Place Concrete" for as-cast finishes.

C. Limit concrete surface irregularities as follows:

1. Surface Finish-1.0: ACI 117 Class D, 1 inch.
2. Surface Finish-2.0: ACI 117 Class B, 1/4 inch.
3. Surface Finish-3.0: ACI 117 Class A, 1/8 inch.

D. Construct forms tight enough to prevent loss of concrete mortar.

1. Minimize joints.
2. Exposed Concrete: Symmetrically align joints in forms.

E. Construct removable forms for easy removal without hammering or prying against concrete surfaces.

1. Provide crush or wrecking plates where stripping may damage cast-concrete surfaces.
2. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
3. Install keyways, reglets, recesses, and other accessories, for easy removal.

F. Do not use rust-stained, steel, form-facing material.

G. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces.

1. Provide and secure units to support screed strips
2. Use strike-off templates or compacting-type screeds.

H. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible.

1. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar.
2. Locate temporary openings in forms at inconspicuous locations.

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I. Chamfer exterior corners and edges of permanently exposed concrete.

J. At construction joints, overlap forms onto previously placed concrete not less than 12 inches.

K. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work.

1. Determine sizes and locations from trades providing such items.
2. Obtain written approval of Architect prior to forming openings not indicated on Drawings.

L. Construction and Movement Joints:

1. Construct joints true to line with faces perpendicular to surface plane of concrete.
2. Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
3. Place joints perpendicular to main reinforcement.
4. Locate joints for beams, slabs, joists, and girders in the middle third of spans.

    a. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.

5. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.

6. Space vertical joints in walls as indicated on Drawings.

    a. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

M. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection.

1. Locate ports and openings in bottom of vertical forms, in inconspicuous location, to allow flushing water to drain.
2. Close temporary ports and openings with tight-fitting panels, flush with inside face of form, and neatly fitted, so joints will not be apparent in exposed concrete surfaces.

N. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

O. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

P. Coat contact surfaces of forms with form-release agent, in accordance with manufacturer's written instructions, before placing reinforcement.

3.2 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining

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work that is attached to or supported by cast-in-place concrete.

1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
3. Install dovetail anchor slots in concrete structures, as indicated on Drawings.
4. Clean embedded items immediately prior to concrete placement.

3.3 REMOVING AND REUSING FORMS

A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.

B. Clean and repair surfaces of forms to be reused in the Work.

1. Split, frayed, delaminated, or otherwise damaged form-facing material are unacceptable for exposed surfaces.
2. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints.

1. Align and secure joints to avoid offsets.
2. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 INSTALLATION OF SHORING AND RESHORING

A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.
1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare test reports.

B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

C. Inspections:

1. Inspect formwork for shape, location, and dimensions of the concrete member

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being formed.

2. Inspect insulating concrete forms for shape, location, and dimensions of the concrete member being formed.

D. Prepare test and inspection reports.

END OF SECTION 031000

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SECTION 032000 - CONCRETE REINFORCING PART 1 -

GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel reinforcement bars.
2. Welded-wire reinforcement.

B. Related Requirements:

1. Section 321313 "Concrete Paving" for reinforcing related to concrete pavement and walks.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Each type of steel reinforcement.
2. Bar supports.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

2. Environmental Product Declaration (EPD): For each product.

3. Manufacturer Inventory: For each product, provide manufacturer's manifest of ingredients.

C. Shop Drawings: Comply with ACI SP-066:

1. Include placing drawings that detail fabrication, bending, and placement.
2. Include bar sizes, lengths, materials, grades, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, location of splices, lengths of lap splices, details of mechanical splice couplers, details of welding splices, tie spacing, hoop spacing, and supports for concrete reinforcement.

D. Construction Joint Layout: Indicate proposed construction joints required to build the structure.

1. Location of construction joints is subject to approval of Architect.

1.3 INFORMATIONAL SUBMITTALS

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A. Material Test Reports: For the following, from a qualified testing agency:

1. Steel Reinforcement:

B. Field quality-control reports.

C. Minutes of preinstallation conference.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage.

1. Store reinforcement to avoid contact with earth.
2. Do not allow epoxy-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
3. Do not allow dual-coated reinforcement to be stored outdoors for more than 60 days without being stored under an opaque covering.
4. Do not allow stainless steel reinforcement to come into contact with uncoated reinforcement.

PART 2 – PRODUCTS

1.1 STEEL REINFORCEMENT

A. Recycled Content: Provide manufacturer documentation for recycled content, indicating postconsumer and preconsumer recycled content.

1. Regional Materials: Steel shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site.

2. Regional Materials: Steel shall be manufactured within 500 miles of Project site.

3. Regional Materials: Steel shall be manufactured within 100 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles of Project site.

4. Indigenous Materials: Steel shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

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5. Regional Materials: Steel shall be manufactured within 500 miles of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site. If materials are transported by rail or water, the distance transported by rail or water shall be multiplied by 0.25 to determine the distance to Project site.

B. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.

C. Galvanized Reinforcing Bars:

1. Steel Bars: ASTM A615/A615M, Grade 60 deformed bars.

D. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.

E. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

1.2 REINFORCEMENT ACCESSORIES

A. Steel Tie Wire: ASTM A1064/A1064M, annealed steel, not less than 0.0508 inch in diameter.

1. Finish: Plain

1.3 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

PART 3 – EXECUTION

3.1 PREPARATION

A. Protection of In-Place Conditions:

1. Do not cut or puncture vapor retarder.
2. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.

3.2 INSTALLATION OF STEEL REINFORCEMENT

A. Comply with CRSI's "Manual of Standard Practice" for placing and supporting reinforcement.

B. Accurately position, support, and secure reinforcement against displacement.

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1. Locate and support reinforcement with bar supports to maintain minimum concrete cover.
2. Do not tack weld crossing reinforcing bars.

C. Preserve clearance between bars of not less than 1 inch, not less than one bar diameter, or not less than 1-1/3 times size of large aggregate, whichever is greater.

D. Provide concrete coverage in accordance with ACI 318.

E. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

F. Splices: Lap splices as indicated on Drawings.

1. Bars indicated to be continuous, and all vertical bars to be lapped not less than 36 bar diameters at splices, or 24 inches, whichever is greater.
2. Stagger splices in accordance with ACI 318.

G. Install welded-wire reinforcement in longest practicable lengths.

1. Support welded-wire reinforcement in accordance with CRSI "Manual of Standard Practice."

   a. For reinforcement less than W4.0 or D4.0, continuous support spacing to not exceed 12 inches.

2. Lap edges and ends of adjoining sheets at least one wire spacing plus 2 inches for plain wire and 8 inches for deformed wire.
3. Offset laps of adjoining sheet widths to prevent continuous laps in either direction.
4. Lace overlaps with wire.

3.3 JOINTS

A. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement.
2. Continue reinforcement across construction joints unless otherwise indicated.
3. Do not continue reinforcement through sides of strip placements of floors and slabs.

B. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length, to prevent concrete bonding to one side of joint.

3.4 INSTALLATION TOLERANCES

A. Comply with ACI 117.

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3.5 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

C. Inspections:

1. Steel-reinforcement placement.

END OF SECTION 032000

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SECTION 033000 - CAST-IN-PLACE CONCRETE PART 1 -

GENERAL

1.1 SUMMARY

A. Section Includes:

1. Concrete standards.
2. Concrete materials.
3. Admixtures.
4. Curing materials.
5. Accessories.
6. Repair materials.
7. Concrete mixture materials.
8. Concrete mixture class types.
9. Concrete mixing.

B. Related Requirements:

1. Section 031000 "Concrete Forming and Accessories" for form-facing materials, form liners, insulating concrete forms, and waterstops.
2. Section 032000 "Concrete Reinforcing" for steel reinforcing bars and welded-wire reinforcement.
3. Section 312000 "Earth Moving" for drainage fill under slabs-on-ground.
4. Section 321313 "Concrete Paving" for concrete pavement and walks.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement or blended hydraulic cement alone or in combination with one or more of the following:

1. Fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. Water/Cementitious Materials (w/cm) Ratio: The ratio by weight of mixing water to cementitious materials.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency responsible for inspections and acceptance

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testing of concrete at Project site.
c. Ready-mix concrete manufacturer.
d. Concrete Subcontractor.

2. Review the following:

a. Special inspection and testing and inspecting agency procedures for field quality control.
b. Construction joints, control joints, isolation joints, and joint-filler strips.
c. Semirigid joint fillers.
d. Vapor-retarder installation.
e. Anchor rod and anchorage device installation tolerances.
f. Cold- and hot-weather concreting procedures.
g. Concrete finishes and finishing.
h. Curing procedures.
i. Forms and form-removal limitations.
j. Shoring and reshoring procedures.
k. Methods for achieving specified floor and slab flatness and levelness.
l. Floor and slab flatness and levelness measurements.
m. Concrete repair procedures.
n. Concrete protection.
o. Initial curing of standard-cured and field curing of field-cured test cylinders (ASTM C31/C31M.)
p. Protection of field cured field test cylinders.
q. Distribution of test reports.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Portland cement.
2. Blended hydraulic cement.
3. Performance-based hydraulic cement.
4. Fly ash.
5. Slag cement.
6. Silica fume.
7. Natural or other pozzolans.
8. Aggregates.
9. Ground calcium carbonate and aggregate mineral fillers.
10. Admixtures:

a. Include limitations of use. Admixtures that do not comply with reference ASTM International requirements must be submitted with test data for approval.

11. Curing materials.

12. Joint fillers.

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13. Repair materials.

B. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

C. Design Mixtures: For each concrete mixture, include the following:

1. Mixture identification.
2. Compressive strength at 28 days or other age as specified.
3. Compressive strength required at stages of construction.
4. Durability exposure classes for Exposure Categories F, S, W, and C.
5. Maximum w/cm ratio.
6. Calculated equilibrium and fresh density for lightweight concrete.
7. Slump or slump flow limit.
8. Air content.
9. Nominal maximum aggregate size.
10. Intended placement method.
11. Submit adjustments to design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant changes.

D. Shop Drawings:

1. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.

a. Location of construction joints is subject to approval of the Architect.

E. Concrete Schedule: For each location of each class of concrete indicated in "Concrete Mixture Class Types" Article, including the following:

1. Concrete class designation.
2. Location within Project.
3. Exposure class designation.
4. Formed surface finish designation and final finish.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For the following:

1. Installer: Include copies of applicable ACI certificates.

2. Testing Agency: Include documentation indicating compliance with ASTM E329 or ASTM C1077 and copies of applicable ACI certificates for testing technicians or ACI Concrete Construction Special Inspector - MH, ASCC.

B. Material Certificates: For each of the following:

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1. Cementitious materials.
2. Admixtures.
3. Curing compounds.
4. Bonding agents.
5. Adhesives.
6. Semirigid joint filler
7. Joint-filler strips.
8. Repair materials.

C. Material Test Reports: For the following:

1. Portland cement.
2. Blended hydraulic cement.
3. Performance-based hydraulic cement.
4. Fly ash.
5. Slag cement.
6. Silica fume.
7. Natural or other pozzolans.
8. Aggregates.
9. Ground calcium carbonate and aggregate mineral filler.
10. Admixtures.

D. Research Reports:

1. For concrete admixtures in accordance with ICC's Acceptance Criteria AC198.
2. For sheet vapor retarder/termite barrier, showing compliance with ICC's Acceptance Criteria AC380.

E. Preconstruction Test Reports: For each mix design.
F. Field quality-control reports.
G. Minutes of preinstallation conference.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified Installer who employs Project personnel qualified as an ACI-certified Concrete Flatwork Associate and Concrete Flatwork Finisher and a supervisor who is a certified ACI Advanced Concrete Flatwork Finisher/Technician or an ACI Concrete Flatwork Finisher with experience installing and finishing concrete.

1. Post-Installed Concrete Anchors Installers: ACI-certified Adhesive Anchor Installer.

B. Ready-Mixed Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer's production facilities and delivery vehicles certified in accordance with NRMCA's certification requirements or equivalent approval by a State DOT.

C. Laboratory Testing Agency Qualifications: A testing agency qualified in accordance

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with ASTM C1077 and ASTM E329 for testing that performs duties on behalf of the Architect/Engineer.

1. Personnel performing laboratory tests to be an ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Level 1. Testing agency laboratory supervisor tests to be an ACI-certified Concrete Laboratory Testing Technician, Level 2.

D. Field Quality-Control Testing Agency Qualifications: An independent agency, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.

1. Personnel conducting field tests on plastic concrete properties are to be qualified as an ACI Concrete Field Testing Technician, Grade 1, in accordance with policies from ACI CPP 610.1 or an equivalent certification program.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on each concrete mixture.

1. Include the following information in each test report:

a. Admixture dosage rates.
b. Slump.
c. Air content.
d. Seven-day compressive strength.
e. 28-day compressive strength.
f. Evaluation of permeability-reducing admixtures.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with ASTM C94/C94M and ACI 301.

1.9 FIELD CONDITIONS

A. Cold-Weather Placement: Comply with ACI 301 as follows:

1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
2. When air temperature has fallen to, or is expected to fall below 40 deg F during the protection period, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
3. Do not use frozen materials or materials containing ice or snow.
4. Do not place concrete in contact with surfaces less than 35 deg F, other than reinforcing steel.

B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:

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1. Maintain concrete temperature at time of discharge to not exceed 95 deg F
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

PART 2 - PRODUCTS

2.1 CONCRETE STANDARDS

A. ACI Publications: Comply with ACI 301 unless modified by requirements in the Contract Documents.

2.2 CONCRETE MATERIALS

A. Source Limitations:

1. Obtain all concrete mixtures from a single ready-mixed concrete manufacturer for entire Project.
2. Obtain each type of admixture from single source from single manufacturer.

B. Cementitious Materials:

1. Portland Cement: ASTM C150/C150M, Type I

2. Pozzolans: ASTM C618, Class C, F, or N.

3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.

4. Ground Glass Pozzolan: ASTM C1866/C1866M, Type GS or GE.

5. Silica Fume: ASTM C1240.

C. Normal-Weight Aggregates:

1. Coarse Aggregate: ASTM C33/C33M, Class 3M

2. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
3. Fine Aggregate: ASTM C33/C33M.

4. Recycled Aggregate: Provide documentation of characteristics of recycled aggregate and mechanical properties and durability of proposed concrete, which incorporates recycled aggregate to conform to appliable requirements for the class of concrete.

2.3 ADMIXTURES

A. Air-Entraining Admixture: ASTM C260/C260M.

B. Chemical Admixtures: Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C494/C494M, Type A.

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2. Retarding Admixture: ASTM C494/C494M, Type B.
3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
5. High-Range, Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type G.
6. Admixtures with special properties, with documentation of claimed performance enhancement, ASTM C494/C494M, Type S.

C. Mixing Water for Concrete Mixtures and Water Used to Make Ice: ASTM C1602/C1602M. Include documentation of compliance with limits for alkalis, sulfates, chlorides, or solids content of mixing water from Table 2 in ASTM C106.

2.4 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd**.** when dry.

C. Moisture-Retaining Cover: ASTM C171, polyethylene film burlap-polyethylene sheet.

1. Color:

a. Ambient Temperature Below 50 deg F (10 deg C): Black.
b. Ambient Temperature between 50 and 85 deg F (10 and 29 deg C): Any color.
c. Ambient Temperature Above 85 deg F (29 deg C): White.

D. Curing Paper: 8 ft. wide paper, consisting of two layers of fibered kraft paper laminated with double coating of asphalt.

E. Water: Potable water that does not cause staining of the surface.

F. Clear, Waterborne, Membrane-Forming, Nondissipating Curing Compound: ASTM C309, Type 1, Class B.

G. Clear, Waterborne, Membrane-Forming, Curing Compound: ASTM C309, Type 1, Class B, 18 to 25 percent solids, nondissipating.

H. Clear, Solvent-Borne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

I. Clear, Waterborne, Membrane-Forming, Curing and Sealing Compound: ASTM C1315, Type 1, Class A.

2.5 ACCESSORIES

A. Expansion and isolation joint filler strips: ASTM D1751, asphalt-saturated cellulosic fiber

B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80 in accordance with ASTM D2240.

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2.6 REPAIR MATERIALS

A. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.

1. Cement Binder: ASTM C150/C150M portland cement or hydraulic or blended hydraulic cement, as defined in ASTM C219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested in accordance with ASTM C109/C109M

2.7 CONCRETE MIXTURE MATERIALS

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, in accordance with ACI 301.

1. Use a qualified testing agency for preparing and reporting proposed mixture designs, based on laboratory trial mixtures.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland or hydraulic cement in concrete assigned to Exposure Class F3 as follows:

1. Fly Ash or Other Pozzolans: 25 percent by mass.
2. Slag Cement: 50 percent by mass.
3. Silica Fume: 10 percent by mass.
4. Total of Fly Ash or Other Pozzolans, Slag Cement, and Silica Fume: 50 percent by mass, with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.
5. Total of Fly Ash or Other Pozzolans and Silica Fume: 35 percent by mass with fly ash or pozzolans not exceeding 25 percent by mass and silica fume not exceeding 10 percent by mass.

C. Admixtures: Use admixtures in accordance with manufacturer's written instructions.

2.8 CONCRETE MIXTURE CLASS TYPES

A. Class A: Normal-weight concrete used for footings, grade beams

1. Exposure Class: ACI 318 Class F2

2. Minimum Compressive Strength: 4500 psi at 28 days

3. Maximum w/cm Ratio: 0.45

4. Slump Limit: 4" to 6" +/-1" for all concrete

5. Air Content:

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a. Exposure Class F1: 5.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.
b. Exposure Classes F2 and F3: 6.0 percent, plus or minus 1.5 percent at point of delivery for concrete containing 3/4-inch nominal maximum aggregate size.

2.9 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete in accordance with ASTM C94/C94M and furnish delivery ticket.

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete in accordance with ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than five minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Before placing concrete, verify that installation of concrete forms, accessories, reinforcement, and embedded items is complete and that required inspections have been performed.
2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Provide reasonable auxiliary services to accommodate field testing and inspections, acceptable to testing agency, including the following:

1. Daily access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Secure space for storage, initial curing, and field curing of test samples, including source of water and continuous electrical power at Project site during site curing period for test samples.
4. Security and protection for test samples and for testing and inspection equipment at Project site.

3.3 TOLERANCES

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A. Comply with ACI 117.

3.4 INSTALLATION OF EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining Work that is attached to or supported by cast-in-place concrete.
   1. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.5 INSTALLATION OF CAST-IN-PLACE CONCRETE

A. Before placing concrete, verify that installation of formwork, reinforcement, embedded items, and vapor retarder is complete and that required inspections are completed.

   1. Immediately prior to concrete placement, inspect vapor retarder for damage and deficient installation, and repair defective areas.
   2. Provide continuous inspection of vapor retarder during concrete placement and make necessary repairs to damaged areas as Work progresses.

B. Notify Architect and testing and inspection agencies 24 hours prior to commencement of concrete placement.

C. Water addition in transit or at the Project site must be in accordance with ASTM C94/C94M and must not exceed the permitted amount indicated on the concrete delivery ticket.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness.

   1. If a section cannot be placed continuously, provide construction joints as indicated.
   2. Deposit concrete to avoid segregation.
   3. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
   4. Consolidate placed concrete with mechanical vibrating equipment in accordance with ACI 301.

      a. Do not use vibrators to transport concrete inside forms.
      b. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer.
      c. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity.
      d. At each insertion, limit duration of vibration to time necessary to consolidate concrete, and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

   1. Do not place concrete floors and slabs in a checkerboard sequence.

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2. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Maintain reinforcement in position on chairs during concrete placement.
4. Screed slab surfaces with a straightedge and strike off to correct elevations.
5. Level concrete, cut high areas, and fill low areas.
6. Slope surfaces uniformly to drains where required.
7. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface.
8. Do not further disturb slab surfaces before starting finishing operations.

3.6 INSTALLATION OF JOINTS

A. Construct joints true to line, with faces perpendicular to surface plane of concrete.

B. Construction Joints: Coordinate with floor slab pattern and concrete placement sequence.

1. Install so strength and appearance of concrete are not impaired, at locations indicated on Drawings or as approved by Architect.Place joints perpendicular to main reinforcement.

a. Continue reinforcement across construction joints unless otherwise indicated.

2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
3. Locate joints for beams, slabs, joists, and girders at third points of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.

C. Control Joints in Slabs-on-Ground: Form weakened-plane control joints, sectioning concrete into areas as indicated. Construction control joints for a depth equal to at least 1/4 of concrete thickness as follows:

1. Sawed Joints: Form control joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut **1/8-inch** wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random cracks.

D. Isolation Joints in Slabs-on-Ground: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated on Drawings.

2. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

3.7 APPLICATION OF FINISHING FLOORS AND SLABS

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A. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and locations indicated on Drawings.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with a fiber-bristle broom perpendicular to main traffic route.

2. Coordinate required final finish with Architect before application.

3.8 APPLICATION OF FINISHING FORMED SURFACES

A. ACI 301 (ACI 301M) Surface Finish SF-2.0: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams.

1. Patch voids larger than 3/4 inch wide or 1/2 inch deep.
2. Remove projections larger than 1/4 inch.
3. Patch tie holes.
4. Surface Tolerance: ACI 117, Class B.
5. Locations: Apply to concrete surfaces exposed to public view

3.9 INSTALLATION OF MISCELLANEOUS CONCRETE ITEMS

A. Filling in:

1. Fill in holes and openings left in concrete structures after Work of other trades is in place unless otherwise indicated.
2. Mix, place, and cure concrete, as specified, to match color and texture with in-place construction exposed to view.
3. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations:

1. Coordinate sizes and locations of concrete bases with actual equipment provided.
2. Construct concrete bases 6 inches high unless otherwise indicated on Drawings, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated on Drawings, or unless required for seismic anchor support.
3. Minimum Compressive Strength: 4000 psi at 28 days.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
6. Prior to pouring concrete, place and secure anchorage devices.

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a. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
b. Cast anchor-bolt insert into bases.
c. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.10 APPLICATION OF CONCRETE CURING

A. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

1. Comply with ACI 301 for cold weather protection during curing.
2. Comply with ACI 301 and ACI 305.1 for hot-weather protection during curing.
3. Maintain moisture loss no more than 0.2 lb/sq. ft. x h, calculated in accordance with ACI 305R, before and during finishing operations.

B. Curing Formed Surfaces: Comply with ACI 308.1 as follows:

1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
2. Cure concrete containing color pigments in accordance with color pigment manufacturer's instructions.
3. If forms remain during curing period, moist cure after loosening forms.
4. If removing forms before end of curing period, continue curing for remainder of curing period as follows:

a. Continuous Fogging: Maintain standing water on concrete surface until final setting of concrete.
b. Continuous Sprinkling: Maintain concrete surface continuously wet.
c. Absorptive Cover: Pre-dampen absorptive material before application; apply additional water to absorptive material to maintain concrete surface continuously wet.
d. Water-Retention Sheeting Materials: Cover exposed concrete surfaces with sheeting material, taping, or lapping seams.
e. Membrane-Forming Curing Compound: Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's written instructions.

1) Recoat areas subject to heavy rainfall within three hours after initial application.
2) Maintain continuity of coating and repair damage during curing period.

C. Curing Unformed Surfaces: Comply with ACI 308.1 as follows:

1. Begin curing after finishing concrete.

3.11 INSTALLATION OF JOINT FILLING

A. Prepare, clean, and install joint filler in accordance with manufacturer's written

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instructions.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints.

D. Overfill joint, and trim joint filler flush with top of joint after hardening.

3.12 INSTALLATION OF CONCRETE SURFACE REPAIRS

A. Defective Concrete:

1. Repair and patch defective areas when approved by Architect.
2. Remove and replace concrete that cannot be repaired and patched to meet specification requirements.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks in excess of 0.01 inch spalls, air bubbles exceeding surface finish limits, honeycombs, rock pockets, fins and other projections on the surface exceeding surface finish limits, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete.

a. Limit cut depth to 3/4 inch.
b. Make edges of cuts perpendicular to concrete surface.
c. Clean, dampen with water, and brush-coat holes and voids with bonding agent.
d. Fill and compact with patching mortar before bonding agent has dried.
e. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement, so that, when dry, patching mortar matches surrounding color.

a. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching.
b. Compact mortar in place and match surrounding surface.

3. Repair defects on concealed formed surfaces that will affect concrete's durability and structural performance, as determined by Architect.

D. Repairing Unformed Surfaces:

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1. Test unformed surfaces, such as floors and slabs, for finish, and verify surface tolerances specified for each surface.

    a. Correct low and high areas.
    b. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

2. Repair finished surfaces containing surface defects, including spalls, popouts, honeycombs, rock pockets, crazing, and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width.
3. After concrete has cured at least 14 days, correct high areas by grinding.
4. Correct localized low areas during, or immediately after, completing surface-finishing operations by adding patching mortar.

    a. Finish repaired areas to blend into adjacent concrete.

5. Correct other low areas scheduled to remain exposed with repair topping.

    a. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations.

    b. Prepare, mix, and apply repair topping and primer in accordance with manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.

6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete.

    a. Remove defective areas with clean, square cuts, and expose steel reinforcement with at least a 3/4-inch clearance all around.
    b. Dampen concrete surfaces in contact with patching concrete and apply bonding agent.
    c. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate.
    d. Place, compact, and finish to blend with adjacent finished concrete.
    e. Cure in same manner as adjacent concrete.

7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar.

    a. Groove top of cracks and cut out holes to sound concrete, and clean off dust, dirt, and loose particles.
    b. Dampen cleaned concrete surfaces and apply bonding agent.
    c. Place patching mortar before bonding agent has dried.
    d. Compact patching mortar and finish to match adjacent concrete.
    e. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

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F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.13 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a special inspector to perform field tests and inspections and prepare testing and inspection reports.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.

1. Testing agency to be responsible for providing curing facility for initial curing of strength test specimens on-site and verifying that test specimens are cured in accordance with standard curing requirements in ASTM C31/C31M.
2. Testing agency to immediately report to Architect, Contractor, and concrete manufacturer any failure of Work to comply with Contract Documents.
3. Testing agency to report results of tests and inspections, in writing, to Owner, Architect, Contractor, and concrete manufacturer within 48 hours of inspections and tests.

    a. Test reports to include reporting requirements of ASTM C31/C31M, ASTM C39/C39M, and ACI 301, including the following as applicable to each test and inspection:

        1) Project name.
        2) Name of testing agency.
        3) Names and certification numbers of field and laboratory technicians performing inspections and testing.
        4) Name of concrete manufacturer.
        5) Date and time of inspection, sampling, and field testing.
        6) Date and time of concrete placement.
        7) Location in Work of concrete represented by samples.
        8) Date and time sample was obtained.
        9) Truck and batch ticket numbers.
        10) Design compressive strength at 28 days.
        11) Concrete mixture designation, proportions, and materials.
        12) Field test results of fresh concrete, including slump or slump flow, air content, temperature and density.
        13) Information on storage and curing of samples at the Project site, including curing method and maximum and minimum temperatures during initial curing period.
        14) Type of fracture and compressive break strengths at seven days and 28 days.

4. Provide a space and source of power or other resources for curing and access to test specimens by the testing agency.

C. Delivery Tickets: comply with ASTM C94/C94M.

D. Inspections:

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1. Headed bolts and studs.
2. Verification of use of required design mixture.
3. Concrete placement, including conveying and depositing.
4. Curing procedures and maintenance of curing temperature.
5. Verification of concrete strength before removal of shores and forms from beams and slabs.
6. Batch Plant Inspections: On a random basis, as determined by Architect.

E. Concrete Tests: Testing of composite samples of fresh concrete obtained in accordance with ASTM C 172/C 172M to be performed in accordance with the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 150 cu. yd. or fraction thereof.

    a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing is to be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C143/C143M:

    a. One test at point of delivery for each composite sample, but not less than one test for each day's pour of each concrete mixture.
    b. Perform additional tests as needed.

3. Air Content: ASTM C231/C231M pressure method, for normal-weight concrete

    a. One test for each composite sample when strength test specimens are cast, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C1064/C1064M:

    a. One test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample when strength test specimens are cast.

5. Concrete Density: ASTM C138/C138M:

    a. One test for each composite sample when strength test specimens are cast.

6. Compression Test Specimens: ASTM C31/C31M:

    a. Cast and standard cure two sets of two 6 inches by 12-inches or 4-inch by 8-inch cylindrical specimens for each composite sample.

7. Compressive-Strength Tests: ASTM C39/C39M.

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a. Test one set of two standard cured specimens at seven days and one set of two specimens at 28 days.

b. A compressive-strength test to be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

8. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor to evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

9. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests of standard cured cylinders equals or exceeds specified compressive strength, and no compressive-strength test value falls below specified compressive strength by more than 500 psi if specified compressive strength is 5000 psi, or no compressive strength test value is less than 10 percent of specified compressive strength if specified compressive strength is greater than 5000 psi.

10. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

11. Additional Tests:

a. Testing and inspecting agency to make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
b. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.

1) Acceptance criteria for concrete strength to be in accordance with ACI 301, Section 1.7.6.3.

12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

F. Measure floor and slab flatness and levelness in accordance with ASTM E1155 within 24 hours of completion of floor finishing and promptly report test results to Architect.

3.14 PROTECTION

A. Protect concrete surfaces as follows:

1. Protect from petroleum stains.
2. Diaper hydraulic equipment used over concrete surfaces.

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3. Prohibit vehicles from interior concrete slabs.
4. Prohibit use of pipe-cutting machinery over concrete surfaces.
5. Prohibit placement of steel items on concrete surfaces.
6. Prohibit use of acids or acidic detergents over concrete surfaces.
7. Protect liquid floor treatment from damage and wear during the remainder of construction period. Use protective methods and materials, including temporary covering, recommended in writing by liquid floor treatments installer.

END OF SECTION 033000

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SECTION 055000 - METAL FABRICATIONS PART 1 -

GENERAL

1.1 SUMMARY

A. Section Includes:

1. Miscellaneous framing and supports.
2. Pipe supports.
3. Metal bollards.

1.2 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of metal fabrications that are anchored to or that receive other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Fasteners.
2. Shop primers.
3. Shrinkage-resisting grout.
4. Metal bollards.

B. Shop Drawings: Show fabrication and installation details. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide Shop Drawings for the following:

1. Miscellaneous framing and supports for applications where framing and supports are not specified in other Sections including pipe supports.

1.4 INFORMATIONAL SUBMITTALS

A. Mill Certificates: Signed by stainless steel manufacturers, certifying that products furnished comply with requirements.

B. Welding certificates.

C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

D. Research Reports: For post-installed anchors.

E. Delegated design engineer qualifications.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with the following welding codes:

1. AWS D1.1/D1.1M, "Structural Welding Code – Steel."

1.6 FIELD CONDITIONS

A. Field Measurements: Verify actual locations of walls, floor slabs, decks, and other construction contiguous with metal fabrications by field measurements before fabrication.

PART 2 – PRODUCTS

2.1 METALS

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

C. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.

D. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.

E. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

1. Size of Channels: As indicated.

2. Galvanized Steel: ASTM A653/A653M, commercial steel, Type B with G90 coating; 0.108-inch nominal thickness.
3. Cold-Rolled Steel: ASTM A1008/A1008M, commercial steel, Type B; 0.0528-inch minimum thickness; hot-dip galvanized after fabrication.

2.2 FASTENERS

A. General: Unless otherwise indicated, provide fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.

C. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 3, heavy-hex steel structural bolts; ASTM A563, Grade DH3, heavy-hex carbon-steel nuts; and where indicated, flat washers.

D. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.

- Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

E. Anchors, General: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing in accordance with ASTM E488/E488M, conducted by a qualified independent testing agency.

F. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.

G. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

H. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts.

2.3 MISCELLANEOUS MATERIALS

A. Shop Primers: Provide primers that comply with MWA Specifications.

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

1. Use primer that contains pigments that make it easily distinguishable from zinc-rich primer.

C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.

D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.

F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

H. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

I. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3000 psi.

2.4 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing

F. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

G. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

H. Provide for anchorage of type indicated; coordinate with supporting structure. Space

anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.5 MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.

B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.
2. Furnish inserts for units installed after concrete is placed.

C. Galvanize miscellaneous framing and supports where indicated.

D. Prime miscellaneous framing and supports with zinc-rich primer where indicated.

2.6 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 80 steel pipe

1. Cap bollards with 1/4-inch-thick, domed top.
2. Where bollards are indicated to receive controls for door operators, provide cutouts for controls and holes for wire.
3. Where bollards are indicated to receive light fixtures, provide cutouts for fixtures and holes for wire.

B. Fabricate sleeves for bollard anchorage from steel or stainless steel pipe with 1/4-inch-thick, steel or stainless steel plate welded to bottom of sleeve. Make sleeves not less than 8 inches deep and 3/4 inch larger than OD of bollard.

C. Fabricate internal sleeves for removable bollards from Schedule 80 steel pipe or 1/4-inch wall-thickness steel tubing with an OD approximately 1/16 inch less than ID of bollards. Match drill sleeve and bollard for 3/4-inch steel machine bolt.

D. Prime steel bollards with zinc-rich primer

2.7 GENERAL FINISH REQUIREMENTS

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into

surrounding surface.

2.8 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean galvanized surfaces of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

C. Shop prime iron and steel items unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with shop primer as indicated in MWA specifications.

D. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
4. Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."
5. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."

E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:

1. Cast Aluminum: Heavy coat of bituminous paint.
2. Extruded Aluminum: Two coats of clear lacquer.

3.2 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installation of Bearing and Leveling Plates" Article.

1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

3.3 INSTALLATION OF METAL BOLLARDS

A. Fill metal-capped bollards solidly with concrete and allow concrete to cure seven days before installing.

1. Do not fill removable bollards with concrete.

B. Provide four 3/4-inch bolts at each bollard unless otherwise indicated.

Anchor bollards in concrete. Fill annular space around bollard solidly with shrinkage-resistant grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward bollard.

C. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

D. Fill bollards solidly with concrete, mounding top surface to shed water.

1. Do not fill removable bollards with concrete.

3.4 REPAIRS

A. Touchup Painting:

1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

a. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

2. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in MWA specifications.

B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION 055000

SECTION 099113 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Surface preparation of exterior substrates and application of the following:

1. Primers.
2. Water-based finish coatings.
3. Solvent-based finish coatings.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for shop priming metal fabrications.
2. Section 099123 "Interior Painting."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include preparation requirements and application instructions.
2. Indicate VOC content.

B. Samples: For each type of topcoat product.

C. Samples for Initial Selection: For each type of topcoat product.

D. Samples for Verification: For each type of paint system and each color and gloss of topcoat. Submit paint manufacturer's standard printed cards for verification Samples.

1. Submit Samples on rigid backing, 8 inches square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

E. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in applicable exterior painting schedule articles to cross-reference paint systems specified in this Section. Include color designations.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match paint products applied and that are packaged with

protective covering for storage and identified with labels describing contents.

1. Paint Products: 5 percent, but not less than 1 gal. of each material and color applied.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.5 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each paint product from single source from single manufacturer.

2.2 EXTERIOR PAINTS, GENERAL

A. Exterior Paints: Subject to compliance with requirements, available products that may be incorporated into the Work include but are not limited to products listed in product types below and applicable exterior painting schedule articles for the paint category indicated.

B. Material Compatibility:

1. Materials for use within each paint system must be 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 topcoat manufacturer for use in paint system and on substrate indicated.

C. VOC Content: For field applications, verify paints and coatings comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Dry-Fog Coatings: 150 g/L.

4. Primers, Sealers, and Undercoaters: 100 g/L.
5. Rust-Preventive Coatings: 100 g/L.
6. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
7. Pretreatment Wash Primers: 420 g/L.

D. Colors: As selected by Owner from manufacturer's full range.

2.3 PRIMERS

A. Zinc-Rich, Inorganic Primer: Corrosion-resistant, inorganic-based, zinc-rich primer formulated for use on prepared ferrous metal substrates subject to severe industrial or marine environments.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Sherwin-Williams Company
b. The Pittsburgh Paints Company

B. Epoxy, Anticorrosive Primer: Solvent-based, two-component, epoxy, anti-corrosive primer; formulated for use on ferrous and galvanized metal substrates.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Benjamin Moore & Co.
b. Sherwin-Williams Company
c. The Pittsburgh Paints Company

2.4 WATER-BASED FINISH COATINGS

A. Exterior, Water-Based, Light Industrial Coating: Corrosion-resistant, water-based, pigmented, emulsion coating formulated for resistance to water, alkalis, moderate abrasion, and mild chemical exposure and for use on exterior substrates.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Behr Paint Company
b. Sherwin-Williams Company
c. The Pittsburgh Paints Company

2. Gloss and Sheen Level: Manufacturer's standard semigloss.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Verify suitability of substrates, including surface conditions and compatibility, with finishes and primers. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of substrates and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and 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.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems specified in this Section.

D. Steel Substrates: Remove loose rust, loose mill scale, loose shop primer, and other loose foreign matter. Clean using methods recommended in writing by paint manufacturer, but not less than the following:

1. SSPC-SP 2.
2. SSPC-SP 3.

E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed substrates.

F. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.3 APPLICATION OF EXTERIOR PAINT PRODUCTS

A. Apply paints in accordance with manufacturer's written instructions.

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
3. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
4. Primers specified in applicable exterior painting schedule articles may be omitted on items that are factory primed or factory finished if compatible with intermediate and topcoat coatings and acceptable to intermediate and topcoat paint manufacturers.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting, Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed to view:

a. Uninsulated metal piping.
b. Pipe hangers and supports.
c. Steel pipe supports.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written instructions, apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written instructions.
3. Cost of retesting is Contractor's responsibility.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded

materials from Project site.

1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
3. Allow empty paint cans to dry before disposal.
4. Collect waste paint by type and deliver to recycling or collection facility.

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.

3.6 EXTERIOR PAINTING SCHEDULE, METAL SUBSTRATES (Pipe and Pipe Supports)

A. Steel and Iron Substrates to include pipe and pipe supports:

1. Water-Based, Light Industrial Coating over Epoxy System:

a. Prime Coat: Epoxy metal primer.
b. Intermediate Coat: High-build epoxy paint, low gloss.
c. Topcoat: Exterior, water-based, light industrial coating, semigloss.

B. Galvanized Metal Substrates:

1. Water-Based, Light Industrial Coating System:

a. Prime Coat: Epoxy metal primer.
b. Intermediate Coat: High-build epoxy paint, low gloss.
c. Topcoat: Exterior, water-based, light industrial coating, semigloss.

END OF SECTION 099113

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Surface preparation of interior substrates and application of the following:

1. Primers.
2. Water-based finish coatings.
3. Solvent-based finish coatings.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for shop priming metal fabrications.
2. Section 099113 "Exterior Painting."
3. Section 321723 "Pavement Markings" for pavement-marking paints.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include preparation requirements and application instructions.
2. Indicate VOC content.

B. Samples: For each type of topcoat product.

C. Samples for Initial Selection: For each type of topcoat product.

D. Samples for Verification: For each type of paint system and each color and gloss of topcoat. Submit paint manufacturer's standard printed cards for verification Samples.

1. Submit Samples on rigid backing, 8 inches square.
2. Apply coats on Samples in steps to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

E. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in applicable interior painting schedule articles to cross-reference paint systems specified in this Section. Include color designations.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match paint products applied and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint Products: 5 percent, but not less than 1 gal. of each material and color applied.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.5 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures of less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each paint product from single source from single manufacturer.

2.2 INTERIOR PAINTS, GENERAL

A. Interior Paints: Subject to compliance with requirements, [available products that may be incorporated into the Work include but are not limited to products listed in product types below and applicable interior painting schedule articles for the paint category indicated.

B. Material Compatibility:

1. Materials for use within each paint system must be 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 topcoat manufacturer for use in paint system and on substrate indicated.

C. VOC Content: For field applications verify paints and coatings comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Primers, Sealers, and Undercoaters: 100 g/L.
4. Rust-Preventive Coatings: 100 g/L.

5. Zinc-Rich Industrial Maintenance Primers: 100 g/L.
6. Pretreatment Wash Primers: 420 g/L.
7. Floor Coatings: 50 g/L.

D. Low-Emitting Materials: For field applications that are inside the weatherproofing system, verify 90 percent of paints and coatings comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Material Emissions and Pollutant Control: Verify not less than 85 percent of field-applied paints and coatings that are inside the weatherproofing system comply with either of the following:

1. Low-Emitting Materials: Verify VOC emissions comply with requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Verify formaldehyde emissions do not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
2. Verify VOC content does not exceed limits of authorities having jurisdiction and the following:

a. Flat Coatings: 50 g/L.
b. Nonflat Coatings: 100 g/L.
c. Nonflat - High-Gloss Coatings: 150 g/L.
d. Industrial Maintenance Coatings: 250 g/L.
e. Low-Solids Coatings: 120 g/L.
f. Mastic Texture Coatings: 100 g/L.
g. Metallic Pigmented Coatings: 500 g/L.
h. Pretreatment Wash Primers: 420 g/L.
i. Primers, Sealers, and Undercoaters: 100 g/L.
j. Reactive Penetrating Sealers: 350 g/L.
k. Recycled Coatings: 250 g/L.
l. Rust-Preventive Coatings: 250 g/L.

F. Colors: As selected by Owner from manufacturer's full range.

2.3 PRIMERS

A. Water-Based, Rust-Inhibitive Primer: Corrosion-resistant, water-based-emulsion primer; formulated for resistance to flash rusting when applied to cleaned, ferrous metal substrates subject to mildly corrosive environments.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Benjamin Moore & Co.
b. Sherwin-Williams Company
c. The Pittsburgh Paints Company

B. Epoxy, Anticorrosive Primer: Solvent-based, two-component, epoxy, anticorrosive primer; formulated for use on ferrous and galvanized metal substrates.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. [Benjamin Moore & Co.]
b. Sherwin-Williams Company
c. The Pittsburgh Paints Company

2.4 WATER-BASED FINISH COATINGS

A. Interior, Water-Based Light Industrial Coating: Pigmented, water-based emulsion coating for interior primed wood and metal surfaces (e.g., walls, doors, frames, trim, and sash), providing resistance to moderate abrasion and mild chemical exposure and corrosive conditions.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Benjamin Moore & Co.
b. Sherwin-Williams Company
c. The Pittsburgh Paints Company

2. Gloss and Sheen Level: Manufacturer's standard semigloss.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Verify suitability of substrates, including surface conditions and compatibility, with finishes and primers. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and 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.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Steel Substrates: Remove loose rust, loose mill scale, loose shop primer, and other loose foreign matter. Clean using methods recommended in writing by paint manufacturer, but not less than the following:

1. SSPC-SP 2.
2. SSPC-SP 3.

E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

F. Galvanized Metal Substrates: Remove grease and oil residue from galvanized metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.3 APPLICATION OF INTERIOR PAINT PRODUCTS

A. Apply paints in accordance with manufacturer's written instructions.

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. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
4. Primers specified in the applicable interior painting schedule articles may be omitted on items that are factory primed or factory finished if compatible with intermediate and topcoat coatings and acceptable to intermediate and topcoat paint manufacturers.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire-Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed to view in equipment rooms:

   a. Uninsulated metal piping.
   b. Pipe hangers and supports.
   c. Metal conduit.
   d. Plastic conduit.
   e. Tanks that do not have factory-applied final finishes.
   f. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.

2. Paint the following work where exposed to view in occupied spaces:

   a. Equipment, including panelboards.
   b. Uninsulated metal piping.
   c. Pipe hangers and supports.
   d. Other items as directed by Architect.

3.4 FIELD QUALITY CONTROL

A. Dry-Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry-film thickness.

1. Touch up and restore painted surfaces damaged by testing.
2. If test results show that dry-film thickness of applied paint does not comply with paint manufacturer's written recommendations, apply additional coats as needed to provide dry-film thickness that complies with paint manufacturer's written recommendations.
3. Cost of retesting is Contractor's responsibility.

3.5 CLEANING

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

1. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
2. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
3. Allow empty paint cans to dry before disposal.
4. Collect waste paint by type and deliver to recycling or collection facility.

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.

3.6 PROTECTION

A. 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.

B. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.7 INTERIOR PAINTING SCHEDULE, METAL SUBSTRATES (Pipe and Pipe Supports)

A. Steel and Iron Substrates to include pipe and pipe supports:

1. Water-Based Light Industrial Coating System over Epoxy Primer System:

a. Prime Coat: Epoxy, anticorrosive primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based light industrial coating.

1) Gloss and Sheen Level: Semigloss.

B. Galvanized Metal Substrates:

1. Water-Based Light Industrial Coating System:

a. Prime Coat: Epoxy metal primer.
b. Intermediate Coat: Matching topcoat.
c. Topcoat: Interior, water-based light industrial coating.

1) Gloss and Sheen Level: Semigloss.

END OF SECTION 099123

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Motors.
2. Packless expansion joints.
3. Alignment guides and anchors.
4. Sleeves without waterstop.
5. Sleeve-seal systems.
6. Grout.
7. Silicone sealants.
8. Escutcheons.
9. Thermometers, liquid in glass, lead free.
10. Thermowells.
11. Pressure gauges, dial type.
12. Gauge attachments.
13. Test plugs.
14. Sight flow indicators.

1.2 DEFINITIONS

A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product, excluding motors which are included in Part 1 of this section and the plumbing equipment Sections.

a. Include construction details, material descriptions, and dimensions of individual components, and finishes.
b. Include operating characteristics and furnished accessories.

B. Welding certificates.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of gauge to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with 2021 ASME Boiler and Pressure Vessel Code, Section IX.

1.6 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Domestic water plumbing piping intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.

C. Capability: Provide products and installations to accommodate maximum axial movement as scheduled or indicated on Drawings.

2.2 MOTORS

A. Motor Requirements, General:

1. Content includes motors for use on alternating-current power systems of up to

600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.
2. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.
3. Comply with NEMA MG 1 unless otherwise indicated.
4. Comply with IEEE 841 for severe-duty motors.

B. Motor Characteristics:

1. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 ft. above sea level.
2. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. Polyphase Motors:

1. Description: NEMA MG 1, Design B, medium induction motor.
2. Efficiency: Premium Efficient, as defined in NEMA MG 1.
3. Service Factor: 1.15.
4. Multispeed Motors: Variable torque.

    a. For motors with 2:1 speed ratio, consequent pole, single winding.
    b. For motors with other than 2:1 speed ratio, separate winding for each speed.

5. Multispeed Motors, Two Winding: Separate winding for each speed.
6. Rotor: Random-wound, squirrel cage.
7. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
8. Temperature Rise: Match insulation rating.
9. Insulation: Class F.
10. Code Letter Designation:

    a. Motors 15 HP and Larger: NEMA starting Code F or Code G.
    b. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

11. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

D. Additional Requirements for Polyphase Motors:

1. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
2. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

    a. Windings: Copper magnet wire with moisture-resistant insulation varnish,

designed and tested to resist transient spikes, high frequencies, and short time-rise pulses produced by pulse-width-modulated inverters.
b. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
c. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
d. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

E. Single-Phase Motors:

1. Motors larger than 1/20 hp must be one of the following, to suit starting torque and requirements of specific motor application:

a. Permanent-split capacitor.
b. Split phase.
c. Capacitor start, inductor run.
d. Capacitor start, capacitor run.

2. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
3. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
4. Motors 1/20 HP and Smaller: Shaded-pole type.
5. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device will automatically reset when motor temperature returns to normal range.

2.3 EXPANSION FITTINGS AND LOOPS FOR FUEL OIL PIPING

A. Performance Requirements:

1. Compatibility: Provide products suitable for piping service fluids, materials, working pressures, and temperatures.
2. Capability: Provide products and installations that will accommodate maximum axial movement as scheduled or indicated on Drawings.

B. Packless Expansion Joints:

1. Rubber Union Connector Expansion Joints:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Amber/Booth Company, Inc.; a VMC Group Company
2) Flex-Hose Co., Inc
3) Flexicraft Industries
4) Flo Fab Inc

b. Source Limitations: Obtain rubber union connector expansion joints from single manufacturer.

c. Material: Twin reinforced EPDM rubber spheres with external restraining cables.
d. Minimum Pressure Rating: 150 psig at 170 deg F unless otherwise indicated.
e. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
f. End Connections for Greater than NPS 2 (DN 50): Flanged.
g. End Fittings: Stainless steel.

2. Flexible-Hose Packless Expansion Joints:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) ASC Engineered Solutions
2) Flex-Hose Co., Inc
3) Flex-Pression
4) Flex-Weld; a division of Kelco

b. Source Limitations: Obtain flexible-hose packless expansion joints from single manufacturer.
c. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
d. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
e. Expansion Joints for Steel Piping NPS 2 and Smaller: Stainless steel fittings with threaded end connections.

1) Stainless steel hoses and double-braid, stainless steel sheaths with 700 psig at 70 deg F and 515 psig at 600 deg F ratings.

f. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Stainless steel fittings with flanged end connections.

1) Stainless steel hoses and double-braid, stainless steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.

3. Metal-Bellows Packless Expansion Joints:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Adsco Manufacturing LLC
2) Badger Industries, Inc
3) Flex-Hose Co., Inc
4) Flex-Pression

b. Source Limitations: Obtain metal-bellows packless expansion joints from single manufacturer.
c. Standards: ASTM F1120 and EJMA's "Standards of the Expansion Joint

Manufacturers Association, Inc."
d. Type: Circular, corrugated bellows with external tie rods.
e. Minimum Pressure Rating: 150 psig unless otherwise indicated.
f. Configuration: Single joint with baseand double joint with base class(es) unless otherwise indicated.
g. Expansion Joints for Steel Piping: Single- or multi-ply stainless steel bellows, stainless steel pipe ends, and carbon steel shroud.

1) End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
2) End Connections for Steel Pipe NPS 2-1/2 and Larger: Flanged.

4. Rubber Packless Expansion Joints:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Amber/Booth Company, Inc.; a VMC Group Company
2) Flex-Hose Co., Inc
3) Flex-Weld; a division of Kelco
4) Flexicraft Industries

b. Source Limitations: Obtain rubber packless expansion joints from single manufacturer.
c. Standards: ASTM F1123 and FSA's "Expansion Joints - Piping Technical Handbook."
d. Material: Fabric-reinforced rubber complying with FSA-PSJ-703.
e. Spherical Type: Single or multiple spheres with external control rods.
f. Minimum Pressure Rating for NPS 1-1/2 to NPS 12: 225 psig at 170 deg F.

C. Alignment Guides and Anchors:

1. Alignment Guides: .

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Advanced Thermal Systems, Inc
2) ASC Engineered Solutions
3) Flex-Hose Co., Inc
4) Flex-Weld; a division of Kelco

b. Source Limitations: Obtain alignment guides from single manufacturer.
c. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe. Provide dielectric spacer for use with copper tubing/piping.

2. Anchor Materials:

a. Steel Shapes and Plates: ASTM A36/A36M.
b. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
c. Washers: ASTM F844, steel, plain, flat washers.
d. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

1) Stud: Threaded, zinc-coated carbon steel.
2) Expansion Plug: Zinc-coated carbon steel.
3) Washer and Nut: Zinc-coated carbon steel.

e. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

1) Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
2) Stud: ASTM A307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
3) Washer and Nut: Zinc-coated carbon steel.

2.4 SLEEVES AND SLEEVE SEALS

A. Sleeves without Waterstop:

1. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron, with plain ends.
2. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, hot-dip galvanized, with plain ends.
3. Steel Sheet Sleeves: ASTM A653/A653M, 24 gauge minimum thickness; hot-dip galvanized, round tube closed with welded longitudinal joint.

B. Sleeve-Seal Systems:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Advance Products & Systems, LLC
b. GPT; a division of EnPRO Industries
c. Metraflex Company (The)
d. Proco Products, Inc

2. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

a. Hydrostatic Seal: 20 psig minimum.
b. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

c. Pressure Plates: Composite plastic.
d. Connecting Bolts and Nuts: Stainless steel, Type 316 of length required to secure pressure plates to sealing elements.

C. Grout:

1. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
2. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
3. Design Mix: 5000 psi, 28-day compressive strength.
4. Packaging: Premixed and factory packaged.

D. Silicone Sealants:

1. Silicone Sealant, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant.

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) GE Construction Sealants; Momentive Performance Materials Inc.
2) ITW Polymers Sealants North America
3) Polymeric Systems, Inc
4) Sherwin-Williams Company (The)

b. Standard: ASTM C920, Type S, Grade NS, Class 25, Use NT.

2. Silicone Sealant, S, P, T, NT: Single-component, 25, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant.

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Pecora Corporation
2) Sika Corporation
3) The Dow Chemical Company
4) Tremco Incorporated

b. Standard: ASTM C920, Type S, Grade P, Class 25, Uses T and NT.

3. Silicone Foam Sealant: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Smooth-On

4. Sealant shall have a VOC content of 250 g/L or less.

a. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.5 ESCUTCHEONS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. BrassCraft Manufacturing Co.; a Masco company
2. Dearborn Brass
3. Jones Stephens Corp.
4. Keeney Manufacturing Company (The)

B. Escutcheon Types:

1. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
2. One-Piece, Stainless Steel Type: With polished stainless steel finish.
3. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
4. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished, chrome-plated finish and spring-clip fasteners.
5. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
6. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

C. Floor Plates:

1. Split Floor Plates: Cast brass with concealed hinge.

2.6 METERS AND GAUGES FOR FUEL OIL PIPING

A. Thermometers, Liquid in Glass, Metal Case, Industrial Style:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Miljoco Corporation
b. Palmer Wahl Instrumentation Group

c. Trerice, H. O. Co
d. Weiss Instruments, Inc

2. Source Limitations: Provide liquid-in-glass, metal-case, industrial-style thermometers from single manufacturer.
3. Standard: ASME B40.200.
4. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
5. Case Form: Adjustable angle unless otherwise indicated.
6. Tube: Glass with magnifying lens and blue or red organic liquid, mercury free.
7. Tube Background: Nonreflective aluminum with permanent scale markings graduated in deg F and deg C.
8. Window: Safety glass.
9. Stem: Aluminum and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

10. Connector: 1-1/4 inches, with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
11. Accuracy: Plus or minus 1 percent of span or one scale division, to a maximum of 1.5 percent of span.

B. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Steel Piping: Type 304 stainless steel.
4. Type: Stepped shank unless straight or tapered shank is indicated.
5. External Threads: NPS 1/2, NPS 3/4, or NPS 1 or as required to match threaded opening in pipe.
6. Internal Threads: Size and thread type as required to match thermometer mounting threads.
7. Bore: Diameter required to match thermometer bulb or stem.
8. Insertion Length: Length to extend one-third of pipe diameter.
9. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
10. Heat-Transfer Medium: Mixture of graphite and glycerin.

C. Pressure Gauges, Dial Type, Direct Mounted, Metal Case:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Trerice, H. O. Co
    b. WATTS; A Watts Water Technologies Company
    c. Weiss Instruments, Inc
    d. Weksler Glass Thermometer Corp.

2. Source Limitations: Provide dial-type, lead-free, direct-mounted, metal-case pressure gauges from single manufacturer.

3. Standard: ASME B40.100.
4. Case: Sealed type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
5. Pressure-Element Assembly: Lead-free Bourdon tube.
6. Pressure Connection: Brass, with NPS 1/4, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanent scale markings graduated in psi.
9. Pointer: Dark-colored metal.
10. Window: Safety glass.
11. Ring: Stainless steel.
12. Accuracy: Grade A, plus or minus 1 percent of middle half of span.

D. Gauge Attachments:

1. Snubbers: ASME B40.100, brass; with NPS 1/4, ASME B1.20.1 pipe threads and piston or porous-metal-type surge-dampening device.
2. Valves: Brass ball, with NPS 1/4, ASME B1.20.1 pipe threads.

E. Test Plugs:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Trerice, H. O. Co
    b. WATTS; A Watts Water Technologies Company
    c. Weiss Instruments, Inc
    d. Weksler Glass Thermometer Corp.

2. Source Limitations: Provide test plugs from single manufacturer.
3. Description: Test-station fitting made for insertion into piping tee fitting.
4. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
5. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
6. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
7. Core Inserts: Chlorosulphonated polyethylene synthetic self-sealing rubber.
8.

F. Sight Flow Indicators:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. ARCHON Industries, Inc
    b. Dwyer Instruments, Inc
    c. Ernst Flow Industries
    d. John C. Ernst Co., Inc.

2. Source Limitations: Provide sight flow indicators from single manufacturer.

3. Description: Piping inline-installation device for visual verification of flow.
4. Construction: Bronze or stainless steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
5. Minimum Pressure Rating: 150 psig.
6. Minimum Temperature Rating: 200 deg F.
7. End Connections: NPS 2 and smaller, threaded NPS 2-1/2 and larger, flanged.

PART 3 - EXECUTION

3.1 INSTALLATION OF EXPANSION JOINTS, GENERAL

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

3.2 INSTALLATION OF PACKLESS EXPANSION JOINTS

A. Install metal-bellows expansion joints in accordance with EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

B. Install rubber packless expansion joints in accordance with FSA-PSJ-703.

3.3 INSTALLATION OF ALIGNMENT GUIDES AND ANCHORS

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install one guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe, and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9.
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-58, Type 24; U bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
3. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

3.4 INSTALLATION OF PIPE LOOP AND SWING CONNECTIONS

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least two pipe fittings, including tee in main.

C. Connect risers and branch connections to terminal units with at least two pipe fittings, including tee in riser.

D. Connect mains and branch connections to terminal units with at least two pipe fittings, including tee in main.

3.5 INSTALLATION OF SLEEVES - GENERAL

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout or silicone sealant, seal the space outside of sleeves in floors/slabs/walls without sleeve-seal system. Select to maintain fire resistance of floor/slab/wall.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants that joint sealant manufacturer's literature indicates is appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.6 INSTALLATION OF SLEEVE-SEAL SYSTEMS

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building, and passing through exterior walls.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.7 INSTALLATION OF ESCUTCHEONS

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

3.8 INSTALLATION OF METERS AND GAUGES

A. Install thermometer with thermowell at each required thermometer location.

B. Install thermowells in vertical position in piping tees.

C. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at most readable position.

G. Install valve and snubber in piping for each pressure gauge for fluids.

H. Install test plugs in piping tees.

I. Install thermometers in the following locations:

1. As indicated on plans and details.

J. Install pressure gauges in the following locations:

1. As indicated on plans and detials.

3.9 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.

3.10 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gauges to proper angle for best visibility.

3.11 FIELD QUALITY CONTROL

A. Sleeves and Sleeve Seals:

1. Perform the following tests and inspections:

a. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
b. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

2. Prepare test and inspection reports.

B. Escutcheons:

1. Using new materials, replace broken and damaged escutcheons and floor plates.

3.12 SLEEVES APPLICATION

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

a. Sleeves without waterstops.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

2. Interior Wall and Partitions:

a. Sleeves without waterstops.

3.13 ESCUTCHEONS APPLICATION

A. Escutcheons for New Piping and Relocated Existing Piping:

1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Chrome-Plated Piping: One piece, steel, cast brass, or split-casting brass with polished, chrome-plated finish.
3. Insulated Piping:

    a. One piece, steel with polished, chrome-plated finish.
    b. One piece, cast brass with polished, chrome-plated finish.
    c. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.

4. Bare Piping at Wall and Floor Penetrations in Finished Spaces:

    a. One piece, steel with polished, chrome-plated finish.
    b. One piece, cast brass with polished, chrome-plated finish.
    c. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.

5. Bare Piping at Ceiling Penetrations in Finished Spaces:

    a. One piece, steel with polished, chrome-plated finish.
    b. One piece, cast brass with polished, chrome-plated finish.
    c. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.

6. Bare Piping in Unfinished Service Spaces:

    a. One piece, steel with polished, chrome-plated finish.
    b. One piece, cast brass with polished, chrome-plated finish.
    c. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.

7. Bare Piping in Equipment Rooms:

    a. One piece, steel with polished, chrome-plated finish.
    b. One piece, cast brass with polished, chrome-plated finish.
    c. One piece, stamped steel or split plate, stamped steel with concealed hinge with polished, chrome-plated finish.

B. Escutcheons for Existing Piping to Remain:

1. Chrome-Plated Piping: Split casting, stamped steel with concealed hinge with polished, chrome-plated finish.
2. Insulated Piping: Split plate, stamped steel with concealed hinge with polished, chrome-plated finish
3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split plate,

stamped steel with concealed hinge with polished, chrome-plated finish.

4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
5. Bare Piping in Unfinished Service Spaces: Split plate, stamped steel with concealed hinge with polished, chrome-plated finish.
6. Bare Piping in Equipment Rooms: Split plate, stamped steel with concealed hinge with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping and Relocated Existing Piping: One piece, floor plate.
2. Existing Piping: Split floor plate.

3.14 THERMOMETER, SCALE-RANGE APPLICATION

A. Scale Range for Piping:

1. 30 to 240 deg F.

3.15 PRESSURE-GAUGE SCALE-RANGE APPLICATION

A. Scale Range for Piping:

1. 0 to 200 psi.

END OF SECTION 220500

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ball valves.
2. Check valves.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. FKM: Fluoroelastomer.

C. NBR: Nitrile butadiene rubber (also known as Buna-N).

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. PTFE: Polytetrafluoroethylene.

G. RPTFE: Reinforced polytetrafluoroethylene.

H. RS: Rising stem.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include material descriptions and dimensions of individual components.
b. Include operating characteristics and furnished accessories.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and weld ends.
3. Set ball valves open to minimize exposure of functional surfaces.
4. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems or other components as lifting or rigging points unless specifically indicated for this purpose in manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 SOURCE LIMITATIONS

A. Obtain each type of valve from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Standards:

1. Domestic-water piping valves intended to convey or dispense water for human consumption must comply with the U.S. Safe Drinking Water Act (SDWA), requirements of authorities having jurisdiction, and NSF 61/NSF 372; or to be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. ASME Compliance:

1. ASME B1.20.1 for threads for threaded-end valves.
2. ASME B16.1 for flanges on iron valves.
3. ASME B16.5 for flanges on steel valves.
4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
5. ASME B16.18 for cast-copper solder-joint connections.
6. ASME B16.22 for wrought-copper solder-joint connections.
7. ASME B16.34 for flanged- and threaded-end connections.
8. ASME B16.51 for press joint connections.
9. ASME B31.9 for building services piping valves.

C. Provide bronze valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are unacceptable.

D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Bypass and Drain Connections: MSS SP-45.

G. Valve Actuator Type:

1. Gear Actuator: For quarter-turn ball valves NPS 6 and larger.
2. Hand Lever: For quarter-turn ball valves NPS 4 and smaller.

2.3 BALL VALVES, LEAD FREE

A. Ball Valves, Lead Free, Threaded Ends - Brass, Two Piece with Full Port and Stainless Steel Trim:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. A.Y. McDonald Mfg. Co.
b. American Valve, Inc
c. Apollo Valves; a part of Aalberts Integrated Piping Systems
d. Hammond Valve
e. Jenkins Valves; a Crane Co. brand
f. Jomar Valve
g. Milwaukee Valve Company
h. Stockham; a Crane Co. brand
i. Viega LLC
j. WATTS; A Watts Water Technologies Company

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: 600 psig.
4. Body Design: Two piece.
5. Body Material: Forged brass.
6. Ends: Threaded. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Blow out proof, Stainless steel, with secondary O-ring stem seal.
9. Ball: Stainless steel, vented.
10. Port: Full.

B. Ball Valves, Lead Free, Flanged or Threaded Ends - Steel, with Full Port, Class 150:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Apollo Valves; a part of Aalberts Integrated Piping Systems
b. Hammond Valve
c. Jomar Valve
d. Milwaukee Valve Company

e. NIBCO INC.
f. Stockham; a Crane Co. brand
g. Viega LLC
h. WATTS; A Watts Water Technologies Company

2. Standards: MSS SP-72 and MSS SP-110.
3. CWP Rating: 285 psig.
4. Body Design: Split body.
5. Body Material: Carbon steel, ASTM A216/A216M, Type WCB.
6. Ends: Flanged or threaded. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Stainless steel.
9. Ball: Stainless steel, vented.
10. Port: Full.

C. Ball Valves, Lead Free, Threaded or Flanged Ends - Stainless Steel, Two Piece with Full Port:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. A.Y. McDonald Mfg. Co.
b. Apollo Valves; a part of Aalberts Integrated Piping Systems
c. Guardian Worldwide LLC.
d. Jomar Valve

2. Standards: MSS SP-110 and MSS SP-145.
3. CWP Rating: 200 psig.
4. Body Design: Split body.
5. Body Material: Type 316 stainless steel.
6. Ends: Threaded or flanged. See Part 3 ball valve schedule articles.
7. Seats: PTFE.
8. Stem: Type 316 stainless steel.
9. Ball: Type 316 stainless steel.
10. Port: Full.

2.4 CHECK VALVES, LEAD FREE

A. Check Valves, Lead Free, Swing Type, Threaded Ends - Bronze, with Bronze Disc, Class 150:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. A.Y. McDonald
b. Apollo
c. Crane
d. Hammond

e. Jenkins

2. Milwaukee NIBCO Standard: MSS SP-80, Type 3.
3. CWP Rating: 300 psig.
4. Body Design: Horizontal flow.
5. Body Material: ASTM B62, bronze.
6. Ends: Threaded or soldered. See Part 3 check valve schedule articles.
7. Disc: Bronze.

B. Check Valves, Lead Free, Swing Type, Flanged or Threaded Ends - Iron, with Metal Seats, Class 125:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Anvil
b. Apollo
c. Clow
d. Milwaukee Victaulic
e. Nibco

2. Standard: MSS SP-71, Type I.
3. CWP Rating: 200 psig.
4. Body Design: Clear or full waterway.
5. Body Material: ASTM A126, gray iron with bolted bonnet.
6. Ends: Flanged or threaded. See Part 3 check valve schedule articles.
7. Trim: Bronze.
8. Gasket: Asbestos free.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves. Remove defective valves from site.

3.2 INSTALLATION OF VALVES

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Provide support of piping adjacent to valves such that no force is imposed upon valves.

C. Locate valves for easy access and where not blocked by equipment, other piping, or building components.

D. For valves in horizontal piping, install valves with stem at or above center of pipe.

E. Install valves in position that does not project into aisles or block access to other equipment.

F. Install valves in position to allow full stem and actuator or manual operator movement.

G. Verify that joints of each valve have been properly installed and sealed to assure there is no leakage or damage.

H. Install check valves for proper direction of flow and as follows:

1. Check Valves: In horizontal or vertical upward flow position, between flanges.
2. Check Valves, Swing Type: In horizontal or vertical upward flow position with hinge pin level.
3. Check Valves, Lift Type: With stem upright and plumb.

I. Valve Tags: Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

J. Adhere to manufacturer's written installation instructions.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

B. Select valves with the following end connections:

1. For Steel Piping, NPS 2 and Smaller: Threaded ends.
2. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded

valve-end option is indicated in valve schedules below.

3. Wafer-Type Valves: Flanged connections.

3.5 FUEL OIL BALL VALVE SCHEDULE - 150 PSIG OR LESS

A. Pipe NPS 2 (DN 50) and Smaller:

1. Ball valves, threaded ends - brass, two piece with full port and stainless steel trim.

B. Pipe NPS 2-1/2 and Larger:

1. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 150.
2. Ball valves, flanged ends - steel, with full port and stainless steel trim, Class 300.

3.6 FUEL OIL CHECK VALVE SCHEDULE - 150 PSIG OR LESS

A. Pipe NPS 2 and Smaller:

1. Horizontal and Vertical Upflow Applications:

a. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 125.
b. Check valves, swing type, threaded ends - bronze, with bronze disc, Class 150.

B. Pipe NPS 2-1/2 and Larger:

1. Check valves, swing type, flanged ends - iron, with metal seats, Class 125.
2. Check valves, swing type, flanged ends - iron, with metal seats, Class 250.

3.7 PUMP-DISCHARGE CHECK VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Check valves, lead free, swing type, threaded ends - bronze, with nonmetallic disc, Class 125.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports - metal.
2. Pipe hangers - metal, trapeze type.
3. Strut support systems - metal, rod type.
4. Fastener systems.
5. Equipment supports.

B. Related Requirements:

1. Section 220500 "Common Work Results for Plumbing" for pipe guides and anchors.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

B. Shop Drawings: Signed and sealed by a qualified professional engineer**.** Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers.
2. Metal strut support systems.
3. Pipe stands.
4. Equipment supports.

C. Delegated Design Submittals: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication/assembly and design calculations for trapeze hangers.
2. Detail fabrication/assembly and design calculations for each type of strut support system, by the manufacturer's technical representative.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.

B. Pipe Welding Qualifications: Qualify procedures and operators in accordance with 2021 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for plumbing piping and equipment are to withstand the effects of gravity loads and stresses within limits and under conditions indicated in accordance with ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment.

2.2 PIPE HANGERS AND SUPPORTS - METAL

A. Pipe Hangers and Supports - Carbon Steel:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Anvil
    b. Cooper B-line
    c. Unitstrut

2. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
3. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
4. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of plated carbon steel.

2.3 PIPE HANGERS - METAL, TRAPEZE TYPE

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly, made from structural-carbon-steel shapes, with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 STRUT SUPPORT SYSTEMS - METAL, ROD TYPE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Anvil
2. Cooper B-line
3. [Flex-Strut Inc.]

B. Description: Factory-fabricated pipe-support assembly, made of steel channels, vertical metal support rods, accessories, fittings, and other components for supporting multiple parallel pipes.

C. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.

D. Struts: Continuous slotted plated carbon-steel channel with inturned lips.

E. Strut Width: Selected for applicable load criteria.

F. Strut Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

G. Hanger Rods: Continuous-thread rod, nuts, and washer made of plated carbon steel.

H. Metallic Coating: Electroplated zinc.

I. Paint Coating: Green epoxy, acrylic, or urethane.

J. Plastic Coating: PVC.

2.5 FASTENER SYSTEMS

A. Fastener System - Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities required for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Hilti, Inc.
b. ITW Ramset/Red Head
c. MKT Fastening, LLC

B. Fastener System - Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities required for supported loads and building materials where used.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Cooper B-line
b. Empire Industries, Inc.
c. Hilti, Inc.
d. ITW Ramset/Red Head

2. Indoor Applications: Zinc-plated or stainless steel.
3. Outdoor Applications: Stainless steel.

2.6 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-carbon-steel shapes.

2.7 MATERIALS

A. Carbon Steel: ASTM A1011/A1011M.

B. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.

C. Stainless Steel: ASTM A240/A240M.

D. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000 psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. 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 is to include weight of supported components plus 200 lb.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

A. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

B. Install lateral bracing with pipe hangers and supports to prevent swaying.

C. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Coordinate location of concrete inserts before concrete is placed.

D. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

E. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

F. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

G. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
2. Field fabricate in accordance with ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel in accordance with AWS D1.1/D1.1M.

H. Strut System Installation: Metal; arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

I. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick after concrete is placed and cured. Use installers that are licensed by powder-actuated tool manufacturer.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners in accordance with manufacturer's written instructions.
3. Install lag screw wood fasteners in accordance with manufacturer's written instructions.
4. Install fasteners in accordance with manufacturer's written instructions.

J. Pipe Stand Installation:

1. Pipe Stand Types, except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

K. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

L. Equipment Support Installation:

1. Fabricate from welded-structural-steel shapes.
2. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
3. Grouting: Place grout under supports for floor-mounted equipment, and make bearing surface smooth.
4. Provide lateral bracing, to prevent swaying.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1- inch .

3.5 PAINTING

A. Touchup:

1. Clean field welds and abraded, shop-painted areas. Paint exposed areas

immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

a. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

2. Comply with manufacturer's requirements for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
3. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.

D. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.

E. Use stainless steel pipe hangers stainless steel or corrosion-resistant attachments for hostile environment applications.

F. Use padded hangers for piping that is subject to scratching.

G. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated stationary pipes NPS 1/2 to NPS 30.
2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility.
3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
4. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
7. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of

noninsulated, stationary pipes NPS 1/2 to NPS 8.

9. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
10. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
11. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
12. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
13. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
14. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
15. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction occurs.
16. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction occurs.
17. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
18. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.
19. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.

H. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

I. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

J. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.

6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

L. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

M. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 220529

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Valve tags.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve-numbering scheme.

D. Valve Schedules: For each piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Brady Corporation
    b. Pipemarker.com
    c. Seton Identification Products

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
3. Letter and Background Color: As indicated for specific application under Part 3.
4. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number.

2.2 WARNING SIGNS AND LABELS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brady Corporation
2. Pipemarker.com
3. Seton Identification Products

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Maximum Temperature: Able to withstand temperatures of up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances of up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA 70E.

J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to,

the following:

1. Marking Services Inc.
2. Pipemarker.com
3. Seton Identification Products

B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

E. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

F. Pipe Label Contents: Include identification of piping service using same designations used on Drawings. Also include:

1. Flow-Direction Arrows: Include flow-direction arrows on all piping. Arrows may be either integral with label or applied separately.
2. Lettering Size: Size letters in accordance with ASME A13.1 for piping.

2.4 VALVE TAGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brady Corporation
2. Pipemarker.com
3. Seton Identification Products

B. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.04-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass link chain or beaded chain.

C. Letter and Background Color: As indicated for specific application under Part 3.

D. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Include valve-tag schedule in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 INSTALLATION, GENERAL REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS AND LABELS

A. Permanently fasten labels on each item of plumbing equipment.

B. Sign and Label Colors.

1. White letters on an ANSI Z535.1 black background.

C. Locate equipment labels where accessible and visible.

3.4 INSTALLATION OF PIPE LABELS

A. Piping Color Coding: Painting of piping is specified in Section 099123 "Interior Painting."

B. Install pipe labels showing service and flow direction with permanent adhesive on pipes.

C. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Within 3 ft. of each valve and control device.
2. At access doors, manholes, and similar access points that permit view of concealed piping.
3. Within 3 ft. of equipment items and other points of origination and termination.

4. Spaced at maximum intervals of 10 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping and equipment.

D. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.

E. Flow-Direction Flow Arrows: Use arrows, in compliance with ASME A13.1, to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

F. Pipe-Label Color Schedule:

1. Fuel Oil Supply Piping: Black letters on an ANSI Z535.1 safety-yellow background.
2. Fuel Oil Return Piping: Black letters on an ANSI Z535.1 safety-yellow background.

3.5 INSTALLATION OF VALVE TAGS

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:

1. Valve-Tag Size and Shape:

a. Fuel Oil Supply: 1-1/2 inches, round.
b. Fuel Oil Return: 1-1/2 inches, round.

2. Valve-Tag Colors:

a. For each piping system, use the same lettering and background coloring system on valve tags as used in the piping system labels and background.

END OF SECTION 220553

SECTION 230923 - PROGRAMMABLE LOGIC CONTROLLER (PLC) SYSTEM FOR FUEL OIL DELIVERY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Programmable Logic Controller (PLC) system for Fuel Oil Delivery.

B. Related Requirements:

1. Section 230923.17 "Level Instruments" for liquid-level switches, sensors, and transmitters that connect to PLC systems.
2. Section 230923.22 "Position Instruments" for limit switches that connect to PLC systems.
3. Section 230993.11 "Sequence of Operations for FUEL OIL DELIVERY PLC" for control sequences in PLC systems.
4. Section 260553 "Identification for Electrical Systems" for identification requirements for electrical power and communications components

1.2 DEFINITIONS

A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.

B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.

C. Discrete: Two-state signal where a high signal level represents "ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Discrete" to indicate a two-state signal.

D. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: network controllers, programmable logic controllers.

E. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.

F. COV: Changes of value.

G. PLC System Provider: Authorized representative of, and trained by, PLC system manufacturer and responsible for execution of PLC system Work indicated.

H. Distributed Control: Processing of system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems to be capable of operating in a standalone mode using the last best available data.

I. SCADA, or Supervisory Control and Data Acquisition, is a type of computerized system that collects and analyzes data from remote locations to control industrial processes and infrastructure, such as power grids, water systems, and manufacturing plants. It uses hardware and software components, including sensors, Remote Terminal Units (RTUs), a Human-Machine Interface (HMI), and communication networks, to enable operators to monitor and manage operations from a central control system.

J. HMI stands for Human-Machine Interface, a user interface that allows people to monitor and control machinery or processes in industrial settings and other devices. HMIs can range from physical panels with buttons and lights to advanced touch screens and software that provide graphical displays of data, trends, and key performance indicators (KPIs). They translate complex data into an easy-to-understand format for operators and supervisors, enabling efficient monitoring, control, and automation.

K. Protocol Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.

L. HLC: Heavy load conditions.

M. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), discrete input (DI), analog output (AO) and discrete output (DO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Discrete signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI) and (DO), is sometimes used interchangeably with "Discrete," (DI) and (DO), respectively.

N. LAN: Local area network.

O. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

P. Modbus TCP/IP: An open protocol for exchange of process data.

Q. EtherNet/IP (Ethernet Industrial Protocol) is an open industrial network standard, developed by Rockwell Automation and managed by ODVA, that adapts the Common Industrial Protocol (CIP) to standard Ethernet for use in industrial automation.

R. MTBF: Mean time between failures.

S. Network Controller: Digital controller, which supports a family of programmable logics controllers, that communicates on peer-to-peer network for transmission of global data.

T. Network Repeater: Device that receives data packet from one network and

rebroadcasts it to another network. No routing information is added to protocol.

U. Peer to Peer: Networking architecture that treats all network stations as equal partners.

V. Server: Computer used to maintain system configuration, historical and programming database.

W. TCP/IP: Transport control protocol/Internet protocol.

X. UPS: Uninterruptible power supply.

Y. USB: Universal Serial Bus.

Z. User

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Amerson WTP, Macon, Georgia.

1.4 ACTION SUBMITTALS

A. Multiple Submissions:

1. If multiple submissions are required to execute work within schedule, first submit a coordinated schedule clearly defining intent of multiple submissions. Include a proposed date of each submission with a detailed description of submittal content to be included in each submission.
2. Clearly identify each submittal requirement indicated and in which submission the information will be provided.
3. Include an updated schedule in each subsequent submission with changes highlighted to easily track the changes made to previous submitted schedule.

B. Product Data: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation, and maintenance instructions including factors effecting performance.
5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.

    a. Protocol gateways.
    b. PLC controllers.

c. Enclosures HMI.
d. Electrical power devices.
e. UPS units.
f. Accessories.
g. Instruments.
h. Pump.Control valves and actuators.

6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
7. Each submitted piece of product literature to clearly cross reference specification and drawings that submittal is to cover.

C. Software Submittal:

1. Cross-referenced listing of software to be loaded on each operator workstation, server, protocol gateways, HMI and PLC controller.
2. Description and technical data of all software provided and cross-referenced to products in which software will be installed.
3. Operating system software, operator interface and programming software, color graphic software, PLC controller software, maintenance management software, and third-party software.
4. Include a flow diagram and an outline of each subroutine that indicates each program variable name and units of measure.
5. Listing and description of each engineering equation used with reference source.
6. Listing and description of each constant used in engineering equations and a reference source to prove origin of each constant.
7. Description of operator interface to alphanumeric and graphic programming.
8. Description of each network communication protocol.
9. Description of system database, including all data included in database, database capacity, and limitations to expand database.
10. Description of each application program and device drivers to be generated, including specific information on data acquisition and control strategies showing their relationship to system timing, speed, processing burden, and system throughout.
11. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

D. Shop Drawings:

1. General Requirements:

a. Include cover drawing with Project name, location, Owner, Architect, Contractor, and issue date with each Shop Drawings submission.
b. Include a drawing index sheet listing each drawing number and title that matches information in each title block.
c. Drawings Size. ANSI D (22” x 34”.

2. Include plans, elevations, sections, and mounting details where applicable.
3. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and

size of each field connection.

4. Detail means of vibration isolation and show attachments to rotating equipment.
5. Plan Drawings indicating the following:

    a. Screened backgrounds of walls, structural grid lines, Fuel Oil Delivery equipment, and piping.
    b. Room names and numbers with coordinated placement to avoid interference with control products indicated.
    c. Each desktop workstation network port, server, protocol gateways, router, PLC HMI controller, control panel instrument connecting to PLC controller, and pump and valve connecting to PLC controller, if included in Project.
    d. Exact placement of products in rooms, ducts, and piping to reflect proposed installed condition.
    e. Network communication cable and raceway routing.
    f. Information, drawn to scale, of control panel locations.
    g. Proposed routing of wiring, cabling, conduit, and tubing; coordinated with building services for review before installation.

6. Schematic drawings for each controlled Fuel Oil Delivery system indicating the following:

    a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each pump and valve, if included in Project.
    b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
    c. A graphic showing location of control I/O in proper relationship to Fuel Oil Delivery system.
    d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
    e. Unique identification of each I/O that to be consistently used between different drawings showing same point.
    f. Elementary wiring diagrams of controls for Fuel Oil Delivery equipment pump circuits including interlocks, switches, relays, and interface to PLC controllers.
    g. Narrative sequence of operation.
    h. Graphic sequence of operation, showing all inputs and output logical blocks.

7. Control panel drawings indicating the following:

    a. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
    b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates, and allocated spare space.
    c. Front, rear, and side elevations and nameplate legend.
    d. Unique drawing for each panel.

8. PLC system network riser diagram indicating the following:

a. Each device connected to network with unique identification for each.
b. Interconnection of each different network in PLC system.
c. For each network, indicate communication protocol, speed, and physical means of interconnecting network devices, such as copper cable type, or optical fiber cable type. Indicate raceway type and size for each.
d. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.

9. PLC system electrical power riser diagram indicating the following:

a. Each point of connection to field power with requirements (volts/phase//hertz/amperes/connection type) listed for each.
b. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
c. Each product requiring power with requirements (volts/phase//hertz/amperes/connection type) listed for each.
d. Power wiring type and size, race type, and size for each.

10. Monitoring and control signal diagrams indicating the following:

a. Control signal cable and wiring between controllers and I/O.
b. Point-to-point schematic wiring diagrams for each product.
c. Control signal tubing to sensors, switches, and transmitters.
d. Process signal tubing to sensors, switches, and transmitters.

11. Color graphics indicating the following:

a. Itemized list of color graphic displays to be provided.
b. For each display screen to be provided, a true color copy showing layout of pictures, graphics, and data displayed.
c. Intended operator access between related hierarchical display screens.

E. System Description:

1. Full description of PLC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, protocol gateways, routers and other network devices, and power supplies.
2. Complete listing and description of each report, log and trend for format and timing, and events that initiate generation.
3. System and product operation under each potential failure condition including, but not limited to, the following:

a. Loss of power.
b. Loss of network communication signal.
c. Loss of controller signals to inputs and outpoints.
d. Operator workstation failure.
e. Protocol Gateway failure.
f. Network failure.
g. Controller failure.
h. Instrument failure.

i. Pump and valve actuator failure.

4. Complete bibliography of documentation and media to be delivered to Owner.
5. Description of testing plans and procedures.
6. Description of Owner training.

F. Samples:

1. For each of the following exposed product(s), installed in finished space for approval of selection of aesthetic characteristics:

a. Moisture instruments specified in Section 230923.11 "Control Valves."
b. Pressure instruments specified in Section 230923.23 "Pressure Instruments."
c. Level instruments specified in Section 2302923.17“ Level Instruments.

G. Delegated Design Submittals: For PLC system products and installation indicated as being delegated.

1. Supporting documentation showing PLC system design complies with performance requirements indicated, including calculations and other documentation necessary to prove compliance.
2. Schedule and design calculations for control pumps and actuators.

a. Flow Rate at Project design and minimum flow conditions.
b. Face velocity at Project design and minimum airflow conditions.
c. Pressure drop across pump at Project design and minimum airflow
d. Fuel Oil usage rates required at worst case condition for sizing actuator.
e. Actuator selection indicating torque provided.
f. Actuator signals to control pump (on, off).
g. Actuator position on loss of power.
h. Actuator position on loss of control signal.

3. Schedule and design calculations for control valves.

a. Flow at Project design and minimum flow conditions.
b. Design and minimum control valve coefficient with corresponding valve position.
c. Maximum close-off pressure.
d. Leakage flow at maximum system pressure differential.
e. Torque required at worst case condition for sizing actuator.
f. Actuator selection indicating torque provided.
g. Actuator signal to control valve (pen, close or modulate).
h. Actuator position on loss of power.
i. Actuator position on loss of control signal.

4. Schedule and design calculations for selecting flow instruments.

a. Instrument flow range.
b. Project design and minimum flow conditions with corresponding accuracy, control signal to transmitter, and output signal for remote control.

c. Extreme points of extended flow range with corresponding accuracy, control signal to transmitter, and output signal for remote control.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Plan drawings, reflected ceiling plans, and corresponding product installation details, drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Qualification Statements:

1. Systems Provider's Qualification Data:

a. Resume of project manager assigned to Project.
b. Resumes of application engineering staff assigned to Project.
c. Resumes of installation and programming technicians assigned to Project.
d. Resumes of service technicians assigned to Project.
e. Brief description of past project including physical address, floor area, number of floors, building system cooling and heating capacity, and building's primary function.
f. Description of past project PLC and SCADA systems, noting similarities to Project scope and complexity indicated.
g. Names of staff assigned to past project that will also be assigned to execute work of this Project.
h. Owner contact information for past project including name, phone number, and email address.
i. Contractor contact information for past project including name, phone number, and email address.
j. Engineer contact information for past project including name, phone number, and email address.

2. Manufacturer's qualification data.
3. Testing agency's qualification data.

C. Product Certificates:

1. Data Communications Protocol Certificates:

a. Certifying that each proposed PLC system component complies with Modbus/IP for pump controls.
b. Certifying that each proposed PLC system component complies with Ethernet/IP for interface to site SCADA system.

D. Test and Evaluation Reports:

1. Product Test Reports: For PLC system equipment and components, for tests performed by manufacturer.
2. Preconstruction Test Reports: For each separate test performed.

E. Source Quality-Control Reports: For PLC system equipment and components.

F. Field Quality-Control Reports: For PLC system equipment and components.

G. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For PLC system.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
c. As-built versions of submittal Product Data.
d. Names, addresses, email addresses, and 24-hour telephone numbers of Installer and service representatives for PLC system and products.
e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing set points and variables.
f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
g. Engineering, installation, and maintenance manuals that explain how to do the following:

1) Design and install new points, panels, and other hardware.
2) Perform preventive maintenance and calibration.
3) Debug hardware problems.
4) Repair or replace hardware.

h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
i. Backup copy of graphic files, programs, and databases on electronic media.
j. List of recommended spare parts with part numbers and suppliers.
k. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
l. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
m. Licenses, guarantees, and warranty documents.
n. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.

o. Owner training materials.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials and parts to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Include product manufacturers' recommended parts lists for proper product operation over four-year period following warranty period. Parts list to be indicated for each year.

C. Furnish parts, as indicated by manufacturer's recommended parts list, for product operation during one-year period following warranty period.

D. Furnish quantity indicated of matching product(s) in Project inventory for each unique size and type of following:

1. Network Controller: Two.
2. Programmable Logic Controller: Two.
3. Transformer: One.
4. DC Power Supply: Two.
5. Modbus/IP-Ethernet/IP protocol gateways: One.

1.8 QUALITY ASSURANCE

A. PLC System Manufacturer Qualifications:

1. Nationally recognized manufacturer of PLC systems and products.
2. PLC systems with similar requirements to those indicated for a continuous period of five years within time of bid.
3. PLC systems and products that have been successfully tested and in use on at least three past projects.
4. Having complete published catalog literature, installation, operation, and maintenance manuals for all products intended for use.
5. Having full-time in-house employees for the following:

a. Product research and development.
b. Product and application engineering.
c. Product manufacturing, testing, and quality control.
d. Technical support for PLC system installation training, commissioning, and troubleshooting of installations.
e. Owner operator training.

B. PLC System Provider Qualifications:

1. Authorized representative of, and trained by, PLC system manufacturer.
2. Demonstrate past experience with installation of PLC system products being installed for period within three consecutive years before time of bid.
3. Demonstrate past experience on five projects of similar complexity, scope, and

value.

4. Demonstrate past experience of the Controls Engineering group assigned to Project.
5. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
6. Service and maintenance staff assigned to support Project during warranty period.

1.9 WARRANTY

A. Special Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.

1. Adjust, repair, or replace failures at no additional cost or reduction in service to Owner.
2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.

    a. Install updates only after receiving Owner's written authorization.

3. Perform warranty service during normal business hours and commence within 48 hours of Owner's warranty service request.
4. Warranty Period: Two year(s) from date of Substantial Completion.

    a. For Protocol Gateways: One-year parts and labor warranty for each.

PART 2 - PRODUCTS

2.1 PROGRAMMABLE LOGIC CONTROLLER (PLC) SYSTEM FOR FUEL OIL DELIVERY

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following :

1. Automation Direct
2. Allen-Bradley
3. ProSoft Technologies

2.2 PLC SYSTEM DESCRIPTION

A. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.

1. PLC system consisting of high-speed, peer-to-peer network of distributed PLC controllers , other network devices , operator interfaces, and software.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 PERFORMANCE REQUIREMENTS

A. Delivery of Selected Control Devices: Deliver to equipment and systems manufacturers for factory installation and to Fuel Oil Delivery systems installers for field installation.

B. Delegated Design, Qualified Professional Engineer: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design PLC system to satisfy requirements indicated.

C. Delegated Design, Qualified Professional: Engage a qualified professional to design PLC system to satisfy requirements indicated.

1. System Performance Objectives:

a. PLC system manages Fuel Oil Delivery systems.
b. PLC system operates Fuel Oil Delivery systems to achieve optimum operating costs while using least possible energy and maintaining specified performance.
c. PLC system responds to power failures, Fuel Oil Delivery equipment failures, and adverse and emergency conditions encountered through connected I/O points.
d. PLC system operates while unattended by an operator and through operator interaction.
e. PLC system records trends and transactions of events and produces report information such as performance, and equipment operation.

D. PLC System Speed:

1. Response Time of Connected I/O:

a. Update AI point values connected to PLC system at least every 0.5 seconds for use by PLC controllers. Points used globally to also comply with this requirement.
b. Update DI point values connected to PLC system at least every 0.5 seconds for use by PLC controllers. Points used globally to also comply with this requirement.
c. AO points connected to PLC system to begin to respond to controller output commands within one second(s). Global commands to also comply with this requirement.
d. DO point values connected to PLC system to respond to controller output commands within 0.1 second(s). Global commands to also comply with this requirement.

2. Display of Connected I/O:

    a. Update and display analog point COV connected to PLC system at least every five seconds for use by operator.
    b. Update and display discrete point COV connected to PLC system at least every 2 seconds for use by operator.
    c. Update and display alarms of analog and digital points connected to PLC system within 5 seconds of activation or change of state.
    d. Update graphic display refresh within 1 seconds.
    e. Point change of values and alarms displayed from workstation to workstation when multiple operators are viewing from multiple workstations to not exceed graphic refresh rate indicated.

E. Network Bandwidth: Design each network of PLC system to include spare bandwidth with PLC system operating under normal and heavy load conditions indicated. Calculate bandwidth usage, and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions. Minimum spare bandwidth as follows:

1. Level 1 Networks: 20.
2. Level 2 Networks: 20.
3. Level 3 Networks: 10.

F. PLC System Data Storage:

1. Include capability to archive not less than 24 consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends, and other information indicated.
2. Local Storage:

    a. Provide SCADA system with data storage indicated. Server(s) to use IT industry standard database platforms and be capable of functions described in "PLC Data Access" Paragraph.

G. PLC Data Access:

1. When logged into the system, operator able to also interact with any PLC controllers connected to PLC system as required for functional operation of PLC system.
2. Use for application configuration; for archiving, reporting, and trending of data; for operator transaction archiving and reporting; for network information management; for alarm annunciation; and for operator interface tasks and controls application management.

H. Future Expandability:

1. PLC system size is expandable to an ultimate capacity of at least 1.25 times total I/O points indicated.
2. Design and install system networks to achieve ultimate capacity with only addition of PLC controllers, I/O, and associated wiring and cable. Design and install initial network infrastructure to support ultimate capacity without having to

remove and replace portions of network installation.

3. Operator interfaces installed initially do not require hardware and software additions and revisions for system when operating at ultimate capacity.

I. Input Point Values Displayed Accuracy: Meet following end-to-end overall system accuracy, including errors associated with meter, sensor, transmitter, lead wire or cable, and analog to digital conversion.

1. Flow:

a. Fuel Oil: Within 2 percent of design flow rate.

2. Level: Within 2 percent of reading.

a. Fuel Oil Tanks (Main/Bulk Storage & Day Tanks: 0.5.

J. Precision of I/O Reported Values: Values reported in database and displayed to have following precision:

1. Energy:

a. Fuel Oil (Usage): For gallons, nearest 1/10th of a gallon up to 100 gal.; nearest gallon for above 100 gal.

2. Level: Nearest 1/100th of an inch through 10 inches; nearest 1/10 of an inch between 10 and 100 inches; nearest inch above 100 inches.

K. Control Stability: Control variables indicated within the following limits:

1. Level: Within 2 percent of reading.

L. Environmental Conditions for Controllers, Protocol Gateways, and Routers:

1. Products to operate without performance degradation under ambient environmental temperature, pressure, and humidity conditions encountered for installed location.

a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure to be internally insulated, electrically heated, cooled, and ventilated as required by product and application.

2. Protect products with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. House products not available with integral enclosures complying with requirements indicated in protective secondary enclosures. Installed location dictates the following NEMA 250 enclosure requirements:

a. Outdoors, Protected: Type 4.
b. Outdoors, Unprotected: Type 4X.
c. Indoors, Heated with Filtered Ventilation: Type 12.
d. Indoors, Heated with Non-Filtered Ventilation: .

e. Indoors, Heated and Air-Conditioned: Type 12.
f. Mechanical Equipment Rooms:

1) Generator Buildings: Type 4.

g. Localized Areas Exposed to Washdown: Type 4.

M. Environmental Conditions for Instruments and Actuators:

1. Instruments and actuators to operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.

a. If instruments and actuators alone cannot comply with requirement, install instruments and actuators in protective enclosures that are isolated and protected from conditions impacting performance. Enclosure is internally insulated, electrically heated , cooled , and ventilated as required by instrument and application.

2. Protect instruments, actuators, and accessories with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. House instruments and actuators not available with integral enclosures complying with requirements indicated in protective secondary enclosures. Installed location is to dictate the following NEMA 250 enclosure requirements:

a. Outdoors, Protected: 4X.
b. Outdoors, Unprotected: Type 4X.
c. Indoors, Heated with Filtered Ventilation: Type 12.
d. Indoors, Heated with Non-Filtered Ventilation: Type 12.
e. Indoors, Heated and Air-conditioned: Type 12.
f. Mechanical Equipment Rooms:

1) Chiller and Boiler Rooms: Type 4.
2) Air-Moving Equipment Rooms: Type 12.

g. Localized Areas Exposed to Washdown: Type 4.

N. PLC System Reliability:

1. Design, install, and configure PLC controllers, protocol gateways, to yield a MTBF of at least 20,000 hours, based on a confidence level of at least 90 percent. MTBF value includes any failure for any reason to any part of products indicated.
2. If required to comply with MTBF indicated, include PLC system and product redundancy to maintain DCC system, and associated systems and equipment being controlled, operational, and under automatic control.
3. See Drawings for critical systems and equipment that require a higher degree of PLC system redundancy than MTBF indicated.

O. Electric Power Quality:

1. Power-Line Surges:

    a. Protect susceptible PLC system products connected to ac power circuits from power-line surges to comply with requirements of IEEE C62.41.1 and IEEE C62.41.2.
    b. Do not use fuses for surge protection.
    c. Test protection in the normal mode and in the common mode, using the following two waveforms:

        1) 10-by-1000-microsecond waveform with a peak voltage of 1500 V and a peak current of 60 A.
        2) 8-by-20-microssecond waveform with a peak voltage of 1000 V and a peak current of 500 A.

2. Power Conditioning:

    a. Protect susceptible PLC system products connected to ac power circuits from irregularities and noise rejection. Characteristics of power-line conditioner are as follows:

        1) At 85 percent load, output voltage to not deviate by more than plus or minus 1 percent of nominal when input voltage fluctuates between minus 20 percent to plus 10 percent of nominal.
        2) During load changes from zero to full load, output voltage to not deviate by more than 2 percent of nominal.
        3) Accomplish full correction of load switching disturbances within five cycles, and 95 percent correction within two cycles of onset of disturbance.
        4) Total harmonic distortion to not exceed 3 percent at full load.

3. Ground Fault: Protect products from ground fault by providing suitable grounding. Products to not fail due to ground fault condition.

P. Backup Power Source:

1. Serve PLC system products that control Fuel Oil Delivery systems and equipment served by a backup power source also from a backup power source.

Q. UPS:

1. PLC system products powered by UPS units are to include the following:

    a. Protocol Gateways.
    b. PLC controllers.

2. PLC system instruments and actuators powered by UPS units are to include the following:

    a. Instruments: Where indicated on Drawings; where associated with the following systems controlled by PLC system:

1) Fuel Storage & Delivery.
2) Monitor tanks, vaults & sumps for moisture/leaks.

b. Valve Actuators: Where indicated on Drawings; where associated with the following systems controlled by PLC system:

1) Fuel Storage & Delivery.

R. Continuity of Operation after Electric Power Interruption:

1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems are to automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

2.4 PANEL-MOUNTED, MANUAL OVERRIDE SWITCHES

A. Manual Override of Control Fuel Oil Valves:

1. Include panel-mounted, two-position, selector switch for each automatic control Fuel Oil Valves being controlled by PLC controller.
2. Label each switch with Fuel Oil Valves designation served by switch.
3. Label switch positions to indicate either "Manual" or "Auto" control signal to Fuel Oil Valves.
4. With switch in "Auto" position, control signal to Fuel Oil Valves actuator with control loop output signal from PLC controller.
5. With switch in "Manual" position, control signal to Fuel Oil Valves actuator at panel with either an integral or a separate switch to include local control.

a. For Discrete Control Fuel Oil Valves: Manual two-position switch with "Close" and "Open" switch positions indicated. With switch in "Close" position, close Fuel Oil Valves. With switch in "Open" position, open Fuel Oil Valves.

6. PLC controller to monitor and report position of each manual override selector switch. With switch placed in "manual" position, PLC controller to signal an override condition to alert operator that pump is under manual, not automatic, control.
7. Configure manual override switches to allow operator to manually operate fuel oil supply pumps, fuel oil fill pump, fuel filter/polisher, return pumps while at panel without PLC controller installed and operational .
8. Terminal equipment including waste oil tank do not require manual override unless otherwise indicated by sequence of operation.

B. Manual Override of Control Valves:

1. Include panel-mounted, two-position, selector switch for each automatic control

valve being controlled by PLC controller.

2. Label each switch with valve designation served by switch.
3. Label switch positions to indicate either "Manual" or "Auto" control signal to valve.
4. With switch in "Auto" position, control signal to valve actuator with a control loop output signal from PLC controller.
5. With switch in "Manual" position, control signal to valve actuator at panel with either an integral or a separate switch to include local control.

    a. For Discrete Control Valves: Manual two-position switch with "Close" and "Open" switch positions indicated. With switch in "Close" position, close valve. With switch in "Open" position, open valve.

6. PLC controller to monitor and report position of each manual override selector switch. With switch placed in "manual" position, PLC controller to signal an override condition to alert operator that valve is under manual, not automatic, control.
7. Configure manual override switches to allow operator to manually operate valve while at panel without PLC controller installed and operational .

2.5 SYSTEM ARCHITECTURE

A. System architecture consisting of no more than three levels of LANs.

1. Level 2 LAN: Connect network controllers and operator workstations.
2. Level 1 or Level 2 LAN: Connect Level 1 or Level 2 programmable application controllers to other programmable logic controllers and to network controllers.
3. Level 2 or Level 3 LAN: Connect Level 2 or Level 3 programmable logic controllers to network controllers.

B. Minimum Data Transfer and Communication Speed:

1. LAN Connecting Operator Workstations and Network Controllers: 100 Mbps.
2. LAN Connecting Programmable Logic Controllers: 100Mbps.

C. Provide dedicated and separated PLC system LANs that are not shared with other building systems communication networks.

D. Provide modular system architecture with inherent ability to expand to not less than 1.25 times system size indicated with no impact to performance indicated.

E. Configure architecture to minimize need to remove and replace existing network equipment for system expansion.

F. Make number of LANs and associated communication transparent to operator. Configure all I/O points residing on any LAN to be capable of global sharing between all system LANs.

G. Design system to eliminate dependence on any single device for system alarm reporting and control execution. Design each controller to operate independently by performing own control, alarm management, and historical data collection.

2.6 PLC SYSTEM OPERATOR INTERFACES

A. Operator Means of System Access: Operator able to access entire PLC system through any of multiple means including, but not limited to, the following:

1. Desktop and portable workstation with hardwired connection through LAN port.
2. Portable operator terminal with hardwired connection through LAN port.

B. Make access to system, regardless of operator means used, transparent to operator.

C. Network Ports: For hardwired connection of desktop or portable workstation. Network port easily accessible, properly protected, clearly labeled, and installed at the following locations:

1. Each outdoor on-grade yard and elevated platform with equipment connected to PLC system.
2.

D. Desktop Workstations:

1. Connect Owner-furnished desktop workstation(s) to PLC system Level 1 LAN through a communications port directly on LAN or through a communications port on a PLC controller.
2. Able to communicate with any device located on any PLC system LAN.

E. Critical Alarm Reporting:

1. Send operator-selected critical alarms to notify operator of critical alarms that require immediate attention.

2.7 NETWORKS

A. Acceptable networks for connecting workstations, mobile devices, and network controllers include the following:

1. IP.
2. ISO/IEC/IEEE 8802-3, Ethernet.

B. Acceptable networks for connecting programmable logic controllers include the following:

1. IP.
2. ISO/IEC/IEEE 8802-3, Ethernet.

C. Acceptable networks for connecting logic-specific controllers include the following:

1. IP.

2.8 NETWORK COMMUNICATION PROTOCOL

A. Use network communication protocol(s) that are open to Owner and available to other companies for use in making future modifications to PLC system.

B. Industry Standard Protocols:

1. Use any one or a combination of the following industry standard protocols for network communication while complying with other PLC system requirements indicated:

    a. Modbus/TCP.
    b. Ethernet/IP.

2. Operator workstations and network controllers are to communicate through Modbus/TCP or Ethernet/IP protocol.
3. Use protocol gateways to connect networks and network devices with different protocols.

2.9 PLC DESKTOP WORKSTATION

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Customer’s existing Wonderware ArchestrA SCADA network system.

2.10 SYSTEM SOFTWARE

A. HMI:

1. Include a full interactive graphical selection means of accessing and displaying system data to operator. Include at least five levels with the penetration path operator assignable (for example, site, building, floor, air-handling unit, and supply temperature loop). Native language descriptors assigned to menu items are to be operator defined and modifiable under password control.
2. Include a hierarchical-linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation. Interface is to use a pointing device with pull-down or penetrating menus, color, and animation to facilitate operator understanding of system.
3. Make descriptors for graphics, points, alarms, and such modifiable through operator's workstation under password control.
4. Make data displayed within a graphic assignable regardless of physical hardware address, or point type.
5. Make graphics online programmable and under password control.
6. Make points assignable to multiple graphics where necessary to facilitate operator understanding of system operation.
7. Display points (physical) with dynamic data provided by PLC system with

appropriate text descriptors, status or value, and engineering unit.

8. Use color, rotation, or other highly visible means, to denote status and alarm states. Make colors variable for each class of points, as chosen by operator.
9. For operators with appropriate privilege, command points directly from display using pointing device.

    a. For an analog command point such as set point, display current conditions and limits so operator can position new set point using pointing device.
    b. For a digital command point such as valve position, show valve in current state such as open or closed so operator could select alternative position using pointing device.

B. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:

1. Plan for each building floor, including interstitial floors, and each roof level of each building, showing the following:

    a. Locations and identification of all monitored and controlled FUEL OIL DELIVERY equipment and other equipment being monitored and controlled by PLC system.
    b. Location and identification of each hardware point being controlled or monitored by PLC system.

2. Control schematic for each of following, including a graphic system schematic representation, similar to that indicated on Drawings, with point identification, set point and dynamic value indication, sequence of operation and control logic diagram.
3. Graphic display for each piece of equipment connected to PLC system through a data communications link. Include dynamic indication of all points associated with equipment.
4. PLC system network riser diagram that shows schematic layout for entire system including all networks and all controllers, protocol gateways and other network devices.

C. Customizing Software:

1. Software to modify and tailor PLC system to specific and unique requirements of equipment installed, to programs implemented and to staffing and operational practices planned.
2. Online modification of PLC system configuration, program parameters, and database using menu selection and keyboard entry of data into preformatted display templates.
3. At a minimum, include the following modification capability:

    a. Operator Assignment: Designation of operator passwords, access levels, point segregation, and auto sign-off.
    b. Peripheral Assignment: Assignment of segregation groups and operators to consoles and printers, designation of backup workstations and printers, designation of workstation header points, and enabling and disabling of printout of operator changes.

c. System Configuration and Diagnostics: Communications and peripheral port assignments, PLC controller assignments to network, PLC controller enable and disable, assignment of command trace to points, and application programs and initiation of diagnostics.
d. System Text Addition and Change: English or native language descriptors for points, segregation groups and access levels and action messages for alarms, run time, and trouble condition.
e. Time and Schedule Change: Time and date set, time and occupancy schedules, exception and holiday schedules, and daylight-savings time schedules.
f. Point related change capability is to include the following:

1) System and point enable and disable.
2) Run-time enable and disable.
3) Assignment of points to segregation groups, calibration tables, lockout, and run time and to a fixed I/O value.
4) Assignment of alarm and warning limits.

g. Application program change capability is to include the following:

1) Enable and disable of software programs.
2) Programming changes.
3) Assignment of comfort limits, global points, time and event initiators, time and event schedules and enable and disable time and event programs.

4. Provide software to allow operator ability to add points, or groups of points, to PLC system and to link them to energy optimization and management programs. Make additions and modifications online programmable using operator workstations, downloaded to other network devices and entered into their databases. After verification of point additions and associated program operation, upload and record database on hard drive and disc for archived record.
5. Include high-level language programming software capability for implementation of custom PLC programs. Include a compiler, linker, and up- and down-load capability.
6. Include a library of PLC algorithms, intrinsic control operators, arithmetic, logic, and relational operators for implementation of control sequences. Also include, at a minimum, the following:

a. Proportional control (P).
b. Proportional plus integral (PI).
c. Proportional plus integral plus derivative (PID).
d. Adaptive and intelligent self-learning control.

1) Algorithm monitors loop response to output corrections and adjust loop response characteristics in accordance with time constant changes imposed.
2) Algorithm operates in a continuous self-learning manner and retains in memory a stored record of system dynamics so that on system shut down and restart, learning process starts from where it left off.

7. Fully implemented intrinsic control operators including sequence, reversing, ratio, time delay, time of day, highest select AO, lowest select AO, analog controlled digital output, analog control AO, and digitally controlled AO.
8. Logic operators such as "And," "Or," "Not," and others that are part of a standard set available with a high-level language.
9. Arithmetic operators such as "Add," "Subtract," "Multiply," "Divide," and others that are part of a standard set available with a high-level language.
10. Relational operators such as "Equal to," "Not Equal to," "Less Than," "Greater Than," and others that are part of a standard set available with a high-level language.

D. Alarm Handling Software:

1. Include alarm handling software to report all alarm conditions monitored and transmitted through PLC controllers, protocol gateways and other network devices.
2. Include first in, first out handling of alarms in accordance with alarm priority ranking, with most critical alarms first, and with buffer storage in case of simultaneous and multiple alarms.
3. Make alarm handling active at all times to ensure that alarms are processed even if an operator is not currently signed on to PLC system.
4. Alarms display is to include the following:

    a. Indication of alarm condition such as "Abnormal Off," "Hi Alarm," and "Low Alarm."
    b. "Analog Value" or "Status" group and point identification with native language point descriptor such as "Space Temperature, Building 110, 2nd Floor, Room 212."
    c. Discrete per point alarm action message, such as "Call Maintenance Dept. Ext-5561."
    d. Include extended message capability to allow assignment and printing of extended action messages. Capability is to be operator programmable and assignable on a per point basis.

5. Direct alarms to appropriate operator workstations, printers, and individual operators by privilege level and segregation assignments.
6. Send email alarm messages to designated operators.
7. Send email, page, text, and voice messages to designated operators for critical alarms.
8. Categorize and process alarms by class.

    a. Class 1:

        1) Associated with fire, security, and other extremely critical equipment monitoring functions; have alarm, trouble, return to normal, and acknowledge conditions printed and displayed.
        2) Unacknowledged alarms to be placed in unacknowledged alarm buffer.
        3) All conditions make an audible alarm sound and require individual acknowledgment to silence audible sound.

b. Class 2:

1) Critical, but not life-safety related, and processed same as Class 1 alarms, except do not require individual acknowledgment.
2) Acknowledgement may be through a multiple alarm acknowledgment.

c. Class 3:

1) General alarms; printed, displayed, and placed in unacknowledged alarm buffer queues.
2) Configure so each new alarm received makes an audible alarm sound that are silenced by "acknowledging" alarm or by pressing a "silence" key.
3) Make acknowledgement of queued alarms either on an individual basis or through a multiple alarm acknowledgement.
4) Print alarms returning to normal condition without an audible alarm sound or require acknowledgment.

d. Class 4:

1) Routine maintenance or other types of warning alarms.
2) Alarms to be printed only, with no display, no audible sound and no acknowledgment required.

9. Include an unacknowledged alarm indicator on display to alert operator that there are unacknowledged alarms in system. Operator able to acknowledge alarms on an individual basis or through a multiple alarm acknowledge key, depending on alarm class.
10. To ensure that no alarm records are lost, make it possible to assign a backup printer to accept alarms in case of failure of primary printer.

E. Programming Software:

1. Include programming software to execute sequences of operation indicated.
2. Include programming routines in simple and easy to follow logic with detailed text comments describing what the logic does and how it corresponds to sequence of operation.
3. Programming Software: One of the following:

a. Graphic Based: Use a library of function blocks made from preprogrammed code designed for PLC control systems.

1) Assemble function blocks with interconnection lines that represent to control sequence in a flowchart.
2) Make programming tools viewable in real time to show present values and logical results of each function block.

b. Menu Based: Done by entering parameters, definitions, conditions, requirements, and constraints.
c. Line by Line and Text Based: Programming is to declare variable types

such as local, global, real, integer, and so on, at the beginning of the program. Use descriptive comments frequently to describe programming code.

4. Include means for detecting programming errors and testing software control strategies with a simulation tool before implementing in actual control. Simulation tool may be inherent with programming software or as a separate product.

F. Protocol Gateways:

1. Perform bidirectional translation from Modbus/TCP to Ethernet/IP.

2.11 PLC CONTROLLERS

A. PLC system consisting of a combination of network controllers, and programmable logic controllers to satisfy performance requirements indicated.

B. PLC controllers to perform monitoring, control, energy optimization, and other requirements indicated.

C. PLC controllers are to use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence.

D. Each PLC controller is capable of full and complete operation as a completely independent unit and as a part of PLC system wide distributed network.

E. Environment Requirements:

1. Controller hardware suitable for anticipated ambient conditions.
2. Controllers located in conditioned space rated for operation at 32 to 120 deg F.
3. Controllers located outdoors rated for operation at 32 to 140 deg F.

F. Power and Noise Immunity:

1. Operate controller at 90 to 110 percent of nominal voltage rating and perform an orderly shutdown below 80 percent of nominal voltage.
2. Protect against electrical noise of 5 to 120 Hz and from keyed radios with up to 5 W of power located within 36 inches of enclosure.

G. PLC Controller Spare Processing Capacity:

1. Include spare processing memory for each controller. RAM, PROM, or EEPROM will implement requirements indicated with the following spare memory:

a. Network Controllers: 10 percent.
b. Programmable Logic Controllers: Not less than 20 percent.

2. Memory for PLC controller's operating system and database are to include the following:

a. Monitoring and control.
b. Alarm management.
c. Historical trend data of all connected I/O points.
d. Operator interfaces.
e. Monitoring of manual overrides.

H. PLC Controller Spare I/O Point Capacity: Include spare I/O point capacity for each controller as follows:

1. Processor Controllers:

a. 10 percent of each AI, AO, DI, and DO point connected to controller.
b. Minimum Spare I/O Points per Controller:

1) AIs: Five.
2) AOs: Three.
3) DIs:Eight.
4) DOs:Six.

I. Maintenance and Support: Include the following features to facilitate maintenance and support:

1. Mount microprocessor components on circuit cards for ease of removal and replacement.
2. Means to quickly and easily disconnect controller from network.
3. Means to quickly and easily access connect to field test equipment.
4. Visual indication that controller electric power is on, of communication fault or trouble, and that controller is receiving and sending signals to network.

J. I/O Point Interface:

1. Connect hardwired I/O points to PLC's applicable I/O cards/points.
2. Protect I/O points so shorting of point to itself, to another point, or to ground will not damage controller.
3. Protect I/O points from voltage up to 24 V of any duration so that contact will not damage controller.
4. AIs:

a. Include monitoring of low-voltage (0 to 10 V dc), current (4 to 20 mA) and resistance signals from thermistor and RTD sensors.
b. Compatible with, and field configurable to, sensor and transmitters installed.
c. Perform analog-to-digital (A-to-D) conversion with a minimum resolution of 8 bits or better to comply with accuracy requirements indicated.
d. Signal conditioning including transient rejection for each AI.
e. Capable of being individually calibrated for zero and span.
f. Incorporate common-mode noise rejection of at least 50 dB from 0 to 100 Hz for differential inputs, and normal-mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10000 ohms.
g. External conversion resistors are not permitted.

5. AOs:

    a. Perform analog-to-digital (A-to-D) conversion with a minimum resolution of 8 bits or better to comply with accuracy requirements indicated.
    b. Output signals range of 4 to 20 mA dc as required to include proper control of output device.
    c. Capable of being individually calibrated for zero and span.
    d. Drift is to be not greater than 0.4 percent of range per year.
    e. External conversion resistors are not permitted.

6. DIs:

    a. Accept contact closures and ignore transients of less than 5 ms duration.
    b. Isolate and protect against an applied steady-state voltage of up to 180 V ac peak.
    c. Include a wetting current of at least 12 mA to be compatible with commonly available control devices and protected against effects of contact bounce and noise.
    d. Sense "dry contact" closure without external power (other than that provided by controller) being applied.
    e. Pulse accumulation input points complying with all requirements of DIs and accept up to 10 pulses per second for pulse accumulation. Include buffer to totalize pulses. Pulse accumulator is to accept rates of at least 20 pulses per second. Reset the totalized value to zero on operator's command.

7. DOs:

    a. Include relay contact closures or triac outputs for momentary and maintained operation of output devices.

        1) Relay contact closures to have a minimum duration of 0.1 second and at least 180 V of isolation.
        2) Include electromagnetic interference suppression on all output lines to limit transients to non-damaging levels.
        3) Minimum contact rating to be 1 A at 24 V ac.
        4) Triac outputs to have at least 180 V of isolation and minimum contact rating of 1 A at 24 V ac.

    b. Include DOs with two-state operation.
    c. DOs to be selectable for either normally open or normally closed operation.

K. Operator Interface:

1. Equip controllers with a service communications port for connection to HMI.
2. Local Keypad and Display:

    a. Equip controller with local keypad and digital display for interrogating and editing data.
    b. Use of keypad and display requires a security password.

L. Serviceability:

1. Equip controller with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Connect wiring and cable connections to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Maintain Basic Input Output System (BIOS) and programming information in event of power loss for at least 96 hours.

2.12 CONTROLLER SOFTWARE

A. General:

1. Software applications are to reside and operate in controllers. Edit applications through hardwired laptop.
2. Identify I/O points by up to 16-character point name and up to 30-character point descriptor. Use same names throughout, including at operator workstations.
3. Execute control functions within controllers using PLC algorithms.
4. Configure controllers to use stored default values to ensure fail-safe operation. Use default values when there is a failure of a connected input instrument or loss of communication of a global point value.

B. Security:

1. Passwords restrict operator to points, applications, and system functions as assigned by system manager.
2. Protect from unauthorized use by automatically logging off after last keystroke. Make the delay time operator-definable.

C. Scheduling: Include capability to schedule each point or group of points in system. Each schedule is to consist of the following:

1. Weekly Schedules:

a. Include separate schedules for each day of week.
b. Each schedule should include capability for start, stop, optimal start, optimal stop, and night economizer.
c. Each schedule may consist of up to 10 events.
d. When a group of objects are scheduled together, include capability to adjust start and stop times for each member.

2. Exception Schedules:

a. Include ability for operator to designate any day of the year as an exception schedule.
b. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by regular schedule for that day of week.

3. Holiday Schedules:

    a. Include capability for operator to define up to 99 special or holiday schedules.
    b. Place schedules on scheduling calendar with ability to repeated each year.
    c. Operator able to define length of each holiday period.

D. System Coordination:

1. Include standard application for proper coordination of equipment.
2. Include operator with a method of grouping together equipment based on function and location.
3. Include groups that may be for use in scheduling and other applications.

E. Discrete Alarms:

1. Set each Discrete point to alarm based on operator-specified state.
2. Include capability to automatically and manually disable alarming.

F. Analog Alarms:

1. Provide each analog object with both high and low alarm limits.
2. Include capability to automatically and manually disable alarming.

G. Alarm Reporting:

1. Include ability for operators to determine action to be taken in event of an alarm.
2. Route alarms to appropriate operator workstations based on time and other conditions.
3. Include ability for alarms to start programs, print, be logged in event logs, generate custom messages, and display graphics.

H. Control Loops:

1. Support any of the following control loops, as applicable to control required:

    a. Two-position (on/off, open/close, slow/fast) control.

I. Staggered Start: Prevent all controlled equipment from simultaneously restarting after a power outage. Make the order which equipment (or groups of equipment) is started, along with the time delay between starts, operator-selectable.

J. Anti-Short Cycling:

1. Protect DO points from short cycling.
2. Feature to allow minimum on-time and off-time to be selected.

K. On and Off Control with Differential:

1. Include algorithm that allows DO to be cycled based on a controlled variable and set point.
2. Use direct- or reverse-acting algorithm and incorporate an adjustable differential.

L. Run-Time Totalization:

1. Include data registers to totalize run-times for all DI points.
2. Assign a high run-time alarm, if required, by operator.

2.13 ENCLOSURES

A. General:

1. House each controller and associated control accessories in singleenclosure. Enclosure is to serve as central tie-in point for control devices such as switches, transmitters, transducers, power supplies, and transformers.
2. Do not house more than one controller in single enclosure.
3. Equip doors of enclosures housing controllers and components with analog or digital displays with windows to allow visual observation of displays without opening enclosure door.
4. Individual, wall-mounted, single-door enclosures maximum of 48 inches wide and 72 inches high.
5. Individual, wall-mounted, double-door enclosures maximum of 72 inches wide and 96 inches high.
6. Freestanding enclosures maximum of 48 inches wide and 96 inches high.
7. Include wall-mounted enclosures with brackets suitable for mounting enclosures to wall or freestanding support stand as indicated.
8. Supply each enclosure with complete set of as-built schematics, tubing, and wiring diagrams and product literature located in pocket on inside of door. For enclosures with windows, include pocket on bottom of enclosure.

B. Internal Arrangement:

1. Arrange internal layout of enclosure to group and protect electric, and electronic components associated with controller, but not an integral part of controller.
2. Arrange layout to group similar products together.
3. Include a barrier between line-voltage and low-voltage electrical and electronic products.
4. Factory or shop install products, tubing, cabling, and wiring complying with requirements and standards indicated.
5. Terminate field cable and wire using heavy-duty terminal blocks.
6. Include spare terminals, equal to not less than 10 percent of used terminals.
7. Install maximum of two wires on each side of terminal.
8. Include enclosure field electric power supply with toggle-type switch located at entrance inside enclosure to disconnect power.
9. Include enclosure with line-voltage nominal 20 A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with 5 A circuit breaker.
10. Mount products within enclosure on removable internal panel(s).
11. Include products mounted in enclosures with engraved, laminated phenolic nameplates (black letters on a white background). Nameplates are to have at least 1/4-inch-high lettering.
12. Route tubing cable and wire located inside enclosure within a raceway with continuous removable cover.

13. Label each end of cable, wire, and tubing in enclosure following an approved identification system that extends from field I/O connection and all intermediate connections throughout length to controller connection.
14. Size enclosure internal panel to include at least 15 percent spare area on face of panel.

C. Environmental Requirements:

1. Evaluate temperature and humidity requirements of each product to be installed within each enclosure.
2. Calculate enclosure internal operating temperature considering heat dissipation of all products installed within enclosure and ambient effects (solar, conduction, and wind) on enclosure.
3. Where required by application, include temperature-controlled electrical heat to maintain inside of enclosure above minimum operating temperature of product with most stringent requirement.
4. Where required by application, include temperature-controlled ventilation fans with filtered louver(s) to maintain inside of enclosure below maximum operating temperature of product with most stringent requirement.
5. Include temperature-controlled cooling within the enclosure for applications where ventilation fans cannot maintain inside temperature of enclosure below maximum operating temperature of product with most stringent requirement.
6. Where required by application, include humidity-controlled electric dehumidifier or cooling to maintain inside of enclosure below maximum relative humidity of product with most stringent requirement and to prevent surface condensation within enclosure.

D. Wall-Mounted, NEMA 250, Type 1:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Cooper B-line; brand of Eaton, Electrical Sector
    b. Hammond Mfg. Co. Inc
    c. Hoffman; brand of nVent Electrical plc
    d. Saginaw Control and Engineering

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

    a. Cooper B-line; brand of Eaton, Electrical Sector
    b. Hammond Mfg. Co. Inc
    c. Hoffman; brand of nVent Electrical plc
    d. Saginaw Control and Engineering

3. NRTL listed in accordance with UL 50 or UL 50E.
4. Construct enclosure of steel, not less than the following:

    a. Enclosure Size Less Than 24 Inches (600 mm): 0.053 inch inch thick.

b. Enclosure Size 24 Inches (600 mm) and Larger: 0.067 inch thick.

5. Finish enclosure inside and out with polyester powder coating that is electrostatically applied and then baked to bond to substrate.

   a. Exterior Color: Manufacturer's standard.
   b. Interior Color: Manufacturer's standard.

6. Hinged door full size of front face of enclosure and supported using the following:

   a. Enclosures Sizes Less Than 36 Inches (900 mm) Tall: Multiple butt hinges.
   b. Enclosures Sizes 36 Inches (900 mm) Tall and Larger: Continuous piano hinges.

7. Removable internal panel with white or gray polyester powder coating that is electrostatically applied and then baked to bond to substrate.

   a. Size Less Than 24 Inches (600 mm): Solid steel, 0.053 inch thick.
   b. Size 24 Inches (600 mm) and Larger: Solid steel, 0.093 inch thick.

8. Internal panel mounting hardware, grounding hardware, and sealing washers.
9. Grounding stud on enclosure body.
10. Thermoplastic pocket on inside of door for record Drawings and Product Data.

E. Wall-Mounted, NEMA 250, Types 4 and 12:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Cooper B-line; brand of Eaton, Electrical Sector
   b. Hammond Mfg. Co. Inc
   c. Hoffman; brand of nVent Electrical plc
   d. Saginaw Control and Engineering

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

   a. Cooper B-line; brand of Eaton, Electrical Sector
   b. Hammond Mfg. Co. Inc
   c. Hoffman; brand of nVent Electrical plc
   d. Saginaw Control and Engineering
   e.

3. NRTL listed in accordance with UL 508A.
4. Seam and joints are continuously welded and ground smooth.
5. Where recessed enclosures are indicated, include enclosures with face flange for flush mounting.
6. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.

7. Single-door enclosure sizes up to 60 inches tall by 36 inches wide.
8. Double-door enclosure sizes up to 36 inches tall by 60 inches wide.
9. Construct enclosure of steel, not less than the following:

    a. Size Less Than 24 Inches (600 mm): 0.053 inch thick.
    b. Size 24 Inches (600 mm) and Larger: 0.067 inch thick.

10. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Exterior Color: Manufacturer's standard.
    b. Interior Color: Manufacturer's standard.

11. Corner-formed door, full size of enclosure face, supported using multiple concealed hinges with easily removable hinge pins.

    a. Sizes through 24 Inches (600 mm) Tall: Two hinges.
    b. Sizes between 24 Inches (600 mm) through 48 Inches (1200 mm) Tall: Three hinges.
    c. Sizes Larger Than 48 Inches (1200 mm) Tall: Four hinges.

12. Double-door enclosures with overlapping door design to include unobstructed full-width access.

    a. Single-door enclosures 48 inches and taller, and all double-door enclosures, with three-point (top, middle and bottom) latch system.

13. Removable internal panel with white or gray polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Size Less Than 24 Inches (600 mm): Solid steel, 0.053 inch thick.
    b. Size 24 Inches (600 mm) and Larger: Solid steel, 0.093 inch thick.

14. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
15. Grounding stud on enclosure body.
16. Thermoplastic pocket on inside of door for record Drawings and Product Data.

F. Wall-Mounted, NEMA 250, Type 4X-SS:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following :

    a. Crouse-Hinds; brand of Eaton, Electrical Sector
    b. Hammond Mfg. Co. Inc
    c. Hoffman; brand of nVent Electrical plc
    d. Saginaw Control and Engineering

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the

following:

a. Crouse-Hinds; brand of Eaton, Electrical Sector
b. Hammond Mfg. Co. Inc
c. Hoffman; brand of nVent Electrical plc
d. Saginaw Control and Engineering

3. NRTL listed in accordance with UL 508A.
4. Seams and joints are continuously welded and ground smooth.
5. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
6. Construct enclosure of Type 304 stainless steel, not less than the following:

a. Size Less Than 24 Inches (600 mm): 0.053 inch thick.
b. Size 24 Inches (600 mm) and Larger: 0.067 inch thick.

7. Outside body and door of enclosure with brushed No. 4 finish.
8. Corner-formed door, full size of enclosure face, supported using multiple concealed hinges with easily removable hinge pins.

a. Sizes through 24 Inches (600 mm) Tall: Two hinges.
b. Sizes between 24 Inches (600 mm) through 48 Inches (1200 mm) Tall: Three hinges.
c. Sizes Larger Than 48 Inches (1200 mm) Tall: Four hinges.

9. Corner-formed door, full size of enclosure face, supported using continuous piano hinge full length of door.
10. Doors fitted with three-point (top, middle, and bottom) latch system with single, heavy-duty, liquidtight, Type 304 stainless steel handle with integral locking mechanism.
11. Removable internal panel of 0.093-inch stainless steel.
12. Internal panel mounting studs and hardware, grounding hardware, and sealing washers.
13. Install corrosion-resistant polyester vent drain in a stainless steel sleeve at bottom of enclosure.
14. Include enclosure with stainless steel mounting brackets.

G. Freestanding, NEMA 250, Type 1:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Cooper B-line; brand of Eaton, Electrical Sector
b. Hammond Mfg. Co. Inc
c. Hoffman; brand of nVent Electrical plc
d. Saginaw Control and Engineering

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. Cooper B-line; brand of Eaton, Electrical Sector
b. Hammond Mfg. Co. Inc
c. Hoffman; brand of nVent Electrical plc
d. Saginaw Control and Engineering

3. NRTL listed in accordance with UL 508A.
4. Seams and joints are continuously welded and ground smooth.
5. Externally formed body flange around perimeter of enclosure face.
6. Single-door enclosure sizes up to 84 inches tall by 36 inches wide.
7. Double-door enclosure sizes up to 84 inches tall by 72 inches wide.
8. Construct enclosure of steel, not less than 0.067 inch thick.
9. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.

    a. Exterior Color: Manufacturer's standard.
    b. Interior Color: Manufacturer's standard.

10. Corner-formed flush door, full size of enclosure face, supported using four concealed hinges with easily removable hinge pins.
11. Double-door enclosures with overlapping door design to include unobstructed full-width access.
12. Doors with three-point (top, middle, and bottom) latch system with single heavy-duty handle and integral locking mechanism.
13. Removable back covers.
14. Removable solid steel internal panel, 0.093 inch thick, with white or gray polyester powder coating that is electrostatically applied and then baked to bond to substrate.
15. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
16. Grounding stud on enclosure body.
17. Thermoplastic pocket on inside of door for record Drawings and Product Data.
18. Nominal 4-inch-tall integral lifting base, not less than 0.123 inch thick, with predrilled holes for attachment to mounting surface.
19. Equip each top end of enclosure with lifting tabs, not less than 0.172 inch thick, or not less than two lifting eyes.
20. Internal rack-mount shelves and angles, as required by application.

H. Freestanding, NEMA 250, Types 4 and 12:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Cooper B-line; brand of Eaton, Electrical Sector
    b. Hammond Mfg. Co. Inc
    c. Hoffman; brand of nVent Electrical plc
    d. Saginaw Control and Engineering

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. Cooper B-line; brand of Eaton, Electrical Sector
b. Hammond Mfg. Co. Inc
c. Hoffman; brand of nVent Electrical plc
d. Saginaw Control and Engineering

3. NRTL listed in accordance with UL 508A.
4. Seams and joints are continuously welded and ground smooth.
5. Externally formed body flange around perimeter of enclosure face.
6. Type 12 Enclosure Sizes:

a. Single-door enclosure sizes up to 90 inches tall by 36 inches wide.
b. Double-door enclosure sizes up to 90 inches tall by 72 inches wide.

7. Type 4 Enclosure Sizes:

a. Single-door enclosure sizes up to 72 inches tall by 36 inches wide.
b. Double-door enclosure sizes larger than 36 inches wide.

8. Construct enclosure of steel, not less than 0.093 inch thick.
9. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.

a. Exterior Color: Manufacturer's standard.
b. Interior Color: Manufacturer's standard.

10. Corner-formed door with continuous perimeter oil-resistant gasket supported using continuous piano hinge full length of door.
11. Doors fitted with three-point (top, middle, and bottom) latch system with latching rod rollers and single, heavy-duty, oiltight handle with integral locking mechanism.
12. Removable solid steel internal panel, 0.093 inch thick, with white or gray polyester powder coating that is electrostatically applied and then baked to bond to substrate.
13. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
14. Grounding stud on enclosure body.
15. Thermoplastic pocket on inside of door for record Drawings and Product Data.
16. Equip top of enclosure with no fewer than two lifting eyes.
17. Internal rack-mount shelves and angles, as required by application.

I. Freestanding, NEMA 250, Type 4X-SS:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Crouse-Hinds; brand of Eaton, Electrical Sector
b. Hammond Mfg. Co. Inc
c. Hoffman; brand of nVent Electrical plc
d. Saginaw Control and Engineering

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

    a. Crouse-Hinds; brand of Eaton, Electrical Sector
    b. Hammond Mfg. Co. Inc
    c. Hoffman; brand of nVent Electrical plc
    d. Saginaw Control and Engineering

3. NRTL listed in accordance with UL 508A.
4. Seams and joints are continuously welded and ground smooth.
5. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
6. Construct enclosure of Type 304 stainless steel, not less than the following:

    a. Size Less Than 24 Inches (600 mm): 0.053 inch thick.
    b. Size 24 Inches (600 mm) and Larger: 0.067 inch thick.

7. Outside enclosure and door of enclosure with brushed No. 4 finish.
8. Doors:

    a. Single-door enclosure sizes up to 36 inches wide.
    b. Double-door enclosure sizes larger than 36 inches wide.
    c. Corner-formed door(s) with continuous perimeter oil-resistant gasket, full size of enclosure face, supported using continuous piano hinge full length of door.
    d. Doors fitted with three-point (top, middle, and bottom) latch system with single, heavy-duty, liquid tight, Type 304 stainless steel handle with integral locking mechanism.

9. Removable internal panel of 0.093-inch stainless steel.
10. Internal panel mounting studs and hardware, grounding hardware, and sealing washers.
11. Install corrosion-resistant polyester vent drain in a stainless steel sleeve at bottom of enclosure.
12. Include enclosure with stainless steel mounting brackets.
13. Thermoplastic pocket on inside of door for record Drawings and Product Data.
14. Equip top of enclosure with no fewer than two lifting eyes.
15. Internal rack-mount shelves and angles, as required by application.

J. Accessories:

1. Electric Heater:

    a. Aluminum housing with brushed finish.
    b. Thermostatic control with adjustable set point from 0 to 100 deg F.
    c. Capacity: 100, 200, 400, and 800 W, as required by application.
    d. Fan draws cool air from bottom of enclosure and passes air across thermostat and heating elements before being released into enclosure cavity. Heated air is discharged through the top of heater.

2. Ventilation Fans, Filtered Intake, and Exhaust Grilles:

    a. Number and size of fans, filters, and grilles, as required by application.
    b. Compact cooling fans engineered for 50,000 hours of continuous operation without lubrication or service.
    c. Fans capable of being installed on any surface and in any position within enclosure for spot cooling or air circulation.
    d. Thermostatic control with adjustable set point from 32 to 140 deg F.
    e. Airflow Capacity at Zero Pressure:

        1) 4-Inch (100-mm) Fan: 100 cfm.
        2) 6-Inch (150-mm) Fan: 240 cfm.
        3) 10-Inch (250-mm) Fan: 560 cfm.

    f. Maximum operating temperature of 158 deg F.
    g. 4-inch fan thermally protected and provided with permanently lubricated ball-bearings.
    h. 6- and 10-inch fans with ball-bearing construction and split capacitor motors thermally protected to avoid premature failure.
    i. Dynamically balanced impellers molded from polycarbonate material.
    j. Fan furnished with power cord and polarized plug for power connection.
    k. Fan brackets, finger guards, and mounting hardware provided with fans to complete installation.
    l. Removable Intake and Exhaust Grilles: ABS plastic or stainless steel, of size to match fan size and suitable for NEMA 250, Types 1 and 12 enclosures.
    m. Filters for NEMA 250, Type 1 Enclosures: Washable foam or aluminum, of size to match intake grille.
    n. Filters for NEMA 250, Type 12 Enclosures: Disposable, of size to match intake grille.

3. Air Conditioner:

    a. Electric-powered, self-contained, air-conditioning unit specially designed for electrical enclosures to maintain temperature inside enclosure below ambient temperature outside enclosure.
    b. Thermostatic control with adjustable set point from 60 to 120 deg F.
    c. Enclosure side or top mounting with unit capacity, as required by application.
    d. Designed for closed-loop cooling with continuous operation in ambient environments up to 125 deg F.
    e. HFC refrigerant.
    f. Reusable and washable air filter.
    g. High-performance, industrial-grade, and high-efficiency fans.
    h. Furnished with power cord and polarized plug for power connection.
    i. Condensate management system with base pan side drain.
    j. Mounting hardware, gaskets, mounting template, and instruction manual furnished with unit.
    k. Outdoor units equipped with head pressure control for low ambient operation, compressor heater, coated condenser coil, and thermostat.

4. Thermoelectric Humidifier:

    a. ABS plastic enclosure.
    b. Capacity of 8 oz. of water per 24 hours.
    c. Built-in drain captures moisture and plastic hose directs moisture to outside enclosure through a drain.
    d. Controlled to maintain enclosure relative humidity at adjustable set point.
    e. Unit power supply is internally wired to enclosure electrical power source.

5. Framed Fixed Window Kit for NEMA 250, Types 4, 4X, and 12 Enclosures:

    a. 0.25-inch-thick, scratch-resistant acrylic or polycarbonate window mounted in a metal frame matching adjacent door material.
    b. Enclosure types, except NEMA 250 Type 1, to have continuous gasket material around perimeter of window and frame to provide watertight seal.
    c. Window kit to be factory or shop installed before shipment to Project.

6. Frameless Fixed Window Kit for NEMA 250, Type 1 Enclosures:

    a. 0.125-inch-thick, polycarbonate window mounted in enclosure door material.
    b. Window attached to door with screw fasteners and continuous strip of high-strength, double-sided tape around window perimeter.
    c. Window kit is factory or shop installed before shipment to Project.

7. Frame Fixed or Hinged Window Kit for NEMA 250, Types 1 and 12 Enclosures:

    a. 0.25-inch-thick, scratch-resistant acrylic or polycarbonate window mounted in a metal frame matching adjacent door material.
    b. Enclosure types, except NEMA 250 Type 1, to have continuous gasket material around perimeter of window and frame to provide watertight seal.
    c. Window kit to be factory or shop installed before shipment to Project.

8. Bar handle with keyed cylinder lock set.

2.14 RELAYS

A. General-Purpose Relays:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Allen Bradley; by Rockwell Automation
    b. Eaton
    c. IDEC Corporation
    d. Omron Americas
    e. Siemens Industry, Inc., Building Technologies Division
    f. Square D; Schneider Electric USA

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

    a. Allen Bradley; by Rockwell Automation
    b. Eaton
    c. IDEC Corporation
    d. Omron Americas
    e. Siemens Industry, Inc., Building Technologies Division
    f. Square D; Schneider Electric USA

3. NRTL listed.
4. Heavy-duty, electromechanical type; rated for at least 10 A at 250 V ac and 60 Hz.
5. SPDT, DPDT, or three-pole double-throw, as required by control application.
6. Plug-in-style relay with 8-pin octal or multiblade plug for DPDT relays and 11-pin octal or multiblade plug for three-pole double-throw relays.
7. Construct contacts of silver, silver alloy, or gold.
8. Enclose relay in a clear transparent polycarbonate dust-tight cover.
9. Include LED indication and push-to-test button to test manual operation of relay without power on coil.
10. Performance:

    a. Mechanical Life: At least 10 million cycles.
    b. Electrical Life: At least 100,000 cycles at rated load.
    c. Pickup Time: 20 ms or less.
    d. Dropout Time: 20 ms or less.
    e. Pull-in Voltage: 85 percent of rated voltage.
    f. Dropout Voltage: 50 percent of nominal rated voltage.
    g. Power Consumption: 2 VA or less.
    h. Ambient Operating Temperatures: Minus 40 to 115 deg F.

11. Equip relays with coil transient suppression to limit transients to non-damaging levels.
12. Plug each relay into industry-standard, 35 mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
13. Include relay socket with screw terminals. Mold into socket the coincident screw terminal numbers.

B. Multifunction Time-Delay Relays:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Allen Bradley; by Rockwell Automation
    b. Eaton
    c. IDEC Corporation
    d. Omron Americas
    e. Siemens Industry, Inc., Building Technologies Division
    f. Square D; Schneider Electric USA

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

    a. Allen Bradley; by Rockwell Automation
    b. Eaton
    c. IDEC Corporation
    d. Omron Americas
    e. Siemens Industry, Inc., Building Technologies Division
    f. Square D; Schneider Electric USA

3. NRTL listed.
4. Continuous-duty type, rated for at least 10 A at 240 V ac and 60 Hz.
5. Relay with up to 2 programmable functions to provide on/off delay, interval, and recycle timing functions.
6. Plug-in-style relay with either multi-pin or blade plug.
7. Construct contacts of silver, silver alloy, or gold.
8. Enclose relay in a dust-tight cover.
9. Include knob and dial scale for alternative digital interface for setting delay time.
10. Visual Status Indication: Power "On" and Output "On" status.
11. Performance:

    a. Mechanical Life: At least 10 million cycles.
    b. Electrical Life: At least 100,000 cycles at rated load.
    c. Timing Ranges: Multiple ranges from 0.1 seconds to 100 minutes.
    d. Repeatability: Within 2 percent.
    e. Recycle Time: 45 ms.
    f. Minimum Pulse-Width Control: 50 ms.
    g. Power Consumption: 5 VA or less.
    h. Ambient Operating Temperatures: Minus 40 to 115 deg F.

12. Equip relays with transient suppression to limit transients to non-damaging levels.
13. Plug each relay into industry-standard, 35 mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
14. Include relay socket with screw terminals. Mold into socket the coincident screw terminal numbers.

C. Latching Relays:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Allen Bradley; by Rockwell Automation
    b. Eaton
    c. IDEC Corporation
    d. Omron Americas
    e. Siemens Industry, Inc., Building Technologies Division
    f. Square D; Schneider Electric USA

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

    a. Allen Bradley; by Rockwell Automation
    b. Eaton
    c. IDEC Corporation
    d. Omron Americas
    e. Siemens Industry, Inc., Building Technologies Division
    f. Square D; Schneider Electric USA

3. NRTL listed.
4. Continuous-duty type, rated for at least 10 A at 250 V ac and 60 Hz.
5. SPDT, DPDT, or three-pole double-throw, as required by control application.
6. Plug-in-style relay with either multi-pin or blade plug.
7. Construct contacts of silver, silver alloy, or gold.
8. Enclose relay in a clear transparent polycarbonate dust-tight cover.
9. Performance:

    a. Mechanical Life: At least 10 million cycles.
    b. Electrical Life: At least 100,000 cycles at rated load.
    c. Pickup Time: 20 ms or less.
    d. Dropout Time: 10 ms or less.
    e. Pull-in Voltage: 85 percent of rated voltage.
    f. Dropout Voltage: 50 percent of nominal rated voltage.
    g. Power Consumption: 2 VA or less.
    h. Ambient Operating Temperatures: Minus 40 to 115 deg F.

10. Equip relays with coil transient suppression to limit transients to non-damaging levels.
11. Plug each relay into industry-standard, 35 mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
12. Relay socket with screw terminals. Mold into socket the coincident screw terminal numbers.

D. Current Sensing Relays:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Eaton
    b. Functional Devices Inc
    c. NK Technologies
    d. Square D; Schneider Electric USA

2. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:

    a. Eaton
    b. Functional Devices Inc

c. NK Technologies
d. Square D; Schneider Electric USA
e. Highland Tank Fuel Oil Storage & Delivery

3. NRTL listed.
4. Monitors ac current.
5. Independent adjustable controls for pickup and dropout current.
6. Energized when supply voltage is present and current is above pickup setting.
7. De-energizes when monitored current is below dropout current.
8. Dropout current is adjustable from 50 to 95 percent of pickup current.
9. Visual indication of contact status.
10. Include current transformer, if required for application.
11. House current sensing relay and current transformer if required in its own enclosure. Use NEMA 250, Type 1 enclosure for indoors applications and NEMA 250, Type 4 for outdoor applications.

E. Combination On-Off Status Sensor and On-Off Control Relays:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Functional Devices Inc
b. Veris Industries

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. Functional Devices Inc
b. Veris Industries

3. Description:

a. On-off control and on-off status indication in a single device.
b. LED status indication of activated relay and current trigger.
c. Closed-Open-Auto override switch located on the load side of relay.

4. Performance:

a. Ambient Temperature: Minus 30 to 140 deg F.
b. Voltage Rating: Single-phase loads rated for 300 V ac. Three-phase loads rated for 600 V ac.

5. Status Indication:

a. Current Sensor: Integral sensing for single-phase loads up to 20 A and external solid or split sensing ring for three-phase loads up to 150 A.
b. Current Sensor Range: As required by application.
c. Current Set Point: Fixed or adjustable, as required by application.
d. Current Sensor Output:

1) Solid-state, SPDT contact rated for 30 V ac and dc and for 0.4 A.
2) Solid-state, SPDT contact rated for 120 V ac and 1.0 A.
3) Analog, 0 to 5 or 10 V dc.
4) Analog, 4 to 20 mA, loop powered.

6. Relay: SPDT, continuous-duty coil; rated for 10-million mechanical cycles.
7. Enclosure: NEMA 250, Type 12 enclosure for indoor applications; NEMA 250, Type 4X enclosure for outdoor applications.

2.15 ELECTRICAL POWER DEVICES

A. Control Transformers:

1. Sizing Criteria: Size control transformers for total connected load, plus additional 25 percent of connected load for future spare capacity.
2. Transformer Minimum Capacity: 100 VA.
3. Protection: Provide transformers with both primary and secondary fuses. Integral circuit breaker is acceptable in lieu of fuses.
4. Enclosure: House control transformers in NEMA 250 enclosures, type as indicated in "Performance Requirements" Article for application.

B. DC Power Supplies:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Acopian Technical Company
   b. Emerson Electric Co., Automation Solutions
   c. IDEC Corporation
   d. Omron Americas

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

   a. Acopian Technical Company
   b. Emerson Electric Co., Automation Solutions
   c. IDEC Corporation
   d. Omron Americas

3. Description: Linear or switched, regulated power supplies with ac input to one or multiple dc output(s).

   a. Include both line and load regulation to ensure stable output.
   b. To protect both power supply and load, include power supply with an automatic current limiting circuit.

4. Performance:

a. Input Voltage: Nominally 120 V ac, 60 Hz.
b. Output Voltage: Nominally 24 V dc with plus or minus 4 V dc adjustment.
c. Output Current: Minimum 100 mA.
d. Load Regulation: Within 0.1 percent.
e. Line Regulation: Within 0.05 percent.
f. Stability: Within 0.1 percent of rated volts after warmup period.
g. Ripple: 1 mV rms.

2.16 UNINTERRUPTABLE POWER SUPPLY (UPS) UNITS

A. Furnish local UPS units, of type indicated, installed with PLC system.

B. DIN Rail Mounted UPS:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. APC by Schneider Electric
b. Emerson Electric Co., Automation Solutions
c. Phoenix Contact

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. APC by Schneider Electric
b. Emerson Electric Co., Automation Solutions
c. Phoenix Contact

3. Provide continuous, regulated output power without using batteries during brown-out, surge, and spike conditions.
4. Performance:

a. Capacity: Load not to exceed 75 percent of rated capacity.
b. Efficiency: Minimum 94 percent.
c. Input Voltage: Single phase, 120 V ac, compatible with field power source.
d. Load Power Factor Range (Crest Factor): 0.65 to 1.0.
e. Output Voltage: 101 to 132 V ac, while input voltage varies between 89 and 152 V ac.
f. On Battery Output Voltage: Sine wave.
g. Inverter Overload Capacity: Minimum 150 percent for 30 seconds.
h. Battery Backup: 60 minutes of operation at full load with battery power.
i. Battery Recharge Time: Maximum of four hours to 90 percent capacity after full discharge.
j. Transfer Time: 6 ms.
k. Surge Voltage Withstand Capacity: IEEE C62.41.1 and IEEE C62.41.2, Categories A and B.

5. Automatic bypass operation during fault or overload conditions.

6. Integral line-interactive, power condition topology to eliminate all power contaminants.
7. Include power switch and visual indication of power, battery, fault.
8. Include audible alarm of faults with silence feature.
9. Include dry contacts (digital output points) for low battery condition and battery-on (primary utility power failure).
10. Batteries: Sealed; maintenance free; replacement without dropping load.

C. Tower UPS Models through 1000 VA:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. APC by Schneider Electric
    b. Eaton
    c. Toshiba International Corporation

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

    a. APC by Schneider Electric
    b. Eaton
    c. Toshiba International Corporation

3. Provide continuous, regulated output power without using batteries during brown-out, surge, and spike conditions.
4. Performance:

    a. Capacity: Load not to exceed 75 percent of rated capacity.
    b. Efficiency: Complying with ENERGY STAR requirements; minimum 91 percent.
    c. Input Voltage: Single phase, 120 V ac, compatible with field power source.
    d. Load Power Factor Range (Crest Factor): 0.65 to 1.0.
    e. Output Voltage: 101 to 132 V ac, while input voltage varies between 89 and 152 V ac.
    f. On Battery Output Voltage: Sine wave.
    g. Inverter Overload Capacity: Minimum 150 percent for 30 seconds.
    h. Battery Backup: 60 minutes of operation at full load with battery power.
    i. Battery Recharge Time: Maximum of four hours to 90 percent capacity after full discharge to cutoff.
    j. Transfer Time: 10 ms.
    k. Surge Voltage Withstand Capacity: IEEE C62.41.1 and IEEE C62.41.2, Categories A and B; 6 kV/200 and 500 A; 100 kHz ring wave.

5. Automatic bypass operation during fault or overload conditions.
6. Integral line-interactive, power condition topology to eliminate all power contaminants.
7. Include power switch and visual indication of power, battery, fault, and temperature.

8. Include audible alarm of faults and front panel silence feature.
9. Receptacles: Minimum four, NEMA WD 1, NEMA WD 6 Configuration 5-15R receptacles.
10. Remote Alarms: Include dry contacts (digital output points) for low battery condition and battery-on (primary utility power failure).
11. Batteries: Sealed type; maintenance free. Battery replacement is to be front accessible by user without dropping load.
12. Install tower models in enclosures rated for location.

D. UPS Models through 3000 VA: Tower.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. APC by Schneider Electric
    b. Eaton
    c. Toshiba International Corporation

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

    a. APC by Schneider Electric
    b. Eaton
    c. Toshiba International Corporation

3. NRTL Listing: UL 1778.
4. Provide continuous, regulated output power without using batteries during brown-out, surge, and spike conditions.
5. Performance:

    a. Capacity: Load not to exceed 75 percent of UPS rated capacity.
    b. Efficiency: Complying with ENERGY STAR requirements; minimum 91 percent.
    c. Input Voltage: Single phase, 120 V ac, plus 20 to minus 30 percent.
    d. Power Factor: Minimum 0.95 at full load.
    e. Output Voltage: Single phase, 120 V ac, within 3 percent.
    f. Inverter overload capacity to be minimum 150 percent for 30 seconds.
    g. Battery Backup: 60 minutes of operation at full load with battery power.
    h. Battery Recharge Time: Maximum of 6 hours to 90 percent capacity.
    i. Transfer Time: 10 ms.

6. LCD display with operator interface.
7. Receptacles: Minimum 6, NEMA WD 1, NEMA WD 6 Configuration 5-15R or 5-20R receptacles.
8. Automatic bypass operation during fault or overload conditions.
9. Remote Alarms: Include dry contacts (digital output points) or serial communication interfacefor low battery condition and battery-on (primary utility power failure) and connect points to PLC system.
10. Batteries: Sealed; maintenance free.

11. Enclosures: Install tower models in enclosures rated for location.

    a.

2.17 CONTROL WIRE AND CABLE

A. Wire: Single conductor control wiring above 24 V.

1. Wire Size: Minimum 16 AWG.
2. Conductors: 7/24 soft annealed copper strand with 2- to 2.5-inch lay.
3. Conductor Insulation: 600 V, Type THWN or Type THHN, and 90 deg C in accordance with UL 83.
4. Conductor Insulation Colors: Black (hot), white (neutral), and green (ground).
5. Furnish on spools.

B. Single, Twisted-Shielded, Instrumentation Cable above 24 V:

1. Wire Size: Minimum 20 AWG.
2. Conductors: Twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch lay.
3. Conductor Insulation: Type THHN/THWN or Type TFN rating.
4. Conductor Insulation Colors:

    a. Twisted Pair: Black and white.
    b. Twisted Triad: Black, red, and white.

5. Shielding: 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
6. Outer Jacket Insulation: 600 V, 90 deg C rating, and Type TC cable.
7. Furnish on spools.

C. Single, Twisted-Shielded, Instrumentation Cable 24 V and Less:

1. Wire Size: Minimum 20 AWG.
2. Conductors: Twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch lay.
3. Conductor Insulation: Nominal 15-mil thickness, constructed from flame-retardant PVC.
4. Conductor Insulation Colors:

    a. Twisted Pair: Black and white.
    b. Twisted Triad: Black, red, and white.

5. Shielding: 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
6. Outer Jacket Insulation: 300 V, 105 deg C rating, and Type PLTC cable.
7. Furnish on spools.

D. LAN and Communication Cable: Comply with PLC system manufacturer requirements for network being installed.

1. Comply with following requirements for balanced twisted pair cable described in Section 271513 "Communications Copper Horizontal Cabling."

    a. Plenum rated.
    b. Unique color that is different from other cables used on Project.

2.18 RACEWAYS

A. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems" for electrical power raceways and boxes.

B. Comply with requirements in Section 270528 "Pathways for Communications Systems" for raceways for balanced twisted pair cables and optical fiber cables.

2.19 OPTICAL FIBER CABLE AND CONNECTORS

A. Comply with requirements in Section 271323 "Communications Optical Fiber Backbone Cabling" for optical fiber backbone cabling and connectors.

B. Comply with requirements in Section 271523 "Communications Optical Fiber Horizontal Cabling" for optical fiber horizontal cabling and connectors.

2.20 ACCESSORIES

A. Pneumatic Pressure Gauges:

1. Face Size: 1.5-inch-diameter face for pressures up through 30 psig and 2.5-inch-diameter face for greater pressures.
2. Face Markings: White dial face with black printing; 1 psig increment for scale ranges through 30 psig and 2 psig increment for larger ranges.
3. Accuracy: Within 1 percent of full-scale range.
4. Applications: Include separate gauges for branch pressure and main pressure tubing.

B. Pressure Electric Switches:

1. Description: Diaphragm-operated, snap-acting switch.
2. Performance:

    a. Rating: Resistance loads at 120 V ac.
    b. Set Point: Adjustable from 3 to 20 psig.
    c. Differential: Adjustable from 2 to 6 psig.

3. Body and Switch Housing: Metal.

C. Instrument Enclosures:

1. Manufacturers: Subject to compliance with requirements, available

manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Hammond Mfg. Co. Inc
b. Hoffman; brand of nVent Electrical plc
c. Saginaw Control and Engineering

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. Hammond Mfg. Co. Inc
b. Hoffman; brand of nVent Electrical plc
c. Saginaw Control and Engineering

3. Application: Include instrument enclosure for secondary protection to comply with requirements indicated in "Performance Requirements" Article.
4. Certification: NRTL listed and labeled to UL 50 or UL 508A as applicable.
5. Subpanel:

a. Size enclosure with least 25 percent spare area on subpanel.
b. Mount instrument(s) within enclosure on internal subpanel(s).

6. Identification: Include on face of enclosure an engraved, laminated phenolic nameplate for each instrument installed within enclosure.
7. Pneumatic Pressure Gauges: Include main pressure gauge and a branch pressure gauge for each pneumatic device installed inside enclosure.
8. Raceways: For enclosures housing multiple instruments, route tubing, cable, and wiring within enclosure in a raceway having continuous removable cover.
9. Access: Provide enclosures larger than 12 inches with hinged full-size face cover.
10. Security: Equip enclosures with lock and common key.

D. Manual Valves:

1. Brass Needle Valves:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the followingavailable manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) BrassCraft Manufacturing Co.; a Masco company
2) Parker (Parker Hannifin)

b. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

1) BrassCraft Manufacturing Co.; a Masco company
2) Parker (Parker Hannifin)

c. Pressure Rating: 150 psig.
d. Temperature Rating: 250 deg F.
e. Body: Brass.
f. Seat: Brass.
g. Handle: Aluminum, brass, or stainless steel T-bar handle.
h. Connections: Include tubing connections.
i. Applications: Copper and polyethylene pneumatic tubing.

2. Stainless Steel Needle Valves:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) DK-LOK USA
2) Parker (Parker Hannifin)
3) Sizto Tech Corporation (STC)

b. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

1) DK-LOK USA
2) Parker (Parker Hannifin)
3) Sizto Tech Corporation (STC)

c. Pressure Rating: 5000 psig.
d. Temperature Rating: 450 deg F.
e. Body: Type 316 stainless steel.
f. Seat: Type 316 stainless steel.
g. Packing: PTFE.
h. Handle: Aluminum or stainless steel T-bar handle.
i. Connections: Include tubing connections.
j. Applications: Copper pneumatic tubing; copper and stainless steel process tubing.

3. Bronze Body Ball Valves:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Apollo Valves; a part of Aalberts Integrated Piping Systems
2) Milwaukee Valve Company
3) NIBCO INC.

b. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

1) Apollo Valves; a part of Aalberts Integrated Piping Systems

2) Milwaukee Valve Company
3) NIBCO INC.

c. Standard: MSS SP-110.
d. SWP Rating: 150 psig.
e. CWP Rating: 600 psig.
f. Body Design: Two piece.
g. Body Material: Bronze.
h. Ends: Threaded.
i. Seats: PTFE.
j. Stem: Stainless steel.
k. Ball: Stainless steel, vented.
l. Handle: Stainless steel with vinyl grip.
m. Port: Full.

2.21 IDENTIFICATION

A. Control Equipment, Instruments, and Control Devices:

1. Laminated acrylic or melamine plastic sign bearing unique identification.

a. Include instruments with unique identification identified by equipment being controlled or monitored, followed by point identification.

2. Letter size as follows:

a. Servers: Minimum of 0.5 inch high.
b. PLC Controllers: Minimum of 0.5 inch high.
c. Protocol Gateways: Minimum of 0.5 inch high.
d. Repeaters: Minimum of 0.5 inch high.
e. Enclosures: Minimum of 0.5 inch high.
f. Electrical Power Devices: Minimum of 0.25 inch high.
g. UPS units: Minimum of 0.5 inch high.
h. Accessories: Minimum of 0.25 inch high.
i. Instruments: Minimum of .25 inch high.
j. Control Pump and Valve Actuators: Minimum of 0.25 inch high.

3. Engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers color-coded black with contrasting white center exposed by engraving through outer layer.
4. Fastened with drive pins.
5. Instruments, control devices, and actuators with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require additional identification.

B. Valve Tags:

1. Brass tags and brass chains attached to valve.
2. Tag Size: Minimum 1.5 inches in diameter.
3. Include tag with unique valve identification indicating control influence such as

flow, level, pressure, or temperature; followed by location of valve, and followed by three-digit sequential number. For example: TV-1.001.

4. Valves with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.

C. Raceway and Boxes:

1. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
2. Paint cover plates on junction boxes and conduit same color as tape banding for conduits. After painting, label cover plate "FUEL OIL DELIVERY Controls" using engraved phenolic tag.
3. For raceways housing pneumatic tubing, add phenolic tag labeled "FUEL OIL DELIVERY Instrument Air Tubing."
4. For raceways housing air signal tubing, add phenolic tag labeled "FUEL OIL DELIVERY Air Signal Tubing."

D. Equipment Warning Labels:

1. Self-adhesive label with pressure-sensitive adhesive back and peel-off protective jacket.
2. Lettering size at least 14-point type with white lettering on red background.
3. Warning label to read "CAUTION-Equipment operated under remote automatic control and may start or stop at any time without warning. Switch electric power disconnecting means to OFF position before servicing."
4. Lettering to be enclosed in a white line border. Edge of label is to extend at least 0.25 inchbeyond white border.

2.22 SOURCE QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to evaluate the following in accordance with industry standards for each product, and to verify PLC system reliability specified in performance requirements:

1. PLC controllers.
2. Protocol Gateways.
3. Routers.
4. HMI.

B. Product(s) and material(s) will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

1. Verify compatibility with and suitability of substrates.

B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.

E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PLC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

A. Communication Interface to Equipment with Integral Controls:

1. PLC system has communication interface with equipment having integral controls and having communication interface for remote monitoring or control.
2. Equipment to Be Connected:

a. Diesel emergency engine generators specified in Section 263213.13 "Diesel-Engine-Driven Generator Sets."

B. Communication Interface to Other Building Systems:

1. PLC system communicates with systems having communication interface.
2. Systems to Be Connected:

a. Existing Booster Pump Building Control Panel.
b. Existing Wonderware ArchetrA SCADA system.

3.3 PREINSTALLATION INTEGRATION TESTING

A. Perform the following pretesting of other systems and equipment integration with PLC system before field installation:

1. Test all communications in a controlled environment to ensure connectivity.
2. Load software and demonstrate functional compliance with each control

sequence of operation indicated.

3. Using simulation, demonstrate compliance with sequences of operation and other requirements indicated including, but not limited to, the following:

    a. FUEL OIL DELIVERY equipment controlled through PLC system, such as pumps.
    b. Equipment faults and system recovery with fault annunciation.
    c. Analog and Boolean value alarming and annunciation.

4. Develop a method for testing interfaces before deployment.
5. Submit documentation supporting compliance upon request.

3.4 PLC SYSTEM INTERFACE WITH EXISTING SYSTEMS

A. Interface with Existing Systems:

1. Interface PLC systems with existing systems to achieve integration indicated.
2. Monitoring and Control of PLC System by Existing Control System:

    a. Satisfy PLC system performance requirements when monitoring and controlling PLC system by existing control system.
    b. Operator of existing system to upload, download, monitor, trend, control, and program every I/O point in PLC system from existing control system using existing control system software and operator workstations.
    c. Make interface so operator of existing system is not required to learn new software for remote monitoring and control from existing control system.
    d. Make interface of PLC system into existing control system transparent to operators of existing control system and allow operators to monitor and control PLC system from any operator workstation connected to existing control system.
    e.

3. Integration of Existing Control System into PLC System:

    a. Satisfy existing control system performance requirements when monitoring and controlling existing control system through PLC system.
    b. Operator to upload, download, monitor, alarm, report, trend, control, and program every I/O point in existing system from PLC system using operator workstations and software provided. Combined systems to share one database.
    c. Make interface of existing control system I/O points into PLC system transparent to operators. Make all operational capabilities identical regardless of whether I/O already exists, or I/O is being installed.

B. Integration with Existing Enterprise System:

1. Interface PLC system with an existing enterprise system to adhere to Owner standards already in-place and to achieve integration.
2. Owner's control system integrator to provide the following services:

a. Enterprise system expansion and development of graphics, logs, reports, trends, and other operational capabilities of enterprise system for I/O being added to PLC control system for use by enterprise system operators.
b. Limited assistance during commissioning to extent of PLC system integration with existing enterprise system.
c. Prepare on-site demonstration mockup of integration of PLC system to be installed with existing system before installing PLC system.

3. Engage Owner's control system integrator to provide the following services:

a. Enterprise system expansion and development of graphics, logs, reports, trends, and other operational capabilities of enterprise system for I/O being added to PLC control system for use by enterprise system operators.
b. Limited assistance during commissioning to extent of PLC system integration with existing enterprise system.
c. Prepare on-site demonstration mockup of integration of PLC system to be installed with existing system before installing PLC system.

4. Control System Integrator Contact Information:

a. Company: MR Systems.
b. Company Street Address: 1185 Beaver Ruin Road A, Norcross, GA 30093.
c. Phone Number: 888-565-5688.
d. Email Address: info@mrsystems.com.

5. Attend meetings with control system integrator to integrate PLC system.

3.5 CONTROL DEVICES FOR INSTALLATION BY INSTALLERS

A. Deliver selected control devices, specified in indicated FUEL OIL DELIVERY instrumentation and control device Sections, to identified equipment and systems manufacturers for factory installation and to identified installers for field installation.

B. Deliver the following to duct fabricator and Installer for installation in ductwork. Include installation instructions to Installer and supervise installation for compliance with requirements.

1. Fuel Oil Tanks, Fuel Oil Pumps, Day Tanks Level Instruments.

C. Deliver the following to plumbing and FUEL OIL DELIVERY piping installers for installation in piping. Include installation instructions to Installer and supervise installation for compliance with requirements.

1. Control valves, which are specified in Section 230923.11 "Control Valves."
2. Tank-mounted sensors, switches, and transmitters. Pressure sensors, switches, and transmitters are specified in Section 230923.23 "Pressure Instruments."
3. Pipe- and tank-mounted thermowells. Liquid thermowells are specified in Section 230923.27 "Temperature Instruments."
4. Level Instruments specified in Section 230923.17.

3.6 CONTROL DEVICES FOR EQUIPMENT MANUFACTURER FACTORY INSTALLATION

A. Deliver the following to manufacturer for factory installation. Include installation instructions to Fuel Oil Delivery system unit manufacturer and supervise installation for compliance with requirements.

1. Programmable logic controller.
2. Unit-mounted leak-detection switches, which are specified in Section 230923.18 "Leak Detection Instruments."
3. Relays.
4. Level Instruments specified in Section 230923.17.

B. Deliver the following to terminal unit manufacturer for factory installation. Include installation instructions to terminal unit manufacturer.

1. Programmable logic controller.
2. Relays.
3. Level Instruments specified in Section 230923.17.

C. Deliver the following to Fuel Oil Tanks manufacturer for factory installation. Include installation instructions to fan-coil unit manufacturer.

1. Programmablelogic controller.
2. Leak-detection switches, which are specified in Section 230923.18 "Leak Detection Instruments."
3. Relays.
4. Level Instruments specified in Section 230923.17.

3.7 GENERAL INSTALLATION REQUIREMENTS

A. Install products to satisfy more stringent of all requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Support products, tubing, piping wiring, and raceways. Brace products to prevent lateral movement and sway or a break in attachment.

D. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.

E. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

F. Firestop Penetrations Made in Fire-Rated Assemblies: Comply with requirements in Section 078413 "Penetration Firestopping."

G. Seal penetrations made in acoustically rated assemblies. Comply with requirements in

Section 079200 "Joint Sealants."

H. Welding Requirements:

1. Restrict welding and burning to supports and bracing.
2. No equipment is cut or welded without approval. Welding or cutting will not be approved if there is risk of damage to adjacent Work.
3. Welding, where approved, is to be by inert-gas electric arc process and is to be performed by qualified welders in accordance with applicable welding codes.
4. If requested on-site, show satisfactory evidence of welder certificates indicating ability to perform welding work intended.

I. Fastening Hardware:

1. Wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

J. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

K. Corrosive Environments:

1. Avoid or limit use of materials in corrosive airstreams and environments including, but not limited to, the following:

    a. Laboratory exhaust-air streams.
    b. Process exhaust-air streams.

2. When conduit is in contact with a corrosive airstream and environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment. Comply with requirements for installation of raceways and boxes specified in Section 260533.13 "Conduits for Electrical Systems," Section 260533.16 "Boxes and Covers for Electrical Systems," and Section 260533.23 "Surface Raceways for Electrical Systems."
3. Where instruments are located in a corrosive airstream and are not already corrosive resistant from instrument manufacturer, field install products in NEMA 250, Type 4X instrument enclosure constructed of Type 316L stainless steel.

3.8 INSTALLATION OF PROTOCOL GATEWAYS

A. Install protocol gateways if required for PLC system communication interface requirements indicated.

1. Install protocol gateway(s) required to suit indicated requirements.

    a. Modbus/TCP-Ethernet/IP Protocol Gateway.

B. Test protocol gateways to verify that communication interface functions properly.

3.9 INSTALLATION OF CONTROLLERS

A. Install controllers in enclosures to comply with indicated requirements.

B. Connect controllers to field power supply and to UPS units where indicated.

C. Install controllers with latest version of applicable software and configure to execute requirements indicated.

D. Test and adjust controllers to verify operation of connected I/O to achieve performance indicated requirements while executing sequences of operation.

E. Installation of Programmable Protocol Controllers:

1. PLC system provider and PLC system manufacturer to determine quantity and location of programmable protocol controllers to satisfy requirements indicated.
2. Install controllers in a protected location that is easily accessible by operators.
3. Locate top of controller within 72 inches of finished floor, except where dedicated controllers are installed at terminal units.

3.10 INSTALLATION OF ENCLOSURES

A. Install the following items in enclosures, to comply with indicated requirements:

1. Protocol Gateways.
2. Controllers.
3. Electrical power devices.
4. UPS units.
5. Relays.
6. Accessories.
7. Instruments.
8. Actuators.

B. Attach wall-mounted enclosures to wall using the following types of steel struts:

1. For NEMA 250 Enclosures: Type 1; use corrosion-resistant-coated steel strut and hardware.
2. For NEMA 250 Enclosures and Enclosures Located Outdoors: Type 4X; use stainless steel strut and hardware.
3. Install plastic caps on exposed cut edges of strut.

C. Align top of adjacent enclosures of like size.

D. Install floor-mounted enclosures located in mechanical equipment rooms on concrete

housekeeping pads. Attach enclosure legs using galvanized-steel anchors.

E. Install continuous and fully accessible wireways to connect conduit, wire, and cable to multiple adjacent enclosures. Wireways used for application are to have protection equal to NEMA 250 rating of connected enclosures.

3.11 ELECTRIC POWER CONNECTIONS

A. Connect electrical power to PLC system products requiring electrical power connections.

B. Design of electrical power to products not indicated with electric power is delegated to PLC system provider and installing trade to provide a fully functioning PLC system. Work is to comply with NFPA 70 and other requirements indicated.

C. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers" for electrical power circuit breakers.

D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power conductors and cables.

E. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems," Section 260533.16 "Boxes and Covers for Electrical Systems," and Section 260533.23 "Surface Raceways for Electrical Systems" for electrical power raceways and boxes.

3.12 INSTALLATION OF IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification products and installation.

B. Install laminated acrylic or melamine plastic signs with unique identification on face for each of the following:

1. Protocol Gateway.
2. PLC controller.
3. Enclosure.
4. Electrical power device.
5. UPS unit.
6. Accessory.

C. Install unique instrument identification for each instrument connected to PLC controller.

D. Install unique identification for each control valve actuator connected to PLC controller.

3.13 INSTALLATION OF NETWORKS

A. Install optical fiber cable when connecting between the following network devices and when located in different buildings on campus, or when distance between devices exceeds 300 cable feet:

1. Operator workstations.
2. Operator workstations and network controllers.
3. Network controllers.
4. Modbus/TCP-Ethernet/IP Protocol Gateway.

B. Install balanced twisted pair cable when connecting between the following network devices and less than 300 cable feet long:

1. Operator workstations.
2. Operator workstations and network controllers.
3. Network controllers.
4. Modbus/TCP-Ethernet/IP Protocol Gateway.
5. Instrumentation with communications.

C. Install balanced twisted pair or copper cable (as required by equipment) when connecting between the following and less than 300 cable feet long:

1. Protocol Gateways .
2. Programmable logic controllers.

D. Install cable in continuous raceway.

1. Where indicated on Drawings, cable trays may be used for copper cable in lieu of conduit.

3.14 NETWORK NAMING AND NUMBERING

A. Coordinate with Owner and provide unique naming and addressing for networks and devices.

B. Controls Networks:

1. Network Numbering:

a. Assign unique numbers to each new network.
b. Provide ability for changing network number through device switches or operator interface.

2. Device Object Identifier Property Number:

a. Assign unique device object identifier property numbers or device instances for each device network.
b. Provide for future modification of device instance number by device switches or operator interface.

3. Device Object Name Property Text:

    a. Device object name property field to support 32 minimum printable characters.
    b. Assign unique device "Object Name" property names with plain-English descriptive names for each device.

        1) Example 1: Device object name for device controlling heating water boiler plant at Building 1000 would be "Heating Water System Bldg. 1000."
        2) Example 2: Device object name for VAV terminal unit controller could be "VAV Unit 102."

4. Object Name Property Text for Other Than Device Objects:

    a. Object name property field is to support 32 minimum printable characters.
    b. Assign object name properties with plain-English names descriptive of application.

        1) Example 1: "Zone 1 Temperature."
        2) Example 2 "Fan Start and Stop."

5. Object Identifier Property Number for Other Than Device Objects:

    a. Assign object identifier property numbers according to Drawings indicated.
    b. If not indicated, object identifier property numbers may be assigned at Installer's discretion but must be approved by Owner in advance, be documented, and be unique for like object types within device.

3.15 INSTALLATION OF CONTROL WIRE, CABLE, AND RACEWAY

A. Comply with NECA 1.

B. Wire and Cable Installation:

1. Comply with installation requirements in Section 260523 "Control-Voltage Electrical Power Cables."
2. Comply with installation requirements in Section 271313 "Communications Copper Backbone Cabling."
3. Comply with installation requirements in Section 271513 "Communications Copper Horizontal Cabling."
4. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.

    a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.

5. Terminate wiring in a junction box.

a. Clamp cable over jacket in a junction box.
b. Individual conductors in the stripped section of cable is to be slack between the clamping point and terminal block.

6. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
7. Install signal transmission components in accordance with IEEE C2, REA Form 511a, NFPA 70, and as indicated.
8. Use shielded cable to transmitters.
9. Use shielded cable to temperature sensors.
10. Perform continuity and meager testing on wire and cable after installation.

C. Conduit Installation:

1. Comply with Section 260533.13 "Conduits for Electrical Systems," Section 260533.16 "Boxes and Covers for Electrical Systems," and Section 260533.23 "Surface Raceways for Electrical Systems" for control-voltage conductors.
2. Comply with Section 270528 "Pathways for Communications Systems" for balanced twisted pair cabling and optical fiber installation.

3.16 INSTALLATION OF OPTICAL FIBER CABLE SYSTEMS

A. Comply with installation requirements in Section 271323 "Communications Optical Fiber Backbone Cabling."

B. Comply with installation requirements in Section 271523 "Communications Optical Fiber Horizontal Cabling."

3.17 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections.

C. Tests and Inspections: Perform the following tests and inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Optical Fiber Cable Testing:

1. Perform preinstallation, in-progress, and final tests, supplemented by additional tests, as necessary.
2. Preinstallation Cable Verification: Verify integrity and serviceability for new cable lengths before installation. This assurance may be provided by using vendor

verification documents, testing, or other methods. At a minimum, furnish evidence of verification for cable attenuation and bandwidth parameters.

3. In-Progress Testing: Perform standard tests for correct pair identification and termination during installation to ensure proper installation and cable placement. Perform tests in addition to those specified if there is any reason to question condition of material furnished and installed. Testing accomplished is to be documented by agency conducting tests. Submit test results for Project record.
4. Final Testing: Perform final test of installed system to demonstrate acceptability as installed. Perform testing according to test plan supplied by PLC system manufacturer. Correct defective Work or material and retest. At a minimum, final testing for cable system, including spare cable, to verify compliance of attenuation, length, and bandwidth parameters with performance indicated.
5. Test Equipment: Use optical fiber time-domain reflectometer for testing of length and optical connectivity.
6. Test Results: Record test results and submit copy of test results for Project record.

3.18 PLC SYSTEM I/O CHECKOUT PROCEDURES

A. Check installed products before continuity tests, leak tests, and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.

D. Control Valve Checkout:

1. Verify that control valves are installed correctly for flow direction.
2. Verify that valve body attachment is properly secured and sealed.
3. Verify that valve actuator and linkage attachment are secure.
4. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
5. Verify that valve ball, disc, or plug travel is unobstructed.
6. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace valve if leaks persist.

E. Instrument Checkout:

1. Verify that instrument is correctly installed for location, orientation, direction, and operating clearances.
2. Verify that attachment is properly secured and sealed.
3. Verify that conduit connections are properly secured and sealed.
4. Verify that wiring is properly labeled with unique identification, correct type, and size and is securely attached to proper terminals.
5. Inspect instrument tag against approved submittal.
6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
7. For flow instruments, verify that recommended upstream and downstream

distances have been maintained.

8. For temperature instruments, verify the following:

    a. Sensing element type and proper material.
    b. Length and insertion.

3.19 PLC SYSTEM I/O ADJUSTMENT, CALIBRATION, AND TESTING

A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.

B. Provide written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.

C. For each analog instrument, make three-point test of calibration for both linearity and accuracy.

D. Equipment and procedures used for calibration to comply with instrument manufacturer's written instructions.

E. Provide diagnostic and test equipment for calibration and adjustment.

1. Use field testing and diagnostic instruments and equipment with an accuracy at least twice the instrument accuracy of instrument to be calibrated. For example, test and calibrate an installed instrument with accuracy of 1 percent using field testing and diagnostic instrument with accuracy of 0.5 percent or better.

F. Calibrate each instrument in accordance with instruction manual supplied by instrument manufacturer.

G. If after calibration the indicated performance cannot be achieved, replace out-of-tolerance instruments.

H. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of FUEL OIL DELIVERY Controls Components," in the absence of specific requirements, and to supplement requirements indicated.

I. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

J. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact making or breaking.

K. Control Pumps:

1. Stroke and adjust control pumps following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Stroke pneumatic control pumps with pilot positioners. Adjust pump and positioner following manufacturer's recommended procedure, so pump is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.
3. Check and document open and close cycle times for applications with cycle time less than 30 seconds.
4. For control pumps equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

L. Control Valves:

1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Check and document open and close cycle times for applications with cycle time less than 30 seconds.
3. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

M. Meters: Check meters at zero, 50, and 100 percent of Project design values.

N. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

O. Switches: Calibrate switches to make or break contact at set points indicated.

P. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

3.20 PLC SYSTEM CONTROLLER CHECKOUT

A. Verify power supply.

1. Verify voltage, phase, and hertz.
2. Verify that protection from power surges is installed and functioning.
3. Verify that ground fault protection is installed.
4. If applicable, verify if connected to UPS unit.
5. If applicable, verify if connected to backup power source.
6. If applicable, verify that power conditioning units are installed.

B. Verify that wire and cabling are properly secured to terminals and labeled with unique identification.

C. Verify that spare I/O capacity is provided.

3.21 PLC CONTROLLER I/O CONTROL LOOP TESTS

A. Testing:

1. Test every I/O point connected to PLC controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
2. Test every I/O point throughout its full operating range.
3. Test every control loop to verify that operation is stable and accurate.
4. Adjust control loop proportional, integral, and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
5. Test and adjust every control loop for proper operation according to sequence of operation.
6. Test software and hardware interlocks for proper operation. Correct deficiencies.
7. Operate each analog point at the following:

    a. Upper quarter of range.
    b. Lower quarter of range.
    c. At midpoint of range.

8. Exercise each Discrete point.
9. For every I/O point in PLC system, read and record each value at operator workstation, at PLC controller, and at field instrument simultaneously. Value displayed at operator workstation, at PLC controller, and at field instrument must match.
10. Prepare and submit report documenting results for each I/O point in PLC system and include in each I/O point a description of corrective measures and adjustments made to achieve desire results.

3.22 PLC SYSTEM VALIDATION TESTS

A. Perform validation tests before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.

B. After approval of Pretest Checklist and Test Plan, execute all tests and procedures indicated in plan.

C. After testing is complete, submit completed Pretest Checklist.

D. Pretest Checklist: Submit the following list with items checked off once verified:

1. Detailed explanation for any items that are not completed or verified.
2. Required mechanical installation work is successfully completed and FUEL OIL DELIVERY equipment is working correctly.
3. FUEL OIL DELIVERY equipment motors operate below full-load amperage ratings.

4. Required PLC system components, wiring, and accessories are installed.
5. Installed PLC system architecture matches approved Drawings.
6. Control electric power circuits operate at proper voltage and are free from faults.
7. Required surge protection is installed.
8. PLC system network communications function properly, including uploading and downloading programming changes.
9. Each controller's programming is backed up.
10. Equipment, products, tubing, wiring cable, and conduits are properly labeled.
11. All I/O points are programmed into controllers.
12. Valves and actuators zero and span adjustments are set properly.
13. Each control valve and actuator goes to failed position on loss of power.
14. Meter, sensor, and transmitter readings are accurate and calibrated.
15. Control loops are tuned for smooth and stable operation.
16. View trend data where applicable.
17. Each controller works properly in standalone mode.
18. Safety controls and devices function properly.
19. Electrical interlocks function properly.
20. Operator workstations and other interfaces are delivered, all system and database software is installed, and graphics are created.
21. Record Drawings are completed.

E. Test Plan:

1. Prepare and submit validation Test Plan including test procedures for performance validation tests.
2. Address all specified functions of PLC system and sequences of operation in Test Plan.
3. Explain detailed actions and expected results to demonstrate compliance with requirements indicated.
4. Explain method for simulating necessary conditions of operation used to demonstrate performance.
5. Include Test Checklist to be used to check and initial that each test has been successfully completed.
6. Submit Test Plan documentation 20 business days before start of tests.

F. Validation Test:

1. Verify operating performance of each I/O point in PLC system.

    a. Verify analog I/O points at operating value.
    b. Make adjustments to out-of-tolerance I/O points.

        1) Identify I/O points for future reference.
        2) Simulate abnormal conditions to demonstrate proper function of safety devices.
        3) Replace instruments and controllers that cannot maintain performance indicated after adjustments.

2. Simulate conditions to demonstrate proper sequence of control.
3. Readjust settings to design values and observe ability of PLC system to establish desired conditions.

4. 24 hours after initial validation test, do as follows:

    a. Re-check I/O points that required corrections during initial test.
    b. Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.

5. 24 Hours after second validation test, do as follows:

    a. Re-check I/O points that required corrections during second test.
    b. Continue validation testing until I/O point is normal on two consecutive tests.

6. Completely check out, calibrate, and test all connected hardware and software to ensure that PLC system performs according to requirements indicated.
7. After validation testing is complete, prepare and submit report indicating results of testing. For all I/O points that required correction, indicate how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.

G. PLC System Response Time Test:

1. Simulate HLC.

    a. Heavy load to be occurrence of 90 percent of total connected Discrete COV, one-half of which represents "alarm" condition, and 50 percent of total connected analog COV, one-half of which represents "alarm" condition, that are initiated simultaneously on a one-time basis.

2. Initiate 10 successive occurrences of HLC and measure response time to typical alarms and status changes.
3. Measure with timer having at least 0.1-second resolution and 0.01 percent accuracy.
4. Purpose of test is to demonstrate PLC system, as follows:

    a. Reaction to COV and alarm conditions during HLC.
    b. Ability to update PLC system database during HLC.

5. Passing test is contingent on the following:

    a. Alarm reporting at HMI beginning no more than two seconds after initiation (time zero) of HLC.
    b. All alarms, both Discrete and analog, are reported and printed; none are lost.
    c. Compliance with response times specified.

6. Prepare and submit report documenting HLC tested and results of test.

H. PLC System Network Bandwidth Test:

1. Test network bandwidth usage on all PLC system networks to demonstrate bandwidth usage under PLC system normal operating conditions and under

simulated HLC.

2. To pass, none of PLC system networks are to use more than 70 percent of available bandwidth under normal and HLC operation.

3.23 FINAL REVIEW

A. Submit Owner Commissioning Agent and Construction Manager when PLC system is ready for final review. State the following:

1. PLC system has been thoroughly inspected for compliance with Contract Documents and found to be in full compliance.
2. PLC system has been calibrated, adjusted, and tested and found to comply with requirements of operational stability, accuracy, speed, and other performance requirements indicated.
3. PLC system monitoring and control of Fuel Oil Delivery systems results in operation according to sequences of operation indicated.
4. PLC system is complete and ready for final review.

B. Upon receipt of written request for final review, Owner Commissioning Agent and Construction Manager to start review within reasonable period and upon completion issue field report(s) documenting observations and deficiencies.

C. Take prompt action to remedy deficiencies indicated in reviewer's field report(s) and submit second written request after all deficiencies have been corrected. Repeat process until no deficiencies are reported.

D. Compensation for Subsequent Reviews: Should more than two reviews be required, PLC system manufacturer and Installer to compensate entity/entities performing reviews for total costs (labor and expenses) associated with subsequent reviews. Estimated cost of each subsequent review to be submitted and approved by PLC system manufacturer and Installer before review.

E. Prepare and submit closeout submittals and begin procedures indicated in "Extended Operation Test" Article when no deficiencies are reported.

F. Part of PLC system final review to include demonstration to parties participating in final review.

1. Provide staff familiar with PLC system installed to demonstrate operation of PLC system during final review.
2. Provide testing equipment to demonstrate accuracy and other performance requirements of PLC system that is requested by reviewers during final review.
3. Demonstration to include, but not be limited to, the following:

a. Accuracy and calibration of 10 I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
b. Fuel Oil Delivery System equipment and system hardwired and software

safeties and life-safety functions are operating according to sequence of operation. Up to 10 I/O points to be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.

c. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected Fuel Oil Delivery systems.
d. Operation of pumps and valves in normal-on, normal-off, and failed positions.
e. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and operator workstations.
f. Software's ability to edit control programs offline.
g. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
h. Execution of digital and analog commands in graphic mode.
i. System speed of response compared to requirements indicated.
j. For Each Controller: Applies to programmable application controllers.

    1) Memory: Programmed data, parameters, trend, and alarm history collected during normal operation are not to be lost during power failure.
    2) Operator Interface: Ability to connect directly to each type of digital controller with portable workstation. Show that maintenance personnel interface tools perform as indicated in manufacturer's technical literature.
    3) Standalone Ability: Demonstrate that controllers provide stable and reliable standalone operation using default values or other method for values normally read over network.
    4) Electric Power: Ability to disconnect any controller safely from its power source.
    5) Wiring Labels: Match control drawings.
    6) Network Communication: Ability to locate controller's location on network and communication architecture matches Shop Drawings.
    7) Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators, and devices.

k. For Each Operator Workstation:

    1) I/O points lists agree with naming conventions.
    2) Graphics are complete.
    3) UPS unit, if applicable, operates.

l. Communications and Interoperability: Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device. Requirements must be met even if only one manufacturer's equipment is installed.

    1) Data Presentation: On each operator workstation, demonstrate graphic display capabilities.
    2) Reading of Any Property: Demonstrate ability to read and display any

used readable object property of any device on network.

3) Set-Point and Parameter Modifications: Show ability to modify set points and tuning parameters indicated.
4) Peer-to-Peer Data Exchange: Network devices are installed and configured to perform without need for operator intervention to implement Project sequence of operation and to share global data.
5) Alarm and Event Management: Alarms and events are installed and prioritized according to Owner. Demonstrate that time delays and other logic are set up to avoid nuisance tripping. Show that operators with sufficient privileges are permitted.
6) Schedule Lists: Schedules are configured for start and stop, mode change, occupant overrides, and night setback as defined in sequence of operations.
7) Schedule Display and Modification: Ability to display any schedule with start and stop times for calendar year. Show that all calendar entries and schedules are modifiable from any connected operator workstation by an operator with sufficient privilege.
8) Archival Storage of Data: Data archiving is handled by operator workstation and server and local trend archiving and display is accomplished.
9) Modification of Trend Log Object Parameters: Operator with sufficient privilege can change logged data points, sampling rate, and trend duration.

3.24 EXTENDED OPERATION TEST

A. Operate PLC system for operating period of 14 consecutive calendar days following Substantial Completion. Coordinate exact start date of testing with Owner.

B. Provide operator familiar with PLC system installed to man an operator workstation while on-site during eight hours of each normal business day occurring during operating period.

C. During operating period, PLC system to demonstrate correct operation and accuracy of monitored and controlled points as well as operation capabilities of sequences, logs, trends, reports, specialized control algorithms, diagnostics, and other software indicated.

1. Correct defects of hardware and software when they occur.

D. Definition of Failures and Downtime during Operating Period:

1. Failed I/O point constituting downtime is I/O point failing to perform its intended function consistently and a point physically failed due to hardware and software.
2. Downtime is when any I/O point in PLC system is unable to fulfill its required function.
3. Calculate downtime as elapsed time between detected point failure as confirmed by operator, and time point is restored to service.
4. Maximum time interval allowed between PLC system detection of failure occurrence and operator confirmation is to be 0.5 hours.

5. Log downtime in hours to nearest 0.1 hour.
6. Power outages do not count as downtime, but do suspend test hours unless systems are provided with UPS and served through a backup power source.
7. Hardware or software failures caused by power outages do count as downtime.

E. During operating period, log downtime and operational problems are encountered.

1. Identify source of problem.
2. Provide written description of corrective action taken.
3. Record duration of downtime.
4. Maintain log showing the following:

    a. Time of occurrence.
    b. Description of each occurrence and pertinent written comments for reviewer to understand scope and extent of occurrence.
    c. Downtime for each failed I/O point.
    d. Running total of downtime and total time of I/O point after each problem has been restored.

5. Make log available to Owner for review at any time.

F. For PLC system to pass extended operation test, total downtime is limited to 1 percent of total point-hours during operating period.

1. If PLC system testing results fail to comply with minimum requirements of passing at end of operating period indicated, extend operating period one consecutive day at a time until PLC system passes requirement.

G. Base evaluation of PLC system passing test on the following calculation:

1. Count downtime on point-hour basis where total number of PLC system point-hours is equal to total number of I/O points in PLC system multiplied by total number of hours during operating period.
2. One point-hour of downtime is one I/O point down for one hour. For example, three I/O points down for five hours is total of 15 point-hours of downtime. Four points down for one-half hour is two point-hours of downtime.
3. Example Calculation: Maximum allowable downtime for 30-day test for PLC system with 1000 total I/O points (combined analog and Discrete) and passing score of 1 percent downtime is computed by 30 days x 24 h/day x 1000 points x 1 percent equals 7200 point-hours of maximum allowable downtime.

H. Prepare test and inspection reports.

3.25 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, verify that maintenance service includes 12 months' full maintenance by PLC system manufacturer's authorized service representative. Include quarterly preventive maintenance, repair or replacement of worn or defective components, cleaning, calibration, and adjusting as required for proper operation. Use only manufacturer's authorized replacement parts and supplies.

3.26 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, verify that service agreement includes software support for one year.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within one year(s) from date of Substantial Completion. Verify that upgrading software includes operating system and new or revised licenses for using software.

1. Upgrade Notice: No fewer than 30 days to allow Owner to schedule and access system and to upgrade computer equipment if necessary.

3.27 DEMONSTRATION

A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain PLC system.

B. Extent of Training:

1. Base extent of training on scope and complexity of PLC system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
3. Minimum Training Requirements:

    a. Provide not less than five days of training total.
    b. Stagger training over multiple training classes to accommodate Owner's requirements. All training to occur before end of warranty period.
    c. Break down total days of training into not more than two separate training classes.
    d. Schedule training so each training class is not less than one consecutive day(s).

C. Training Schedule:

1. Schedule training with Owner 20 business days before expected Substantial Completion.
2. Schedule training to provide Owner with at least 20 business days of notice in advance of training.
3. Training to occur within normal business hours at mutually agreed on time. Unless otherwise agreed to, training to occur Monday through Friday, except on U.S. Federal holidays, with two morning sessions and two afternoon sessions. Each morning session and afternoon session to be split in half with 30-minute break between sessions. Morning and afternoon sessions to be separated by 60-minute lunch period. Training, including breaks and excluding lunch period, are not to exceed eight hours per day.

4. Provide staggered training schedule as requested by Owner.

D. Training Attendee List and Sign-in Sheet:

1. Request from Owner in advance of training a proposed attendee list with name, phone number, and email address.
2. Provide preprinted sign-in sheet for each training session with proposed attendees listed and no fewer than six blank spaces to add additional attendees.
3. Include preprinted sign-in sheet with training session number, date and time, instructor name, phone number, email address, and brief description of content to be covered during session. List attendees with columns for name, phone number, and email address and a column for attendee signature or initials.
4. Circulate sign-in sheet at beginning of each session and solicit attendees to sign or initial in applicable location.
5. At end of each training day, send Owner an email with attachment of scanned copy (PDF) of circulated sign-in sheet for each session. Indicate which attendees, if any, joined for only part of training sessions.

E. Training Attendee Headcount:

1. Plan in advance of training for five attendees.
2. Make allowance for Owner to add up to two attendee(s) at time of training.
3. Headcount may vary depending on training content covered in session. Attendee access may be restricted to some training content for purposes of maintaining system security.

F. Training Attendee Prior Knowledge: For guidance in planning required training and instruction, assume attendees have the following:

1. High school education and degree.
2. Intermediate user knowledge of computers and office applications.
3. Intermediate knowledge of Fuel Oil Delivery & Generator systems.
4. Intermediate knowledge of PLC systems.
5. Basic knowledge of PLC system and products installed.

G. Attendee Training Manuals:

1. Provide each attendee with color hard copy of all training materials and visual presentations.
2. Organize hard-copy materials in three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes DVD or flash drive with PDF copy of all hard-copy materials.

H. Instructor Requirements:

1. One or multiple qualified instructors, as required, to provide training.
2. Use instructors who have provided not less than 1 year of instructional training

on not less than five past projects with similar PLC system scope and complexity to PLC system installed.

I. Organization of Training Sessions:

1. Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system. Plan training sessions to accommodate the following three levels of operators:

   a. Daily operators.
   b. Advanced operators.
   c. System managers and administrators.

2. Plan and organize training sessions to group training content to protect PLC system security. Some attendees may be restricted to some training sessions to ensure PLC system security.

J. Training Outline:

1. Submit training outline for Owner review at least 10 business day before scheduling training.
2. Include in outline a detailed agenda for each training day that is broken down into each of four training sessions that day, training objectives for each training session, and synopses for each lesson planned.

K. On-Site Training:

1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power, and data connectivity for instructor and each attendee.
2. Provide training materials, projector, and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by Owner.
4. Include on-site training with regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration, and service requirements.
5. Use operator workstation that is to be used with PLC system in the training. If operator workstations are unavailable, provide temporary workstation to convey training content.

L. Off-Site Training:

1. Provide conditioned training rooms and workspace with ample tables desks or tables, chairs, power, and data connectivity for each attendee.
2. Provide operator workstation for use by each attendee.

M. Training Content for Daily Operators:

1. Basic operation of system.
2. Understanding PLC system architecture and configuration.
3. Understanding each unique product type installed including performance and

service requirements for each.

4. Understanding operation of each system and equipment controlled by PLC system including sequences of operation, each unique control algorithm, and each unique optimization routine.
5. Operating operator workstations, printers, and other peripherals.
6. Logging on and off system.
7. Accessing graphics, reports, and alarms.
8. Adjusting and changing set points and time schedules.
9. Recognizing PLC system malfunctions.
10. Understanding content of operation and maintenance manuals including control drawings.
11. Understanding physical location and placement of PLC controllers and I/O hardware.
12. Accessing data from PLC controllers.
13. Operating portable operator workstations.
14. Review of PLC testing results to establish basic understanding of PLC system operating performance and FUEL OIL DELIVERY system limitations as of Substantial Completion.
15. Running each specified report and log.
16. Displaying and demonstrating each data entry to show Project-specific customizing capability. Demonstrating parameter changes.
17. Stepping through graphics penetration tree, displaying all graphics, demonstrating dynamic updating, and direct access to graphics.
18. Executing digital and analog commands in graphic mode.
19. Demonstrating control loop precision and stability via trend logs of I/O for not less than 10 percent of I/O installed.
20. Demonstrating PLC system performance through trend logs and command tracing.
21. Demonstrating scan, update, and alarm responsiveness.
22. Demonstrating spreadsheet and curve plot software, and its integration with database.
23. Demonstrating on-line user guide, and help function and mail facility.
24. Demonstrating multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.
25. Demonstrating the following for Fuel Oil Storage systems and equipment controlled by PLC system:

    a. Operation of Fuel Oil Storage equipment in normal-off, normal-on, and failed conditions while observing individual equipment, pumps, and valves for correct position under each condition.
    b. For Fuel Oil Storage equipment with factory-installed software, show that integration into PLC system is able to communicate with programmable logic controllers or protocol gateways, as applicable.
    c. Using graphed trends, show that sequence of operation is executed in correct manner, and HVAC systems operate properly through complete sequence of operation including seasonal change, occupied and unoccupied modes, warm-up and cool-down cycles, and other modes of operation indicated.
    d. Hardware interlocks and safeties function properly and PLC system performs correct sequence of operation after electrical power interruption and resumption after power is restored.

e. Reporting of alarm conditions for each alarm, and confirm that alarms are received at assigned locations, including operator workstations.
f. Each control loop responds to set-point adjustment and stabilizes within time period indicated.
g. Sharing of previously graphed trends of all control loops to demonstrate that each control loop is stable and set points are being maintained.

N. Training Content for Advanced Operators:

1. Making and changing workstation graphics.
2. Creating, deleting, and modifying alarms including annunciation and routing.
3. Creating, deleting, and modifying point trend logs including graphing and printing on an ad-hoc basis and operator-defined time intervals.
4. Creating, deleting, and modifying points.
5. Creating, deleting, and modifying programming including ability to edit control programs offline.
6. Creating, deleting, and modifying system graphics and other types of displays.
7. Adding PLC controllers and other network communication devices such as protocol gateways and routers.
8. Performing PLC system checkout and diagnostic procedures.
9. Performing PLC controllers operation and maintenance procedures.
10. Performing operator workstation operation and maintenance procedures.
11. Configuring PLC system hardware including controllers, workstations, communication devices, and I/O points.
12. Maintaining, calibrating, troubleshooting, diagnosing, and repairing hardware.
13. Adjusting, calibrating, and replacing PLC system components.

O. Training Content for System Managers and Administrators:

1. PLC system software maintenance and backups.
2. Uploading, downloading, and offline archiving of all PLC system software and databases.
3. Interface with Project-specific, third-party operator software.
4. Understanding password and security procedures.
5. Adding new operators and making modifications to existing operators.
6. Operator password assignments and modification.
7. Operator authority assignment and modification.
8. Workstation data segregation and modification.

P. Video of Training Sessions:

1. Provide digital video and audio recording of each training session. Create separate recording file for each session.
2. Stamp each recording file with training session number, session name, and date.
3. Provide Owner with two copies of digital files on cloud and flash drives for later reference and for use in future training.
4. Owner retains right to make additional copies for intended training purposes without having to pay royalties.

END OF SECTION 230923

SECTION 230923.11 - CONTROL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Ball-style control valves.
2. Globe-style control valves.
3. Solenoid valves.
4. Electric and electronic control valve actuators.

B. Related Requirements:

1. Section 230923 "Programmable Logic Controller (PLC) System for HVAC" control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

1.2 DEFINITIONS

A. Cv: Valve coefficient.

B. PLC: Programmable Logic Controller.

C. EPT: Ethylene-propylene terpolymer rubber.

D. HNBR: Hydrogenated nitrile butadiene rubber.

E. NBR: Nitrile butadiene rubber.

F. PEEK: Polyether Ether Ketone rubber.

G. PTFE: Polytetrafluoroethylene.

H. RMS: Root-mean-square value of alternating voltage, which is the square root of the mean value of the square of the voltage values during a complete cycle.

I. RTFE: Glass-fiber-reinforced PTFE.

J. TFM: A chemically modified PTFE.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Ball-style control valves.

2. Globe-style control valves.
3. Solenoid valves.
4. Electric and electronic control valve actuators.

B. Product Data Submittals: For each product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation, and maintenance instructions, including factors affecting performance.

C. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include diagrams for pneumatic signal and main air tubing.

D. Delegated Design Submittals:

1. Schedule and design calculations for control valves and actuators, including the following:

a. Flow at project design and minimum flow conditions.
b. Pressure differential drop across valve at project design flow condition.
c. Maximum system pressure differential drop (pump close-off pressure) across valve at project minimum flow condition.
d. Design and minimum control valve coefficient with corresponding valve position.
e. Maximum close-off pressure.
f. Leakage flow at maximum system pressure differential.
g. Torque required at worst-case condition for sizing actuator.
h. Actuator selection indicating torque provided.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plan drawings and corresponding product installation details, drawn to scale, on which the following items are indicated and coordinated with each other, using input from installers of the items involved:

1. Control valve installation location indicated in relationship to room, duct, pipe,

and equipment.
2. Size and location of wall access panels for control valves installed behind walls.
3. Size and location of ceiling access panels for control valves installed above inaccessible ceilings.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For control valves.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASME Compliance: Fabricate and label products to comply with ASME Boiler and Pressure Vessel Code where required by authorities having jurisdiction.

C. Code Compliance: Comply with governing energy code.

D. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to size products where indicated as delegated design.

E. Ground Fault: Properly ground products to prevent failing due to ground fault conditions.

F. Backup Power Source: Serve control valve actuators from a backup power source where associated with systems and equipment served by a backup power source.

G. Environmental Conditions: For actuators not available with integral enclosures complying with requirements indicated, house in protective secondary enclosures complying with requirements.

H. Selection Criteria:

1. Suitable for operation throughout full range of system operating conditions encountered.

    a. Fuel Oil: See section 220523: General-Duty Valves For Plumbing for performance requirements.

2. Control Valve Leakage: FCI 70-2, Class IV or less leakage, unless otherwise indicated.
3. Control Valve Pattern: Straight-through, as indicated on Drawings.
4. Control Valve Flow Characteristics, Unless Otherwise Indicated:

a. Modulating, Two-Way Pattern: Equal percentage.

5. Fail-Safe Positions, Unless Otherwise Indicated:

a. Fuel Oil: Close.

6. Stable Operation: Select control valves and actuators for stable operation throughout full range of operation, from design Cv at design flow to minimum Cv.
7. Control Valve Styles:

a. Hydronic Systems:

1) Pipe Sizes NPS 2 (DN 50) and Smaller: Ball-or globe-style control valves.
2) Pipe Sizes Larger than NPS 2 (DN 50): Ball-or globe-style control valves.

I. Sizing Criteria: Unless otherwise indicated, select control valve size using the following:

1. ISA Standards:

a. Control Valve Sizes and Flow Coefficients: ISA 75.01.01.
b. Control Valve Characteristics and Rangeability: ISA 75.11.01.

2. Correction Factors: Consider viscosity, flashing, and cavitation corrections when selecting control valves.
3. Ball-Style Control Valves: Select valve size with design Cv at design flow between 65 and 75 degrees of valve full open position and minimum Cv between 15 and 25 percent of open position.
4. Globe-Style Control Valves: Select valve size to pass the design Cv at design flow with not more than 95 percent of stem travel.
5. Two-Position Valves: Select two-position control valves for full pipeline size.

2.2 BALL-STYLE CONTROL VALVES

A. Ball Valves with Threaded Ends, Two Way:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Belimo Aircontrols (USA), Inc
b. Bonomi North America, Inc.
c. Honeywell Building Solutions; Honeywell International, Inc.
d. Johnson Controls, Inc.
e. Milwaukee Valve Company
f. NIBCO INC.
g. Siemens Industry, Inc., Building Technologies Division

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

    a. Belimo Aircontrols (USA), Inc
    b. Bonomi North America, Inc.
    c. Honeywell Building Solutions; Honeywell International, Inc.
    d. Johnson Controls, Inc.
    e. Milwaukee Valve Company
    f. NIBCO INC.
    g. Siemens Industry, Inc., Building Technologies Division

3. Source Limitations: Obtain threaded end two-way ball valves from single manufacturer.

4. Performance:

    a. Stem Action: Rotary, 0 to 90 degrees.
    b. Flow Characteristic: Modified equal percentage.
    c. Leakage: FCI 70-2, Class IV or less.
    d. Hydronic Pressure:

        1) Rating for Sizes NPS 1-1/4 (DN 32) and Smaller: Nominal 600 psig.
        2) Rating for Sizes NPS 1-1/2 through NPS 2 (DN 38 through DN 50): Nominal 400 psig.
        3) Close-off Pressure: 200 psig.
        4) Pressure Differential (Maximum): 50 psig.

    e. Hydronic Process Temperature Range: 0 to 250 deg F.

5. Construction for Ball Valves with Threaded Ends, Two Way:

    a. Size Range: NPS 1/2 to NPS 2.
    b. Body: Cast carbon steel.
    c. End Connections: Female threaded (NPT) ends.
    d. Ball: Stainless steel.
    e. Ball Seats: Reinforced PTFE.
    f. Stem and Stem Extension:

        1) Material to match ball.
        2) Blowout-proof design.
        3) For valves installed in insulated piping systems, provide stem extension extending beyond OD of insulation.
        4) Provide sleeve or other approved means to allow valve to be opened and closed without damaging the insulation and the insulation vapor barrier seal.

    g. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an

equivalent cycle endurance can be demonstrated by testing.

B. Ball Valves with Flanged Ends, Two Way:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Bonomi North America, Inc.
   b. Milwaukee Valve Company
   c. NIBCO INC.
   d. Valve Solutions, Inc.

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

   a. Bonomi North America, Inc.
   b. Milwaukee Valve Company
   c. NIBCO INC.
   d. Valve Solutions, Inc.

3. Source Limitations: Obtain flanged end two-way ball valves from single manufacturer.

4. Performance:

   a. Stem Action: Rotary, 0 to 90 degrees.
   b. Controllable Flow Range: 75 percent open.
   c. Flow Characteristic: Modified equal percentage.
   d. Leakage: FCI 70-2, Class VI or less.
   e. Hydronic Pressure:

      1) Rating: ASME B16.34, Class 300.
      2) Close-off Pressure: Equal to rating.
      3) Pressure Differential (Maximum): 45psi.

   f. Hydronic Process Temperature Range: 0 to 250 deg F<Insert temperature range>.

5. Standards for Ball Valves with Flanged Ends, Two Way: ASME B16.34, MSS SP-72.

6. Features:

   a. Full or standard port.
   b. Replaceable ball, seat and stem packing.
   c. Pressure equalized between body cavity and the line flow.
   d. Mounting pad for actuator.

7. Construction:

    a. Size Range: NPS 1/2 to NPS 12.
    b. Body: Cast steelorstainless steel; two pieces.
    c. End Connections: Flanged ends suitable for mating to ASME B16.5 flanges.
    d. Ball: Stainless steel; vented.
    e. Ball Seats: Reinforced PTFE.
    f. Stem: Material to match ball; blowout-proof design.
    g. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure.

C. Ball Valves with Characterized Disk and Threaded Ends, Two Way:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Belimo Aircontrols (USA), Inc
    b. Bray Commercial
    c. Honeywell Building Solutions; Honeywell International, Inc.
    d. Johnson Controls, Inc.
    e. Siemens Industry, Inc., Building Technologies Division

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

    a. Belimo Aircontrols (USA), Inc
    b. Bray Commercial
    c. Honeywell Building Solutions; Honeywell International, Inc.
    d. Johnson Controls, Inc.
    e. Siemens Industry, Inc., Building Technologies Division

3. Source Limitations: Obtain two-way ball valves, with characterized disk and threaded ends, from single manufacturer.

4. Performance:

    a. Stem Action: Rotary, 0 to 90 degrees.
    b. Controllable Flow Range: 75 percent open.
    c. Flow Characteristic: Equal percentage.
    d. Leakage: FCI 70-2, Class IV or less.
    e. Hydronic Pressure:

        1) Rating for Sizes NPS 1-1/4 (DN 32) and Smaller: Nominal 600 psig.
        2) Rating for Sizes NPS 1-1/2 through NPS 2 (DN 38 through DN 50): Nominal 400 psig.

3) Close-off Pressure: 200 psig.
4) Pressure Differential (Maximum): 50 psig.

f. Hydronic Process Temperature Range: 0 to 250 deg F.
g. Rangeability: 300 to 1.

5. Construction:

a. Size Range: NPS 1/2 to NPS 2.
b. Body: Cast bronze.
c. End Connections: Female threaded (NPT) ends.
d. Ball: 300 series stainless steel.
e. Ball Seats: Reinforced PTFE.
f. Characterizing Disk: Glass-filled PTFE, Tefze or stainless steel.
g. Stem and Stem Extension:

1) Material to match ball.
2) Blowout-proof design.
3) For valves installed in insulated piping systems, provide stem extension extending beyond OD of insulation.
4) Provide sleeve or other approved means to allow valve to be opened and closed without damaging the insulation and the insulation vapor barrier seal.

h. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.

D. Ball Valves with Characterized Disk and Flanged Ends, Two Way:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Belimo Aircontrols (USA), Inc
b. Bray Commercial
c. Honeywell Building Solutions; Honeywell International, Inc.
d. Johnson Controls, Inc.

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. Belimo Aircontrols (USA), Inc
b. Bray Commercial
c. Honeywell Building Solutions; Honeywell International, Inc.
d. Johnson Controls, Inc.

3. Source Limitations: Obtain two-way ball valves, with characterized disk and flanged ends, from single manufacturer.

4. Performance:

    a. Stem Action: Rotary, 0 to 90 degrees.
    b. Controllable Flow Range: 75 percent open.
    c. Flow Characteristic: Equal percentage.
    d. Leakage: FCI 70-2, Class IV or less.
    e. Hydronic Pressure:

        1) Rating: In accordance with ASME B16.1, Class B.
        2) Close-off Pressure:

            a) Class 125: 175 psig.
            b) Class 250: 310 psig.

        3) Pressure Differential (Maximum): 50 psig<Insert pressure>.

    f. Hydronic Process Temperature Range: 0 to 250 deg F.
    g. Rangeability: 300 to 1.

5. Construction:

    a. Size Range: NPS 2-1/2 to NPS 6.
    b. Body: Cast iron, Class B in accordance with ASME B16.1.
    c. End Connections: Flanged, Class 125 or 250 in accordance with ASME B16.1.
    d. Ball: Stainless steel.
    e. Ball Seats: Reinforced PTFE.
    f. Characterizing Disk: Stainless steel.
    g. Stem and Stem Extension: Material to match ball; blowout-proof design.
    h. Stem Seal: Reinforced PTFE packing ring with a threaded packing ring follower to retain the packing ring under design pressure with the linkage removed. Alternative means, such as EPDM O-rings, are acceptable if an equivalent cycle endurance can be demonstrated by testing.

E. Ball Valves with Segmented Ball, Two Way:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Bray Commercial
    b. Fischer; Emerson Electric Co., Automation Solutions
    c. Flo-Tite, Inc.
    d. Flowserve Corporation
    e. Max-Air Technology Inc.
    f. Valve Solutions, Inc.

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. Bray Commercial
b. Fischer; Emerson Electric Co., Automation Solutions
c. Flo-Tite, Inc.
d. Flowserve Corporation
e. Max-Air Technology Inc.
f. Valve Solutions, Inc.

3. Source Limitations: Obtain two-way ball valves, with segmented ball, from single manufacturer.
4. Performance:

a. Stem Action: Rotary, 0 to 90 degrees.
b. Controllable Flow Range: 75 percent open.
c. Flow Characteristic: Equal percentage or modified equal percentage.
d. Leakage: FCI 70-2, Class VI.
e. Hydronic Pressure:

1) Rating: ASME B16.34, Class 300.
2) Close-off Pressure: 250 psig.
3) Pressure Differential (Maximum): Approximately 1/3 inlet pressure.

f. Hydronic Process Temperature Rating: 0 to 250 deg FMinus 20 to plus 450 deg F<Insert temperature range>.

5. Standards: ASME B16.10, ASME B16.34.

6. Features:

a. Stem and ball pinned and welded.
b. Replaceable ball, seat and packing.

7. Construction:

a. Size Range: NPS 1 to NPS 12NPS 1 to NPS 16NPS 1 to NPS 24.
b. End Connections: Flanged ends suitable for mating to ASME B16.5 flanges. Female threaded (NPT) ends are also acceptable for valve sizes NPS 2 and smaller.
c. Face-to-Face Dimensions: ASME B16.10 or ISA S75.08.02.
d. Body: Cast carbon steel.
e. Ball: Stainless steel.
f. Seat: TFM or reinforced PTFE.
g. Stem: Stainless steel.
h. Stem Packing: PTFE V-rings.
i. Label each valve with following:

1) Manufacturer's name, model number, and serial number.
2) Body size.
3) Flow directional arrow.

F. Ball Valves with Full Ball and Characterized V-Notch, Two Way:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Bray Commercial
    b. Flo-Tite, Inc.
    c. Flow-Tek; a subsidiary of Bray International
    d. Valve Solutions, Inc.

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

    a. Bray Commercial
    b. Flo-Tite, Inc.
    c. Flow-Tek; a subsidiary of Bray International
    d. Valve Solutions, Inc.

3. Source Limitations: Obtain two-way ball valves, with full ball and characterized v-notch, from single manufacturer.

4. Performance:

    a. Stem Action: Rotary, 0 to 90 degrees.
    b. Controllable Flow Range: 80 percent open.
    c. Flow Characteristic: Equal percentage.
    d. Leakage: FCI 70-2, Class VI.
    e. Hydronic Pressure:

        1) Rating:

            a) Sizes NPS 2 (DN 50) and Smaller: ASME B16.34, Class 300 or 600.
            b) Larger Sizes: ASME B16.34, Class 300.

        2) Close-off Pressure: Equal to rating.
        3) Pressure Differential (Maximum): Approximately 1/3 inlet pressure.

    f. Hydronic Process Temperature Rating: 0 to 250 deg FMinus 20 to plus 450 deg F.

5. Standards: ASME B16.34, MSS SP-72.
6. Features:

    a. Full or standard port.
    b. Replaceable ball, seat, shaft bushings, and packing.
    c. Pressure equalized between body cavity and the line flow.
    d. Universal mounting pad complying with ISO 5211 for actuator mounting.

7. Construction:

a. Size Range: NPS 1/2 to NPS 12.
b. Sizes NPS 2 (DN 50) and Smaller:

1) End Connections: Female threaded (NPT) ends complying with ASME B1.20.1 or flanged ends suitable for mating to ASME B16.5 flanges.
2) Stem Seals: Live-loaded, self-adjusting, primary and secondary sealing using belleville washers.

a) Primary Seal: Combination of thrust washer and thrust washer protector.
b) Secondary Seal: Adjustable stem packing composed of RPTFE V-rings.

c. Sizes Larger than NPS 2 (DN 50):

1) Stem Seals: Independent packing gland, adjusted without removing mounting hardware or operator, and contoured to uniformly distribute load across packing.

a) Primary Seal: Combination of thrust washer and thrust washer protector.
b) Secondary Seal: Adjustable stem packing composed of RPTFE V-rings.

2) Flanged ends suitable for mating to ASME B16.5 flanges.

d. Face-to-Face Dimension: ASME B16.10 short or long pattern, or ISA S75.08.02.
e. Body: Carbon steel; two- or three-piece design.
f. Ball: Stainless steel.
g. Seat: Reinforced PTFE, TFM, PEEK.
h. Shaft: Stainless steel.

8. Label each valve with following:

a. Manufacturer's name, model number, and serial number.
b. Body size.
c. Flow directional arrow.

2.3 GLOBE-STYLE CONTROL VALVES

A. General Requirements:

1. Body Dimensions: Comply with ISA 75.08.01.
2. Field Service: Construct the valves to be serviceable from the top with replaceable seats and plugs.
3. Field-Interchangeable Trim:

a. Cage Guided Valves: Available with field-interchangeable trim for different valve flow characteristics, such as equal percentage, linear, and quick opening.
b. Industrial Valves NPS 1 and Larger: Available with reduced trim one nominal size smaller.

4. Nameplate: Corrosion-resistant, indicating the following:

a. Manufacturer's name, model number, and serial number.
b. Body and trim size.
c. Arrow indicating direction of flow.

B. Globe Valves NPS 2 (DN 50) and Smaller, Two Way:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Belimo Aircontrols (USA), Inc
b. IMI
c. Johnson Controls, Inc.
d. Siemens Industry, Inc., Building Technologies Division

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. Belimo Aircontrols (USA), Inc
b. IMI
c. Johnson Controls, Inc.
d. Siemens Industry, Inc., Building Technologies Division

3. Source Limitations: Obtain two-way globe valves, NPS 2 and smaller, from single manufacturer.

4. Performance:

a. Stem Action: Linear stem travel.
b. Flow Characteristic: Equal percentage.
c. Leakage: FCI 70-2, Class IV for brass trim or 0.05 percent of maximum flow for stainless steel trim.
d. Hydronic Pressure:

1) Rating: In accordance with ASME B16.15, Class 250.
2) Close-off Pressure: Equal to pressure rating at maximum temperature.
3) Pressure Differential (Maximum): 30 psig for sizes through NPS 235 psig.

e. Ambient Operating Temperature: 35 to 150 deg F.
f. Process Temperature Range:

1) Hydronic: 35 to 248 deg F.
2) Steam: Temperature at saturated steam pressure.

g. Rangeability: 100 to 1.

5. Construction:

a. Size Range: NPS 1/2 to NPS 2.
b. Body: Cast bronze or forged brass; ASME B16.15, Class 250.
c. End Connections: Female NPT threaded ends, Unions with threaded ends.
d. Bonnet: Bronze or brass, threaded.
e. Plug: Top guided.
f. Brass Trim:

1) Packing: Self-adjusting Ethylene Propylene Rubber (EPR) rings or PTFE V-ring.
2) Plug: Brass.
3) Seat: Bronze or molded elastomeric disk.
4) Stem: Stainless steel.

g. Stainless Steel Trim:

1) Packing: PTFE V-ring.
2) Plug: Stainless steel.
3) Seat: Stainless steel.
4) Stem: Stainless steel.

C. Globe Valves NPS 2-1/2 to NPS 6 (DN 65 to DN 150), Two Way:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Belimo Aircontrols (USA), Inc
b. Bray Commercial
c. Honeywell Building Solutions; Honeywell International, Inc.
d. Johnson Controls, Inc.
e. Siemens Industry, Inc., Building Technologies Division

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. Belimo Aircontrols (USA), Inc
b. Bray Commercial
c. Honeywell Building Solutions; Honeywell International, Inc.
d. Johnson Controls, Inc.
e. Siemens Industry, Inc., Building Technologies Division

3. Source Limitations: Obtain two-way globe valves, NPS 2-1/2 to NPS 6, from single manufacturer.

4. Performance:

    a. Stem Action: Linear stem travel.
    b. Flow Characteristic: Equal percentage or linear.
    c. Leakage: FCI 70-2, Class IV.
    d. Hydronic Pressure:

        1) Rating: In accordance with ASME B16.1, Class 125 or 250 as required by application.
        2) Close-off Pressure: Equal to pressure rating.
        3) Pressure Differential (Maximum): 25 psig.

    e. Hydronic Process Temperature: 35 to 280 deg F.
    f. Ambient Operating Temperature: 0 to 150 deg F.
    g. Rangeability: 100 to 1.

5. Construction:

    a. Size Range: NPS 2-1/2 to NPS 6.
    b. Body: Cast iron; ASME B16.1.
    c. End Connections: Flanged; suitable for mating to ASME B16.5 flanges.
    d. Bonnet: Cast iron; bolted.
    e. Plug: Top or bottom guided.
    f. Brass or Bronze Trim:

        1) Packing: EPT rings or PTFE V-ring.
        2) Plug: Brass or bronze.
        3) Seat: Brass or bronze.
        4) Stem: Stainless steel.

    g. Stainless Steel Trim:

        1) Packing: PTFE V-ring.
        2) Plug: Stainless steel.
        3) Seat: Stainless steel.
        4) Stem: Stainless steel.

D. Industrial-Grade Globe Valves NPS 1 (DN 25) and Larger, Two Way:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Fischer; Emerson Electric Co., Automation Solutions
    b. Flowserve Corporation
    c. Jordan Valve; Richards Industries Company
    d. Spirax Sarco Limited

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

    a. Fischer; Emerson Electric Co., Automation Solutions
    b. Flowserve Corporation
    c. Jordan Valve; Richards Industries Company
    d. Spirax Sarco Limited

3. Source Limitations: Obtain two-way industrial-grade globe valves from single manufacturer.

4. Performance:

    a. Stem Action: Linear stem travel.
    b. Flow Characteristic: Equal percentage Linear.
    c. Leakage: FCI 70-2, Class IV.
    d. Hydronic Pressure:

        1) Rating for Cast-Iron Body Valves: In accordance with ASME B16.1, Class 125 or 250, as required by application.
        2) Rating for Cast-Steel and Stainless Steel Body Valves: In accordance with ASME B16.34, Class 150 or 300, as required by application.
        3) Close-off Pressure: Equal to pressure rating.
        4) Pressure Differential (Maximum): 35 psig100 psig<Insert pressure>.

    e. Hydronic Process Temperature: 0 to 450 deg F<Insert temperature range>.

5. Features:

    a. Interchangeable, restricted-capacity and full-size trim.
    b. Interchangeable, cage and plug styles for three different flow characteristics: equal percentage, linear and quick opening.
    c. Trim options to prevent damage caused by cavitation where required by application.

6. Construction:

    a. Size Range: NPS 1 to NPS 30.
    b. Body: Cast carbon steel.
    c. End Connections:

        1) NPS 2 (DN 50) and Smaller: Female NPT threaded or flanged suitable for mating to ASME B16.5 flanges.
        2) NPS 2-1/2 (DN 65) and Larger: Raised face flanges suitable for mating to ASME B16.5 or ASME B16.47 flanges.

    d. Bonnet: Bolted, material to match body.
    e. Packing: PTFE V-ring.
    f. Plug: Cage guided and balanced.

g. Plug, Seat, Cage, and Stem: Stainless steel plug and seat with hardened facing, stainless steel cage and stem.
h. Stem: Thread and pin stem to plug; polished finish.

2.4 SOLENOID VALVES

A. Brass and Bronze Solenoid Valves, Two Way:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ASCO; Emerson Electric Co., Automation Solutions
b. Danfoss, Inc.
c. Parker (Parker Hannifin)
d. Sizto Tech Corporation (STC)
e. Velcor Engineering Corporation

2. Basis-of-Design Product: Subject to compliance with requirements, provide < Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. ASCO; Emerson Electric Co., Automation Solutions
b. Danfoss, Inc.
c. Parker (Parker Hannifin)
d. Sizto Tech Corporation (STC)
e. Velcor Engineering Corporation

3. Source Limitations: Obtain two-way brass and bronze solenoid valves from single manufacturer.

4. Performance:

a. Ambient Operating Temperature: 32 to 125 deg F.
b. Leakage: Bubbletight.
c. Hydronic Operating Pressure:

1) Maximum: 125 psig150 psig200 psig300 psig<Insert pressure>.
2) Minimum Operating: 0 psig5 psig<Insert pressure>.

d. Hydronic Process Temperature Range: 0 to 250 deg F.

5. Features:

a. Action: Either normally open (open when de-energized) or normally closed (closed when de-energized), as required by the application.

b. Operation: Direct-acting or pilot-operated diaphragm or piston, as required by the application.
c. Override: Integral manual override.

6. Construction:

a. Size Range: NPS 1/2 to NPS 2.
b. Body: Brass or bronze.
c. End Connections: Female threaded (NPT) ends.
d. Discs and Seats: NBR, EPDM or PTFE.
e. Orifice: Select size for performance required by application.
f. Wetted Parts: Stainless steel.
g. Coil: Copper.
h. Coil Insulation: Class F or Class H.
i. Solenoid Enclosure: NEMA 250, Type 4.

B. Stainless Steel Solenoid Valves, Two Way:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ASCO; Emerson Electric Co., Automation Solutions
b. Danfoss, Inc.
c. Parker (Parker Hannifin)
d. Sizto Tech Corporation (STC)
e. Velcor Engineering Corporation

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. ASCO; Emerson Electric Co., Automation Solutions
b. Danfoss, Inc.
c. Parker (Parker Hannifin)
d. Sizto Tech Corporation (STC)
e. Velcor Engineering Corporation

3. Source Limitations: Obtain two-way stainless steel solenoid valves from single manufacturer.

4. Performance:

a. Ambient Operating Temperature: 32 to 125 deg F .
b. Leakage: Bubbletight.
c. Hydronic Operating Pressure:

1) Maximum: 125 psig150 psig200 psig300 psig.
2) Minimum Operating: 0 psig5 psig.

d. Hydronic Process Temperature Range: 0 to 250 deg F<Insert temperature range>.

5. Features:

a. Action: Either normally open (open when de-energized) or normally closed (closed when de-energized), as required by the application.
b. Operation: Direct-acting or pilot-operated diaphragm or piston, as required by the application.
c. Override: Integral manual override.

6. Construction:

a. Size Range: NPS 1/2 to NPS 2.
b. Body: Stainless steel.
c. End Connections: Female threaded (NPT) ends.
d. Discs and Seats: NBR, EPDM, or PTFE.
e. Orifice: Select size for performance required by application.
f. Wetted Parts: Stainless steel.
g. Coil: Silver.
h. Coil Insulation: Class F or Class H.
i. Solenoid Enclosure: NEMA 250, Type 4.

2.5 ELECTRIC AND ELECTRONIC CONTROL VALVE ACTUATORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Asahi/America
2. Belimo Aircontrols (USA), Inc
3. Bray Commercial
4. Fischer; Emerson Electric Co., Automation Solutions
5. Flo-Tite, Inc.
6. Flowserve Corporation
7. Honeywell International Inc.
8. Jordan Valve; Richards Industries Company
9. Keystone; Emerson Electric Co., Automation Solutions
10. Max-Air Technology Inc.
11. Max-Seal, Inc.
12. Milwaukee Valve Company
13. NIBCO INC.
14. Spence Engineering Company, Inc
15. Spirax Sarco Limited
16. Valve Solutions, Inc.

B. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

1. Asahi/America
2. Belimo Aircontrols (USA), Inc
3. Bray Commercial
4. Fischer; Emerson Electric Co., Automation Solutions
5. Flo-Tite, Inc.
6. Flowserve Corporation
7. Honeywell International Inc.
8. Jordan Valve; Richards Industries Company
9. Keystone; Emerson Electric Co., Automation Solutions
10. Max-Air Technology Inc.
11. Max-Seal, Inc.
12. Milwaukee Valve Company
13. NIBCO INC.
14. Spence Engineering Company, Inc
15. Spirax Sarco Limited
16. Valve Solutions, Inc.

C. Furnish control valves with factory-installed actuators from control valve manufacturer. Actuators manufactured by listed control valve manufacturers are acceptable subject to compliance with requirements.

D. Actuators for Control Valves in Hydronic Systems: Select actuators to close off against system pump shutoff head.

E. Type: Motor operated, with or without gears, electric and electronic.

F. Voltage:

1. Actuator to deliver torque required for continuous uniform movement of controlled device from limit to limit when operated at rated voltage.
2. Actuator to function properly within a range of 85 to 120 percent of nameplate voltage.

G. Construction:

1. Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.
2. 100 up to 400 W: Ground steel gears, oil immersed; shaft-hardened steel running in bronze, copper alloy, or ball bearings. Operator and gear trains are to be totally enclosed in dustproof cast-iron, cast-steel, or cast-aluminum housing.
3. Greater Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

H. Local Field Adjustment: Make spring-return actuators easily switchable from fail-safe open to fail-safe closed in the field without replacement.

I. Local Manual Override: Provide gear-type actuators with an external manual adjustment mechanism to allow manual positioning of the damper when the actuator is not powered.

J. Two-Position Actuators: Single direction, spring-return or reversing type.

a. Programmable Multifunction:

1) Control input, position feedback, and running time are to be factory or field programmable.
2) Diagnostic feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.
3) Service data, including at a minimum, number of hours powered and number of hours in motion.

K. Position Feedback:

1. Equip two-position actuators with limit switches or other positive means of a position indication signal for remote monitoring of open and close position.
2. Provide a position indicator and graduated scale on each actuator indicating open and closed travel limits.

L. Fail-Safe:

1. Where indicated, provide actuator to fail to an end position.
2. Internal spring-return mechanism to drive controlled device to an end position (open or close) on loss of power.
3. Batteries, capacitors, and other nonmechanical forms of fail-safe operation are acceptable only where uniquely indicated.

M. Integral Overload Protection:

1. Provide against overload throughout the entire operating range in both directions.
2. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

N. Valve Attachment:

1. Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to valve stem without the need for connecting linkages.
2. Attach actuator to valve drive shaft in a way that ensures maximum transfer of power and torque without slippage.
3. Bolt and set screw method of attachment is acceptable only if provided with at least two points of attachment.

O. Temperature and Humidity:

1. Temperature: Suitable for operating temperature range encountered by application with minimum operating temperature range of minus 20 to plus 120 deg F.
2. Humidity: Suitable for humidity range encountered by application; minimum operating range is to be from 5 to 95 percent relative humidity, noncondensing.

P. Enclosure:

1. Suitable for ambient conditions encountered by application.
2. NEMA 250, Type 4 for indoor and protected applications.
3. NEMA 250,Type 4 or Type 4X for outdoor and unprotected applications.
4. NEMA 250, Type 7 or Type 9 for hazardous applications requiring explosion-proof construction.
5. Provide actuator enclosure with a heater and controller where required by application.

Q. Stroke Time:

1. Select operating stroke time to be compatible with equipment and system operation, and as follows:

a. Operate valve from fully closed to fully open position within 30 seconds.
b. Operate valve from fully open to fully closed position within 60 seconds.
c. Move valve to fail-safe position within 15 seconds.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for valves installed in piping to verify actual locations of piping connections before installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONTROL VALVE APPLICATIONS

A. Control Valves:

1. Select from valves specified in "Control Valves" Article to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.
2. Fuel Oil Delivery System, Fuel Oil, Two-Way Applications Controlled by Flow: Ball valves, Ball valves with characterized disk, Ball valves with segmented ball, Ball valves with full ball and characterized V-notch, Pressure-independent valves,, Solenoid valves.
3. Fuel Oil Delivery System, Fuel Oil, Two-Way Applications Controlled by Pressure: Ball valves, Ball valves with characterized disk, Ball valves with segmented ball, Ball valves with full ball and characterized V-notch, Pressure-

independent valves, Globe valves, Industrial-grade, globe valves, Solenoid valves.

4. Fuel Oil Delivery System, Fuel Oil, Two-Way Applications Controlled by Temperature: Ball valves, Ball valves with characterized disk, Ball valves with segmented ball, Ball valves with full ball and characterized V-notch, Pressure-independent valves,, Solenoid valves, Self-contained temperature-regulating valves.

3.3 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy most stringent requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Properly support control valves and actuators, tubing, piping, wiring, and conduits to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment when subjected to a seismic event, wind, or other forces common to the application.

D. Provide ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location first for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

E. Seal penetrations made in fire-rated and acoustically rated assemblies.

F. Fastening Hardware:

1. Wrenches, pliers, and other tools that will cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

G. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

H. Corrosive Environments:

1. Use products that are suitable for environment to which they will be subjected.
2. Use Type 316 stainless steel tubing and fittings when in contact with a corrosive environment.
3. When conduit is in contact with a corrosive environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
4. Where control devices are located in a corrosive environment and are not

corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.4 CONTROL VALVES

A. Install pipe reducers for control valves smaller than line size. Position reducers as close to control valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.

B. Install flanges or unions to allow drop-in and -out valve installation.

C. Drain Valves:

1. Install drain valves in piping upstream and downstream of each control valve larger than NPS 2NPS 4.
2. Install drain valves in piping upstream and downstream of each control valve installed in a three-valve manifold.

D. Test Plugs: Install pressure temperature test plugs in piping upstream and downstream of each control valve larger than1/2 inch.

E. Valve Orientation:

1. Where possible, install ball and globe valves that are installed in horizontal piping, with stems upright and not more than 15 degrees off of vertical, not inverted.
2. Install valves in a position to allow full stem movement.

F. Clearance:

1. Locate valves for easy access, and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.
2. Install valves with at least 12 inches of clear space around valve and between valves and adjacent surfaces.

G. Threaded Valves:

1. Note internal length of threads in valve ends, and proximity of valve internal seat or wall, to determine how far pipe should be threaded into valve.
2. Align threads at point of assembly.
3. Apply thread compound to external pipe threads, except where dry seal threading is specified.
4. Assemble joint, wrench tight. Apply wrench on valve end as pipe is being threaded.

H. Flanged Valves:

1. Align flange surfaces parallel.
2. Assemble joints by sequencing bolt-tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt

threads. Tighten bolts gradually and uniformly with a torque wrench.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Use same designation at each end for each piece of wire, cable, and tubing for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with valve identification on valve. Comply with requirements in Section 230923 "Programmable Logic Controller (PLC) System for HVAC."

3.6 ELECTRICAL CONNECTIONS

A. Install electrical power to field-mounted control devices requiring electrical power.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260523 "Control-Voltage Electrical Power Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems."

E. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.7 CONTROL CONNECTIONS

A. Install control signal wiring to field-mounted control devices.

B. Connect control signal wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems."

3.8 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed surfaces.

3.9 STARTUP

A. Control Valve Checkout:

1. Check installed products before continuity tests, leak tests, and calibration.
2. Check valves for proper location and accessibility.
3. Check valves for proper installation for direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
4. Verify that control valves are installed correctly for flow direction.
5. Verify that valve body attachment is properly secured and sealed.
6. Verify that valve actuator and linkage attachment are secure.
7. Verify that actuator wiring is complete, enclosed, and connected to correct power source.
8. Verify that valve ball, disc, and plug travel are unobstructed.
9. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

A. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

B. Stroke pneumatic control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed, and 100 percent open at proper air pressures.

C. Check and document open and close cycle times for applications with a cycle time of less than 15 seconds.

D. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

END OF SECTION 230923.11

SECTION 230923.14 - FLOW INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Liquid flow meters.
2. Liquid flow switches.

B. Related Requirements:

1. Section 230923 "Programmable Logic Controller (PLC) System for Fuel Oil Systems" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

1.2 DEFINITIONS

A. Ethernet: Local area network based on IEEE 802.3.1.

B. FEP: Fluorinated ethylene propylene.

C. HART: Highway addressable remote transducer protocol is the global standard for sending and receiving digital information across analog wires between smart devices and control or monitoring systems through bidirectional communication that provides data access between intelligent field instruments and host systems. A host can be any software application from a technician's hand-held device or laptop to a plant's process control, asset management, safety, or other system using any control platform.

D. PEEK: Polyetheretherketone.

E. PTFE: Polytetrafluoroethylene.

F. PPS: Polyphenylene sulfide.

G. RS-485: A TIA standard for multipoint communications using two twisted pairs.

H. RTD: Resistance temperature detector.

I. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

1.3 ACTION SUBMITTALS

A. Product Data:

1.
2. Liquid flow switches.

B. Product Data Submittals: For each product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics; electrical characteristics; and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation instructions, including factors affecting performance.
5. Product certificates.

C. Shop Drawings:

1. Include plans, elevations, sections, and mounting details.
2. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Include diagrams for air and process signal tubing.
5. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

D. Delegated Design Submittals:

1. Schedule and design calculations for flow instruments, including the following:

a. Flow at Project design and minimum flow conditions.
b. Pressure drop at Project design and minimum flow conditions.
c. Show a side-by-side direct comparison to performance characteristics indicated for each instrument.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each product requiring a certificate.

B. Product Test Reports: For each product, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For instruments to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Provide parts, as indicated by manufacturer's recommended parts list, for product operation during one-year period following warranty period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Product manufacturer's qualified staff to select and size products to achieve specified performance requirements.

B. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 LIQUID FLOW SWITCHES

A. Liquid Flow Switch (Bellows Type):

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Johnson Controls, Inc.
    b. Penn Controls
    c. W.E. Anderson; a division of Dwyer Instruments, Inc.

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil & Delivery or comparable product by one of the following:

    a. Johnson Controls, Inc.
    b. Penn Controls
    c. W.E. Anderson; a division of Dwyer Instruments, Inc.

3. Source Limitations: Obtain all bellows-type liquid flow switches from a single manufacturer.
4. Description:

    a. Field-adjustable four-vane combinations.
    b. Field-adjustable set-point adjustment screw.
    c. Suitable for pipe sizes NPS 1 through NPS 8.
    d. Switch mounted vertically in horizontal pipe.

5. Performance:

    a. Flow Rate Actuation and De-actuation: Varies with vane combination and set-point adjustment.
    b. Pressure Limit: 145 psig.
    c. Temperature Limit: 230 deg F.
    d. Electrical Rating: 10 A resistive, 3 A conductive at 250 V ac.
    e. Switch Type: SPDT snap switch.

6. Wetted Parts Construction:

    a. Bellows: Tin-bronze.
    b. Vanes: Stainless steel.
    c. Body: Forged brass.
    d. Process Connection: NPS 1.

7. Enclosure:

    a. Material: Die-cast aluminum alloy.
    b. Rating: NEMA 250, Type 4.
    c. Electrical Connection: Cable gland with attached wire leads.

B. Liquid Flow Switch (Magnetic Type):

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. W.E. Anderson; a division of Dwyer Instruments, Inc.

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

    a. W.E. Anderson; a division of Dwyer Instruments, Inc.

3. Description:

    a. Field-adjustable five-vane combinations.
    b. Suitable for pipe sizes NPS 1-1/2 through NPS 20.
    c. Mounting Suitable for Application: Switch vertically mounted in horizontal pipe, or switch horizontally mounted in vertical pipe with flow up.
    d. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for hazardous-environment Class II, Groups E, F, and G.

4. Performance:

    a. Flow Rate Actuation and De-actuation: Varies with vane combination.
    b. Pressure Limit: 2000 psig for Type 316 stainless steel body.
    c. Temperature Range: Minus 4 to plus 275 deg F.
    d. Electrical Rating: 10 A at 125/250 V ac.

e. Switch Type: SPDT or DPDT snap switch.

5. Wetted Parts Construction:

a. Vanes: Type 316 stainless steel.
b. Body: Type 316 stainless steel.
c. Magnetic Keeper: Type 316 stainless steel.
d. Process Connection: NPS 1-1/2.

6. Enclosure:

a. Material: Die-cast aluminum alloy.
b. Threaded cover.
c. Rating: NEMA 250, Type 4.
d. Electrical Connection: Labeled terminal block.
e. Conduit Connection: 3/4-inch trade size.

C. Liquid Flow Switch (Magnetic Type) for Small-Diameter Pipe:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. W.E. Anderson; a division of Dwyer Instruments, Inc.

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. W.E. Anderson; a division of Dwyer Instruments, Inc.

3. Description:

a. Suitable for pipe sizes NPS 1/2 through NPS 2.
b. Mounting Suitable for Application: Switch vertically mounted in horizontal pipe, or switch horizontally mounted in vertical pipe with flow up.
c. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for hazardous-environment Class II, Groups E, F, and G.

4. Performance:

a. Flow Rate Actuation and De-actuation: Not adjustable.
b. Pressure Limit of Body2000 psig for Type 303 stainless steel.
c. Pressure Limit of Tee: 2000 psig for forged carbon steel and stainless steel.
d. Temperature Range: Minus 4 to plus 220 deg F.
e. Electrical Rating: 5 A at 125/250 V ac.
f. Switch Type: SPDT or DPDT snap switch.

5. Wetted Parts Construction (Lower Body):

a. Vanes: Type 301 stainless steel.
b. Body Material: Type 303 stainless steel.
c. Magnet: Ceramic.
d. Process Connection: NPS 1/2.

6. Enclosure (Upper Body):

a. Material: Type 303 stainless steel.
b. Rating: NEMA 250, Type 4.
c. Electrical Connection: Labeled terminal block.
d. Conduit Connection: 3/4-inch trade size.

7. Integral Mounting Tee Furnished with Switch:

a. Material: Forged carbon steel.
b. Size: Match adjacent pipe.
c. Connection: Threaded pipe.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.

C. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.

D. Provide the services of an independent inspection agency to confirm that proposed mounting locations comply with requirements indicated and approved submittals.

1. Indicate dimensioned locations with mounting height for all surface-mounted products to walls and ceilings on Shop Drawings.
2. Do not begin installation without submittal approval of mounting location.

E. Complete installation rough-in only after confirmation by independent inspection is complete and approval of location is documented for review by Owner and Architect on request.

F. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTRUMENT APPLICATIONS

A. Select from instrument types to achieve performance requirements and characteristics indicated while subjected to full range of system operation encountered.

B. Liquid Flow Switches:

1. Bellows Type: Highland Fuel Oil System.

2. Magnetic Type: Highland Fuel Oil System.
3. Magnetic Type for Small Diameter Pipe: Highland Fuel Oil System.

3.3 INSTALLATION, GENERAL

A. Furnish and install products required to satisfy more stringent of all requirements indicated.

B. Install products level, plumb, parallel, and perpendicular with building construction.

C. Properly support instruments, tubing, piping wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment.

D. Install ceiling, floor, roof, and wall openings and sleeves required by installation. Before proceeding with drilling, punching, or cutting, check location for concealed products that could potentially be damaged. Patch, flash, grout, seal, and refinish openings to match adjacent condition.

E. Install products in locations that are accessible and that will permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

F. Corrosive Environments:

1. Use products that are suitable for environment to which they will be subjected.
2. If possible, avoid or limit use of materials in corrosive environments, including, but not limited to, the following:

    a. Laboratory exhaust airstreams.
    b. Process exhaust airstreams.

3. When conduit is in contact with a corrosive environment, use Type 316 stainless steel conduit and fittings or conduit and fittings with a corrosive-resistant coating that is suitable for environment.
4. Where instruments are located in a corrosive environment and are not corrosive resistant from the manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.4 INSTRUMENTS, GENERAL INSTALLATION REQUIREMENTS

A. Mounting Location:

1. Rough-in: Outline instrument-mounting locations before setting instruments and routing cable, wiring, tubing, and conduit to final location.
2. Install switches and transmitters for air and liquid flow associated with individual air-handling units and connected ductwork and piping near air-handlings units co-located in air-handling unit system control panel, to provide service personnel a single and convenient location for inspection and service.
3. Install liquid and steam flow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
4. Install airflow switches and transmitters for indoor applications in mechanical equipment rooms. Do not locate in user-occupied space unless indicated specifically on Drawings.
5. Mount switches and transmitters not required to be mounted within system control panels on walls, floor-supported freestanding pipe stands, or floor-supported structural support frames. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent vibration and movement.
6. Install instruments in steam, liquid, and liquid-sealed-piped services below their process connection point. Slope tubing down to instrument with a slope of 2 percent.
7. Install instruments in dry gas and non-condensable-vapor piped services above their process connection point. Slope process connection lines up to instrument with a minimum slope of 2 percent.

B. Mounting Height:

1. Mount remote displays, switches and transmitters, located in mechanical equipment rooms and other similar space not subject to code, state, and federal accessibility requirements, within a range of 42 to 72 inches above the adjacent floor, grade, or service catwalk or platform.

    a. Make every effort to mount at 60 inches.

C. Seal penetrations to ductwork, plenums, and air-moving equipment to comply with duct static-pressure class and leakage and seal classes indicated using neoprene gaskets or grommets.

3.5 INSTALLATION OF FLOW INSTRUMENTS

A. Liquid Switches:

1. Install system process connection full size of switch connection, but not less than NPS 1. Install stainless steel bushing if required to mate switch to system connection.
2. Install switch in top dead center of horizontal pipe positioned in an accessible location to allow for inspection and replacement.

3. In applications where top-dead-center location is not possible due to field constraints, install switch at location along top half of pipe if switch is acceptable by manufacturer for mounting orientation.

3.6 INSTALLATION OF ELECTRICAL POWER CONNECTIONS

A. Furnish and install electrical power to products requiring electrical connections.

B. Furnish and install power wiring. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems."

E. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.7 INSTALLATION OF CONTROL CONNECTIONS

A. Install control signal wiring to field-mounted control devices.

B. Connect control signal wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems."

3.8 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing is to have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification.

3.9 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

3.10 CHECKOUT PROCEDURES

A. Description:

1. Check out installed products before continuity tests, leak tests, and calibration.
2. Check instruments for proper location and accessibility.
3. Check instruments for proper installation with respect to direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.
4. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material, and support.

B. Flow Instrument Checkout:

1. Verify that sensors are installed correctly with respect to flow direction.
2. Verify that sensor attachment is properly secured and sealed.
3. Verify that processing tubing attachment is secure and isolation valves have been provided.
4. Inspect instrument tag against approved submittal.
5. Verify that recommended upstream and downstream distances have been maintained.

3.11 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
4. Equipment and procedures used for calibration are to meet instrument manufacturer's instructions.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments are to have accuracy at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent needs to be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If after-calibration-indicated performance cannot be achieved, replace out-of-tolerance instruments.

9. Comply with field-testing requirements and procedures indicated by ASHRAE Guideline 11 in the absence of specific requirements, and to supplement requirements indicated.

B. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

C. Switches: Calibrate switches to make or break contact at set points indicated.

3.12 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, verify that maintenance service includes 12 months' full maintenance by skilled employees of systems and equipment Installer semiannual annual preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

3.13 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.

B. Coordinate training video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

C. Record Owner training and submit digital files with closeout documents for Owner's future use.

END OF SECTION 230923.14

SECTION 230923.17 - LEVEL INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Liquid-level switches.
2. Drain pan liquid-level switches.
3. Liquid-level sensors and transmitters.

B. Related Requirements:

1. Section 230923 "Programmable Logic Controller (PLC) System for Fuel Oil Systems" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, cable, and other requirements that relate to this Section.

1.2 DEFINITIONS

A. HART: Highway Addressable Remote Transducer.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Liquid-level switches.
2. Drain pan liquid-level switches.
3. Liquid-level sensors and transmitters.

B. Product Data Submittals: For each product.

1. Include operating characteristics; electrical characteristics; and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
2. Include product description with complete technical data, performance curves, and product specification sheets.

C. Shop Drawings:

1. Details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Diagrams for power, signal, and control wiring.

3. Number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For level instruments.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Environmental Conditions:

1. Instruments are to operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.

    a. If instrument alone cannot comply with requirement, install instrument in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure is to be internally insulated, electrically heated and cooled , filtered, and ventilated as required by instrument and application.

2.2 LIQUID-LEVEL SWITCHES

A. Liquid-Level Switches, Magnetic-Float Type:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Magnetrol; AMETEK STC
    b. W.E. Anderson; a division of Dwyer Instruments, Inc.

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

    a. Magnetrol; AMETEK STC
    b. W.E. Anderson; a division of Dwyer Instruments, Inc.

3. Source Limitations: Provide magnetic-float-type liquid-level switches from single manufacturer.
4. Description:

    a. Mounting: Suitable for application; horizontal or vertical.
    b. Float assembly designed to prevent sticking.

c. Replaceable float with threaded connection.
d. Hazardous Environments: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for hazardous environments (Class I, Groups C and D; Class II, Groups E, F, and G).

5. Performance:

a. Level Actuation and De-Actuation Deadband: 0.75 inch.
b. Body Pressure Limit: 300 psig for brass body; 300 psig for Type 316 stainless steel body.
c. Float Pressure Limit: Minimum 150 psig.
d. Temperature Range: Minus 4 to plus 275 deg F .
e. Electrical Rating: 10 A at 125/250 V ac.

6. Wetted Parts Construction:

a. Float and Rod: Type 316 stainless steel.
b. Body: Brass or Type 316 stainless steel.
c. Magnetic Keeper: Type 430 stainless steel or Type 316 stainless steel.
d. Process Connection: NPS 1-1/2 NPT with flange adapter where required by application.

7. Enclosure:

a. Material: Die-cast aluminum alloy.
b. Threaded cover.
c. NEMA 250, Type 4.
d. Electrical Connection: Terminal block.
e. Switch Type: DPDT snap switch.
f. Conduit Connection: NPS 3/4 trade size.

B. Liquid-Level Switches, Electrode Type:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. KOBOLD Instruments, Inc. - USA
b. Omega Engineering, Inc.
c. Proximity Controls; a division of Dwyer Instruments, Inc.
d. VEGA Americas, Inc.

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. KOBOLD Instruments, Inc. - USA
b. Omega Engineering, Inc.
c. Proximity Controls; a division of Dwyer Instruments, Inc.
d. VEGA Americas, Inc.

3. Source Limitations: Provide electrode-type liquid-level switches from single manufacturer.
4. Description:

    a. Conductivity technology.
    b. Multi-point or single-point level settings as required by application.
    c. No moving parts.
    d. Adjustable sensitivity.

5. Performance:

    a. Pressure Limit: 30 psig, 90 psig or 290 psig.
    b. Temperature Limit: 212 deg F.
    c. Power Supply: 120 V ac, 50 or 60 Hz.
    d. Electrical Rating: 3 A at 120 V ac.

6. Sensors:

    a. Electrodes: Minimum 0.125-inch diameter.
    b. Material: Type 316 stainless steel.
    c. Length: To suit applications up to 72 inches.
    d. Process Connection: NPS 1 or NPS 1-1/2 NPT.

7. Enclosure:

    a. Material: aluminum.
    b. NEMA 250, Type 4 .
    c. Electrical Connection: Wire terminal block or cable with standard octal socket.
    d. Switch Type: SPDT snap switch.

C. Liquid-Level Switches, Radio-Frequency (RF) Admittance and Capacitance Type:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Omega Engineering, Inc.
    b. Proximity Controls; a division of Dwyer Instruments, Inc.
    c. Siemens Industry, Inc., Building Technologies Division
    d. VEGA Americas, Inc.

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

    a. Omega Engineering, Inc.
    b. Proximity Controls; a division of Dwyer Instruments, Inc.
    c. Siemens Industry, Inc., Building Technologies Division
    d. VEGA Americas, Inc.

3. Source Limitations: Provide RF admittance and capacitance-type liquid-level switches from single manufacturer.
4. Description:

    a. Capacitive technology.
    b. No moving parts.
    c. Not affected by sticky, dusty, or clingy materials that coat or build up on probe.
    d. Sensitivity: Eight selectable settings.
    e. Mounting: Suitable for application; horizontal or vertical.

5. Performance:

    a. Pressure Limit: 290 psig.
    b. Ambient Temperature Range: Minus 40 to plus 185 deg F.
    c. Process Temperature Range: Minus 40 to plus 250 deg F.
    d. Power Supply: 12 to 240 V ac and dc.
    e. Electrical Rating: 5 A at 120 and 240 V ac.
    f. Response Time:0.2 seconds.
    g. Time Delay: Adjustable, zero to 60 seconds.
    h. Immune to external RF sources.

6. Sensors:

    a. Sensor Material: Type 316 stainless steel.
    b. Insulator Material: PTFE or PVDF.
    c. Length: To suit application up to 72 inches.
    d. Process Connection: NPS 3/4, NPS 1 or NPS 1-1/2 NPT.

7. Enclosure:

    a. NEMA 250, Type 4X.
    b. Electrical Connection: Screw terminals on removable terminal block.
    c. Switch Type: DPDT snap switch, selectable for normally open or closed operation.
    d. Conduit Connection: NPS 1/2 trade size.

D. Liquid-Level Switches, Ultrasonic Type:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. AMETEK Drexelbrook
    b. Flowline
    c. Magnetrol; AMETEK STC
    d. Omega Engineering, Inc.
    e. Siemens Industry, Inc., Building Technologies Division

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the

following:

a. AMETEK Drexelbrook
b. Flowline
c. Magnetrol; AMETEK STC
d. Omega Engineering, Inc.
e. Siemens Industry, Inc., Building Technologies Division

3. Source Limitations: Provide ultrasonic-type liquid-level switches, from single manufacturer.
4. Description: Complete package with electronics unit and sensor.

a. Non-contact-point level measurement with a digital output signal.
b. No moving parts and no routine cleaning and recalibration necessary.
c. Hazardous Environments: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for hazardous environments (Class I, Groups A, B, C and D; Class II, Groups E, F, and G).

5. Performance:

a. Operating Range: Within 0.1 inch.
b. Repeatability: Within 0.1 inch.
c. Response Time: Two seconds, adjustable.
d. Electrical Rating: 6 A at 120 and 240 V ac.
e. .
f. Free from effects of RF interference.

6. Sensor:

a. Material: Type 316 stainless steel.
b. Process Connection: NPS 3/4 NPT.

7. Electronics Unit:

a. Enclosure: NEMA 250, Type 4X.
b. Material: Powder-coated cast aluminum.
c. Conduit Connection: NPS 3/4 trade size.
d. Fail-Safe: High or low liquid-level as required by application; field selectable.
e. Switch Type: DPDT snap switch, selectable for normally open or closed operation.

2.3 DRAIN PAN LIQUID-LEVEL SWITCHES

A. Drain Pan Liquid-Level Switches, Inline-Float Type:

1. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Little Giant; a brand of Franklin Electric Co., Inc.
b. RectorSeal HVAC; a CSW Industrials Company

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. Little Giant; a brand of Franklin Electric Co., Inc.
b. RectorSeal HVAC; a CSW Industrials Company

3. Source Limitations: Provide inline-float type drain pan liquid-level switches from single manufacturer.
4. Description: Inline-float switch for direct mounting onto primary or secondary drain pan outlet, or for inline mounting in drain pipe, to detect drain pan pre-overflow condition and trigger equipment shutdown.
5. Material:

a. Mechanical switch and float valve. Switch and cap assembly is to be removable to permit access for cleaning and clearing of clogs.
b. Schedule 40 PVC Housing:

1) 1-inch x 3/4-inch x 1-inch slip tee housing.
2) 3/4-inch x 1-inch slip PVC bushing.
3) 3/4-inch x 3/4-inch slip PVC adaptor to fit standard 3/4-inch primary drain-pan outlets.
4) Secondary drain pan, plug: 3/4-inch slip plug.
5) Alarm Action: Equipment shutdown via pre-wired 72-inch 18 AWG cables suitable for 24 V ac Class 2 circuit.

6. Standard: UL 508 listed.

B. Drain Pan Liquid-Level Switches, Right-Angle Float Type:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Little Giant; a brand of Franklin Electric Co., Inc.
b. RectorSeal HVAC; a CSW Industrials Company

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. Little Giant; a brand of Franklin Electric Co., Inc.
b. RectorSeal HVAC; a CSW Industrials Company

3. Source Limitations: Provide right-angle float type drain pan liquid-level switches from single manufacturer.
4. Description: Right-angle, L-shaped, float switch for direct mounting onto primary drain pan outlet to detect drain pan pre-overflow condition and trigger equipment

shutdown.

5. Material:

    a. Mechanical switch and float valve. Switch and cap assembly to be removable to permit access for cleaning and clearing of clogs.
    b. Schedule 40 PVC Housing:

        1) 1-inch x 3/4-inch slip "L" housing.
        2) 3/4-inch x 3/4-inch slip PVC adapter.
        3) Alarm Action: Equipment shutdown via pre-wired 72-inch 18 AWG cables suitable for 24 V ac Class 2 circuit.

6. Standard: UL 508 listed.

C. Drain Pan Liquid-Level Switches, In-Pan Float Type:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Little Giant; a brand of Franklin Electric Co., Inc.
    b. RectorSeal HVAC; a CSW Industrials Company

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

    a. Little Giant; a brand of Franklin Electric Co., Inc.
    b. RectorSeal HVAC; a CSW Industrials Company

3. Source Limitations: Provide in-pan float type drain pan liquid-level switches, from single manufacturer.
4. Description: In-pan type float switch for direct mounting in primary drain pan to detect drain pan pre-overflow condition and trigger equipment shutdown.
5. Material:

    a. Mechanical switch and float valve, in sealed waterproof housing.
    b. Corrosion-resistant clip to position and secure float switch to side of drain pan.

6. Alarm Action: Equipment shutdown via pre-wired 72-inch 18 AWG cables suitable for 24 V ac Class 2 circuit.
7. Standard: UL 508 listed.

2.4 LIQUID-LEVEL SENSORS AND TRANSMITTERS

A. Liquid-Level Sensors and Transmitters, RF Admittance-and-Capacitance Type:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include,

but are not limited to, the following:

a. AMETEK Drexelbrook
b. Magnetrol; AMETEK STC
c. Omega Engineering, Inc.

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. AMETEK Drexelbrook
b. Magnetrol; AMETEK STC
c. Omega Engineering, Inc.

3. Source Limitations: Provide RF admittance-and-capacitance type liquid-level sensors and transmitters, from single manufacturer.
4. Description: Complete package with electronics unit, sensor, and connecting cable.

a. Continuous level measurement and an output signal that is proportional to level.
b. Measurement independent of changes in material density and unaffected by presence of material clinging to sensing element.
c. No moving parts and no routine cleaning and recalibration necessary.
d. Electronic unit integral to sensor, except where indicated, mount remotely from sensor.
e. Hazardous Environments: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for hazardous environments (Class I, Groups C and D; Class II, Groups E, F, and G).

5. Performance:

a. Calibrated Range: Varies with application; at least 20 percent beyond high- and low-level set point and alarm levels.
b. Accuracy: Within 1 percent of calibrated range.
c. Supply Voltage: 11.5 to 50 V dc.
d. Maximum Electrical Load: 625 ohms at 24 V dc.
e. Response Time: 0.5 to 30 seconds, adjustable.
f. Temperature Range: Minus 40 to plus 248 deg F.
g. Free from effects of RF interference.
h. Free from harmful effects of static electricity on sensor with discharges of up to 10 A without damage .
i. Measurement free from effects of changes in temperature, density, or acoustic noise in vapor space above level.

6. Sensor:

a. Material: Teflon-coated Type 316 stainless steel.
b. Length: To suit application.
c. Connection: NPS 3/4 NPT with mounting flange if required by the application .

7. Electronics Unit:

    a. Enclosure: NEMA 250, Type 4X.
    b. Two wire, loop powered.
    c. Output Signal: 4 to 20 mA dc.
    d. Zero and Span Adjustments: Non-interacting.
    e. Visual Indication: Continuous digital display of level in units indicated on Drawings.
    f. Field-changeable fail-safe condition and phasing-in event measurement requires changes to optimize level reading.
    g. Adjustable time delay (signal dampening).

B. Liquid-Level Sensors and Transmitters, Ultrasonic Type:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. AMETEK Drexelbrook
    b. Flowline
    c. Magnetrol; AMETEK STC
    d. Omega Engineering, Inc.
    e. Siemens Industry, Inc., Building Technologies Division
    f. VEGA Americas, Inc.

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

    a. AMETEK Drexelbrook
    b. Flowline
    c. Magnetrol; AMETEK STC
    d. Omega Engineering, Inc.
    e. Siemens Industry, Inc., Building Technologies Division
    f. VEGA Americas, Inc.

3. Source Limitations: Provide ultrasonic-type liquid-level sensors and transmitters from single manufacturer.
4. Description: Complete package with electronics unit and sensor.

    a. Non-contact continuous level measurement with an output signal that is proportional to level.
    b. No moving parts and no routine cleaning and recalibration necessary.
    c. Electronic unit integral to sensor.
    d. Hazardous Environments: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for hazardous environments (Class I, Div. 1 and 2, Zone 0 and 1).

5. Performance:

    a. Range: 1 to 30 ft.

b. Span: Adjustable; varies with application. At least 20 percent beyond high- and low-level set point and alarm levels.

1) Minimum Span: 3 inches.
2) Maximum Span: 30 ft..

c. Accuracy: Within greater than 0.15 percent of range or 0.2 inch.
d. Repeatability: Within 0.12 inch.
e. Resolution: Within 0.12 inch
f. Supply Voltage: 19 to 30 V dc.
g. Maximum Electrical Load: 600 ohms at 24 V dc.
h. Response Time: 0.30 seconds, adjustable.
i. Pressure: 50 psig.
j. Ambient Temperature Range: minus 40 to plus 175 deg F.
k. Free from effects of RF interference.

6. Sensor:

a. Material: CPVC, or PVDF.
b. Process Connection: NPS 2 NPT.

7. Electronics Unit:

a. Enclosure: NEMA 250, Type 4X.
b. Material: Plastic with UV protection or powder-coated cast aluminum, explosion proof.
c. Conduit Connection: NPS 1/2 trade size.
d. Two wire, loop powered.
e. Output Signal: 4 to 20 mA dc.
f. Fail-Safe Error Signals: User selectable; 4 to 20 mA or hold.
g. Local Display: LCD; minimum of two lines and seven digits. Display of level in units indicated on Drawings.
h. Operator Interface: Keypad or through touchscreen display; located on face of unit.
i. Signal Dampening: User programmable; 0 to 99 seconds.
j. Temperature Compensation: Automatic and readable for display.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for instruments to verify actual locations of connections before installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to

performance.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install products level, plumb, parallel, and perpendicular with building construction.

B. Properly support instruments, tubing, piping, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement, sway, or a break in attachment when subjected to seismic or external loads.

C. Fastening Hardware:

1. Wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by using excessive force or oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

D. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

E. Mount switches and transmitters not subject to code, state, and federal accessibility requirements within a range of 42 to 72 inches above the adjacent floor, grade or service catwalk, or platform.

1. Make every effort to mount at 60 inches.

F. Corrosive Environments:

1. Use products that are suitable for environment to which they are subjected.
2. If possible, avoid or limit use of materials in corrosive environments.
3. When conduit is in contact with a corrosive environment, use Type 316 stainless steel conduit and fittings or conduit and fittings that are coated with a corrosive-resistant coating that is suitable for environment.
4. Where instruments are located in a corrosive environment and are not corrosive resistant from manufacturer, field install products in a NEMA 250, Type 4X enclosure constructed of Type 316L stainless steel.

3.3 INSTALLATION OF LEVEL INSTRUMENTS

A. Mounting Location: Rough-in instrument-mounting locations before setting instruments and routing, cable, wiring, tubing, and conduit to final location.

3.4 ELECTRICAL CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

C. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

D. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 CONTROL CONNECTIONS

A. Install control signal wiring to field-mounted control devices.

B. Connect control signal wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems" and Section 260533.16 "Boxes and Covers for Electrical Systems."

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire, cable, and tubing must have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification on face.

3.7 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed interior and exterior surfaces.

3.8 CHECKOUT PROCEDURES

A. Check out installed products before continuity tests, leak tests, and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation that impacts performance.

3.9 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. For each analog instrument, perform a three-point calibration test for both linearity and accuracy.
4. Equipment and procedures used for calibration must comply with instrument manufacturer's written recommendations.
5. Provide diagnostic and test equipment for calibration and adjustment.
6. Field instruments and equipment used to test and calibrate installed instruments must have an accuracy of at least twice the instrument accuracy being calibrated. For example, an installed instrument with an accuracy of 1 percent must be checked by an instrument with an accuracy of 0.5 percent.
7. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
8. If, after calibration, indicated performance cannot be achieved, replace out-of-tolerance instruments.
9. Comply with field-testing requirements and procedures in ASHRAE's Guideline 11, in the absence of specific requirements, and to supplement requirements indicated.

B. Analog Signals:

1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.

C. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

D. Switches: Calibrate switches to make or break contact at setpoints indicated.

E. Transmitters: Check and calibrate transmitters at zero, 50, and 100 percent of Project design values. Field calibration is not required for instruments that have been factory

calibrated and provided with certificates.

3.10 MAINTENANCE SERVICE

A. Beginning at Substantial Completion, verify that maintenance service includes 12 months' full maintenance by skilled employees of system and equipment Installer. Include annual preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Verify that parts and supplies are manufacturer's authorized replacement parts and supplies.

3.11 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.

B. Coordinate training video with operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

C. Record Owner training and submit digital files with closeout documents for Owner's future use.

END OF SECTION 230923.17

SECTION 230923.18 - LEAK DETECTION INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Leak-detection switches.
2.

B. Related Requirements:

1. Section 230923 "Programmable Logic Controller (PLC) System for Fuel Oil Storage and Delivery Systems" for control equipment and software, relays, electrical power devices, uninterruptible power supply units, wire, and cable.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Operating characteristics, electrical characteristics, and furnished accessories indicating control signal, default control signal with loss of power, and electrical power requirements.
2. Product description with complete technical data and product specification sheets.
3. Installation operation and maintenance instructions, including factors affecting performance.

B. Shop Drawings:

1. Include details of product assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.
3. Include number-coded identification system for unique identification of wiring, cable, and tubing ends.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: To include in operation and maintenance manuals.

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PART 2 - PRODUCTS

2.1 LEAK-DETECTION SWITCHES

A. Point-Type, Leak-Detection Switches:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. RectorSeal HVAC; a CSW Industrials Company
    b. Veris Industries
    c. Vertiv Co.
    d. Anderson; a division of Dwyer Instruments, Inc.

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

    a. RectorSeal HVAC; a CSW Industrials Company
    b. Veris Industries
    c. Vertiv Co.
    d. Anderson; a division of Dwyer Instruments, Inc.

3. Source Limitations: Obtain point-type, leak-detection switches from single manufacturer.
4. Features:

    a. Alarms: Audible and visual alarm with relay output for remote indication.
    b. Operation: Alarm activation based on detection of liquid by change in resistance.

5. Performance:

    a. Field Power: 24 V ac or dc.
    b. Service: Fuel Oil.
    c. Temperature Limits: 32 to 122 deg F.
    d. Sensing Height: Adjustable.

6. Construction:

    a. Electric Connection: Cable Plug-in connector or screw terminals .
    b. Enclosure: Acrylic, ABS plastic or painted metal .
    c. Switch Type: DPDT relay.

B. Cable-Type, Leak-Detection Switches:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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a. Veris Industries
b. Vertiv Co.
c. Anderson; a division of Dwyer Instruments, Inc.

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. Veris Industries
b. Vertiv Co.
c. Anderson; a division of Dwyer Instruments, Inc.

3. Source Limitations: Obtain cable-type, leak-detection switches from single manufacturer.
4. Control Module Features:

a. Power and alarm LEDs.
b. Alarm test switch.
c. Continuous cable integrity self-check.

5. Performance:

a. Service: Water or other conductive liquid.
b. Switch Type: DPDT.
c. Electric Connection: Screw terminals.
d. Conduit Connection: 0.5 inch.

6. Construction:

a. Control Module Enclosure: Painted metal.
b. Cable: Hydrophobic.
c. Cable Length:

1) As required by application.
2) Standard Cable Lengths: 25 ft..
3) Field Extendable: Cable with connector on each end for field extension.

d. NRTL Listing: NRTL listed for application where cable is installed in air plenums.

7. Field Power: 24 V ac or 24 to 30 V dc unless otherwise required by application.
8. Non-sensing Cable: Non-sensing cable may be used to extend sensing cable length in areas where sensing is not required. Non-sensing cable is not to affect performance or accuracy of readings.
9. Accessories: Cable cross and tee cable connectors, end connectors, and attachment clips.

a.

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PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 LEAK-DETECTION INSTRUMENT APPLICATION

A. Leak-Detection Switches (Point Type): Fuel Oil.

B. Leak-Detection Switches (Cable Type): Fuel Oil.

3.3 INSTALLATION, GENERAL

A. Properly support instruments, wiring, and conduit to comply with requirements indicated. Brace all products to prevent lateral movement and sway or a break in attachment.

B. Fastening Hardware:

1. Wrenches, pliers, and other tools that cause injury to or mar surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening nuts.
2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force, or by oversized wrenches.
3. Lubricate threads of bolts, nuts, and screws with graphite and oil before assembly.

C. Install products in locations that are accessible and that permit calibration and maintenance from floor, equipment platforms, or catwalks. Where ladders are required for Owner's access, confirm unrestricted ladder placement is possible under occupied condition.

3.4 INSTALLATION OF LEAK-DETECTION SWITCHES

A. Use manufacturer mounting brackets to accommodate field mounting. Securely support and brace products to prevent movement.

B. Fasten cable-type leak detection product to floor or supporting substrate using accessory clips furnished with product or a comparable product if furnished separately. Secure clip to floor and cable according to cable installation instructions.

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3.5 ELECTRICAL POWER CONNECTIONS

A. Install electrical power to field-mounted control devices requiring electrical power.

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260523 "Control-Voltage Electrical Power Cables."

C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

D. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems."

E. Furnish and install circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers."

F. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA/NEIS 1.

G. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate to be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate to be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.6 CONTROL CONNECTIONS

A. Install control signal wiring to field-mounted control devices.

B. Connect control signal wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

C. Furnish and install raceways. Comply with requirements in Section 260533.13 "Conduits for Electrical Systems."

3.7 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Each piece of wire and cable is to have the same designation at each end for operators to determine continuity at points of connection. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install engraved phenolic nameplate with instrument identification.

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3.8 CLEANING

A. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels, and other foreign materials from exposed surfaces.

3.9 CHECKOUT PROCEDURES

A. Check installed products before continuity tests and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation for applicable considerations that impact performance.

D. Apply test fluid to floor or substrate to check proper switch operation. Test fluid is to be the same as for operation.

1. For cable-type leak detectors, check multiple locations across cable length. Number of locations will increase with length of cable.

    a. Up to 20 ft.: Two, equally spaced.
    b.

3.10 ADJUSTMENT, CALIBRATION, AND TESTING

A. Description:

1. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
2. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
3. Equipment and procedures used for calibration are to meet instrument manufacturer's written instructions.
4. Provide diagnostic and test equipment for calibration and adjustment.
5. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
6. If after calibration, indicated performance cannot be achieved, replace out-of-tolerance instruments.
7. Comply with field-testing requirements and procedures indicated by ASHRAE's Guideline 11 in the absence of specific requirements, and to supplement requirements indicated.

B. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact.

C. Switches: Calibrate switches that are adjustable to make or break contact at set points indicated.

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3.11 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain instrumentation and control devices.

B. Coordinate operation and maintenance manuals and classroom instruction for use by Owner in operating, maintaining, and troubleshooting.

END OF SECTION 230923.18

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SECTION 231113 - FACILITY FUEL-OIL PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fuel-oil pipes, tubes, and fittings.
2. Piping specialties.
3. Joining materials.
4. Specialty valves.
5. Leak-detection and monitoring system.
6. Labels and identification.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Fuel-oil pipes, tubes, and fittings.
2. Piping specialties.
3. Joining materials.
4. Specialty valves.
5. Mechanical leak-detection valves.
6. Leak-detection and monitoring system.
7. Labels and identification.

B. Product Data Submittals:

1. Include construction details, material descriptions, and dimensions of individual components and profiles.
2. Include rated capacities, pressure ratings, operating characteristics, electrical characteristics, settings, and furnished specialties and accessories.

C. Shop Drawings: For fuel-oil piping.

1. Include plans, elevations sections, hangers, and supports for multiple pipes.
2. Include details of location of anchors, alignment guides, and expansion joints and loops.
3. Scale: 1/8 inch per foot.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Plans and details, or Building Information Model (BIM), drawn to scale, on which

fuel-oil piping and tanks are shown and coordinated with other installations, using input from installers of the items involved.

B. Welding certificates.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-oil equipment and accessories.

1. Indicate actual installed items by marking submittals with an arrow or box.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Material: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.6 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and personnel in accordance with ASME Boiler and Pressure Vessel Code.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Lift and support fuel-oil storage tanks only at designated lifting or supporting points, as indicated on Shop Drawings. Do not move or lift tanks unless empty.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.8 FIELD CONDITIONS

A. Interruption of Existing Fuel-Oil Service: Do not interrupt fuel-oil service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fuel-oil supply in accordance with requirements indicated:

1. Notify Construction Manager and Owner no fewer than fourteen days in advance

of proposed interruption of fuel-oil service.
2. Do not proceed with interruption of fuel-oil service without Construction Manager's and Owner's written permission.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of fuel oil piping and related equipment that fail in materials or workmanship within specified warranty period.

1. Failures include those due to defective materials or workmanship for materials including piping fittings, and above ground storage tanks.
2. Warranty Period: 30 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

B. Comply with ASME B31.9, "Building Services Piping," for fuel-oil piping materials, installation, testing, and inspecting.

C. Fuel-Oil Valves: Comply with UL 842 and have service mark initials "WOG" permanently marked on valve body.

D. Comply with requirements of the EPA and of state and local authorities having jurisdiction.

2.2 FUEL-OIL PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A234/A234M, for butt and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

a. Material Group: 1.1.
b. End Connections: Threaded or butt welding to match pipe.
c. Lapped Face: Not permitted underground.
d. Gasket Materials: Asbestos free, ASME B16.20 metallic, or ASME B16.21 nonmetallic; gaskets compatible with fuel oil.

e. Bolts and Nuts: ASME B18.2.1, zinc alloy-plated steel.

2.3 PIPING SPECIALTIES

A. Flexible Connectors - Metallic:

1. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. FLEX-ING, Inc
   b. Flexicraft Industries
   c. Hose Master, Inc

2. Source Limitations: Obtain flexible connectors - metallic, from single manufacturer.
3. Listed and labeled for aboveground and underground applications by an NRTL acceptable to authorities having jurisdiction.
4. Stainless steel bellows with woven, flexible, bronze or stainless steel, wire-reinforcing protective jacket.
5. Minimum Operating Pressure: 150 psig.
6. End Connections: Socket, flanged, or threaded end to match connected piping.
7. Maximum Length: 30 inches.

B. Flexible Connectors - Nonmetallic:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. FLEX-ING, Inc
   b. Flexicraft Industries
   c. Hosecraft USA

2. Source Limitations: Obtain flexible connectors - nonmetallic, from single manufacturer.
3. Listed and labeled for aboveground applications by an NRTL acceptable to authorities having jurisdiction.
4. PFTE bellows with woven, flexible, bronze or stainless steel, wire-reinforcing protective jacket.
5. Minimum Operating Pressure: 150 psig.
6. End Connections: Socket, flanged, or threaded end to match connected piping.
7. Maximum Length: 30 inches.

C. Strainers - Y-Pattern:

1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 60-mesh startup strainer and perforated stainless steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

D. Strainers - Basket:

1. Body: ASTM A126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 60-mesh startup strainer and perforated stainless steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

E. Strainers - T-Pattern:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 60-mesh startup strainer and perforated stainless steel basket with 57 percent free area.
4. CWP Rating: 750 psig.

F. Air Vents - Manual:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

2.4 JOINING MATERIALS

A. Joint Compound and Tape for Threaded Joints: Suitable for fuel oil.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.5 SPECIALTY VALVES

A. Pressure Relief Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Highland Tank & Manufacturing Co, Inc.
    b. Simplex

2. Source Limitations: Obtain pressure relief valves from single manufacturer.
3. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
4. Body: Brass, bronze, or cast steel.
5. Springs: Stainless steel, interchangeable.
6. Seat and Seal: NBR.
7. Orifice: Stainless steel, interchangeable.
8. Factory-Applied Finish: Baked enamel.
9. Maximum Inlet Pressure: 150 psig.
10. Relief Pressure Setting: 75 psig.

2.6 LEAK-DETECTION AND MONITORING SYSTEM

A. Cable and Sensor Leak-Detection Monitoring System for above ground storage tanks interstitial space and existing day tank rupture basins:

1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following:

    a. Simplex
    b. Highland Tank & Manufacturing Company, Inc.

2. Source Limitations: Obtain cable and sensor leak-detection monitoring system from single manufacturer.
3. Standard: Comply with UL 1238.
4. Calibrated leak-detection and monitoring system with probes and other sensors and remote alarm panel for fuel-oil piping.
5. Include fittings and devices required for testing.
6. Leak detection for interstitial space of above ground storage tanks to be provided and monitored by fill station panel manufacturer. Leak detection of existing day tank rupture basins to be provided and monitored by new day tank controls manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of fuel-oil piping.

B. Examine installation of fuel-burning equipment and fuel-handling and storage equipment to verify actual locations of piping connections before installing fuel-oil piping.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Close equipment shutoff valves before turning off fuel oil to premises or piping section.

B. Comply with NFPA 30 and NFPA 31 requirements for prevention of accidental ignition.

3.3 INSTALLATION OF OUTDOOR AND INDOOR PIPING

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction to allow for mechanical installations.

C. Install piping in non-concealed locations unless otherwise indicated.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping free of sags and bends.

F. Install fittings for changes in direction and branch connections.

G. Comply with requirements for equipment specifications for roughing-in requirements.

H. Prohibited Locations:

1. Do not install fuel-oil piping in or through HVAC ducts and plenums, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
2. Do not install fuel-oil piping in solid walls or partitions.
3. Do not install fuel-oil piping below slab on grade.

I. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

J. Connect branch piping from top or side of horizontal piping.

K. Install unions in pipes NPS 2 and smaller at final connection to each piece of equipment and elsewhere as indicated. Unions are not required on flanged devices.

L. Do not use fuel-oil piping as grounding electrode.

M. Install sleeves and sleeve seals for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220500 "Common Work Results for Plumbing."

N. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220500 "Common Work Results for Plumbing."

3.4 INSTALLATION OF VALVES

A. Install manual fuel-oil shutoff valves on all connections to fuel-oil tanks, pump skids, and equipment.

B. Install valves in accessible locations.

C. Install oil safety valves at inlet of each oil-fired appliance.

D. Install pressure relief valves in distribution piping between the supply and return lines.

E. Install one-piece, bronze ball valve with hose end connection at low points in fuel-oil piping. Comply with requirements in Section 220523 "General Duty Valves for Plumbing Piping."

F. Install manual air vents at high points in fuel-oil piping.

3.5 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints: Construct joints in accordance with AWS D10.12/D10.12M, using qualified processes and welding operators in accordance with "Quality Assurance" Article.

1. Bevel plain ends of steel pipe.
2. Patch factory-applied protective coating as recommended in writing by manufacturer at field welds and where damage to coating occurs during construction.

E. Flanged Joints: Install gasket material, size, type, and thickness for service application. Install gasket concentrically positioned.

3.6 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements for hangers, supports, and anchor devices specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

B. Install hangers for steel piping with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

C. Support horizontal piping within 12 inches of each fitting and coupling.

D. Support vertical runs of steel piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 INSTALLATION OF LEAK-DETECTION AND MONITORING SYSTEM

A. Install leak-detection and monitoring system. Connect to equipment panels supplied with each day tank and above ground storage tank.

3.8 PIPING CONNECTIONS

A. Where installing piping adjacent to equipment, allow space for service and maintenance.

B. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment having threaded pipe connection.

C. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.

D. Connect piping to equipment with shutoff valve and union. Install union between valve and equipment.

E. Install flexible piping connectors at final connection to pump skids, tanks, equipment, and day tanks.

3.9 LABELING AND IDENTIFYING

A. Nameplates, pipe identification, valve tags, and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on each tank, equipment, and pump skid.

1. Text: In addition to identifying unit, distinguish between multiple units; inform operator of operational requirements; indicate safety and emergency precautions; and warn of hazards and improper operations.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Contractor to perform tests and inspections.

B. Manufacturer Field Services: Engage a factory-authorized service representative to support and supervise field tests and inspections.

C. Tests and Inspections:

1. Piping Pressure Test: Minimum hydrostatic or pneumatic test-pressures measured at highest point in system.

a. Fuel-Oil Distribution Piping:

1) Hydrostatic: Minimum 150 percent of maximum anticipated pressure or 75 psig.
2) Pneumatic: Minimum 110 percent of maximum anticipated pressure.
3) Pressure to be maintained while complete visual inspection of all joints and connections is conducted.
4) In no case is test pressure to be less than a gauge pressure of 75 psi measured at the highest point of the system.
5) In no case is test pressure to be maintained for less than 10 minutes.

b. Isolate storage tanks if test pressure in piping will cause pressure in storage tanks to exceed 5 psig.

D. Inspect and test fuel-oil piping in accordance with NFPA 31, "Tests of Piping" Paragraph; and in accordance with requirements of authorities having jurisdiction.

E. Test Above Ground Storage Tank leak-detection and monitoring system for accuracy by manually operating sensors and checking against alarm panel indication.

F. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

G. Bleed air from fuel-oil piping using manual air vents.

H. Fuel-oil piping and equipment will be considered defective if they do not pass tests and inspections.

I. Prepare test and inspection reports.

1. Submit all test and inspection reports with O and M information.

3.11 OUTDOOR PIPING SCHEDULE

A. Aboveground fuel-oil piping to be the following:

1. NPS 1-1/4 Pipe Size and Smaller: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints.
2. NPS 1-1/2 Pipe Size and Larger: Steel pipe, steel welding fittings, and welded joints.

3.12 INDOOR PIPING SCHEDULE

A. Aboveground fuel-oil piping to be the following:

1. NPS 1-1/4 Pipe Size and Smaller: Steel pipe with threaded joints.
2. NPS 1-1/2 Pipe Size and Larger: Steel pipe, steel fittings, and welded or flanged joints.

3.13 SHUTOFF VALVE SCHEDULE

A. Valves for aboveground distribution piping NPS 2 (DN 50) and smaller to be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

B. Distribution piping valves for pipe NPS 2-1/2 (DN 65) and larger to be the following:

1. Two-piece, full-port, flanged, ball valves with bronze trim.

C. Valves in branch piping for single appliance to be the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION 231113

SECTION 231213 - FACILITY FUEL-OIL PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fuel-oil pumps Single Pump Remote Fill Station.
2. Fuel-oil pumps - Single Pump Day Tank Return Pump
3. Fuel-oil pump sets – Duplex Pumps – Main Supply Pumps.
4. Fuel-oil polishing systems.

1.2 ACTION SUBMITTALS

A. Product Data:

1. Fuel-oil pumps - simplex.
2. Fuel-oil pumps - multiplex.
3. Fuel-oil polishing systems.

B. Product Data Submittals: For each product.

1. Include construction details, material descriptions, and dimensions of individual components and profiles.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Shop Drawings: For fuel-oil pumps and fuel-oil polishing systems.

1. Include construction details and dimensions of individual components for fuel-oil pumps.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Scale: 1/4 inch per foot.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and details, or Building Information Model (BIM), drawn to scale, showing items described in this Section and coordinated with all building trades.

B. Sample Warranties: For fuel-oil pumps and fuel-oil polishing system.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-oil pumps and fuel-oil polishing systems.

1.5 WARRANTY

A. Manufacturer Warranty: Manufacturer and installer agree to repair or replace fuel-oil pumps and fuel-oil polishing systems that fail in materials or workmanship within specific warranty period.

B. Warranty Period for Fuel-Oil Pumps: one year(s) from date of Substantial Completion.

C. Warranty Period for Fuel-Oil Polishing Systems: one year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.

B. Maximum Operating-Pressure Ratings: 50 psig fuel-oil supply pressure and 100 psig fuel-oil return pressure to and from equipment. Pressure rating of 25 psig for remote fill station pump.

1. <

C. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.

2.2 FUEL-OIL PUMPS – SINGLE PUMP-REMOTE FILL STATION

A. Manufacturers: Subject to compliance with requirements, provide products by the following owner preferred manufacturer:

1. Simplex, Inc.

B. Source Limitations: Obtain fuel-oil pumps - simplex, from single manufacturer.

C. Description: Comply with UL 343 and HI 3.1-3.5.

1. Two Tank Fuel Filling System

2. Provide a grade level fuel transfer pumping system with spill containment; overfill prevention and automatic fill shutoff. The 2-TANK SMARTPUMP will be used for filling two fuel oil storage tanks. The SMARTPUMP is for use with class ll,

flammable liquids, those having a flash point greater than 100 degrees F: fuel oil, diesel fuel, and kerosene.

3. The SMARTPUMP will be installed outdoors on a concrete pad at a location as indicated on contract drawings.

4. The SMARTPUMP will transfer fuel from a gravity tanker truck to storage tanks via the pump system on-board the unit, as described below. The SMARTPUMP will permit full draining of the truck delivery hose upon completion of fuel delivery.

5. The SMARTPUMP will include the following fittings and features:

    a. Steel, weatherproof, lockable containment box with hinged door finished in Simplex gray with blue doors.
    b. External, stainless steel ground stud for attachment of delivery truck ground cable.
    c. 3” quick disconnect coupling for attachment of user’s delivery hose.
    d. Inlet shut off manual valve.
    e. Motorized valves, shipped loose, Qty 4, two per tank installed per contract drawings.
    f. Thermal expansion pressure relief valve, shipped loose, Qty 1, one installed per contract drawings.
    g. 17-gallon spill containment sump with drain to pump inlet (handpump on enclosed units).
    h. Outlet check valve.
    i. Outlet shut off manual valve.
    j. 3” threaded fitting for attachment of outlet pipe to tank.
    k. Permanently affixed operating instructions per NFPA and IFC requirements.

6. The SMARTPUMP will include a BY-PASS connection to bypass the onboard pump for use with a pumper truck fuel delivery. The connection will be a 3” quick disconnect coupling.

7. The SMARTPUMP will include a motor driven high capacity fuel transfer pump as follows:

    a. Pump: 300 GPM at 55 feet of head, 3600 RPM, cast iron, bronze fitted, carbon-ceramic / BUNA-N mechanical shaft seal.
    b. Motor: Totally enclosed, fan cooled, rigid base, 3600 RPM, 5 HP, 460 VAC, 3-phase.

8. The SMARTPUMP will include a PLC and 3” HMI controlled system with overfill alarm and shutoff system as described below. The system will require an external source of AC power, 208/230/460, 3-phase. The control system will include:

    a. TYPE 3R rainproof, lockable enclosure with hinged door.
    b. 4-20mA Level transmitter for installation in the storage tank, Qty 2, one per

tank.

c. Leak sensor float switch for installation in the storage tank's interstitial space, Qty 2, one per tank.
d. Level display reading in Percent and Gallons.
e. High visibility notification on HMI: 90% level.
f. High visibility red alarm banner on HMI: 95% level.
g. High visibility red alarm banner on HMI: 98% level.
h. 90 dB audible alarm horn activated at 90%, 95%, 98% and on storage tank leak.
i. Control power ON/OFF switch.
j. Fill Start/Stop controlled via HMI.
k. Automatic valve closure at 90% level.
l. Override circuit and 30 second timer to permit override of 90% shutoff to allow pump-out of delivery hose or spill containment. 95%, 98% and leak lockout cannot be overridden.
m. Leak sensor alarm circuit input which activates automatic valve closure.
n. Indicators for:

    1) Power available.
    2) Fill valve disarm / closed.
    3) Fill valve open.
    4) Tank leak.

o. Tank selection via HMI on multi-tank systems. The fill valve for the selected tank will be operated by the fill controller described herein. Furthermore, the controller will be dedicated to the selected tank. Any non-selected tank will have its fill valve disabled and rendered inoperative. The 90%, 95%, 98%, and leak floats are also monitored to prevent inadvertent cross filling.
p. Transfer pump motor starter with overload relay.
q. Control power transformer for 120 VAC operation of controls.
r. Control power fuses.
s. Remote alarm contacts:

    1) Summary Tank Critical High
    2) Summary Tank High
    3) Summary Leak
    4) Selected tank Full

t. Modbus via Ethernet communication to Simplex network.

9. The SMARTPUMP system will be supplied with standard manufacturer's one year warranty.

10. The services of a factory-authorized or factory based, field service technician to provide training and start-up services, including inspection, calibration, and first operation for the SMARTPUMP must be included.

11. The system will be as scheduled on contract drawings.

D. Drive: Direct, close coupled.

2.3 FUEL-OIL PUMPS – SINGLE PUMP-DAY TANK RETURN PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by the following owner preferred manufacturer:

1. Simplex, Inc.

B. Source Limitations: Obtain fuel-oil pumps - simplex, from single manufacturer.

C. Description: Comply with UL 343 and HI 3.1-3.5.

1. Fuel Supply System: Provide a packaged, fully enclosed, fuel oil pump set with controls for base tank level controls and overflow return back to the main tank.
2. Pump set construction:

a. The pump set will consist of a fully enclosed, freestanding pump set enclosure consisting of an all-welded steel cabinet with separate mechanical and electrical compartments. The enclosure will have separate hinged and lockable access doors for each compartment. The enclosure will include a containment basin for capturing any leaks from the fuel valves, fittings, pumps or piping.
b. The drip pan/containment will be equipped with a leak sensor to detect leakage of fuel. This sensor will activate an alarm on the pump set control panel and have dry contacts for remote annunciation.
c. The pump set will include top access 1-inch return inlet, and 1-inch return pump outlet. 1-inch pipe thread connections shall be supplied.
d. The pump set controller will be installed within the separate electrical compartment of the pump set enclosure
e. The pump set will be painted in a fuel oil resistant white industrial enamel and Type 1 rated for indoor use.

3. Overflow-return pump:

a. 1.5 HP, 15 GPM at 100 PSI at 1750 rpm, when operating with fuel oil having a viscosity of 50SSU.
b. Direct drive, motor driven pump coupled via flexible coupling.
c. Motors to be TEFC construction, 1.5 Hp, NEMA type B, continuous duty at 40C, 1750 RPM, 460 V AC, 3-phase, 60 hertz, 1.15 service factor.
d. Pumps to be directly driven, positive displacement, internal gear type. Pump will be a high pressure, hydraulic type consisting of two intermeshing, hardened steel, precision ground gear assemblies enclosed by a high strength, die cast aluminum housing, hardened drive shaft.
e. Provide check valve on pump outlet.

4. Base tank level controller:

a. A UL Listed, integrated design PLC level controller package shall be supplied which provides differential level control for activation of supply

pump, tank level indication, leak indication, system alarms and manual operating controls. The controller shall utilize discrete level sensors and circuit paths for level alarms and fill pump control. Failure in one sensor or circuit path shall not necessarily disable the entire controller. All indicators are to be long life light emitting diodes.

5. The level controller will have an intrinsic overflow cutout backup control which, upon sensing an overflow, will stop the main supply pump, activate an alarm and cause the controller to revert to an emergency backup level control mode which allows the tank to continue operating automatically but which inhibits overflow.

6. The level controls will provide the following:

    a. Mode control switch: "Manual – OFF - Auto".
    b. Pump running indicator.
    c. Automation Direct PLC.
    d. 7-inch Color touch screen HMI.
    e. MODBUS via Ethernet communication to Simplex network.
    f. Audible Alarm horn

7. Control functions:

    a. Auto-off-manual pump control mode switch.
    b. Press to test pump push-button.
    c. Pump start-stop automatic level control.
    d. Pump overflow control backup.
    e. Output call for fuel.
    f. Press to reset fault.
    g. Silence alarm push-button.

8. Indication Functions Normal Conditions on HMI interface and available via MODBUS:

    a. Day tank full level.
    b. Day tank filling.

9. Standby Conditions on HMI interface and available via MODBUS:

    a. Normal range level.
    b. Volume display via 4-20mA signal.

10. Outputs:

    a. Call for fuel/lag all for fuel.

11. Alarm Conditions on HMI interface and available via MODBUS:

    a. Fill mode not in auto.
    b. Critical high.
    c. High fuel level.
    d. Low fuel level.

e. Critical low.
f. Secondary containment leak.
g. E-stop active.

12. Overflow-return pump controls:

    a. Arm return pump at 70% base tank level.
    b. Activate return pump at 95% base tank level and pump down to 70% level.
    c. Lock-out fill system when overflow-return pump is activated.
    d. Provide alarm when overflow-return pump is activated.
    e. Provide test push-button, running and armed indicators.

13. Provide a ship loose level control float assembly for installation into a top port on the existing base tank. The float assembly will utilize UL recognized magnetic reed type float switches compatible with the proper operation of the level controller while operating in class ll petroleum liquids. There will be a minimum of four switch positions to allow for low level alarm, high level alarm, supply pump on & supply pump off. The level switches will terminate in an appropriately rated, Killark type conduit hub with terminal strip connection to aid in ease of installation.

14. Provide a single magnetic reed switch of similar design as above with conduit hub for installation in the base tank's interstitial containment area for wiring back to the leak circuit contacts on the control panel.

15. Provide a single 4-20mA Level transmitter for installation in the day tank to provide volume display on HMI touch screen.

16. The following inlet devices to the base tank should be provided:

    a. Inlet strainer.
    b. (2) Main inlet solenoid valves (redundant), 100PSI rated,1-inch brass body, Viton or buna-n seal, mounted in parallel.
    c. Manual shut off valve, bypass arrangement.
    d. Needle valve.
    e. Flow gauge.

17. Needle valve will be adjusted to maximum day tank flow of 12 GPM.

18. The pump set / control system will be designed and manufactured by a single supplier and be a standard product in serial production. The manufacturer will have at least 10 years' experience in the design and manufacture of these products.

19. The pump set / control system will be supplied with standard manufacturer's one year warranty.

20. The services of a factory-authorized or factory based, field service technician to provide owner training and start-up services, including inspection, calibration, and first operation for the pump set / control system must be included.

21. The system will be as scheduled on contract drawings.

D. Drive: Direct, close coupled.

2.4 FUEL-OIL PUMP SETS – DUPLEX PUMPS-MAIN SUPPLY PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by the following owner preferred manufacturer:

1. Simplex, Inc.

B. Source Limitations: Obtain fuel-oil pump sets - multiplex, from single manufacturer.

C. Description: Comply with HI 3.1-3.5.

1. Duplex Pump set, PLC based with Main Tank Selection for use in selecting a primary supply/return vessel in a fuel oil supply system when there are two main tanks to choose from. The use of this panel allows the system to feed day tank(s) from two fuel sources. Corresponding motorized valves are opened on the supply and return lines of the selected vessel. When the selected tank drops to a low-level condition an on-panel alarm indicator is activated and the next tank in the sequence is automatically alternated to supply fuel. Supply and return valves change position automatically. The low-level alarm locks specific tank out of the supply selection until it is refilled and the low level alarm is reset. Placing any tank's toggle switch in the "manual" position can manually activate that tank and override automatic selection. Low-level lockout cannot be overridden.

2. Fuel Oil Pump Set:

a. Fuel Supply System: Provide a packaged, fully enclosed, fuel oil pump set with duplex controls for supply of fuel from a main storage tank to four(4) day tanks.

3. Pump Set Construction:

a. The pump set will consist of a fully enclosed, freestanding pump set enclosure consisting of an all-welded steel cabinet with separate mechanical and electrical compartments. The enclosure will have separate hinged and lockable access doors for each compartment. The enclosure will include a containment basin for capturing any leaks from the fuel valves, fittings, pumps or piping.
b. The drip pan/containment will be equipped with a leak sensor to detect leakage of fuel. This sensor will activate an alarm on the pump set control panel and have dry contacts for remote annunciation.
c. The pump set will include top access 1-1/2-inch fuel supply manifold, 1-inch fuel outlet manifold and 1-inch fuel return manifold. 1 and 1-1/2-inch pipe thread connections shall be supplied.
d. The pump set duplex controller will be installed within the separate electrical compartment of the pump set enclosure.
e. The pump set will be painted in a fuel oil resistant white industrial enamel

and Type 1 rated for indoor use.

4. Duplex Supply Pumps:

   a. 1.5 HP, 15 GPM at 50 PSI at 1725 rpm, when operating with fuel oil having a viscosity of 50SSU.
   b. Direct-drive, motor-driven pump coupled via flexible coupling.
   c. Motors will be open drip proof construction, 1.5 HP, NEMA type B, continuous duty at 40C, 1750 RPM, 460V AC, 3-phase, 60 hertz, 1.15 service factor.
   d. Pumps will be directly driven, positive-displacement, internal gear type. Pumps will be a high pressure, hydraulic type consisting of two intermeshing, hardened steel, precision ground gear assemblies enclosed by a high strength, die cast aluminum housing, hardened drive shaft.
   e. Pump pressure relief valve, for each pump, adjustable type, 30-200PSI, set at 60PSI, bronze construction with stainless steel spring. To be connected to pressure-relief return manifold for return to main tank.
   f. Shutoff ball valves, installed as below, brass or bronze construction, stainless steel ball, Teflon seal, 600PSI:

      1) Pump inlet shutoff valves, each pump.
      2) Pump outlet shutoff valves, each pump.

   g. Pump check valve, spring-type, each pump, bronze construction, 400PSI.
   h. Inlet wye-strainer on each pump.

5. An adjustable anti-siphon valve suitable for suction service will be supplied as a loose item for field installation at the Above ground Storage Tank supply-to-pumps fitting.

6. Flow switches, one each installed on the outlet of each supply pump. Switches will be used to sense for proper pump operation as required by control system described below. Switches will be bronze construction, shuttle/reed switch type, 400 psig rated.

7. Fuel oil gauges:

   a. 2-inch dial pressure gauge installed on the outlet of each pump. Gauge construction will be brass socket, stainless steel case, copper alloy bourdon tube, brass movement, polycarbonate window, white enameled aluminum dial with black scale, black enameled aluminum pointer. Gauge will be filled with liquid glycerin to dampen vibrations. 270º-scale shall be 0-500 psig. Gauge will be installed with isolation ball valve.
   b. 2-inch dial vacuum gauges, installed on the inlet to each pump after the strainer and on the inlet to the duplex strainer. Gauge construction will be same as pressure gauge above.

8. Duplex Digital PLC Pump Controller:

   a. Activation by remote level controller or equipment “run” contacts.
   b. Function:

1) Automatic duplex pump controller to provide lead-lag operation with automatic alternation of pumps on successive starts and automatic lag pump back-up.
2) With remote control switch in "automatic" position, upon closure of control contacts, lead pump starts and runs.
3) In normal operation, upon subsequent closure of control contacts, pumps alternate operation.
4) Upon activation of a day tank low level alarm, lag pump starts and runs.
5) Upon time-out of either lead pump flow switch, lag pump starts and runs.
6) In either normal or alarm operation, pumps do not run simultaneously.

c. 7-inch color touch screen operator interface.
d. MODBUS via Ethernet communication to Simplex Network.
e. MODBUS via Fiber communication to Building Management System.
f. Single power input 460V AC, 3-phase, 60 hertz, with control power transformer 120V AC, single phase, 60 hertz.
g. Mode control switch: "alternate-both".
h. Hand-off-auto switch mode control switch for each pump.
i. Pump running indicators.
j. Audible alarm and silence.

9. General Sequence of Operations:

a. Automatic Mode:

1) Receives call for fuel signal from any one or multiple of four day tanks.
2) Signal Filter to stop running if day tank calls for fuel.
3) Select next supply pump in alternating sequence.
4) Run pump.
5) Pump runs until call for fuel signal is satisfied.
6) E-stop input, stop pumps.

b. Manual Mode:

1) Operator selects manual mode.
2) Operator selects pump to run and places that pump’s HOA switch in Hand.
3) Pump runs continuously until stopped.

c. Abnormal Modes:

1) Pump fail.
2) System detects “loss of flow” on selected pump.
3) After timeout, system de-selects and alarms failed pump.
4) Starts and runs offline pump, opening supply pump.
5) System bypasses failed pump on all subsequent call for fuel signals

until reset by operator.
6) All pumps stopped and disabled.
7) Alarm to Building Management System.

10. Main Tank Selection Program:

    a. Three position toggle-switch for each tank in the system: Off-Auto-Manual Override.
    b. Tank selected indicator lamp (one per tank).
    c. Tank low level indicator lamp with reset (one per tank).
    d. “All Tanks Low” indicator lamp with contacts for pump shutdown.
    e. Supply valve opened (one per tank).
    f. Supply valve closed (one per tank).
    g. Return valve open (one per tank).
    h. Return valve closed (one per tank).
    i. RED Flashing Valve Malfunction.
    j. Alarm horn.
    k. Four (4) Motorized ball valves with limit switch, two (2) per tank – Sized based online size and pump flow rate.
    l. Two (2) Low level tank contacts derived from Simplex low-level switch.

11. The pump set / control system will be designed and manufactured by a single supplier and be a standard product in serial production. The manufacturer will have at least 10 years’ experience in the design and manufacture of these products.

12. The pump set / control system will be supplied with standard manufacturer’s one year warranty.

13. The services of a factory-authorized or factory based, field service technician to provide training and start-up services, including inspection, calibration, and first operation for the pump set / control system must be included.

14. The system will be as scheduled on contract drawings.

D. Drive: Direct close coupled.

2.5 FUEL-OIL POLISHING SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by the following owner preferred manufacturer:

1. Simplex, Inc.

B. Source Limitations: Obtain fuel-oil polishing system from single manufacturer.

C. Description: Factory-fabricated and -wired, fuel-oil polishing system for fuel-oil filtration; with enclosure, filter, fuel-oil pump, and controls.

1. Filtration, maintenance system for fuel oil in bulk, long-term storage.

2. For permanent, on-site installation, outdoor.

3. Comprehensive system: pump, filter and water removal elements, controller.

    a. Fully automated.
    b. 15 gpm.
    c. 5 micron final filtration.
    d. 15 ppm water removal.
    e. Two-tank selection including four (4) 1” Motorized Ball Valves.
    f. Outdoor, heated enclosure.
    g. 5 gallon waste-water retention tank. Automatic water drain from separator.
    h. Cabinet heater.
    i. MODBUS via Ethernet communication to the Simplex network.

4. The polishing skid will combine several elements to form a comprehensive, integrated, automated system:

    a. Multi-stage, progressive particulate filtration and water removal.
    b. Integrated, high-performance pump.
    c. Flow control and monitoring devices.
    d. User-programmable controller.

5. The polishing skid will use a progressive filtration and conditioning regime:

    a. Coarse straining through 40 mesh washable screen.
    b. Pre-filtration through 10 micron disposable media filter.
    c. Final filtration through 5 micron disposable media filter.
    d. Water coalescing to 15 PPM.
    e. Water separation and collection.

6. Fuel circulation and transfer is accomplished via an on-board, high-performance, cast iron positive-displacement gear pump direct-driven via an industrial, heavy-duty motor. The pump combines high vacuum prime maintenance with linear flow versus pressure performance. Drive motors are NEMA class industrial type, conservatively applied and include ball-bearings, class H insulation, continuous duty ratings.

7. The polishing skid will include shutoff ball valves, check valves, flow switches, pressure and differential pressure transducers, and differential pressure sensors across each filtration element.

8. The polishing skid will include a UL508 listed and labeled industrial control panel featuring a user programmable cycle timer and rugged, industrial-analog operator interface. The controller provides fully automatic operation of the system and is operator field programmable to set filtration cycle duration, time of day, day of week operation. Manual override capability is included. Differential pressure sensors across each filtration element, and a high water level sensor are included with alarms.

9. System Includes:

    a. Outdoor, weatherproof, pad-mountable enclosure, also suitable for indoor installation. 1-inch NPT.
    b. On-board, integrated controller, UL508. See Controller Section
    c. Inlet, outlet ball-type shutoff valves.
    d. Check valve.
    e. Pressure differential gauges across pre-filter and across final filter-separator.
    f. Differential pressure switches, high water detector. See Controller Section.
    g. Circulation pump, 15 GPM and 1.0 hp.
    h. Filtration elements:

        1) Strainer, 40 mesh, wye-type.
        2) Pre-filter, 10-micron, spin-on type, disposable media.
        3) Final filter-separator, 5-micron, 15 PPM, canister type with replaceable cartridge.

    i. 115v cabinet heater with thermostat.
    j. 5-gallon, poly construction, water retention tank. Includes control solenoid valve and check valve. Includes vent and high-level sensing float switch.

10. Controller, UL508 Listed, TYPE-3R enclosed:

    a. Auto-off-manual switch.
    b. Time of day, day of week, interval programmable timing.
    c. Control devices:

        1) Pump motor starter.
        2) Control power fuses.
        3) Terminal blocks.
        4) Valve control relays.

    d. Automatic water drain control:

        1) Water detection sensor.
        2) Back-up oil detection sensor to prevent transfer of fuel to holding tank.
        3) Automatic control of water drain solenoid valve.
        4) High level, water tank alarm.

11. Heated control box.

12. High pressure differential alarms.

13. Main power disconnect switch.

14. The pump / control system will be designed and manufactured by a single supplier and be a standard product in serial production. The manufacturer will have at least 10 years' experience in the design and manufacture of these

products.

15. The pump / control system will be supplied with standard manufacturer's one year warranty.

16. The services of a factory-authorized or factory based, field service technician to provide training and start-up services, including inspection, calibration, and first operation for the pump set / control system must be included.

17. The system will be as scheduled on contract drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for fuel-oil pumps to verify actual locations of pump connections before equipment installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.3 PREPARATION

A. Close equipment shutoff valves before turning off fuel oil to premises or piping section.

B. Comply with NFPA 30 and NFPA 31 requirements for prevention of accidental ignition.

3.4 INSTALLATION OF FUEL-OIL PUMPS

A. Simplex and Multiplex Fuel-Oil Pumps:

1. Install pumps with access space for periodic maintenance including removal of motors, impellers, and accessories.
2. Set pumps on and anchor to concrete base.
3. Pump Mounting:

    a. Install base-mounted pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Structural Specificaiton.

B. Install two-piece, full-port ball valves at suction and discharge of pumps. Comply with requirements in Section 220523 "General Duty Valves for Plumbing Piping."

C. Install strainer on inlet side of all fuel-oil pumps.

D. Install check valve on discharge of all fuel-oil pumps unless provided with built-in check valve.

E. Install suction piping with minimum fittings and change of direction.

F. Install vacuum and pressure gauge, upstream and downstream, respectively, at each pump to measure the differential pressure across the pump. Pressure gauges are specified in Section 220500 "Common Work Results for Plumbing."

G. Provide and install warning signage per NFPA and IFC requirements.

3.5 INSTALLATION OF FUEL-OIL POLISHING SYSTEMS

A. Polishing System Mounting:

1. Install equipment cabinet on cast-in-place concrete equipment base. Comply with requirements for equipment bases and foundations specified in Structural Specifications.

B. Install suction line, with foot valve, at one end of storage tank, 6 inches from the bottom of tank.

C. Install return line at the opposite end of storage tank from suction line.

D. Provide and install warning signage per NFPA and IFC requirements.

3.6 LABELING AND IDENTIFYING

A. Install nameplates and signs on each fuel-oil pump.

B. Provide and install warning signage per NFPA and IFC requirements.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Contractor to perform tests and inspections with some assistance from factory authorized representative during start up.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to support field tests and inspections.

C. Tests and Inspections:

1. Start fuel-oil transfer pumps and fuel-oil polishing system pumps to verify for proper operation of pump, and check for leaks.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Fuel-oil pumps and fuel-oil polishing systems will be considered defective if they

do not pass tests and inspections.

D. Prepare test and inspection reports.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fuel-oil pumps and fuel-oil polishing system.

END OF SECTION 231213

SECTION 231323 - FACILITY ABOVEGROUND FUEL-OIL STORAGE TANKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aboveground fuel-oil storage tanks, insulated, steel.
2. Aboveground fuel-oil storage tank, shop painting.
3. Aboveground fuel-oil storage tank accessories.
4. Fuel-oil-level gauge system.
5. Fuel-oil leak-detection and monitoring systems.
6. Fuel oil.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and dimensions of individual components and profiles.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Fuel-oil storage tank accessories.
4. Fuel-oil leak-detection and monitoring system.

B. Shop Drawings: For aboveground fuel-oil storage tanks.

1. Include plans, elevations, sections, concrete bases, anchors, and lifting or supporting points.
2. Indicate details of equipment assemblies. Indicate dimensions, components, and location and size of each field connection.
3. Shop Drawing Scale: 1/4 inch per foot.

1.3 INFORMATIONAL SUBMITTALS

A. Site Survey: Plans, drawn to scale, on which fuel-oil storage tanks are indicated and coordinated with other services and utilities.

B. Seismic Qualification Data: Certificates for aboveground fuel oil storage tanks, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Welding certificates.

D. Field quality-control reports.

E. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-oil equipment and accessories to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Lift and support fuel-oil storage tanks only at designated lifting or supporting points, as shown on Shop Drawings. Do not move or lift tanks unless empty.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of fuel-oil storage tanks that fail in materials or workmanship within specified warranty period.

1. Storage Tanks:

a. Failures include, but are not limited to, the following when used for storage of fuel oil at temperatures not exceeding 150 deg F:

1) Structural failures including cracking, breakup, and collapse.
2) Corrosion failure including external and internal corrosion of steel tanks.

b. Warranty Period: 30 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ABOVEGROUND FUEL-OIL STORAGE TANKS, INSULATED, STEEL

A. Manufacturers: Subject to compliance with requirements, provide products by the

following owner preferred manufacturer:

1. Highland Tank & Manufacturing Company, Inc.

B. Source Limitations: Obtain insulated, steel, aboveground fuel-oil storage tanks from single manufacturer.

C. Description: UL 142, UL 2085, and STI Fireguard requirements, thermally insulated and fire resistant as defined in NFPA 30, double-wall, horizontal steel tank; with primary- and secondary-containment walls and insulation in the interstitial space.

D. Construction: Fabricated with welded carbon steel and insulation; suitable for operation at atmospheric pressure and for storing fuel oil with specific gravity up to 1.1 and with test temperature in accordance with UL 2085.

E. Capacities and Characteristics:

1. Capacity: 25,000 gal.
2. Diameter: 11 feet.
3. Length: 39 feet, 3 inches..
4. Connection Sizes:

    a. Remote Tank Fill Supply Line: 4 NPS.
    b. Primary Emergnecy Vent Line: 10 NPS, Flanged.
    c. Interstitial Emergency Vent Line: 10 NPS Flanged.
    d. Tank Normal Vent: 4 NPS.
    e. Fuel Oil Supply Outlet: 4 NPS.
    f. Fuel Oil Return Inlet: 4 NPS.
    g. Polished Fuel Oil Supply: 4 NPS.
    h. Polished Fuel Oil Return: 4 NPS.
    i. Polished Fuel Oil Supply PRV: 4 NPS.
    j. Tank Level Sensor: 4 NPS.
    k. Interstitial Leak Monitoring: 2 NPS.
    l. Extra tank openings: Two – 4 NPS, as indicated on contract drawings.
    m. Provide and install factory signage to meet all NFPA and IFC requirements for:

        1) Fuel Type
        2) Storage Capacity
        3) Flammable Product Warning
        4) No Smoking Warning

5. Manholes:

    a. Number Required: One.
    b. Diameter: 24 inches.

6. Fuel: Diesel.

2.2 ABOVEGROUND FUEL-OIL STORAGE TANK, SHOP PAINTING

A. Apply manufacturer's standard prime coat to exterior steel surface of aboveground fuel-oil storage tank and tank supports.

B. Prepare exterior steel surface of aboveground fuel-oil storage tank and tank supports.

C. Shop Cleaning: After fabrication, blast clean in accordance with SSPC-SP 6 White Blast.

D. After cleaning, remove dust or residue from cleaned surfaces.

E. If surface develops rust before prime coat is applied, repeat surface preparation.

F. Apply manufacturer's standard prime coat to shop-cleaned, dry surface same day as surface preparation.

G. Apply manufacturer's standard urethane 5-7 DFT finish coats.

H. Apply manufacturer’s standard signage to comply with NFPA and IFC requirements.

2.3 ABOVEGROUND FUEL-OIL STORAGE TANK ACCESSORIES

A. Tank Manholes:

1. 24-inch minimum diameter; bolted, flanged, and gasketed; centered on top of tank.

B. Threaded pipe connection fittings on top of tank for interstitial space monitoring, level sensors, interstitial fire refractory fill, remote fuel oil fill, fuel oil supply, fuel oil return, polished fuel oil supply, polished fuel oil return, normal vent, primary tank emergency vent, interstitial emergency vent, PRV discharge and two extra openings.. Interstitial monitoring must be 2 NPS, interstitial fire refractory fill install must be 2 NPS, and all other ports for pipe connections must be 4 NPS. Include cast-iron plugs for shipping.

C. Striker Plates: Inside tank, on bottom below fill, vent, sounding, gauge, and other tube openings.

D. Lifting Lugs: For handling and installation.

E. Ladders:

1. Carbon-steel ladder inside tank, anchored to top and bottom, and located as indicated. Include reinforcement of tank at bottom of ladder.
2. Carbon-steel stairs outside tank, anchored to full length cat walk for top of tank access to all ports.

    a. Handrails: Include welded steel handrails for stairs.
    b. Platforms: Include standard platform and walkway per manufacturer full length of both tanks and 5 feet bridge between tanks to access man hole

and all tank openings.

F. Supply Tube: Extension of supply piping fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle.

G. Overfill Prevention Valve: Provide on remote fill supply line as close to top of inside tanks as possible

H. Double Poppet Foot Valve: Provide on all pump suction lines per manufacturer's installation recommendations.

2.4 FUEL-OIL-LEVEL GAUGE SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products by the following owner preferred manufacturer:

1. Highland Tank & Manufacturing Company, Inc.
2. Simplex, Inc.

B. Source Limitations: Obtain fuel-oil-level gauge system from single manufacturer of remote fill station and pumping equipment.

C. Description: Calibrated fuel-oil-level gauge system complying with UL 180 with floats or UL 1238 with probes or other sensors interconnected and interacting with remote tank fill station, primary fuel oil supply pump skid, and secondary fuel polishing pump skid.

D. Controls: Electrical, operating on 4-20mA.

2.5 FUEL-OIL LEAK-DETECTION AND MONITORING SYSTEMS

A. Fuel-Oil Leak Detection and Monitoring, Cable and Sensor System: Comply with UL 1238.

1. Manufacturers: Subject to compliance with requirements, provide products by the following owner preferred manufacturer:

a. Highland Tank & Manufacturing Company, Inc.
b. Simplex, Inc.

2. Source Limitations: Obtain cable-and-sensor fuel-oil leak-detection and monitoring system from single manufacturer.
3. Calibrated fuel-oil leak-detection and monitoring system with probes and other sensors and remote alarm panel for fuel-oil storage tanks and fuel-oil piping.
4. Include fittings and devices required for testing.
5. Controls: Electrical, operating on 120] V ac or 4-20mA per manufacturer's requirement.

2.6 FUEL OIL

A. Fuel Oil: ASTM D396, Grade No. 2.

B. Diesel Fuel Oil: ASTM D975, [Grade No. 2-D, general purpose, high volatility.

C. Provide Fuel as indicated by Owner.

2.7 SOURCE QUALITY CONTROL

A. Pressure test and inspect fuel-oil storage tanks, after fabrication and before shipment, in accordance with ASME and the following:

1. Horizontal, Insulated, Steel Aboveground Fuel-Oil Storage Tanks: UL 142 and UL 2085, shipped under vacuum.

B. Affix standards organization's code stamp.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for aboveground fuel-oil storage tanks to verify actual locations.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.3 INSTALLATION OF ABOVEGROUND FUEL-OIL STORAGE TANKS

A. Install tank in accordance with NFPA 30 and 31 by a tank-manufacturer-trained and -certified contractor.

B. Install tank bases and supports.

C. Concrete Bases: Anchor aboveground fuel oil storage tank to concrete base in accordance with equipment manufacturer's written instructions and in accordance with seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete slab. Unless otherwise indicated, install dowel rods on 6 inch centers around the full perimeter of the

base or as shown on structural drawings.

3. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded. Refer to structural drawings.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Use psig per structural drawings, 28-day, compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

D. Connect piping and vent fittings.

E. Install ground connections.

F. Confirm new tanks are shipped and arrive at site under vacuum seal from manufacturer.

G. Install interconnected remote fill station, primary fuel supply pump skid, secondary fuel polishing pump skid, and four-day tank return pump skids with two above ground storage tanks.

H. Install tank leak-detection and monitoring devices.

I. Install steel double wall insulated aboveground fuel-oil storage tanks in accordance with STI Fireguard standards.

J. Fill storage tanks with fuel product per Owner’s direction.

3.4 INSTALLATION OF FUEL-OIL-LEVEL GAUGE SYSTEM

A. Install liquid-level gauge system. Install interconnected remote fill station, primary fuel supply pump skid, and secondary fuel polishing pump skid panels where indicated on Drawings.

3.5 INSTALLATION OF LEAK-DETECTION AND MONITORING SYSTEM

A. Install leak-detection and monitoring system. Install alarm panel where indicated on Drawings.

1. Double-Wall, Fuel-Oil Storage Tanks: Install probes in interstitial space.
2. Existing Rupture Containment Tank for each Day Tank: Install probes in rupture containment tank and connect to day tank return pump skid control panel.
3. Install liquid-level gauge in each above ground storage tank.

3.6 LABELING AND IDENTIFYING

A. Nameplates, pipe identification, and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Provide and install manufacturer’s signage to comply with NFPA and IFC requirements.

3.7 ABOVEGROUND FUEL-OIL STORAGE TANK, FIELD PAINTING

A. Prepare and touch up damaged exterior surface of aboveground fuel-oil storage tank, stairs, catwalks, and supports as specified in "Aboveground Fuel-Oil Storage Tank, Shop Painting" Article.

B. Prepare exterior steel surface of aboveground fuel-oil storage tank and tank supports.

C. Field Cleaning: After fabrication, blast clean in accordance with SSPC-SP 6.

D. After cleaning, remove dust or residue from cleaned surfaces.

E. If surfaces develop rust before prime coat is applied, repeat surface preparation.

F. Prepare surface of aboveground fuel-oil storage tank, stairs, catwalks, and supports. Apply painting for moderate environment semigloss finish for ferrous metal.

3.8 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Engage factory-authorized service representatives to install Fireguard refractory and tank pedestals. Install, emergency vents, stairs, and catwalks per manufacturer’s installation instructions.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Tanks: Minimum hydrostatic or compressed-air test pressures for fuel-oil storage tanks that have not been factory tested and do not bear the ASME code stamp or a listing mark acceptable to authorities having jurisdiction:

    a. Double-Wall Tanks:

        1) Inner Tanks: Minimum 3 psig and maximum 5 psig.
        2) Interstitial Space: Minimum 3 psig and maximum 5 psig, or 5.3-in. Hg vacuum.

    b. Where vertical height of fill and vent pipes is such that the static head imposed on the bottom of the tank is greater than 10 psig, hydrostatically test the tank and fill and vent pipes to a pressure equal to the static head thus imposed.
    c. Maintain the test pressure for one hour.

D. Aboveground fuel-oil storage tanks will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 231323

SECTION 260010 - SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes requirements generally applicable to all electrical Work on the Project, including but not limited to Work specified in Divisions 26, 27, and 28.

1.2 REFERENCES

A. Abbreviations and Acronyms for Electrical Terms and Units of Measure:

1. 8P8C: An 8-position 8-contact modular jack.
2. A: Ampere, unit of electrical current.
3. AC or ac: Alternating current.
4. AFCI: Arc-fault circuit interrupter.
5. AGC: Automatic gain control.
6. AIC: Ampere interrupting capacity.
7. AL, Al, or ALUM: Aluminum.
8. ASD: Adjustable-speed drive.
9. ATP: Acceptance test procedure.
10. ATS: Automatic transfer switch.
11. A/V: Audio/visual.
12. AWG: American wire gauge; see ASTM B258.
13. BAS: Building automation system.
14. BDA: Bi-directional amplifier.
15. BIL: Basic impulse insulation level.
16. BIM: Building information modeling.
17. BMS: Building management system.
18. BNC: Bayonet Neill-Concelman - type of connector.
19. B/W: Black and white.
20. CAD: Computer-aided design or drafting.
21. CATV: Community antenna television.
22. CB: Circuit breaker.
23. CCD: Charge-coupled device.
24. CCTV: Closed-circuit television.
25. cd: Candela, the SI fundamental unit of luminous intensity.
26. CO/ALR: Copper-aluminum, revised.
27. COPS: Critical operations power system.
28. CU or Cu: Copper.
29. CU-AL or AL-CU: Copper-aluminum.
30. DACR: Digital alarm communicator receiver.
31. DACT: Digital alarm communicator transmitter.
32. DAS: Distributed antenna system.
33. dB: Decibel, a unitless logarithmic ratio of two electrical, acoustical, or optical power values.

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34. dB(A-weighted) or dB(A): Decibel acoustical sound pressure level with A-weighting applied in accordance with IEC 61672-1.
35. dB(adjusted) or dBa: Decibel weighted absolute noise power with respect to 3.16 pW (minus 85 dBm).
36. dBm: Decibel absolute power with respect to 1 mW.
37. dBmV: Decibel absolute voltage with respect to 1 mV across identical impedance.
38. DC or dc: Direct current.
39. DCOA: Designated critical operations area.
40. DDC: Direct digital control (HVAC).
41. DGP: Data gathering panel.
42. DHCP: Dynamic host configuration protocol.
43. EGC: Equipment grounding conductor.
44. ELV: Extra-low voltage.
45. EMF: Electromotive force.
46. EMI: Electromagnetic interference.
47. EMP: Electrical maintenance program (operation and maintenance); electromagnetic pulse (transient analysis).
48. EPS: Emergency power supply.
49. EPSS: Emergency power supply system.
50. ERCES: Emergency responder communications enhancement system.
51. ESS: Energy storage system.
52. EV: Electric vehicle.
53. EVPE: Electric vehicle power export equipment.
54. EVSE: Electric vehicle supply equipment.
55. FACU: Fire-alarm control unit.
56. FAS: Fire-alarm system.
57. fc: Footcandle, an internationally recognized unit of illuminance equal to one lumen per square foot or 10.76 lx. The simplified conversion 1 fc = 10 lx in the Specifications is common practice and considered adequate precision for building construction activities. When there are conflicts, lux is the primary unit; footcandle is specified for convenience.
58. FCC: Federal Communications Commission; fire command center.
59. FLC: Full-load current.
60. ft: Foot.
61. ft-cd: Foot-candle, the antiquated U.S. standard unit of illuminance, equal to one international candle measured at a distance of one foot, that was superseded in 1948 by the unit "footcandle" when the SI unit candela (cd) replaced the international candle; see "fc."
62. FTP: File transfer protocol.
63. FXO: Foreign exchange office.
64. GEC: Grounding electrode conductor.
65. GFCI: Ground-fault circuit interrupter.
66. GFPE: Ground-fault protection of equipment.
67. GND: Ground.
68. GROL: General Radiotelephone Operator License (FCC).
69. H.323: Audio and video protocol.
70. HACR: Heating, air conditioning, and refrigeration.
71. HDPE: High-density polyethylene.
72. HID: High-intensity discharge.
73. HP or hp: Horsepower.

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74. HVAC: Heating, ventilating, and air conditioning.
75. Hz: Hertz.
76. I&TFAS: Inspection and testing of fire-alarm system.
77. IB-PSC: In-building public safety communications.
78. IBT: Intersystem bonding termination.
79. ICT: Information and communications technology.
80. IDC: Initiating device circuit.
81. inch: Inch. To avoid confusion, the abbreviation "in." is not used.
82. I/O: Input/output.
83. IP: Ingress protection rating (enclosures); Internet protocol (communications).
84. IR: Infrared.
85. IS: Intrinsically safe.
86. IT&R: Inspecting, testing, and repair.
87. ITE: Information technology equipment.
88. kAIC: Kiloampere interrupting capacity.
89. kcmil or MCM: One thousand circular mils.
90. kV: Kilovolt.
91. kVA: Kilovolt-ampere.
92. kvar: Kilovolt-ampere reactive.
93. kW: Kilowatt.
94. kWh: Kilowatt-hour.
95. LAN: Local area network.
96. lb: Pound (weight).
97. lbf: Pound (force).
98. LCD: Liquid-crystal display.
99. LCDI: Leakage-current detector-interrupter.
100. LED: Light-emitting diode.
101. Li-ion: Lithium-ion.
102. lm: Lumen, the SI-derived unit of luminous flux.
103. LNG: Liquefied natural gas.
104. LP-Gas: Liquefied petroleum gas.
105. LRC: Locked-rotor current.
106. LTE: Long-term evolution (mobile device technology standard).
107. LV: Low voltage.
108. lx: Lux, the SI-derived unit of illuminance equal to one lumen per square meter.
109. m: Meter.
110. MATV: Master antenna television.
111. MCC: Motor-control center.
112. MDC: Modular data center.
113. MG set: Motor-generator set.
114. MIDI: Musical instrument digital interface.
115. MLO: Main lugs only.
116. MPEG: Moving Picture Experts Group.
117. MPEG-2: Abbreviation for the ISO/IEC Moving Picture Experts Group's standard for generic coding of moving pictures and associated audio information (ISO/IEC 13818) released in 1995 and used for most over-the-air and satellite broadcast digital television.
118. MPEG-4: Abbreviation for the ISO/IEC Moving Picture Experts Group's standard framework for coding of audio-visual objects (ISO/IEC 14496) released in 1999, with digital rights management and more advanced compression algorithms than MPEG-2.

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119. MOV: Metal-oxide varistor.
120. MV: Medium voltage.
121. MVA: Megavolt-ampere.
122. mW: Milliwatt.
123. MW: Megawatt.
124. MWh: Megawatt-hour.
125. NAC: Notification appliance circuit.
126. N.C.: Normally closed.
127. NFC: Near field communications.
128. Ni-Cd: Nickel-cadmium.
129. NICET: National Institute for Certification in Engineering Technologies, a division of the National Society of Professional Engineers.
130. Ni-MH: Nickel-metal hydride.
131. NIU: Network interface unit.
132. N.O.: Normally open.
133. NPT: National (American) standard pipe taper.
134. NTSC: National Television System Committee.
135. OCPD: Overcurrent protective device.
136. ONT: Optical network terminal.
137. PC: Personal computer.
138. PCS: Power conversion system.
139. PCU: Power-conditioning unit.
140. Percent obs/ft (percent obs/m): Percent obscuration per unit distance; unit of measure for sensitivity of smoke detectors.
141. PF or pf: Power factor.
142. PHEV: Plug-in hybrid electric vehicle.
143. PIR: Passive infrared.
144. PLC: Programmable logic controller.
145. PLFA: Power-limited fire alarm.
146. PoE: Power over Ethernet.
147. POTS: Plain old telephone service. See "public switched telephone network" definition.
148. PSTN: Public switched telephone network.
149. PTZ: Pan-tilt-zoom.
150. PV: Photovoltaic.
151. PVC: Polyvinyl chloride.
152. pW: Picowatt.
153. RAID: Redundant array of inexpensive disks; redundant array of independent disks.
154. RAM: Random-access memory.
155. RAT: Radio alarm transmitter.
156. REX: Request-to-exit.
157. RF: Radio frequency.
158. RFI: (electrical) Radio-frequency interference; (contract) Request for interpretation.
159. RMS or rms: Root-mean-square.
160. RPM or rpm: Revolutions per minute.
161. SCADA: Supervisory control and data acquisition.
162. SCCR: Short-circuit current rating.
163. SCR: Silicon-controlled rectifier.
164. SIP: Session initiation protocol.

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165. SLC: Signaling-line circuit.
166. SPD: Surge protective device.
167. SPDT: Single pole, double throw.
168. sq.: Square.
169. SWD: Switching duty.
170. TCP/IP: Transmission Control Protocol/Internet Protocol.
171. TEFC: Totally enclosed fan-cooled.
172. TR: Tamper resistant.
173. TVSS: Transient voltage surge suppressor.
174. UHF: Ultra-high frequency.
175. UL: (standards) UL Standards & Engagement Inc.; (product categories) UL, LLC.
176. UL CCN: UL Category Control Number.
177. UPS: Uninterruptible power supply.
178. USB: Universal serial bus.
179. UTC: Coordinated universal time.
180. UV: Ultraviolet.
181. V: Volt, unit of electromotive force.
182. V(ac): Volt, alternating current.
183. V(dc): Volt, direct current.
184. VA: Volt-ampere, unit of complex electrical power.
185. VAR: Volt-ampere reactive, unit of reactive electrical power.
186. VFC: Variable-frequency controller.
187. VOM: Volt-ohm-multimeter.
188. VoIP: Voice over Internet Protocol.
189. VPN: Virtual private network.
190. VRLA: Valve regulated lead acid; also called "sealed lead acid (SLA)" or "valve regulated sealed lead acid."
191. VU: Volume unit.
192. W: Watt, unit of real electrical power.
193. WAN: Wide area network.
194. Wh: Watt-hour, unit of electrical energy usage.
195. WPT: Wireless power transfer.
196. WPTE: Wireless power transfer equipment.
197. WR: Weather resistant.

B. Abbreviations and Acronyms for Electrical Raceway Types:

1. EMT: Electrical metallic tubing.
2. EMT-A: Aluminum electrical metallic tubing.
3. EMT-S: Steel electrical metallic tubing.
4. EMT-SS: Stainless steel electrical metallic tubing.
5. ENT: Electrical nonmetallic tubing.
6. EPEC: Electrical HDPE underground conduit (thin wall).
7. EPEC-A: Type A electrical HDPE underground conduit.
8. EPEC-B: Type B electrical HDPE underground conduit.
9. ERMC: Electrical rigid metal conduit.
10. ERMC-A: Aluminum electrical rigid metal conduit.
11. ERMC-S: Steel electrical rigid metal conduit.
12. ERMC-S-G: Galvanized-steel electrical rigid metal conduit.
13. ERMC-S-PVC: PVC-coated-steel electrical rigid metal conduit.
14. ERMC-SS: Stainless steel electrical rigid metal conduit.

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15. FMC: Flexible metal conduit.
16. FMC-A: Aluminum flexible metal conduit.
17. FMC-S: Steel flexible metal conduit.
18. FMT: Steel flexible metallic tubing.
19. FNMC: Flexible nonmetallic conduit. See "LFNC."
20. HDPE: HDPE underground conduit (thick wall).
21. HDPE-40: Schedule 40 HDPE underground conduit.
22. HDPE-80: Schedule 80 HDPE underground conduit.
23. IMC: Steel electrical intermediate metal conduit.
24. LFMC: Liquidtight flexible metal conduit.
25. LFMC-A: Aluminum liquidtight flexible metal conduit.
26. LFMC-S: Steel liquidtight flexible metal conduit.
27. LFMC-SS: Stainless steel liquidtight flexible metal conduit.
28. LFNC: Liquidtight flexible nonmetallic conduit.
29. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
30. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.
31. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.
32. PVC: Rigid PVC conduit.
33. PVC-40: Schedule 40 rigid PVC conduit.
34. PVC-80: Schedule 80 rigid PVC Conduit.
35. PVC-A: Type A rigid PVC concrete-encased conduit.
36. PVC-EB: Type EB rigid PVC concrete-encased underground conduit.
37. RGS: See ERMC-S-G.
38. RMC: See ERMC.
39. RTRC: Reinforced thermosetting resin conduit.
40. RTRC-AG: Low-halogen, aboveground reinforced thermosetting resin conduit.
41. RTRC-AG-HW: Heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
42. RTRC-AG-SW: Standard wall, low-halogen, aboveground reinforced thermosetting resin conduit.
43. RTRC-AG-XW: Extra heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
44. RTRC-BG: Low-halogen, belowground reinforced thermosetting resin conduit.

C. Abbreviations and Acronyms for Electrical Single-Conductor and Multiple-Conductor Cable Types:

1. AC: Armored cable.
2. CATV: Coaxial general-purpose cable.
3. CATVP: Coaxial plenum cable.
4. CATVR: Coaxial riser cable.
5. CI: Circuit integrity cable.
6. CL2: Class 2 cable.
7. CL2P: Class 2 plenum cable.
8. CL2R: Class 2 riser cable.
9. CL2X: Class 2 cable, limited use.
10. CL3: Class 3 cable.
11. CL3P: Class 3 plenum cable.
12. CL3R: Class 3 riser cable.
13. CL3X: Class 3 cable, limited use.
14. CM: Communications general-purpose cable.

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15. CMG: Communications general-purpose cable.
16. CMP: Communications plenum cable.
17. CMR: Communications riser cable.
18. CMUC: Under-carpet communications wire and cable.
19. CMX: Communications cable, limited use.
20. DG: Distributed generation cable.
21. FC: Flat cable.
22. FCC: Flat conductor cable.
23. FPL: Power-limited fire-alarm cable.
24. FPLP: Power-limited fire-alarm plenum cable.
25. FPLR: Power-limited fire-alarm riser cable.
26. IGS: Integrated gas spacer cable.
27. ITC: Instrumentation tray cable.
28. ITC-ER: Instrumentation tray cable, exposed run.
29. MC: Metal-clad cable.
30. MC-FPL/FPLR/FPLP: Metal-clad cable containing FPL, FPLR, or FPLP.
31. MC-HL: Metal-clad cable, hazardous location.
32. MI: Mineral-insulated, metal-sheathed cable.
33. MTW: (machine tool wiring) Moisture-, heat-, and oil-resistant thermoplastic cable.
34. MV: Medium-voltage cable.
35. NM: Nonmetallic sheathed cable.
36. NMC: Nonmetallic sheathed cable with corrosion-resistant nonmetallic jacket.
37. NMS: Nonmetallic sheathed cable with signaling, data, and communications conductors, plus power or control conductors.
38. NPLF: Non-power-limited fire-alarm circuit cable.
39. NPLFP: Non-power-limited fire-alarm circuit cable for environmental air spaces.
40. NPLFR: Non-power-limited fire-alarm circuit riser cable.
41. NUCC: Nonmetallic underground HDPE conduit with conductors.
42. OFC: Conductive optical fiber general-purpose cable.
43. OFCG: Conductive optical fiber general-purpose cable.
44. OFCP: Conductive optical fiber plenum cable.
45. OFCR: Conductive optical fiber riser cable.
46. OFN: Nonconductive optical fiber general-purpose cable.
47. OFNG: Nonconductive optical fiber general-purpose cable.
48. OFNP: Nonconductive optical fiber plenum cable.
49. OFNR: Nonconductive optical fiber riser cable.
50. P: Marine shipboard cable.
51. PLTC: Power-limited tray cable.
52. PLTC-ER: Power-limited tray cable, exposed run.
53. PV: Photovoltaic cable.
54. RHH: (high heat) Thermoset rubber, heat-resistant cable.
55. RHW: Thermoset rubber, moisture-resistant cable.
56. SA: Silicone rubber cable.
57. SE: Service-entrance cable.
58. SER: Service-entrance cable, round.
59. SEU: Service-entrance cable, flat.
60. SIS: Thermoset cable for switchboard and switchgear wiring.
61. TBS: Thermoplastic cable with outer braid.
62. TC: Tray cable.
63. TC-ER: Tray cable, exposed run.

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64. TC-ER-HL: Tray cable, exposed run, hazardous location.
65. THW: Thermoplastic, heat- and moisture-resistant cable.
66. THHN: Thermoplastic, heat-resistant cable with nylon jacket outer sheath.
67. THHW: Thermoplastic, heat- and moisture-resistant cable.
68. THWN: Thermoplastic, moisture- and heat-resistant cable with nylon jacket outer sheath.
69. TW: Thermoplastic, moisture-resistant cable.
70. UF: Underground feeder and branch-circuit cable.
71. USE: Underground service-entrance cable.
72. XHH: Cross-linked polyethylene, heat-resistant cable.
73. XHHW: Cross-linked polyethylene, heat- and moisture-resistant cable.

D. Abbreviations for Grounding and Bonding:

1. BBC: Backbone bonding conductor, for connecting multiple TBBs serving the same floor.
2. PBB: Primary bonding busbar; located in main distribution frame room, ideally near electrical service entrance.
3. RBB: Rack bonding busbar; located in equipment cabinets and racks.
4. SBB: Secondary bonding busbar; located in intermediate distribution frame rooms.
5. TBB: Telecommunications bonding backbone, for connecting SBBs to PBB.
6. TBC: Telecommunications bonding conductor, for connecting PBB to intersystem bonding termination device or busbar at electrical service entrance.
7. TEBC: Telecommunications equipment bonding conductor, for connecting RBBs to SBBs or PBB.

E. UBC: Unit bonding conductor, for connecting individual communications equipment to RBBs or SBBs.Definitions:

1. 8-Position 8-Contact (8P8C) Modular Jack: An unkeyed jack with up to eight contacts commonly used to terminate twisted pair and multiconductor Ethernet cable. Also called a "TIA-1096 miniature 8-position series jack" (8PSJ), or an "IEC 8877 8-pole jack."

    a. Be careful when suppliers use "RJ45" generically. Obsolete RJ45 jacks used for analog telephone cables have rejection keys. 8P8C jacks used for digital telephone cables and Ethernet cables do not have rejection keys.

2. Agile Receiver: A broadband receiver that can be tuned to any desired channel.
3. Backbone: Primary segment of ERCES between donor antenna and distribution cabling.
4. Basic Impulse Insulation Level (BIL): Reference insulation level expressed in impulse crest voltage with a standard wave not longer than 1.5 times 50 microseconds and 1.5 times 40 microseconds.
5. Cable: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "cable" is (1) a conductor with insulation, or a stranded conductor with or without insulation (single-conductor cable); or (2) a combination of conductors insulated from one another (multiple-conductor cable).
6. Carrier: A pure-frequency signal that is modulated to carry information. In the

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process of modulation, the signal is spread out over a wider band. The carrier frequency is the center frequency on any television channel.

7. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.
8. Conductive Cable: Cable containing non-current-carrying electrically conductive members such as metallic strength members and metallic vapor barriers.
9. Conductor: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "conductor" is (1) a wire or combination of wires not insulated from one another, suitable for carrying an electric current; (2) (National Electrical Safety Code) a material, usually in the form of wire, cable, or bar, suitable for carrying an electric current; or (3) (general) a substance or body that allows a current of electricity to pass continuously along it.
10. Conduit: A structure containing one or more duct raceways.
11. Control Unit: A system component that monitors inputs and controls outputs through various types of circuits.

    a. Autonomous Control Unit (ACU): The primary control unit for an in-building mass notification system (MNS).
    b. Emergency Communications Control Unit (ECCU): A system capable of sending mass notification messages to individual buildings, zones of buildings, individual outdoor loudspeaker arrays, or zones of outdoor loudspeaker arrays; or a building, multiple buildings, outside areas, or a combination of these.
    c. Fire-alarm control unit (FACU).
    d. Wireless Control Unit: A component that transmits/receives and processes wireless signals.

12. Direct Buried: Installed underground without encasement in concrete or other protective material.
13. Downlink: The signal from a base station to portable radios.
14. Duct Bank: An arrangement of conduit providing one or more continuous duct raceways between two points.
15. Duct Raceway: A single enclosed raceway for conductors or cable.
16. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include the following:

    a. Cabinet: An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.
    b. Concrete Box: A box intended for use in poured concrete.
    c. Conduit Body: A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
    d. Conduit Box: A box having threaded openings or knockouts for conduit, EMT, or fittings.
    e. Cover Plate: A cover designed for protecting wiring devices installed in

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flush-mounted device boxes while permitting their safe operation; also called a faceplate or wallplate.

f. Cutout Box: An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure.
g. Device Box: A box with provisions for mounting a wiring device directly to the box.
h. Extension Ring: A ring intended to extend the sides of an outlet box or device box to increase the box depth, volume, or both.
i. Floor Box: A box mounted in the floor intended for use with a floor box cover and other components to complete the floor box enclosure.
j. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed against the entrance of scrub water at the floor level.
k. Floor Nozzle: An enclosure used on a wiring system, intended primarily as a housing for a receptacle, provided with a means, such as a collar, for surface-mounting on a floor, which may or may not include a stem to support it above the floor level, and is sealed against the entrance of scrub water at the floor level.
l. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.
m. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.
n. Pedestal Floor Box Cover: A floor box cover that, when installed as intended, provides a means for typically vertical or near-vertical mounting of receptacle outlets above the floor's finished surface.
o. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.
p. Raised-Floor Box: A floor box intended for use in raised floors.
q. Recessed Access Floor Box: A floor box with provisions for mounting wiring devices below the floor surface.
r. Recessed Access Floor Box Cover: A floor box cover with provisions for passage of cords to recessed wiring devices mounted within a recessed floor box.
s. Ring: A sleeve, which is not necessarily round, used for positioning a recessed wiring device flush with the plaster, concrete, drywall, or other wall surface.
t. Ring Cover: A box cover, with raised center portion to accommodate a specific wall or ceiling thickness, for mounting wiring devices or luminaires flush with the surface.
u. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.

17. Fault Limited: Providing or being served by a source of electrical power that is limited to not more than 100 W when tested in accordance with UL 62368-1.

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a. The term "fault limited" is intended to encompass most Class 1, 2, and 3 power-limited sources complying with Article 725 of NFPA 70; Class ES1 and ES2 electrical energy sources that are Class PS1 electrical power sources (e.g., USB); and Class ES3 electrical energy sources that are Class PS1 and PS2 electrical power sources (e.g., PoE). See UL 62368-1 for discussion of classes of electrical energy sources and classes of electrical power sources.

18. High-Performance Building: A building that integrates and optimizes on a life-cycle basis all major high-performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.
19. One-Line Diagram: A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein. Also called "single-line diagram."
20. Protective Device: A device that senses when an abnormal current flow, abnormal voltage potential, or other abnormal electrical waveform exists and then disconnects the affected portion of the circuit from the system. Common protective devices include fuses, circuit breakers, relays, ground-fault circuit interrupters, and arc-fault circuit interrupters.
21. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.
22. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.
23. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
24. Sheath: A continuous metallic covering for conductors or cables.
25. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
26. Systems Integration: The bringing together of components of several systems containing interacting components to achieve indicated functional operation of combined systems.
27. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:

    a. Control Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is supplied from a battery or other Class 2 or Class 3 power-limited source.
    b. Line Voltage: (1) (controls) Designed to operate using the supplied low-voltage power without transformation. (2) (transmission lines, transformers, SPDs) The line-to-line voltage of the supplying power system.
    c. Extra-Low Voltage (ELV): Not having electromotive force between any two conductors, or between a single conductor and ground, exceeding 30 V(ac rms), 42 V(ac peak), or 60 V(dc).
    d. Low Voltage (LV): Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 30 V but not exceeding 1000 V.

28. Wire: In accordance with NIST NBS Circular 37 and IEEE standards, in the United States for the purpose of interstate commerce, the definition of "wire" is a

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slender rod or filament of drawn metal. A group of small wires used as a single wire is properly called a "stranded wire." A wire or stranded wire covered with insulation is properly called an "insulated wire" or a "single-conductor cable." Nevertheless, when the context indicates that the wire is insulated, the term "wire" will be understood to include the insulation.

29. Zone. A defined area within a protected premises. It is a space or area for which an intrusion must be detected and uniquely identified. The sensor or group of sensors must then be assigned to perform the detection, and any interface equipment between sensors and communication must link to master control unit.

1.3 COORDINATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify [**Architect**][**Construction Manager**][**Owner**][**Tenant**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without [**Architect's**][**Construction Manager's**][**Owner's**][**Tenant's**] written permission.
3. Coordinate interruption with systems impacted by outage including, but not limited to, the following:

    a. Exercising generators.

4. Arrange to provide temporary emergency and standby electrical [**service**][**or**][**power**] so facility may remain occupied during the outage in accordance with requirements. Coordinate power requirements with Owner.

B. Interruption of Existing Fire-Alarm System: Do not interrupt fire-alarm system to facilities occupied by Owner or others unless permitted under the following conditions:

1. Notify [**Architect**][**Construction Manager**][**Owner**][**Tenant**] no fewer than [**seven**]<**Insert number**> days in advance of proposed interruption of fire-alarm system.
2. Do not proceed with interruption of fire-alarm system without [**Architect's**][**Construction Manager's**][**Owner's**][**Tenant's**] written permission.

1.4 PREINSTALLATION MEETINGS

A. Electrical Preconstruction Conference: Schedule conference with Architect and Owner, not later than **10** days after Notice to Proceed. Agenda topics include, but are not limited to, the following:

1. Electrical installation schedule.
2. Status of power system studies.
3. Value analysis proposals and requests for substitution of electrical equipment.
4. Utility work coordination and class of service requests.
5. Commissioning activities.

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6. Sustainability activities[**, including Measurement and Verification Plan**].

1.5 SEQUENCING

A. Conduct and submit results of power system studies before submitting product data and Shop Drawings for electrical equipment.

1.6 ACTION SUBMITTALS

A. Coordination Drawings for Structural Supports: Show coordination of structural supports for equipment and devices, including restraints and bracing for control of seismic and wind loads, with other systems, equipment, and structural supports in the vicinity.

B. Coordination Drawings for Conduit Routing: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

C. Coordination Drawings for Large Equipment Outdoor Installations:

1. Utilities site plan, drawn to scale, showing heavy equipment or truck access paths for maintenance and replacement, with the following items shown and coordinated with each other, based on input from installers of the items involved:

a. Fences and walls, dimensioned concrete bases, outlines of equipment, conduit entries, and grounding and bonding locations.
b. Indicate clear dimensions for fence gates and wall openings.
c. Indicate depth and type of ground cover, and locations of trees, shrubbery, and other obstructions in access path.
d. Indicate clear height below tree branches, overhead lines, bridges, and other overhead obstructions in access path, or where cranes and hoists will be needed to handle large electrical equipment.
e. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways.
f. Dimensioned working clearances and dedicated areas around electrical equipment.

1.7 INFORMATIONAL SUBMITTALS

A. Electrical Installation Schedule: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for electrical installation Work to Owner and Architect including, but not limited to, milestone dates for the following activities:

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1. Submission of power system studies.
2. Submission of specified coordination drawings.
3. Submission of action submittals specified in Division 26.
4. Orders placed for major electrical equipment.
5. Arrival of major electrical equipment on-site.
6. Preinstallation meetings specified in Division 26.
7. Utility service outages.
8. Utility service inspection and activation.
9. Mockup reviews.
10. Closing of walls and ceilings containing electrical Work.
11. System startup, testing, and commissioning activities for major electrical equipment.
12. System startup, testing, and commissioning activities for emergency lighting.
13. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
14. Pouring of concrete housekeeping pads for electrical equipment and testing of concrete samples.
15. Requests for special inspections.
16. Requests for inspections by authorities having jurisdiction.

B. Welding certificates.

C. Qualification Statements:

1. For structural professional engineer.
2.
3. For electrical testing and inspecting agency and its on-site electrical testing supervisor.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. Include the following information:

a. Manufacturer's operating specifications.
b. User's guides for software and hardware.
c. Schedule of maintenance material items recommended to be stored at the Project site.
d. Detailed instructions covering operation under both normal and abnormal conditions.
e. Time-current curves for overcurrent protective devices and manufacturer's written instructions for testing and adjusting their settings.
f. List of load-current and overload-relay heaters with related motor nameplate data.
g. List of lamp types and photoelectric relays used on the Project, with ANSI and manufacturers' codes.
h. Manufacturer's instructions for setting field-adjustable components.
i. Manufacturer's instructions for testing, adjusting, and reprogramming microprocessor controls.

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B. Software and Firmware Operational Documentation: Provide software and firmware operational documentation, including the following:

1. Software operating and upgrade manuals.
2. Names, versions, and website addresses for locations of installed software.
3. Device address list.
4. Printout of software application and graphic screens.
5. Testing and adjusting of panic and emergency power features.
6. For lighting controls, include the following:

a. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.
b. Operation of adjustable zone controls.

C. Software:

1. Program Software Backup: Provide [**username and password for approved online or cloud solution**][**and**][**USB media that is clearly and permanently labeled with attached placard on lanyard to prevent misplacement**].

1.9 MOCKUPS

A. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.

PART 2 - PRODUCTS

2.1 SUBSTITUTION LIMITATIONS FOR ELECTRICAL EQUIPMENT

A. Substitution requests for electrical equipment will be entertained under the following conditions:

1. Substitution requests may be submitted for consideration prior to the Electrical Preconstruction Conference if accompanied by value analysis data indicating that substitution will comply with the Project performance requirements while significantly increasing value for Owner throughout life of facility.
2. Substitution requests may be submitted for consideration concurrently with submission of power system study reports when those reports indicate that substitution is necessary for safety of maintenance personnel and facility occupants.
3. Contractor is responsible for sequencing and scheduling power system studies and electrical equipment procurement. After the Electrical Preconstruction Conference, insufficient lead time for electrical equipment delivery will not be considered a valid reason for substitution.

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PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. <**Insert Project requirements**>.

B. Preinstallation Testing:

1. <**Insert Project requirements**>.

C. Evaluation and Assessment:

1. <**Insert Project requirements**>.

3.2 PREPARATION

A. Protection of In-Place Conditions:

1. <**Insert Project requirements**>.

3.3 INSTALLATION OF ELECTRICAL WORK

A. Unless more stringent requirements are specified in the Contract Documents or manufacturers' written instructions, comply with NFPA 70 and NECA NEIS 1 for installation of electrical Work on the Project. Consult Architect for resolution of conflicting requirements.

END OF SECTION 260010

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SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermoplastic-insulated wire.
2. Connectors and splices.

B. Related Requirements:

1. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
2. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
3. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
4. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
5. Section 260533.13 "Conduits for Electrical Systems" specifies installation of raceways referenced by this Section.
6. Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling" specifies installation of sleeves and sleeve seals referenced by this Section.
7. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.

1.2 ACTION SUBMITTALS

A. Product Schedule: Indicate type, use, location, and termination locations.

B. Product Data: For each type of product.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

B. Field Reports:

1. Field reports for infrared scanning.

1.4 QUALIFICATIONS

A. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials

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from qualified electrical testing laboratory recognized by authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 THERMOPLASTIC-INSULATED WIRE

A. Description: Thermoplastic-insulated wire for use in accordance with Article 310 of NFPA 70.

B. Type THHN Insulated Wire:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Alan Wire Company
    b. Alpha Wire; brand of Belden, Inc.
    c. Belden Inc.
    d. Cerro Wire LLC
    e. Encore Wire Corporation
    f. Okonite Company (The)
    g. Prysmian Cables and Systems; Prysmian Group North America
    h. Southwire Company, LLC

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Thermoplastic-Insulated Wire: UL 83.

3. Standard Features:

    a. Referenced Standard: Article 310 of NFPA 70.
    b. Insulation Voltage Rating: 600 V.
    c. Insulation Temperature Rating: 90 deg C.
    d. Conductor Material: Copper.
    e. Conductor Size: As indicated on the Drawings.

        1) Minimum Conductor Size: 12 AWG.

C. Type THHW Insulated Wire:

1. Manufacturers: Subject to compliance with requirements, available

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manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Alpha Wire; brand of Belden, Inc.
b. Encore Wire Corporation
c. Prysmian Cables and Systems; Prysmian Group North America
d. Southwire Company, LLC

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoplastic-Insulated Wire: UL 83.

3. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Temperature Rating: 75 deg C.
d. Conductor Material: Copper.
e. Conductor Size: As indicated on the Drawings.

1) Minimum Conductor Size: 12 AWG.

D. Type THWN Insulated Wire :

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Alpha Wire; brand of Belden, Inc.
b. Belden Inc.
c. Cerro Wire LLC
d. Encore Wire Corporation
e. Okonite Company (The)
f. Prysmian Cables and Systems; Prysmian Group North America
g. Southwire Company, LLC

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

a. Thermoplastic-Insulated Wire: UL 83.

3. Standard Features:

a. Referenced Standard: Article 310 of NFPA 70.
b. Insulation Voltage Rating: 600 V.
c. Insulation Temperature Rating: 75 deg C.
d. Conductor Material: Copper.
e. Conductor Size: As indicated on the Drawings.

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1) Minimum Conductor Size: 12 AWG.

2.3 CONNECTORS AND SPLICES

A. Wire Connectors and Soldering Lugs :

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. ABB, Installation Products
   b. Amphenol TPC Wire & Cable
   c. Burndy; brand of Hubbell Electrical Solutions; Hubbell Incorporated
   d. Eaton
   e. Fastenal Co.
   f. Gardner Bender; brand of ECM Industries LLC; division of nVent Electric plc
   g. Hillsdale Terminal
   h. Ideal Industries, Inc.
   i. ILSCO; brand of ECM Industries LLC; division of nVent Electric plc
   j. Marinco Power Products
   k. Morris Products Inc.
   l. Newark; an Avnet Company
   m. Panduit Corp
   n. Penn-Union Corp.; subsidiary of Nesco, Inc.
   o. TE Connectivity Ltd.

2. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

   a. Wire Connectors and Soldering Lugs: UL 486A-486B or UL 486C.

3. Standard Features:

   a. One piece, seamless, designed to terminate conductors specified in this Section.
   b. Material: Copper.
   c. Type: One hole with standard barrels.
   d. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders:

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1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits:

1. Material: Copper.

a. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway

B. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

3.3 INSTALLATION OF LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Work in Confined Spaces: NFPA 350.
6. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Complete raceway installation between conductor and cable termination points prior to pulling conductors and cables.
2. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
3. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
4. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
5. Provide support for cables.
6. Complete cable tray systems installation prior to installing conductors and cables.
7. Connections:

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a. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
b. Make splices, terminations, and taps that are compatible with conductor material.

8. Wiring at Outlets: Install conductor at each outlet, with at least 6 inch of slack.

D. Interfaces with Other Work:

1. Identification:

a. Identify and color-code conductors and cables.
b. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

2. Sleeves and Sleeve Seals: Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.
3. Firestopping: Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.
2. Perform each of the following visual and electrical tests:

a. Inspect exposed sections of conductor and cable for physical damage and correct connection in accordance with the single-line diagram.
b. Test bolted connections for high resistance using one or more of the following:

1) A low-resistance ohmmeter.
2) Calibrated torque wrench.
3) Thermographic survey.

c. Inspect compression-applied connectors for correct cable match and indentation.
d. Inspect for correct identification.
e. Inspect cable jacket and condition.
f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
g. Continuity test on each conductor and cable.

B. Nonconforming Work:

1. Wire or cable assembly will be considered defective if it does not pass tests and inspections.

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2. Remove and replace defective units and retest.

C. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

END OF SECTION 260519

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SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grounding and bonding conductors.
2. Grounding and bonding clamps.
3. Grounding and bonding bushings.
4. Grounding and bonding connectors.
5. Grounding (earthing) electrodes.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
2. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.

B. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

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1.4 QUALIFICATIONS

A. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1.5 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Electrical and ICT Equipment Grounding (Earthing): Do not exceed 25 Ω resistance to ground (earth).

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 GROUNDING AND BONDING CONDUCTORS

A. Equipment Grounding Conductor:

1. Standard Features: 600 V, THHN/THWN-2 or THWN-2 copper wire or cable, green color, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. ASTM - Bare Copper Grounding and Bonding Conductor:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ERICO; brand of nVent Electrical plc
b. Harger Lightning & Grounding; business of Harger, Inc.

2. Standard Features: Complying with one or more of the following:

a. Soft or Annealed Copper Wire: ASTM B3.
b. Concentric-Lay Stranded Copper Conductor: ASTM B8.
c. Tin-Coated Soft or Annealed Copper Wire: ASTM B33.
d. 19-Wire Combination Unilay-Stranded Copper Conductor: ASTM B787/B787M.

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2.3 GROUNDING AND BONDING CLAMPS

A. Description: Clamps suitable for attachment of grounding and bonding conductors to grounding electrodes, pipes, tubing, and rebar. Grounding and bonding clamps specified in this article are also suitable for use with communications applications.

B. Exothermically Welded Connection:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. ABB Electrification Installations Products
    b. ALLTEC LLC
    c. Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated
    d. Crouse-Hinds; brand of Eaton, Electrical Sector
    e. ERICO; brand of nVent Electrical plc
    f. Harger Lightning & Grounding; business of Harger, Inc.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

4. Standard Features: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING AND BONDING BUSHINGS

A. Description: Bonding bushings connect conduit fittings, tubing fittings, threaded metal conduit, and unthreaded metal conduit to metal boxes and equipment enclosures, and have one or more bonding screws intended to provide electrical continuity between bushing and enclosure. Grounding bushings have provision for connection of bonding or grounding conductor and may or may not also have bonding screws.

B. Bonding Bushing :

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. ABB Electrification Installations Products
    b. Arlington Industries, Inc.
    c. Crouse-Hinds; brand of Eaton, Electrical Sector
    d. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated
    e. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions,

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Appleton Group

2. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL 467.

4. Standard Features: Threaded bushing with insulated throat.

C. Grounding Bushing:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. ABB Electrification Installations Products
    b. Arlington Industries, Inc.
    c. Crouse-Hinds; brand of Eaton, Electrical Sector
    d. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated
    e. O-Z/Gedney; brand of Emerson Electric Co., Automation Solutions, Appleton Group
    f. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated

2.5 GROUNDING AND BONDING CONNECTORS

A. Lay-In Lug Mechanical-Type Grounding and Bonding Busbar Terminal:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. ABB Electrification Installations Products
    b. Chatsworth Products, Inc.
    c. Greaves Corp.; Essex Products Group, Inc.
    d. ILSCO; brand of ECM Industries LLC; division of nVent Electric plc

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.

4. Standard Features: Mechanical-type, copper rated for direct burial terminal with set screw.

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2.6 GROUNDING (EARTHING) ELECTRODES

A. Rod Electrode :

1. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. ABB Electrification Installations Products
    b. allG Fabrication (formerly ALT)
    c. Continental Industries; brand of Hubbell Utility Solutions; Hubbell Incorporated
    d. ERICO; brand of nVent Electrical plc
    e. Galvan Industries, Inc.; Electrical Products Division, LLC
    f. Harger Lightning & Grounding; business of Harger, Inc.

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Grounding and Bonding Equipment: UL 467.

4. Standard Features: Copper-clad steel; 3/4 inch by 10 ft.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.

B. Inspect test results of grounding system measured at point of electrical service equipment connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of electrical service equipment only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF GROUNDING AND BONDING PRODUCTS

A. Grounding and Bonding Conductors:

1. Provide solid conductor for 8 AWG and smaller, and stranded conductors for 6 AWG and larger unless otherwise indicated.

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2. Bonding Cable: 28 kcmil, 14 strands of 17 AWG conductor, 1/4 inch in diameter.
3. Bonding Conductor: 4 AWG or 6 AWG, stranded conductor.
4. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.
5. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch wide and 1/16 inch thick.
6. Underground Grounding Conductors: Install bare tinned-copper conductor, 2/0 AWG minimum.

B. Grounding and Bonding Connectors:

1. 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.

3.3 INSTALLATION OF GROUNDING AND BONDING

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Maintenance: NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
5. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Grounding and Bonding Conductors:

a. 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. Underground Grounding Conductors:

1) Bury at least 30 inches below grade.

2. Grounding and Bonding Connectors: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
b. Make connections with clean, bare metal at points of contact.

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c. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
f. 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 adjacent parts.
2) Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3) Use exothermic-welded connectors for outdoor locations; if disconnect-type connection is required, use bolted clamp.

3. Grounding and Bonding Busbars:

a. Install busbar horizontally, on insulated spacers 2 inch minimum from wall, 6 inch above finished floor unless otherwise indicated.
b. Where busbars are indicated on both sides of doorways, route bonding conductor up to top of door frame, across top of doorway, and down; connect to continuation of horizontal busbar.

4. Electrodes:

a. Ground Rods: Drive rods until tops are 2 inch below finished floor or final grade unless otherwise indicated.

1) Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2) Use exothermic welds for below-grade connections.

b. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least same distance from other grounding electrodes, and connect to service grounding electrode conductor.
c. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and must be at least 12 inch deep, with cover.

1) Install at least one test well for each service unless otherwise indicated. Install at ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

5. Equipment Grounding and Bonding:

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a. Install insulated equipment grounding conductors with 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) Single-phase motor and appliance branch circuits.
3) Three-phase motor and appliance branch circuits.
4) Flexible raceway runs.

3.4 FIELD QUALITY CONTROL FOR GROUNDING AND BONDING

A. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench in accordance with manufacturer's published instructions.
3. Test completed grounding system at each location where maximum ground-resistance level is specified, and at individual ground rods. Make tests at ground rods before conductors are connected.

a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by 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 in accordance with IEEE Std 81.
c. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to record of tests and observations. Include number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

B. Nonconforming Work:

1. Grounding system will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective components and retest.

C. Collect, assemble, and submit test and inspection reports.

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3.5 PROTECTION

A. After installation, protect grounding and bonding cables and equipment from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 260526

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SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Support systems.
2. Mounting, anchoring, and attachment components.
3. Installation of fabricated metal supports.
4. Installation of concrete bases.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
2. Section 033000 "Cast-in-Place Concrete" specifies concrete materials, reinforcement, and placement requirements referenced by this Section.
3. Section 055000 "Metal Fabrications" specifies site-fabricated metal supports referenced by this Section.

1.2 DELEGATED DESIGN SERVICES

A. Delegated Design Professionals: Engage qualified structural professional engineer to design hangers and supports for electrical systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Slotted support systems, hardware, and accessories.
b. Clamps.
c. Hangers.
d. Sockets.
e. Eye nuts.
f. Fasteners.
g. Anchors.
h. Saddles.
i. Brackets.

2. Include rated capacities and furnished specialties and accessories.

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B. Delegated Design Submittals: For hangers and supports for electrical systems.

1. Include details of hangers.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 REGULATORY AGENCY APPROVALS

A. Delegated design submittals and shop drawings requiring approval by authorities having jurisdiction must be signed by qualified structural professional engineer responsible for their preparation.

1.6 QUALIFICATIONS

A. Structural Professional Engineer: Professional engineer possessing active qualifications specified in Section 014000 "Quality Requirements," with expertise in structural engineering, including design of seismic and wind controls, equipment hangers and supports, and concrete foundations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Prepare design calculations in accordance with criteria specified in Section 260010 "Supplemental Requirements for Electrical".

2.2 SUPPORT SYSTEMS

A. Steel Slotted Support Systems :

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ABB Electrification Installations Products
b. Allied Tube & Conduit; Atkore International
c. Atkore Unistrut
d. CADDY; brand of nVent Electrical plc
e. Cooper B-line; brand of Eaton, Electrical Sector
f. Flex-Strut Inc.
g. G-Strut
h. Gripple Inc.
i. Haydon Corporation

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j. Metal Ties Innovation
k. MIRO Industries Inc.
l. Rocket Rack; Robroy Industries
m. Wesanco/ZSi-Foster; an Ideal Tridon Group Company

2. Standard Features: Preformed steel channels and angles with minimum 13/32 inch diameter holes at a maximum of 8 inch on center in at least one surface.

a. Referenced Standard: MFMA-4 factory-fabricated components for field assembly.
b. Material for Channel, Fittings, and Accessories: Galvanized steel.
c. Channel Width: 1-5/8 inch.
d. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

B. Aluminum Slotted Support Systems :

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ABB Electrification Installations Products
b. Atkore Unistrut
c. Eaton
d. Flex-Strut Inc.
e. Haydon Corporation
f. MKT Metal Manufacturing

2. Standard Features: Extruded-aluminum channels and angles with minimum 13/32 inch diameter holes at a maximum of 8 inch on center in at least one surface.

a. Referenced Standard: MFMA-4 factory-fabricated components for field assembly.
b. Channel Material: 6063-T5 aluminum alloy.
c. Fittings and Accessories Material: 5052-H32 aluminum alloy.
d. Channel Width: 1-5/8 inch.

C. Conduit and Cable Support Devices:

1. Standard Features: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit:

1. Standard Features: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must

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be made of malleable iron.

E. Structural Steel for Fabricated Supports and Restraints:

1. Standard Features: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

2.3 MOUNTING, ANCHORING, AND ATTACHMENT COMPONENTS

A. Powder-Actuated Fasteners :

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Hilti, Inc.
b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
c. MKT Fastening, LLC

2. Standard Features: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors :

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Cooper B-line; brand of Eaton, Electrical Sector
b. Empire Industries, Inc.
c. Hilti, Inc.
d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
e. MKT Fastening, LLC

2. Standard Features: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

C. Concrete Inserts:

1. Standard Features: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.

D. Clamps for Attachment to Steel Structural Elements:

1. Standard Features: MSS SP-58 units are suitable for attached structural element.

E. Through Bolts:

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1. Standard Features: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.

F. Toggle Bolts:

1. Standard Features: All steel springhead type.

G. Hanger Rods:

1. Standard Features: Threaded steel.

PART 3 - EXECUTION

3.1 SELECTION OF HANGERS AND SUPPORTS

A. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERMC as required byNFPA 70. Minimum rod size must be 1/4 inch in diameter.

B. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Installation of Steel Conduit: NECA NEIS 101.
3. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Raceway Support Methods: In addition to methods described in NECA NEIS 1, IMC and ERMC may be supported by openings through structure members, in accordance with NFPA 70.
2. 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 must be weight of supported components plus 200 lb.
3. Mounting and Anchorage of Surface-Mounted Equipment and Components:

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Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

a. To Wood: Fasten with lag screws or through bolts.
b. To New Concrete: Bolt to concrete inserts.
c. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
d. To Existing Concrete: Expansion anchor fasteners.
e. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inch thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inch thick.
f. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
g. To Light Steel: Sheet metal screws.
h. 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.

4. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

D. Interfaces with Other Work:

1. Touchup Finishes:

a. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1) Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

2. Installation of Fabricated Metal Supports:

a. Provide site-fabricated metal supports.
b. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
c. Field Welding: Comply with AWS D1.1/D1.1M. Submit welding certificates.

3. Installation of Concrete Bases:

a. Provide concrete bases of dimensions indicated, but not less than 4 inch larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
b. Use 3000 psi, 28-day compressive-strength concrete.
c. Anchor equipment to concrete base as follows:

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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.

END OF SECTION 260529

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SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Labels.
2. Tapes and stencils.
3. Signs.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule: For each piece of electrical equipment and electrical system components to be index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 LABELS

A. Performance Criteria:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
2. Listing Criteria: UL 969.

B. Self-Adhesive Labels: Polyester, thermal, transfer-printed, 3 mil thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

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1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. A'n D Cable Products
    b. Brady Corporation
    c. Brother International Corporation
    d. emedco
    e. Grafoplast Wire Markers
    f. HellermannTyton
    g. Ideal Industries, Inc.
    h. LEM Products Inc.
    i. Marking Services Inc.
    j. Panduit Corp
    k. Seton Identification Products; a Brady Corporation company

2. Minimum Nominal Size:

    a. 1-1/2 by 6 inch for raceway and conductors.
    b. 3-1/2 by 5 inch for equipment.
    c. As required by authorities having jurisdiction.

2.2 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Brady Corporation
    b. Carlton Industries, LP
    c. Champion America
    d. HellermannTyton
    e. Ideal Industries, Inc.
    f. Marking Services Inc.
    g. Panduit Corp

B. Tape and Stencil: 4 inch wide black stripes on 10 inch centers placed diagonally over orange background and are 12 inch wide. Stop stripes at legends.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. HellermannTyton
    b. LEM Products Inc.
    c. Marking Services Inc.

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d. Pipemarker.com; Brimar Industries, Inc.
e. Seton Identification Products; a Brady Corporation company

C. Floor Marking Tape: 2 inch wide, 5 mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Brady Corporation
b. Carlton Industries, LP
c. Seton Identification Products; a Brady Corporation company
d.

D. Underground-Line Warning Tape:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Brady Corporation
b. Ideal Industries, Inc.
c. LEM Products Inc.
d. Marking Services Inc.
e. Pipemarker.com; Brimar Industries, Inc.
f. Reef Industries, Inc.
g. Seton Identification Products; a Brady Corporation company

2. Tape:

a. Recommended by manufacturer for method of installation and suitable to identify and locate underground electricalutility lines.
b. Printing on tape must be permanent and may not be damaged by burial operations.
c. Tape material and ink must be chemically inert and not be subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

3. Nonconducting Line-Warning Tape :

a. Pigmented polyolefin, bright colored, compounded for direct-burial service.
b. Width: 3 inch.
c. Thickness: 4 mil.
d. Weight: 18.5 lb/1000 sq. ft.
e. Tensile in accordance with ASTM D882: 30 lbf and 2500 psi.

4. Reinforced Nonconducting Line-Warning Tape :

a. Multilayer laminate, consisting of high-density polyethylene scrim coated

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with pigmented polyolefin; bright colored, compounded for direct-burial service.
b. Width: 3 inch.
c. Thickness: 12 mil.
d. Weight: 36.1 lb/1000 sq. ft.
e. Tensile in accordance with ASTM D882: 400 lbf and 11,500 psi.

5. Detectable Line-Warning Tape :

a. Detectable three-layer laminate, consisting of printed pigmented polyolefin film, solid aluminum-foil core, and clear protective film that allows inspection of continuity of conductive core; bright colored, compounded for direct-burial service.
b. Width: 3 inch.
c. Overall Thickness: 5 mil.
d. Foil Core Thickness: 0.35 mil.
e. Weight: 28 lb/1000 sq. ft.
f. Tensile in accordance with ASTM D882: 70 lbf and 4600 psi.

6. Reinforced Detectable Line-Warning Tape :

a. Reinforced, detectable three-layer laminate, consisting of printed pigmented woven scrim, solid aluminum-foil core, and clear protective film that allows inspection of continuity of conductive core; bright-colored, compounded for direct-burial service.
b. Width: 3 inch.
c. Overall Thickness: 8 mil.
d. Foil Core Thickness: 0.35 mil.
e. Weight: 34 lb/1000 sq. ft.
f. Tensile in accordance with ASTM D882: 300 lbf and 12,500 psi.

E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height must be 1 inch.

F. Write-on Tags:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Brady Corporation
b. Carlton Industries, LP
c. LEM Products Inc.
d. Pipemarker.com; Brimar Industries, Inc.
e. Seton Identification Products; a Brady Corporation company

2. Polyester Tags: 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment.
3. Marker for Tags:

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a. Permanent, waterproof, black ink marker recommended by tag manufacturer.
b. Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.3 SIGNS

A. Baked-Enamel Signs:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Brady Corporation
    b. Carlton Industries, LP
    c. Champion America
    d. emedco]
    e. Marking Services Inc.

2. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
3. 1/4 inch grommets in corners for mounting.
4. Nominal Size: 7 by 10 inch.

B. Laminated Acrylic or Melamine Plastic Signs:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Brady Corporation
    b. Carlton Industries, LP
    c. emedco
    d. Marking Services Inc.
    e. Seton Identification Products; a Brady Corporation company

2. Engraved legend.
3. Thickness:

    a. For signs up to 20 sq. inch, minimum 1/16 inch thick.
    b. For signs larger than 20 sq. inch, 1/8 inch thick.
    c. Engraved legend with black letters on white face.
    d. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

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PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 SELECTION OF COLORS AND IDENTIFICATION MARKINGS

A. Comply with 29 CFR 1910.144 for color identification of hazards, and the following:

1. Fire-protection equipment, including raceways, must be finished, painted, or suitably marked safety red.

B. Pipe and Conduit Labeling: Comply with ASME A13.1 and IEEE C2.

C. Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed below for ungrounded feeder and branch-circuit conductors.

1. Color must be factory applied.
2. Colors for 208Y/120 V Circuits:

    a. Phase A: Black.
    b. Phase B: Red.
    c. Phase C: Blue.

3. Colors for 240 V Circuits:

    a. Phase A: Black.
    b. Phase B: Red.

4. Colors for 480Y/277 V Circuits:

    a. Phase A: Brown.
    b. Phase B: Orange.
    c. Phase C: Yellow.

5. Color for Neutral (Grounded Conductor): White.
6. Color for Equipment Ground: Green.

D. Color-Coding Raceways, Cable Trays, Junction Boxes, and Conductors for Intrinsically-Safe Circuits: Light blue. When used to identify intrinsically-safe circuits, Article 504 of NFPA 70 requires that the color light blue not be used for any other purpose.

E. Color-Coding Instructional Signs: Self-adhesive labels, including color code for grounded and ungrounded conductors.

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F. Accessible Fittings for Raceways: Identify cover of junction and pull box of the following systems with wiring system legend and system voltage. System legends must be as follows:

1. "POWER."

G. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

H. Locations of Underground Lines: Underground-line warning tape for power and lighting.

I. Vaults, Manholes, Handholes, and Pull and Junction Boxes, 1000 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use self-adhesive vinyl tape to identify phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft maximum intervals in straight runs, and at 25 ft maximum intervals in congested areas.
2. Identify system voltage with black letters on orange field.

J. Conductors to Be Extended in Future: Attach write-on tags to conductors.

K. Cover Plates: Label individual cover plates with self-adhesive labels. Place label at top of cover plate. Label cover plate with the following information, in the order listed:

1. Panelboard designation.
2. Colon or dash.
3. Branch circuit number.

L. Workspace Indication: Apply floor marking tape or tape and stencil to finished surfaces. Show working clearances in direction of access to live parts. Workspace must comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

M. Equipment Identification Labels:

1. Black letters on white field.
2. Indoor Equipment: Self-adhesive label, Baked-enamel signs or Laminated acrylic or melamine plastic sign.
3. Outdoor Equipment: Laminated acrylic or melamine sign.
4. Equipment to Be Labeled:

a. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels.
b. Panelboards: Typewritten directory of circuits in location provided by panelboard manufacturer. Panelboard identification must be in form of laminated acrylic or melamine label.
c. Enclosures and electrical cabinets.
d. Access doors and panels for concealed electrical items.
e. Transformers: Label that includes tag designation indicated on Drawings

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for transformer, feeder, and panelboards or equipment supplied by secondary.
f. Enclosed switches.
g. Enclosed controllers.
h. Variable-speed controllers.
i. Monitoring and control equipment.

3.3 SELECTION OF SIGNS AND HAZARD MARKINGS

A. Comply with 29 CFR 1910.145 for danger, caution, warning, and safety instruction signs.

B. Signs, labels, and tags required for personnel safety must comply with the following standards:

1. Safety Colors: NEMA Z535.1.
2. Facility Safety Signs: NEMA Z535.2.
3. Safety Symbols: NEMA Z535.3.
4. Product Safety Signs and Labels: NEMA Z535.4.
5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.

C. Electrical Hazard Warnings:

1. Arc-Flash Hazard Warning: Self-adhesive labels. Comply with NFPA 70E requirements for arc-flash hazard warning labels.
2. OSHA Workspace Clearance Warning Legend: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 3 FEET MINIMUM."

D. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.

1. Apply to exterior of door, cover, or other access.
2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:

a. Transformer(s).
b. Controls with external control power connections.
c. Panelboard(s).

E. Operating Instruction Signs: Baked-enamel warning signs.

3.4 INSTALLATION

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Thermal Movements: Allow for thermal movements from ambient and surface

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temperature changes typical for electrical equipment environments specified in Section 260010 "Supplemental Requirements for Electrical."

C. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

D. Fasteners for Labels and Signs: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers.

E. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

F. Install identifying devices before installing acoustical ceilings and similar concealment.

G. Verify identity of item before installing identification products.

H. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

I. Apply identification devices to surfaces that require finish after completing finish work.

J. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from floor.

L. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's instructions.

M. Underground Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape not less than 12 inch directly above cables or raceways buried 18 inch or more below grade. Use multiple tapes where width of multiple lines installed in common trench exceeds 16 inch overall.
2. Install underground-line warning tape for direct-buried cables and cables in raceways.

N. Write-on Tags:

1. Place in location with high visibility and accessibility.
2. Secure using general-purpose cable ties.

O. Baked-Enamel Signs: Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.

P. Laminated Acrylic or Melamine Plastic Signs: Attach signs that are not self-adhesive

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type with mechanical fasteners appropriate to location and substrate.

END OF SECTION 260553

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SECTION 262213 - LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution, dry-type transformers with nominal primary and secondary rating of 600 V and less, with capacities up to 1500 kVA.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of product.

a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
b. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of field connections.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Include diagrams for power, signal, and control wiring.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation instructions

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issued to Installer by manufacturer for the following:

1. Transformer temporary heating, working clearances, anchoring, torque values, and insulation-resistance testing.

B. Source quality-control reports.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Inspection: On receipt, inspect for and note shipping damage to packaging and transformer.

1. If manufacturer packaging is removed for inspection, and transformer will be stored after inspection, re-package transformer using original or new packaging materials that provide protection equivalent to manufacturer's packaging.

B. Storage: Store in warm, dry, and temperature-stable location in original shipping packaging.

C. Temporary Heating: Apply temporary heat in accordance with manufacturer's published instructions within enclosure of ventilated-type units, throughout periods during which equipment is not energized and when transformer is not in space that is continuously under normal control of temperature and humidity.

D. Handling: Follow manufacturer's instructions for lifting and transporting transformers.

PART 2 - PRODUCTS

2.1 LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ABB Electrification Installations Products
2. Acme Electric; brand of Hubbell Electrical Solutions; Hubbell Incorporated
3. Dongan Electric Manufacturing Company
4. Eaton]
5. Federal Pacific
6. Hammond Power Solutions Inc.
7. Jefferson Electric, Inc.
8. Lincoln Electric Products Co., Inc.
9. Mag-Tran; a division of Quality Transformer & Electronics
10. Marcus Transformer LTD
11. MGM Transformer Company
12. Micron Industries Corporation
13. Mirus International Inc.]
14. Powersmiths International Corp.; Socomec Group

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15. Prolec GE; A Xignux and General Electric Company Joint Venture
16. Rex Power Magnetics
17. Siemens Industry, Inc., Energy Management Division
18. SolaHD; Emerson Electric Co., Automation Solutions
19. Square D; Schneider Electric USA
20. TEMCo Transformers

B. Source Limitations: Obtain each type of transformer from single source from single manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60 Hz service.

B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

C. Transformers Rated 15 kVA and Larger:

1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
2. Marked as compliant with DOE 2016 efficiency levels by qualified electrical testing laboratory recognized by authorities having jurisdiction.

D. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside transformer enclosure.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70.

B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

1. One leg per phase.
2. Grounded to enclosure.

C. Coils: Continuous windings except for taps.

1. Coil Material: Aluminum.
2. Internal Coil Connections: Brazed or pressure type.
3. Terminal Connections: Welded.

D. Enclosure: Ventilated.

1. Core and coil must be encapsulated within resin compound to seal out moisture and air.
2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.

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3. Wiring Compartment: Sized for conduit entry and wiring installation.
4. Environmental Protection:

    a. Indoor: UL 50E, Type 2.

5. Finish Color: Gray weather-resistant enamel.

E. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

F. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with maximum of 150 deg C rise above 40 deg C ambient temperature.

G. Grounding: Provide ground-bar kit or ground bar installed on inside of transformer enclosure.

2.4 IDENTIFICATION

A. Nameplates:

1. Engraved, laminated-acrylic or melamine plastic signs for distribution transformers, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 260553 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Factory Tests and Inspections: Test and inspect assembled system, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, in accordance with IEEE C57.12.01 and IEEE C57.12.91 before delivering to site. Affix label with name and date of manufacturer's certification of system compliance on control units.

1. Resistance measurements of windings at rated voltage connections and at tap connections.
2. Ratio tests at rated voltage connections and at tap connections.
3. Phase relation and polarity tests at rated voltage connections.
4. No load losses, and excitation current and rated voltage at rated voltage connections.
5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
6. Applied and induced tensile tests.
7. Regulation and efficiency at rated load and voltage.
8. Insulation-Resistance Tests:

    a. Line-side to ground.
    b. Load-side to ground.
    c. Line-side to load-side.

9. Temperature tests.

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B. Nonconforming Work:

1. System equipment that does not pass tests and inspections will be considered defective.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for transformers.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's published instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met.

E. Environment: Enclosures must be rated for environment in which they are located. Covers for UL 50E, Type 4X enclosures may not cause accessibility problems.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install transformers level and plumb on concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

B. Construct concrete bases and anchor floor-mounted transformers in accordance with manufacturer's published instructions[, seismic requirements applicable to Project,] and requirements in Section 260529 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

C. Secure transformer to concrete base in accordance with manufacturer's published instructions.

D. Secure covers to enclosure and tighten bolts to manufacturer-recommended torques to reduce noise generation.

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E. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals in accordance with manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Provide flexible connections at conduit and conductor terminations and supports to eliminate sound and vibration transmission to building structure.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Small (Up to 167 kVA Single-Phase or 500 kVA Three-Phase) Dry-Type Transformer Field Tests:

a. Visual and Mechanical Inspection.

1) Inspect physical and mechanical condition.
2) Inspect anchorage, alignment, and grounding.
3) Verify that resilient mounts are free and that shipping brackets have been removed.
4) Verify that unit is clean.
5) Perform specific inspections and mechanical tests recommended by manufacturer.
6) Verify that as-left tap connections are as specified.
7) Verify presence of surge arresters and that their ratings are as specified.

b. Electrical Tests:

1) Measure resistance at windings, taps, and bolted connections.
2) Perform insulation-resistance tests winding-to-winding and windings-to-ground. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: value of index may not be less than 1.0.
3) Perform turns-ratio tests at tap positions. Test results may not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.

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4) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

B. Test Labeling: On completion of satisfactory testing of units, attach dated and signed "Satisfactory Test" label to tested components.

C. Nonconforming Work:

1. Transformer will be considered defective if it does not pass tests and inspections.
2. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Assemble and submit test and inspection reports.

E. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

3.5 ADJUSTING

A. Record transformer secondary voltage at unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

3.7 MAINTENANCE

A. Infrared Scanning: Two months after Substantial Completion, perform infrared scan of transformer connections.

1. Use infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform two follow-up infrared scans of transformers, one at four months and another at 11 months after Substantial Completion.
3. Prepare certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

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SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Panelboards.
2. Disconnecting and overcurrent protective devices.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" specifies additional abbreviations, definitions, submittals, qualifications, testing agencies, and other requirements applicable to the Work for electrical, communications, and electronic safety and security systems on Project, including wiring methods.
2. Section 260529 "Hangers and Supports for Electrical Systems" specifies concrete bases and supports for panelboards installed by this Section.
3. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs installed by this Section.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. In addition to information identified in Section 013300 "Submittal Procedures," submit the following:

1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.
2. Include manufacturer's sample extended warranty language.

B. Shop Drawings: For each panelboard and related equipment:

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for series rating of installed devices.
7. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for SPD as installed in panelboard.
8. Detail features, characteristics, ratings, and factory settings of individual

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overcurrent protective devices and auxiliary components.
9. Include wiring diagrams for power, signal, and control wiring.
10. Key interlock scheme drawing and sequence of operations.

C. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Panelboard Schedules: For installation in panelboards.

B. Manufacturer's published instructions.

C. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Field reports for voltage monitoring and adjusting.
3. Field reports for infrared scanning.

1.4 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

B. Special tools.

1.6 QUALIFICATIONS

A. Low-Voltage Electrical Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must have documented certification and experience with testing electrical equipment in accordance with NETA testing standards.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation in accordance with NEMA PB 1.

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1.8 WARRANTY

A. Special Installer Extended Warranty: Installer warrants that fabricated and installed panelboards perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.

1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

B. Special Manufacturer Extended Warranty: Manufacturer warrants that panelboards perform in accordance with specified requirements and agrees to provide repair or replacement of components or products that fail to perform as specified within extended-warranty period.

1. Initial Extended-Warranty Period: Three years from date of Substantial Completion; full coverage for labor, materials, and equipment.
2. Follow-On Extended-Warranty Period: Five years from date of Substantial Completion; full coverage for materials that failed because of transient voltage surges only, free on board origin, freight prepaid.

PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Description: Provide overcurrent protection at existing installation as noted on Drawings.

2.2 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Comply with NEMA PB 1.

D. Enclosures: Surface-mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: UL 50E, Type 1.

2. Height: 7 ft maximum.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within

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hinged trim cover. Trims must cover live parts and may have no exposed hardware.

4. Finishes:

    a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

E. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.

    a. Plating must run entire length of bus.
    b. Bus must be fully rated for entire length.

2. Interiors must be factory assembled into unit. Replacing switching and protective devices may not disturb adjacent units or require removing main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

F. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Terminations must allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Mechanical type, with lug on neutral bar for each pole in panelboard.
5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with lug on bar for each pole in panelboard.

G. Future Devices: Panelboards or load centers must have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

1. Percentage of Future Space Capacity: 10 percent.

H. Panelboard Short-Circuit Current Rating:

1. Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for 100 percent interrupting capacity.

    a. Panelboards and overcurrent protective devices rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
    b. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V must have short-circuit ratings as shown on Drawings, but not less than 14 000 A(rms) symmetrical.

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2.3 PANELBOARDS

A. Lighting and Appliance Branch-Circuit Panelboard :

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. ABB Electrification Installations Products
    b. Bender Inc.; Bender GmbH & Co. KG
    c. Eaton
    d. Siemens Industry, Inc., Energy Management Division
    e. Square D; Schneider Electric USA

2. Source Limitations: Obtain products from single manufacturer.
3. Listing Criteria: Investigated, labeled, and marked by qualified electrical testing laboratory in accordance with guide information and standards specified for the following UL product categories:

    a. Lighting and Appliance Branch-Circuit Type Panelboards: UL CCN QEUY; including UL 67 and NEMA PB 1.

4. Standard Features:

    a. Mains: Circuit breaker.

        1) Location: Convertible between top and bottom.
        2) Main Breaker: Main lug interiors up to 400 A must be field convertible to main breaker.

    b. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

5. Other Available Features Required by Project:

    a.
    b. Doors: Door-in-door construction with concealed hinges; secured with [flush][or][multipoint] latch with tumbler lock; keyed alike

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ABB Electrification Installations Products
2. Eaton
3. Siemens Industry, Inc., Energy Management Division
4. Square D; Schneider Electric USA

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B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:

a. Inverse time-current element for low-level overloads.
b. Instantaneous magnetic trip element for short circuits.
c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. MCCB Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.
b. Breaker handle indicates tripped status.
c. UL listed for reverse connection without restrictive line or load ratings.
d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.

2.5 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing panelboards and related equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:

1. Keys: Two spares for each type of panelboard cabinet lock.

B. Special Tools: Furnish to Owner proprietary equipment, keys, and software required to operate, maintain, repair, adjust, or implement future changes to panelboards and related equipment, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:

1. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards in accordance with NEMA PB 1.1.

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

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D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Reference Standards:

1. Panelboards: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA PB 1.1.
2. Consult Architect for resolution of conflicting requirements.

C. Special Techniques:

1. Equipment Mounting:

    a. Attach panelboard to vertical finished or structural surface behind panelboard.
    b. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.

2. Mount top of trim 7.5 ft above finished floor unless otherwise indicated.
3. Mount panelboard cabinet plumb and rigid without distortion of box.
4. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
5. Install overcurrent protective devices and controllers not already factory installed.

    a. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver in accordance with manufacturer's published instructions.

6. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
7. Install filler plates in unused spaces.
8. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

D. Interfaces with Other Work:

1. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

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3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components.

B. Install warning signs.

C. Panelboard Nameplates: Label each panelboard with nameplate.

D. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles must be located on interior of panelboard door.

E. Breaker Labels: Faceplate must list current rating, UL and IEC certification standards, and AIC rating.

F. Circuit Directory:

1. Provide directory card inside panelboard door, mounted in transparent card holder.

    a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.

2. Provide computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

    a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.

3. Create directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

3.4 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers stated in NETA ATS, Paragraph 7.6 Circuit Breakers. Do not perform optional tests. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.

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c. Instruments and Equipment:

1) Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

B. Nonconforming Work:

1. Panelboards will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

1. Include certified report that identifies panelboards included and that describes scanning results, with comparisons of two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

D. Manufacturer Services: Engage factory-authorized service representative to support field tests and inspections.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.

1. Measure loads during period of normal facility operations.
2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
4. Tolerance: Maximum difference between phase loads, within panelboard, may not exceed 20 percent.

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature in accordance with manufacturer's published instructions.

END OF SECTION 262416

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SECTION 262716 - ELECTRICAL CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cabinets and cutout boxes.
2. Termination boxes.
3. Miscellaneous enclosures.
4.
5. Enclosure-mounted power distribution.

B. Products Installed, but Not Furnished, under This Section:

1. Supply Pump Set Main Control Panel.
2. Smart Pump Control Panel.
3. Return Pump Set Control Panels (4)
4. Smart Filter Control Panel.

C. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies temperature, humidity, acoustical, and other field conditions applicable to the Work specified in this Section.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies seismic hazard, wind hazard, and other structural design conditions applicable to the Work specified in this Section.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
4. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
5. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding for RBBs referenced by this Section.
6. Section 260573 "Power System Studies" specifies arc-flash hazard analysis and warning labels referenced by this Section.
7. Section 270528 "Pathways for Communications Systems specifies additional requirements for raceway materials, routing, locations, and identification of communications equipment and cabling.

1.2 DEFINITIONS

A. RBB: Rack bonding busbar, located in equipment cabinets and racks.

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1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Prepare and submit the following:

1. Shop Drawings for Custom Enclosures and Cabinets: Include plans, elevations, sections, and attachment details.
2. Shop Drawings for Racks or Frames:

a. Include plans, elevations, sections, details, and attachments to other work.
b. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
c. Include workspace requirements and access for cable connections.
d. Grounding: Indicate location of RBB and its mounting detail showing standoff insulators and wall-mounting brackets.

C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' published instructions.

1.5 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures; conduct tests of complex equipment; analyze test and equipment data; plan a job; and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multi-team projects.

C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician III certification.

D. Communications Testing and Inspecting Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site communications testing supervisor must have BICSI Technician (TECH) certification and documented training, and be experienced with testing communications equipment in accordance with BICSI testing standards.

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PART 2 - PRODUCTS

2.1 EXISTING PRODUCTS TO BE MODIFIED

A. Basis for Pricing: MR Systems, Booster Pump Station LCP-A Control Panel.

B. Accessories: A new Ethernet connection from the Supply Pump Set Main Control Panel to the Booster Pump Building's Panel LCP-A will be added.

2.2 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.3 CABINETS AND CUTOUT BOXES

A. UL CYIV - Indoor Sheet Metal Cabinets:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. ABB Electrification Installations Products
    b. Adalet; division of Scott Fetzer Co.
    c. Cooper B-line; brand of Eaton, Electrical Sector
    d. Crouse-Hinds; brand of Eaton, Electrical Sector
    e. Erickson Electrical Equipment Company
    f. FSR Inc.
    g. Hoffman; brand of nVent Electrical plc
    h. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated
    i. Milbank Manufacturing Company
    j. N J Sullivan Company
    k. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated
    l. Robroy Enclosures; Robroy Industries
    m. Siemens Industry, Inc., Building Technologies Division
    n. Square D; Schneider Electric USA

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

    a. ABB Electrification Installations Products
    b. Adalet; division of Scott Fetzer Co.
    c. Cooper B-line; brand of Eaton, Electrical Sector
    d. Crouse-Hinds; brand of Eaton, Electrical Sector

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e. Erickson Electrical Equipment Company
f. FSR Inc.
g. Hoffman; brand of nVent Electrical plc
h. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated
i. Milbank Manufacturing Company
j. N J Sullivan Company
k. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated
l. Robroy Enclosures; Robroy Industries
m. Siemens Industry, Inc., Building Technologies Division
n. Square D; Schneider Electric USA

3. Listing Criteria:

a. UL CCN CYIV.
b. Non-Environmental Characteristics: UL 50.
c. Environmental Characteristics: UL 50E.

4. Standard Features:

a. Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung.

b. Degree of Protection: Type 12.

B. UL CYIV - Indoor Sheet Metal Cutout Boxes:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ABB Electrification Installations Products
b. Adalet; division of Scott Fetzer Co.
c. Cooper B-line; brand of Eaton, Electrical Sector
d. Crouse-Hinds; brand of Eaton, Electrical Sector
e. Erickson Electrical Equipment Company
f. FSR Inc.
g. Hoffman; brand of nVent Electrical plc
h. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated
i. Milbank Manufacturing Company
j. N J Sullivan Company
k. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated
l. Robroy Enclosures; Robroy Industries
m. Siemens Industry, Inc., Building Technologies Division
n. Square D; Schneider Electric USA
o. Saginaw Control and Engineering

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

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a. ABB Electrification Installations Products
b. Adalet; division of Scott Fetzer Co.
c. Cooper B-line; brand of Eaton, Electrical Sector
d. Crouse-Hinds; brand of Eaton, Electrical Sector
e. Erickson Electrical Equipment Company
f. FSR Inc.
g. Hoffman; brand of nVent Electrical plc
h. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated
i. Milbank Manufacturing Company
j. N J Sullivan Company
k. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated
l. Robroy Enclosures; Robroy Industries
m. Siemens Industry, Inc., Building Technologies Division
n. Square D; Schneider Electric USA
o. Saginaw Control and Engineering

3. Listing Criteria:

a. UL CCN CYIV.
b. Non-Environmental Characteristics: UL 50.
c. Environmental Characteristics: UL 50E.

4. Standard Features:

a. Enclosure that has swinging doors or covers secured directly to and telescoping with walls of enclosure.

b. Degree of Protection: Type 12.

C. UL CYIV - Outdoor Sheet Metal Cabinets:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ABB Electrification Installations Products
b. Adalet; division of Scott Fetzer Co.
c. Cooper B-line; brand of Eaton, Electrical Sector
d. Crouse-Hinds; brand of Eaton, Electrical Sector
e. Erickson Electrical Equipment Company
f. FSR Inc.
g. Hoffman; brand of nVent Electrical plc
h. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated
i. Milbank Manufacturing Company
j. N J Sullivan Company
k. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated
l. Robroy Enclosures; Robroy Industries
m. Siemens Industry, Inc., Building Technologies Division
n. Square D; Schneider Electric USA

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o. Saginaw Control and Engineering

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. ABB Electrification Installations Products
b. Adalet; division of Scott Fetzer Co.
c. Cooper B-line; brand of Eaton, Electrical Sector
d. Crouse-Hinds; brand of Eaton, Electrical Sector
e. Erickson Electrical Equipment Company
f. FSR Inc.
g. Hoffman; brand of nVent Electrical plc
h. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated
i. Milbank Manufacturing Company
j. N J Sullivan Company
k. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated
l. Robroy Enclosures; Robroy Industries
m. Siemens Industry, Inc., Building Technologies Division
n. Square D; Schneider Electric USA
o. Saginaw Control and Engineering

3. Listing Criteria:

a. UL CCN CYIV.
b. Non-Environmental Characteristics: UL 50.
c. Environmental Characteristics: UL 50E.

4. Standard Features:

a. Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung.

b. Degree of Protection: Type 4.

D. UL CYIV - Outdoor Sheet Metal Cutout Boxes:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ABB Electrification Installations Products
b. Adalet; division of Scott Fetzer Co.
c. Cooper B-line; brand of Eaton, Electrical Sector
d. Crouse-Hinds; brand of Eaton, Electrical Sector
e. Erickson Electrical Equipment Company
f. FSR Inc.
g. Hoffman; brand of nVent Electrical plc
h. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated
i. Milbank Manufacturing Company

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j. N J Sullivan Company
k. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated
l. Robroy Enclosures; Robroy Industries
m. Siemens Industry, Inc., Building Technologies Division
n. Square D; Schneider Electric USA
o. Saginaw Control and Engineering

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. ABB Electrification Installations Products
b. Adalet; division of Scott Fetzer Co.
c. Cooper B-line; brand of Eaton, Electrical Sector
d. Crouse-Hinds; brand of Eaton, Electrical Sector
e. Erickson Electrical Equipment Company
f. FSR Inc.
g. Hoffman; brand of nVent Electrical plc
h. Killark; brand of Hubbell Electrical Solutions; Hubbell Incorporated
i. Milbank Manufacturing Company
j. N J Sullivan Company
k. Raco Taymac Bell; brand of Hubbell Electrical Solutions; Hubbell Incorporated
l. Robroy Enclosures; Robroy Industries
m. Siemens Industry, Inc., Building Technologies Division
n. Square D; Schneider Electric USA
o. Saginaw Control and Engineering

3. Listing Criteria:

a. UL CCN CYIV.
b. Non-Environmental Characteristics: UL 50.
c. Environmental Characteristics: UL 50E.

4. Standard Features:

a. Enclosure that has swinging doors or covers secured directly to and telescoping with walls of enclosure.

b. Degree of Protection: Type 4.

2.4 TERMINATION BOXES

A. Description: Enclosure for termination base consisting of lengths of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors or both.

B. UL XCKT - Termination Boxes and Termination Bases for Installation on Line Side of Service Equipment :

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1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. ABB Electrification Installations Products
    b. Appleton; Emerson Electric Co., Automation Solutions
    c. Cooper B-line; brand of Eaton, Electrical Sector
    d. Erickson Electrical Equipment Company
    e. Hoffman; brand of nVent Electrical plc
    f. Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated
    g. Milbank Manufacturing Company
    h. N J Sullivan Company
    i. Square D; Schneider Electric USA
    j. Saginaw Control and Engineering

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

    a. ABB Electrification Installations Products
    b. Appleton; Emerson Electric Co., Automation Solutions
    c. Cooper B-line; brand of Eaton, Electrical Sector
    d. Erickson Electrical Equipment Company
    e. Hoffman; brand of nVent Electrical plc
    f. Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated
    g. Milbank Manufacturing Company
    h. N J Sullivan Company
    i. Square D; Schneider Electric USA

3. Listing Criteria:

    a. UL CCN XCKT; including UL 1773.
    b. Non-Environmental Characteristics: UL 50.
    c. Environmental Characteristics: UL 50E.

4. Standard Features:

    a. Listed and labeled for installation on line side of service equipment.

    b. Indoor Degree of Protection: Type 12.
    c. Outdoor Degree of Protection: Type 4.

C. UL XCKT - Termination Boxes and Termination Bases for Installation on Load Side of Service Equipment :

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. ABB Electrification Installations Products
    b. Appleton; Emerson Electric Co., Automation Solutions

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c. Cooper B-line; brand of Eaton, Electrical Sector
d. Erickson Electrical Equipment Company
e. Hoffman; brand of nVent Electrical plc
f. Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated
g. Milbank Manufacturing Company
h. N J Sullivan Company
i. Square D; Schneider Electric USA
j. Saginaw Control and Engineering

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. ABB Electrification Installations Products
b. Appleton; Emerson Electric Co., Automation Solutions
c. Cooper B-line; brand of Eaton, Electrical Sector
d. Erickson Electrical Equipment Company
e. Hoffman; brand of nVent Electrical plc
f. Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated
g. Milbank Manufacturing Company
h. N J Sullivan Company
i. Square D; Schneider Electric USA
j. Saginaw Control and Engineering

3. Listing Criteria:

a. UL CCN XCKT; including UL 1773.
b. Non-Environmental Characteristics: UL 50.
c. Environmental Characteristics: UL 50E.

4. Standard Features:

a. Listed and labeled for installation on load side of service equipment.

b. Indoor Degree of Protection: Type 12.
c. Outdoor Degree of Protection: Type 4.

2.5 MISCELLANEOUS ENCLOSURES

A. UL XCKT or NWIN - Indoor Sheet Metal Miscellaneous Enclosures:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ABB Electrification Installations Products
b. Appleton; Emerson Electric Co., Automation Solutions
c. Cooper B-line; brand of Eaton, Electrical Sector
d. Erickson Electrical Equipment Company
e. Hoffman; brand of nVent Electrical plc

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f. Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated
g. Milbank Manufacturing Company
h. N J Sullivan Company
i. Square D; Schneider Electric USA
j. Saginaw Control and Engineering

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. ABB Electrification Installations Products
b. Appleton; Emerson Electric Co., Automation Solutions
c. Cooper B-line; brand of Eaton, Electrical Sector
d. Erickson Electrical Equipment Company
e. Hoffman; brand of nVent Electrical plc
f. Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated
g. Milbank Manufacturing Company
h. N J Sullivan Company
i. Square D; Schneider Electric USA
j. Saginaw Control and Engineering

3. Listing Criteria:

a. UL CCN XCKT; including UL 1773; or UL CCN NWIN, including UL 2416.
b. Non-Environmental Characteristics: UL 50.
c. Environmental Characteristics: UL 50E.

4. Standard Features:

a. Degree of Protection: Type 12.

B. UL XCKT or NWIN - Outdoor Sheet Metal Miscellaneous Enclosures:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ABB Electrification Installations Products
b. Appleton; Emerson Electric Co., Automation Solutions
c. Cooper B-line; brand of Eaton, Electrical Sector
d. Erickson Electrical Equipment Company
e. Hoffman; brand of nVent Electrical plc
f. Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated
g. Milbank Manufacturing Company
h. N J Sullivan Company
i. Square D; Schneider Electric USA
j. Saginaw Control and Engineering

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

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a. ABB Electrification Installations Products
b. Appleton; Emerson Electric Co., Automation Solutions
c. Cooper B-line; brand of Eaton, Electrical Sector
d. Erickson Electrical Equipment Company
e. Hoffman; brand of nVent Electrical plc
f. Metron; brand of Hubbell Electrical Solutions; Hubbell Incorporated
g. Milbank Manufacturing Company
h. N J Sullivan Company
i. Square D; Schneider Electric USA
j. Saginaw Control and Engineering

3. Listing Criteria:

a. UL CCN XCKT; including UL 1773; or UL CCN NWIN, including UL 2416.
b. Non-Environmental Characteristics: UL 50.
c. Environmental Characteristics: UL 50E.

4. Standard Features:

a. Degree of Protection: Type 4.

PART 3 - EXECUTION

3.1 SELECTION OF ELECTRICAL CABINETS AND ENCLOSURES

A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of electrical cabinets and enclosures. Consult Architect for resolution of conflicting requirements.

B. Degree of Protection:

1. Outdoors:

a. Type 4 unless otherwise indicated.
b. Locations Exposed to Hosedown: Type 4.
c. Locations Subject to Potential Flooding: Type 6P.
d. Locations Aboveground Where Mechanism Must Operate When Ice Covered: Type 3S.
e. Locations in-Ground or Exposed to Corrosive Agents: Type 4X.
f. Locations in-Ground or Exposed to Corrosive Agents Where Mechanism Must Operate When Ice Covered: Type 3SX.

2. Indoors:

a. Type 1 unless otherwise indicated.
b. Damp or Dusty Locations: Type 12Type 4.
c. Surface Mounted in Kitchens and Other Locations Exposed to Oil or Coolants: Type 12.
d. Flush Mounted in Kitchens and Other Locations Exposed to Oil or

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Coolants: Type 12.
e. Locations Exposed to Airborne Dust, Lint, Fibers, or Flyings: Type 4.
f. Locations Exposed to Hosedown: Type 4.
g. Locations Exposed to Brief Submersion: Type 6P.
h. Locations Exposed to Prolonged Submersion: Type 6P.
i. Locations Exposed to Corrosive Agents: Type 4X.
j. Locations Exposed to Spraying Oil or Coolants: Type 13.

3.2 INSTALLATION OF ELECTRICAL CABINETS AND ENCLOSURES

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in Contract Documents or manufacturers' published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NFPA 1, NFPA 70, and NECA NEIS 1.
2. Electrical Safety: NFPA 70E.
3. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
4. Communications Work: BICSI N1.
5. Work in ITE Rooms: NFPA 75.
6. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
7. Cabinets and Cutout Boxes: Article 312 of NFPA 70.
8. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Mount cabinets and enclosures at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to top of box unless otherwise indicated.
2. Do not install cabinets, enclosures, or fittings in contact with concrete or earth.
3. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
4. Identification: Provide labels for cabinets, enclosures, racks and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Provide warning signs.
c. Label each cabinet, enclosure, and rack with engraved metal or laminated-plastic nameplate.

D. Interfaces with Other Work:

1. Firestop penetrations of rated walls and partitions.
2. Ground and bond RBBs in cabinets, enclosures, and racks.
3. Apply arc-flash hazard warning labels cabinets, enclosures, and racks.
4. Coordinate installation of new products for Fuel Oil Storage & Delivery with existing conditions.

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a. New Fuel Oil Pump Control Panel & existing Day Tanks .
b. New Fuel Oil Pump Control Panel & existing Booster Pump Control Panel LCP-A.

3.3 FIELD QUALITY CONTROL OF ELECTRICAL CABINETS AND ENCLOSURES

A. Administrant for Electrical Power Tests and Inspections:

1. Owner will engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified medium-voltage electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections.

B. Administrant for Communications Tests and Inspections:

1. Owner will engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified communications testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections.

C. Field tests and inspections must be witnessed by authorities having jurisdiction.

D. Tests and Inspections:

1. Perform manufacturer's recommended tests and inspections.

E. Nonconforming Work:

1. Cabinet, enclosure, or rack will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.4 CLEANING

A. Remove construction dust and debris from cabinets, enclosures, and racks.

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3.5 PROTECTION

A. Protect coatings and finishes of cabinets, enclosures, and racks from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 262716

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SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Enclosures.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

A. Product Data:

1. For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
2. Enclosure types and details for types other than UL 50E, Type 1.
3. Current and voltage ratings.
4. Short-circuit current ratings (interrupting and withstand, as appropriate).
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

B. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

C. Field Quality-Control Submittals:

1. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

A. Sample warranties.

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1.4 CLOSEOUT SUBMITTALS

A. Warranty documentation.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Spare Parts: Furnish to Owner spare parts, for repairing enclosed switches and circuit breakers, that are packaged with protective covering for storage on-site and identified with labels describing contents.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Source Limitations: Obtain products from single manufacturer.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

2.2 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ABB Electrification Installations Products
2. Eaton]
3. Siemens Industry, Inc., Energy Management Division
4. Square D; Schneider Electric USA

B. Type HD, Heavy Duty:

1. Single throw.
2. Three pole.
3. 600 V(ac).
4. 1200 A and smaller.
5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses.
6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

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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. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Hookstick Handle: Allows use of hookstick to operate handle.
5. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120 V(ac).
6. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.3 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. ABB Electrification Installations Products
2. Eaton
3. Siemens Industry, Inc., Energy Management Division
4. Square D; Schneider Electric USA

B. Type HD, Heavy Duty, Three Pole, Single Throw, 600 V(ac), 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. 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. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Hookstick Handle: Allows use of hookstick to operate handle.
5. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open. Contact rating - 120 V(ac).
6. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.4 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, UL 50E, and UL 50, to comply with environmental conditions at installed location.

B. Enclosure Finish: Enclosure must be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (UL 50E Type 1).

C. Operating Mechanism: Circuit-breaker operating handle must be externally operable

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with operating mechanism being integral part of box, not cover. Cover interlock mechanism must have externally operated override. Override may not permanently disable interlock mechanism, which must return to locked position once override is released. Tool used to override cover interlock mechanism must not be required to enter enclosure in order to override interlock.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

1. Commencement of work will indicate Installer's acceptance of areas and conditions as satisfactory.

3.2 SELECTION OF ENCLOSURES

A. Indoor, Dry and Clean Locations: UL 50E, Type 1.

B. Outdoor Locations: UL 50E, Type 3R.

3.3 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
2. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
3. Install fuses in fusible devices.

3.4 IDENTIFICATION

A. Comply with requirements in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

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3.5 FIELD QUALITY CONTROL

A. Tests and Inspections for Switches:

1. Visual and Mechanical Inspection:

a. Inspect physical and mechanical condition.
b. Inspect anchorage, alignment, grounding, and clearances.
c. Verify that unit is clean.
d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
e. Verify that fuse sizes and types match the Specifications and Drawings.
f. Verify that each fuse has adequate mechanical support and contact integrity.
g. Inspect bolted electrical connections for high resistance using one of the following methods:

1) Use low-resistance ohmmeter.

a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.

2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.

h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on Drawings.
i. Verify correct phase barrier installation.
j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

B. Nonconforming Work:

1. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
2. Remove and replace defective units and retest.

C. Collect, assemble, and submit test and inspection reports.

1. Test procedures used.
2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
3. List deficiencies detected, remedial action taken, and observations after remedial

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action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

3.7 PROTECTION

A. After installation, protect enclosed switches and circuit breakers from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.8 MAINTENANCE

A. Infrared Scanning of Enclosed Switches and Breakers: Two months after Substantial Completion, perform infrared scan of joints and connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.

1. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Follow-up Infrared Scanning: Perform two follow-up infrared scans of enclosed switches and breakers, one at four months and another at 11 months after Substantial Completion.
3. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
4. Report: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 262816

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SECTION 262913.03 - MANUAL AND MAGNETIC MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Manual motor controllers.
2. Magnetic motor controllers.
3. Combination motor controllers.

B. Related Requirements:

1. Section 018116 "Facility Environmental Requirements" specifies basis-of-design environmental conditions and performance criteria that are applicable to product selection and installation of the Work on the Project.
2. Section 018123 "Facility Seismic and Wind Criteria" specifies basis-of-design seismic and wind criteria for nonstructural components on the Project.
3. Section 260010 "Supplemental Requirements for Electrical" specifies additional requirements applicable to coordinating, scheduling, and sequencing of the Work specified in this Section.
4. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding referenced by this Section.
5. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers, supports, and concrete bases referenced by this Section.
6. Section 260548 "Vibration and Seismic Controls for Electrical Systems" specifies vibration isolation and seismic-control devices referenced by this Section.
7. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
8. Section 260573 "Power System Studies" specifies arc-flash hazard analysis, warning labels, and circuit-breaker trip ranges referenced by this Section.

1.2 DEFINITIONS

A. CPT: Control power transformer.

B. MCCB: Molded-case circuit breaker.

C. MCP: Motor circuit protector.

D. N.C.: Normally closed.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

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G. SCPD: Short-circuit protective device.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing laboratory, certifying that model number corresponding to specified product complies with specified listing criteria.

B. Shop Drawings: Prepare and submit the following:

1. Include plans, elevations, sections, and mounting details.
2. Indicate dimensions, weights, required clearances, and location and size of each field connection.
3. Wire Termination Diagrams and Schedules: Include diagrams for signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
4. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

C. Product Schedule: List the following for each enclosed controller:

1. Each installed magnetic controller type.
2. Laboratory and file number for listing by qualified electrical testing laboratory.
3. Factory-installed accessories.
4. Nameplate legends.
5. SCCR of integrated unit.
6. For each combination magnetic controller include features, characteristics, ratings, and factory setting of the SCPD and OCPD.

    a. Listing document proving Type 2 coordination.

7. For each series-rated combination state the listed integrated short-circuit current (withstand) rating of SCPD and OCPDs by qualified electrical testing laboratory recognized by authorities having jurisdiction.

D. Field quality-control reports.

E. System startup testing reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturer's published instructions.

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B. Field Reports:

1. Manufacturer's field reports for field quality-control support.
2. Manufacturer's field reports for system startup support.
3. Field reports for infrared scanning.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Spare parts.

1.6 QUALIFICATIONS

A. Electrical Power Testing (EPT) Technician I: Possessing active NICET EPT Level I certification. Able to work safely around electrical power equipment and cabling under supervision.

B. Electrical Power Testing (EPT) Technician II: Possessing active NICET EPT Level II certification. Able to isolate and ground electrical power equipment, to connect test equipment, and to conduct and document standard tests of basic equipment.

C. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, to conduct tests of complex equipment, to analyze test and equipment data, to plan a job, and to lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.

D. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; to evaluate tests, test equipment, test results, and power system performance; to recommend actions to maintain or improve system performance; and to lead multi-team projects.

E. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.

1. On-site electrical testing supervisors must possess active NICET EPT Technician III certification.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 50 W per controller connect factory-installed space heaters to temporary electrical service.

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1.8 SERVICE CONDITIONS FOR ELECTRICAL EQUIPMENT

A. Modeling, analysis, product selection, installation, and quality control for all electrical Work on the Project must comply with service condition requirements specified in Section 018116 "Facility Environmental Requirements" and Section 018123 "Facility Seismic and Wind Criteria."

B. Ambient Environment Ratings: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than 23 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 ft for electromagnetic and manual devices.

3. The effect of solar radiation is insignificant.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Products or components listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.

B. Enclosures:

1. Environmental Ratings: Comply with UL 50E, type designations as indicated on the Drawings.
2. Construction: Comply with NEMA IA 10030.
3. Controllers in Hazardous (Classified) Locations: Comply with UL 1203.

C. Seismic and Wind Performance: Installed assembly must perform in accordance with Section 018123 "Facility Seismic and Wind Criteria" and the following:

1. Withstand Requirement: Unit must remain in place without separation of parts when subjected to specified criteria during seismic events, and unit must be fully operational after seismic events.
2. Component Importance Factor (Ip): 1.0.
3. Component Amplification Factor (ap): 1.0.
4. Component Response Modification Factor (Rp): 1.5.
5. Component Overstrength Factor (Ωo): 1.5.

2.2 MANUAL MOTOR CONTROLLERS

A. Motor-Starting Switches (MSS):

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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a. ABB, Motion Business
b. Eaton
c. Rockwell Automation, Inc.
d. Siemens Industry, Inc., Energy Management Division
e. Square D; Schneider Electric USA

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. ABB, Motion Business
b. Eaton
c. Rockwell Automation, Inc.
d. Siemens Industry, Inc., Energy Management Division
e. Square D; Schneider Electric USA

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by UL Solutions or FM Approvals, CSA Group (with "US" marking), Intertek ETL, or other qualified electrical testing laboratory recognized by authorities having jurisdiction in accordance with one or more of the following guide information and corresponding standards:

a. Motor Controllers, Manual: UL CCN NLRV, including UL 60947-1 and UL 60947-4-1.

5. Standard Features: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

a. Referenced Standards: Comply with NEMA ICS 2, general purpose, Class A.
b. Configuration: Nonreversing.

c. Mounting: Surface.

d. Pilot Light Color: Red (stopped and Green (running).

B. Fractional Horsepower Manual Controllers (FHPMC):

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ABB Electrification Installations Products
b. ABB, Motion Business
c. Eaton
d. Rockwell Automation, Inc.
e. Siemens Industry, Inc., Energy Management Division
f. Square D; Schneider Electric USA

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

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a. ABB Electrification Installations Products
b. ABB, Motion Business
c. Eaton
d. Rockwell Automation, Inc.
e. Siemens Industry, Inc., Energy Management Division
f. Square D; Schneider Electric USA

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by UL Solutions, CSA Group (with "US" marking), in accordance with one or more of the following guide information and corresponding standards:

a. Motor Controllers, Manual: UL CCN NLRV, including UL 60947-1 and UL 60947-4-1.

5. Standard Features: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

a. Referenced Standards: Comply with NEMA ICS 2.

1) Overload Relays:

a) Inverse-time-current characteristics; Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
b) Bimetallic class as scheduled on the Drawings.

b. Configuration: Nonreversing.

c. Pilot Light: Red.

C. Integral Horsepower Manual Controllers (IHPMC):

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ABB Electrification Installations Products
b. ABB, Motion Business
c. Eaton
d. Rockwell Automation, Inc.
e. Siemens Industry, Inc., Energy Management Division
f. Square D; Schneider Electric USA

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

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a. ABB Electrification Installations Products
b. ABB, Motion Business
c. Eaton
d. Rockwell Automation, Inc.
e. Siemens Industry, Inc., Energy Management Division
f. Square D; Schneider Electric USA

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by UL Solutions or FM Approvals, CSA Group (with "US" marking), in accordance with one or more of the following guide information and corresponding standards:

    a. Motor Controllers, Manual: UL CCN NLRV, including UL 60947-1 and UL 60947-4-1.

5. Standard Features: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

    a. Referenced Standards: Comply with NEMA ICS 2.

        1) Overload Relays:

            a) Inverse-time-current characteristics; Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
            b) Bimetallic class as scheduled on the Drawings.

    b. Configuration: Nonreversing.

2.3 MAGNETIC MOTOR CONTROLLERS

A. Enclosed Full-Voltage Magnetic Motor Controllers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. ABB Electrification Installations Products
    b. ABB, Motion Business
    c. Eaton
    d. Rockwell Automation, Inc.
    e. Siemens Industry, Inc., Energy Management Division
    f. Square D; Schneider Electric USA

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

    a. ABB Electrification Installations Products

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b. ABB, Motion Business
c. Eaton
d. Rockwell Automation, Inc.
e. Siemens Industry, Inc., Energy Management Division
f. Square D; Schneider Electric USA

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by UL Solutions or FM Approvals, CSA Group (with "US" marking), in accordance with one or more of the following guide information and corresponding standards:

    a. Motor Controllers, Magnetic: UL CCN NLDX, including UL 60947-1 and UL 60947-4-1.

5. Standard Features: Across-the-line start, electrically held, for nominal system voltage of 600 V(ac) and less.

    a. Referenced Standards: Comply with UL 508 and NEMA ICS 2, general purpose, Class A.

    b. Configuration: Nonreversing.
    c. Contactor Coils: Pressure-encapsulated type with coil transient suppressors when indicated.

        1) Operating Voltage: Manufacturer's standard unless otherwise indicated.

    d. Control Power: For on-board control power, obtain from line circuit or from integral CPT with capacity to operate integral devices and remotely located pilot, indicating, and control devices.

        1) Spare CPT Capacity as Indicated on the Drawings: 50 VA.

    e. Overload Relays:

        1) Thermal Overload Relays:

            a) Inverse-time-current characteristic.
            b) Class 10 tripping characteristic.
            c) Heaters: In each phase; coordinate with nameplate full-load current of actual protected motor; include appropriate adjustment for duty cycle.

            d) Ambient compensated.
            e) Automatic resetting.

        2) Solid-State Overload Relay:

            a) Switch or dial selectable for motor-running overload protection.
            b) Sensors in each phase.

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c) Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

f. Class II Ground-Fault Protection: Comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system includes circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

B. Enclosed Reduced-Voltage Magnetic Motor Controllers :

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ABB Electrification Installations Products
b. ABB, Motion Business
c. Eaton
d. Rockwell Automation, Inc.
e. Siemens Industry, Inc., Energy Management Division
f. Square D; Schneider Electric USA

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. ABB Electrification Installations Products
b. ABB, Motion Business
c. Eaton
d. Rockwell Automation, Inc.
e. Siemens Industry, Inc., Energy Management Division
f. Square D; Schneider Electric USA

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by UL Solutions or FM Approvals, CSA Group (with "US" marking), in accordance with one or more of the following guide information and corresponding standards:

a. Motor Controllers, Magnetic: UL CCN NLDX, including UL 60947-1 and UL 60947-4-1.

5. Standard Features: Electrically held; closed transition; adjustable time delay on transition, 600 V(ac) or less.

a. Referenced Standards: Comply with UL 508 and NEMA ICS 2, general purpose, Class A.
b. Configuration:

1) Wye-Delta Controller: Four contactors, with a three-phase starting resistor/reactor bank.

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2) Part-Winding Controller: Separate START and RUN contactors, field-selectable for one-half- or two-thirds-winding start mode, with either six- or nine-lead motors; with separate overload relays for starting and running sequences.
3) Autotransformer Reduced-Voltage Controller: Medium-duty service, with integral overtemperature protection; taps for starting at 50, 65, and 80 percent of line voltage; two START and one RUN contactors.

c. Contactor Coils: Pressure-encapsulated type with coil transient suppressors when indicated.

1) Operating Voltage: Manufacturer's standard unless otherwise indicated.

d. Control Power: 120 V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.

1) Spare CPT Capacity: 50 VA.

e. Overload Relays:

1) Thermal Overload Relays: Bimetallic type.

a) Inverse-time-current characteristic.
b) Class 10 tripping characteristic.
c) Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
d) Ambient compensated.
e) Automatic resetting.

2) Solid-State Overload Relay:

a) Switch or dial selectable for motor-running overload protection.
b) Sensors in each phase.
c) Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

f. Class II Ground-Fault Protection: Comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system includes circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

2.4 COMBINATION MAGNETIC MOTOR CONTROLLERS

A. Combination Full-Voltage Magnetic Motor Controller:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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a. ABB Electrification Installations Products
b. ABB, Motion Business
c. Eaton
d. Rockwell Automation, Inc.
e. Siemens Industry, Inc., Energy Management Division
f. Square D; Schneider Electric USA

2. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

a. ABB Electrification Installations Products
b. ABB, Motion Business
c. Eaton
d. Rockwell Automation, Inc.
e. Siemens Industry, Inc., Energy Management Division
f. Square D; Schneider Electric USA

3. Source Limitations: Obtain products from single manufacturer.
4. Listing Criteria: Investigated, labeled, and marked by UL Solutions or FM Approvals, CSA Group (with "US" marking), in accordance with one or more of the following guide information and corresponding standards:

a. Combination Motor Controllers: UL CCN NKJH (36 BPMs), including UL 60947-1 and UL 60947-4-1.

5. Standard Features: Factory-assembled, combination full-voltage magnetic motor controller consisting of the controller described in this article, indicated disconnecting means, SCPD and OCPD, in a single enclosure.

a. Referenced Standards: Comply with NEMA ICS 2, general purpose, Class A.
b. Configuration: Nonreversing.
c. Contactor Coils: Pressure-encapsulated type with coil transient suppressors when indicated.

1) Operating Voltage: Manufacturer's standard unless otherwise indicated.

d. Control Power: For on-board control power, obtain from line circuit or from integral CPT with capacity to operate integral devices and remotely located pilot, indicating, and control devices.

1) Spare CPT Capacity as Indicated on the Drawings: 50 VA.

e. Overload Relays:

1) Thermal Overload Relays:

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a) Inverse-time-current characteristic.
b) Class 10 tripping characteristic.
c) Heaters: In each phase coordinate with nameplate full-load current of actual protected motor; include appropriate adjustment for duty cycle.
d) Ambient compensated.
e) Automatic resetting.

2) Solid-State Overload Relay:

a) Switch or dial selectable for motor-running overload protection.
b) Sensors in each phase.
c) Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.

f. Class II Ground-Fault Protection: Comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system includes circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

g. Fusible Disconnecting Means:

1) NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate indicated fuses.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

h. Nonfusible Disconnecting Means:

1) NEMA KS 1, heavy-duty, horsepower-rated, nonfusible switch.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

i. MCP Disconnecting Means:

1) UL 489 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.
2) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

j. MCCB Disconnecting Means:

1) UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse-time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.
2) Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

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3) Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

2.5 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push-Buttons, Pilot Lights, and Selector Switches: Standard duty, except as needed to match enclosure type. Heavy duty or oiltight where indicated in the controller schedule.

a. Push-Buttons: As indicated in the controller schedule.
b. Pilot Lights: As indicated in the controller schedule.

2. Elapsed Time Meters: Heavy duty with digital readout in hours; resettable.

B. Motor Protection Relays: Provide solid-state sensing circuit and isolated output contacts for hardwired connections.

1. Phase-failure.
2. Phase-reversal, with bicolor LED to indicate normal and fault conditions. Automatic reset when phase reversal is corrected.
3. Under/overvoltage, operate when the circuit voltage reaches a preset value, and drop out when the operating voltage drops to a level below the preset value. Include adjustable time-delay setting.

C. Breather Assemblies: Maintain interior pressure and release condensation in Type 4 and Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

D. Space Heaters: Provide N.C. auxiliary contacts, to mitigate condensation in Type 4X and Type 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

E. Sun Shields: Install on fronts, sides, and tops of enclosures that are installed outdoors and subject to direct and extended sun exposure.

2.6 MAINTENANCE MATERIAL ITEMS

A. Spare Parts: Furnish to Owner spare parts, for repairing motor controllers, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:

1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than six of each size and type.
2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than six of each size and type.
3. Indicating Lights: Two of each type and color installed.

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4. Auxiliary Contacts: Furnish two spare(s) for each size and type of magnetic controller installed.
5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.

3.2 INSTALLATION OF MANUAL AND MAGNETIC MOTOR CONTROLLERS

A. Comply with manufacturer's published instructions.

B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:

1. Electrical Construction: ICC IBC, ICC IFC, NECA NEIS 1, NFPA 1, and NFPA 70.
2. Electrical Maintenance: NECA NEIS 91 and NFPA 70B.
3. Electrical Safety: NFPA 70E.
4. Commissioning of Electrical Systems: NECA NEIS 90.
5. Hot Work: NFPA 51B.
6. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
7. Work in Confined Spaces: NFPA 350.
8. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
9. Evaluation of Unlabeled Electrical Equipment: NFPA 791.
10. Consult Architect for resolution of conflicting requirements.

C. Special Installation Techniques:

1. Wall-Mounted Controllers: Install magnetic controllers on walls with tops at uniform height 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 for support unless otherwise indicated.

2. Floor-Mounted Controllers: Install controllers on cast-in-place concrete equipment base(s).

3. Provide seismic control devices.
4. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
5. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special

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motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

D. Interfaces with Other Work:

1. Identification: Provide labels for motor controllers and associated electrical equipment.

a. Identify field-installed conductors, interconnecting wiring, and components.
b. Label each enclosure and each compartment with laminated acrylic or melamine plastic signs, mounted with corrosion-resistant screws.
c. Provide warning signs for electrical equipment.

2. Arc-Flash Warning Labels:

a. Provide self-adhesive equipment label for each work location.
b. Labels must be machine printed, with no field-applied markings.
c. Labels must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from the arc-flash hazard analysis:

1) Location designation.
2) Nominal voltage.
3) Flash protection boundary.
4) Hazard risk category.
5) Incident energy.
6) Working distance.
7) Engineering report number, revision number, and issue date.

3.3 FIELD QUALITY CONTROL OF MANUAL AND MAGNETIC MOTOR CONTROLLERS

A. Administrant for Electrical Power Tests and Inspections:

1. Owner will engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
2. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
3. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
4. Administer and perform tests and inspections with assistance of factory-authorized service representative.

B. Acceptance Testing Preparation:

1. <Insert requirements>.

C. Field tests and inspections must be witnessed by authorities having jurisdiction.

D. Tests and Inspections:

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1. Comply with NFPA 70B.
2. Visual and Mechanical Inspection:

    a. Compare equipment nameplate data with drawings and specifications.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, and grounding.
    d. Verify the unit is clean.
    e. Inspect contactors:

        1) Verify mechanical operation.
        2) Verify contact gap, wipe, alignment, and pressure are in accordance with manufacturer's published data.

    f. Motor-Running Protection:

        1) Verify overload element rating is correct for its application.
        2) If motor-running protection is provided by fuses, verify correct fuse rating.

    g. Inspect bolted electrical connections for high resistance using one of the two following methods:

        1) Use a low-resistance ohmmeter. Compare bolted connection resistance values with values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
        2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

    h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

3. Electrical Tests:

    a. For the contactor and circuit breaker, perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole.

        1) Insulation Resistance: In accordance with manufacturer's published data or NETA ATS Table 100.1. In the absence of manufacturer's published data, use Table 100.5.
        2) Investigate and correct insulation resistance values less than those of this table or manufacturer's published instructions.

    b. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
    c. Test motor protection devices in accordance with manufacturer's published data.
    d. Test circuit breakers as follows:

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1) Operate the circuit breaker to ensure smooth operation.
2) For adjustable circuit breakers, adjust protective device settings in accordance with the coordination study. Comply with coordination study recommendations.

e. Perform operational tests by initiating control devices.

E. Nonconforming Work:

1. Motor controller will be considered defective if it does not pass tests and inspections.
2. Remove and replace defective units and retest.

F. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

G. Manufacturer Services: Engage factory-authorized service representative to support field tests and inspections.

1. Manufacturer's Field Reports for Field Quality-Control Support: Prepare and submit report after each visit by factory-authorized service representative, documenting activities performed at the Project site.

3.4 SYSTEM STARTUP

A. Perform startup service in accordance with manufacturer's published instructions.

B. System Startup Testing: Verify the correct interaction of sensing, processing, and action devices. Perform system startup testing after field quality control tests have been completed and all components have passed specified tests.

1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
3. Verify the correct operation of sensing devices, alarms, and indicating devices.

C. Nonconforming Work:

1. Motor controller will be considered defective if it does not pass system startup testing.

D. System Startup Testing Report: Compile, prepare, and submit system startup testing reports.

E. Manufacturer Services: Engage factory-authorized service representative to support system startup.

1. Manufacturer's Field Reports for System Startup Support: Prepare and submit report after each visit by factory-authorized service representative, documenting

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activities performed at the Project site.

3.5 CLOSEOUT ACTIVITIES

A. Training:

1. With assistance from factory-authorized service representatives, train Owner's maintenance personnel on the following topics:

    a. How to adjust, operate, and maintain equipment specified in Section 262913.03 "Manual and Magnetic Motor Controllers."

3.6 MAINTENANCE

A. Infrared Scanning of Motor Controllers: Perform infrared scanning during periods of maximum possible loading. Comply with NFPA 70B requirements. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.

1. Equipment: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C. The equipment must detect emitted radiation and convert detected radiation to a visual signal.
2. Act on inspection results and recommended action, and considering the recommendations of NETA ATS Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.
3. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of the electrical power connections of each motor controller.
4. Follow-On Infrared Scanning: Perform follow-up infrared scans of motor controller at 11 months after Substantial Completion.
5. Field Reports for Infrared Scanning: Prepare a certified report including the following information:

    a. Identities of personnel performing infrared scanning.
    b. Description of test equipment used and record of their calibration.
    c. Description of motor controllers and associated equipment tested.
    d. Deficiencies found, remedial actions taken, and observations found when scans were repeated after the remedial actions.
    e. Temperature difference between the area of concern and the reference area.
    f. Probable cause of temperature difference.
    g. Areas inspected. Identify inaccessible and unobservable areas and equipment.
    h. Load conditions at time of inspection.
    i. Photographs and thermograms of the deficient area.
    j. Recommended action.

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END OF SECTION 262913.03

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SECTION 263213.13 - DIESEL-ENGINE-DRIVEN GENERATOR SETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Diesel fuel-oil system.

1.2 DEFINITIONS

A. EPS: Emergency power supply.

B. EPSS: Emergency power supply system.

C. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include fuel consumption in gallons per hour at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
2. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.

B. Shop Drawings:

1. Include plans and elevations for engine generator and other components specified. Indicate access requirements affected by height of subbase fuel tank.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for engine generators and functional relationship between all electrical components.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and testing agency.

B. Source Quality-Control Reports: Including, but not limited to, the following:

1. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
2. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.

C. Field quality-control reports.

D. Warranty: For special warranty.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 1 year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 DIESEL-ENGINE-DRIVEN GENERATOR SETS

A. Manufacturers: Subject to compliance with requirements, (4) generators are existing. A concrete pad exists to accommodate a fifth generator, at which time specific generator specifications will be generated.

1. Caterpillar, Inc.; Electric Power Division

B. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

1. Caterpillar, Inc.; Electric Power Division

C. Source Limitations: Obtain auxiliary components from single source from single manufacturer.

2.2 DIESEL ENGINE

A. Fuel: ASTM D975, diesel fuel oil, Grade 2-D S15.

2.3 DIESEL FUEL-OIL SYSTEM

A. Comply with NFPA 37.

B. Piping: Fuel-oil piping shall be Schedule 40 black steel, complying with requirements in Section 231113 "Facility Fuel-Oil Piping." Cast iron, aluminum, copper, and galvanized steel shall not be used in the fuel-oil system.

C. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.

D. Fuel Filtering: Remove water and contaminants larger than 1 micron.

E. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Fuel-Oil Storage Tank: Comply with requirements in Section 231323 "Facility Aboveground Fuel-Oil Storage Tanks."

1. Fuel Tank Capacity:(2) 25,000 gallons.
2. Duplex Fuel-Oil Transfer Pump: Comply with requirements in Section 231213 "Facility Fuel-Oil Pumps."

G. Day Tank: Comply with UL 142, freestanding, factory-fabricated fuel tank assembly, with integral, float-controlled transfer pump and the following features:

1. Containment: Integral rupture basin with a capacity of 150 percent of nominal capacity of day tank.

    a. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.

2. Tank Capacity: Existing day tanks will remain (275 gallons).
3. Pump Capacity: Exceeds maximum flow of fuel drawn by engine-mounted fuel supply pump at 110 percent of rated capacity, including fuel returned from engine.
4. Low-Level Alarm Sensor: Liquid-level device operates alarm contacts at 25 percent of normal fuel level.

5. High-Level Alarm Sensor: Liquid-level device operates alarm and redundant fuel shutoff contacts at midpoint between overflow level and 100 percent of normal fuel level.
6. Piping Connections: Factory-installed fuel supply and return lines from tank to engine; local fuel fill, vent line, overflow line; and tank drain line with shutoff valve.

7. Redundant High-Level Fuel Shutoff: Actuated by high-level alarm sensor in day tank to operate a separate motor-control device that disconnects day-tank pump motor. Sensor shall signal solenoid valve, located in fuel suction line between fuel storage tank and day tank, to close. Both actions shall remain in shutoff state until manually reset. Shutoff action shall initiate an alarm signal to control panel but shall not shut down engine generator.

8. Return Pump Manifold: Actuated by level sensor to prevent tank overfill/over flow. Return pump energizing will trigger alarm. High fuel level will stop fuel oil supply pump.

2.4 CONTROL AND MONITORING

A. Control and Monitoring Panel:

1. Controls and Protective Devices: Controls, common alarm indication, including the following:

   a. Hand-Off-Auto switch.
   b. Day Tank Fuel Level.

   c. Leak alarm.
   d. High alarm.
   e. Pump start/stop control.

2.5 SOURCE QUALITY CONTROL

A. Project-Specific Equipment Tests: Before shipment, other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.

2. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.

3. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.

B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than two working days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

3.3 INSTALLATION

A. Comply with NECA 1 and NECA 404.

B. Fuel Piping:

1. Diesel storage tanks, tank accessories, piping, valves, and specialties for fuel systems are specified in Section 231113 "Facility Fuel-Oil Piping."
2. Copper and galvanized steel shall not be used in the fuel-oil piping system.

C. Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel piping to engines with a gate valve and union and flexible connector.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.

E. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.5 FIELD QUALITY CONTROL

A. Testing Agency:

1. Perform tests and inspections with the assistance of a factory-authorized service representative.

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in first two subparagraphs below, as specified in NETA ATS. Certify compliance with test parameters.

a. Visual and Mechanical Inspection:

1) Compare equipment nameplate data with Drawings and the Specifications.
2) Inspect physical and mechanical condition.

b. Electrical and Mechanical Tests:

1) Perform insulation-resistance tests according to IEEE 43.

a) Machines Larger Than 200 hp: Test duration shall be 10 minutes. Calculate polarization index.
b) Machines 200 hp or Less: Test duration shall be one minute. Calculate the dielectric-absorption ratio.

2) Test protective relay devices.
3) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.

2. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for fluid leaks.

C. Leak Test: After installation, fuel systems and test for leaks. Repair leaks and retest until no leaks exist.

D. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation for generator and associated equipment.

E. Test and adjust controls and safeties. Replace damaged and malfunctioning controls

and equipment.

F. Remove and replace malfunctioning units and retest as specified above.

G. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.

H. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.6 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance of fuel oil delivery system and day tank upgrades by skilled employees of manufacturer's authorized service representative. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Parts shall be manufacturer's authorized replacement parts and supplies.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION 263213.13

SECTION 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Category 5e twisted pair cable.
2. Twisted pair cable hardware.
3. Cable management system.
4. Identification products.

B. Related Requirements:

1. Section 270513 "Conductors and Cables for Communications Systems" for data cabling associated with system panels and devices.

1.2 DEFINITIONS

A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

B. EMI: Electromagnetic interference.

C. FTP: Shielded twisted pair.

D. F/FTP: Overall foil screened cable with foil screened twisted pair.

E. F/UTP: Overall foil screened cable with unscreened twisted pair.

F. IDC: Insulation displacement connector.

G. Jack: Also commonly called an "outlet," it is the fixed, female connector.

H. LAN: Local area network.

I. Plug: Also commonly called a "connector," it is the removable, male communications connector.

J. RCDD: Registered Communications Distribution Designer.

K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

M. S/FTP: Overall braid screened cable with foil screened twisted pair.

N. S/UTP: Overall braid screened cable with unscreened twisted pairs.

O. UTP: Unscreened (unshielded) twisted pair.

1.3 COPPER HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the communications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1. TIA-568-C.2 requires that a minimum of two equipment outlets be installed for each work area.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the communications equipment outlet.
3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately 100 sq. ft., and includes the components that extend from the equipment outlets to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.4 ACTION SUBMITTALS

A. Product Data:

1. Category 5e twisted pair cable.
2. Twisted pair cable hardware.
3. Cable management system.
4. Identification products.

B. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules:

a. Electronic copy of labeling schedules, in software and format selected by Owner.
b. Electronic copy of labeling schedules that are part of cabling and asset identification system of software.

2. Cabling administration Drawings and printouts.
3. Wiring diagrams and installation details of communications equipment, to show location and layout of communications equipment, including the following:

a. Communications pathways.
b. Communications system access points.
c. Communications conductor drop locations.
d. Typical telecommunications details.
e. Mechanical, electrical, and plumbing systems.

C. Twisted pair cable testing plan.

D. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Plugs: two of each type.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and cabling administration Drawings by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, during the remainder of the construction period.

1.11 COORDINATION

A. Coordinate layout and installation of communications pathways and cabling with Owner's communications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.2, when tested according to test procedures of this standard.

B. Communications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Plenum Rated:

a. Type CMP complying with UL 1685.
b. Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2. Communications, Non-Plenum Rated:

a. Type CMR complying with UL 1666.
b. Type CMP or Type CMR in listed plenum or riser communications raceway.
c. Type CMP or Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. RoHS compliant.

2.3 CATEGORY 5e TWISTED PAIR CABLE

A. Category 5e Twisted Pair Cable: Four-pair, balanced twisted pair cable, certified to meet transmission characteristics of Category 5e cable at frequencies up to 100 MHz.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AMP NETCONNECT; a TE Connectivity Ltd. company
2. Belden Inc.
3. Berk-Tek, a Leviton Company
4. CommScope, Inc
5. General Cable; Prysmian Group North America
6. Hitachi Cable America Inc.
7. Mohawk; a division of Belden Networking, Inc.
8. West Penn Wire; brand of Belden, Inc.

C. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

1. AMP NETCONNECT; a TE Connectivity Ltd. company
2. Belden Inc.
3. Berk-Tek, a Leviton Company
4. CommScope, Inc
5. General Cable; Prysmian Group North America
6. Hitachi Cable America Inc.
7. Mohawk; a division of Belden Networking, Inc.
8. West Penn Wire; brand of Belden, Inc.

D. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 5e cables.

E. Conductors: 100-ohm, 24 AWG solid copper.

1. Lead Content: Less than 300 parts per million.

F. Shielding/Screening: Shielded twisted pairs (FTP).

G. Cable Rating: Riser.

H. Jacket: thermoplastic.

2.4 TWISTED PAIR CABLE HARDWARE

A. Twisted Pair Cable Hardware: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to,

the following:

1. 3M
2. American Technology Systems Industries, Inc
3. AMP NETCONNECT; a TE Connectivity Ltd. company
4. Belden Inc.
5. Berk-Tek, a Leviton Company
6. CommScope, Inc
7. Dynacom Corporation
8. General Cable; Prysmian Group North America
9. Genesis; Resideo Technologies, Inc.
10. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated
11. Leviton Manufacturing Co., Inc.
12. Mohawk; a division of Belden Networking, Inc.
13. Molex Premise Networks
14. Panduit Corp
15. Prysmian Cables and Systems; Prysmian Group North America
16. Siemon Co. (The)
17. Superior Essex Inc.; subsidiary of LS Corp.

C. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

1. 3M
2. American Technology Systems Industries, Inc
3. AMP NETCONNECT; a TE Connectivity Ltd. company
4. Belden Inc.
5. Berk-Tek, a Leviton Company
6. CommScope, Inc
7. Dynacom Corporation
8. General Cable; Prysmian Group North America
9. Genesis; Resideo Technologies, Inc.
10. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated
11. Leviton Manufacturing Co., Inc.
12. Mohawk; a division of Belden Networking, Inc.
13. Molex Premise Networks
14. Panduit Corp
15. Prysmian Cables and Systems; Prysmian Group North America
16. Siemon Co. (The)
17. Superior Essex Inc.; subsidiary of LS Corp.

D. General Requirements for Twisted Pair Cable Hardware:

1. Comply with the performance requirements of Category 5e.
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

E. Source Limitations: Obtain twisted pair cable hardware from single source from single

manufacturer.

F. Connecting Blocks:

1. 110-style IDC for Category 5e.
2. 66-style IDC for Category 5e.
3. Provide blocks for the number of cables terminated on the block, plus 10 percent spare, integral with connector bodies, including plugs and jacks where indicated.

G. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

H. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.

1. Features:

a. Universal T568A and T568B wiring labels.
b. Labeling areas adjacent to conductors.
c. Replaceable connectors.

I. Patch Cords: Factory-made, four-pair cables in 36-inch lengths; terminated with an eight-position modular plug at each end.

1. Patch cords shall have color-coded boots for circuit identification.

J. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Standard: Comply with TIA-568-C.2.

K. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Designed to snap-in to a patch panel or cover plate.
3. Standard: Comply with TIA-568-C.2.

L. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.5 CABLE MANAGEMENT SYSTEM

A. Document physical characteristics by recording the network, TIA details, and

connections between equipment and cable.

B. Information shall be presented in schematic plans, or technical drawings.

1. AutoCAD drawing software shall be used as drawing and schematic plans software.

2.6 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.7 SOURCE QUALITY CONTROL

A. Cable will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Routing:

1. Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters. Conceal raceway and cables, except in unfinished spaces.

a. Install plenum cable in environmental air spaces, including plenum ceilings.
b. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."

B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF PATHWAYS

A. Comply with Section 260529 "Hangers and Supports for Electrical Systems."

B. Drawings indicate general arrangement of pathways and fittings.

3.3 INSTALLATION OF TWISTED PAIR HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
6. MUTOA shall not be used as a cross-connect point.
7. Consolidation points may be used only for making a direct connection to equipment outlets:

    a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
    b. Locate consolidation points for twisted pair cables at least 49 feet from communications equipment room.

8. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
10. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
11. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
12. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
13. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
14. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Group connecting hardware for cables into separate logical fields.

E. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with "Firestopping Systems" Article in BISCI's "Telecommunications Distribution Methods Manual."

3.5 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

C. Comply with TIA-607-B and NECA/BICSI-607.

D. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

E. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Administration Class: Class 1.
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration.

C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

    a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a

building-mounted device, with the name and number of a particular device.
b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Field tests and inspections must be witnessed by authorities having jurisdiction.

B. Tests and Inspections:

1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

D. Nonconforming Work:

1. End-to-end cabling will be considered defective if it does not pass tests and inspections.
2. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. Collect, assemble, and submit test and inspection reports.

F. Manufacturer Services:

1. Engage factory-authorized service representative to support field tests and inspections.

END OF SECTION 271513

SECTION 271523 - COMMUNICATIONS OPTICAL FIBER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. 62.5/125-micrometer, multimode, optical fiber cable (OM1).
2. 50/125 micrometer, multimode, optical fiber cable (OM2).
3. 850 nanometer laser-optimized 50/125 micrometer multimode optical fiber cable (OM3).
4. 850 nanometer laser-optimized 50/125 micrometer multimode optical fiber cable (OM4).
5. 9/125 micrometer, single-mode, indoor-outdoor optical fiber cable (OS1).
6. 9/125 micrometer, single-mode, indoor-outdoor optical fiber cable (OS2).
7. Optical fiber cable hardware.
8. Cross-connects and patch panels.
9. Grounding.
10. Identification products.

1.2 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. RCDD: Registered Communications Distribution Designer.

1.3 OPTICAL FIBER HORIZONTAL CABLING DESCRIPTION

A. Optical fiber horizontal cabling system is to provide interconnections between Distributor A, Distributor B, or Distributor C and the equipment outlet, otherwise known as "Cabling Subsystem 1" in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
2. Horizontal cabling is to contain no more than one transition point or consolidation point between the horizontal cross-connect and the equipment outlet.
3. Bridged taps and splices are not to be installed in the horizontal cabling.

B. A work area is approximately 100 sq. ft., and includes the components that extend from the equipment outlets to the equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.4 ACTION SUBMITTALS

A. Product Data:

1. 62.5/125-micrometer, multimode, optical fiber cable (OM1).
2. 50/125 micrometer, multimode, optical fiber cable (OM2).
3. 850 nanometer laser-optimized 50/125 micrometer multimode optical fiber cable (OM3).
4. 850 nanometer laser-optimized 50/125 micrometer multimode optical fiber cable (OM4).
5. 9/125 micrometer, single-mode, indoor-outdoor optical fiber cable (OS1).
6. 9/125 micrometer, single-mode, indoor-outdoor optical fiber cable (OS2).
7. Optical fiber cable hardware.
8. Cross-connects and patch panels.
9. Grounding.
10. Identification products.

B. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules:

a. Electronic copy of labeling schedules, in software and format selected by Owner.
b. Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.

2. Cabling administration Drawings and printouts.
3. Wiring diagrams and installation details of communications equipment, to show location and layout of telecommunications equipment, including the following:

a. Communications rooms plans and elevations.
b. Communications pathways.
c. Communications system access points.
d. Communications grounding system.
e. Communications conductor drop locations.
f. Typical communications details.
g. Mechanical, electrical, and plumbing systems.

C. Fiber optic cable testing plan.

D. Samples: For telecommunications jacks and plugs, in specified finish, one for each type and configuration.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Software and Firmware Operational Documentation:

1. Device address list.

B. Maintenance Data: For optical fiber cable, splices, and connectors to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Connecting Blocks: One of each type.
2. Jacks: Two of each type.
3. Patch-Panel Units: One of each type.
4. Plugs: Two of each type.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by an Technician.
2. Installation Supervision: Installation is to be under the direct supervision of Technician, who is to be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an Technician.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, during the remainder of the construction period.

1.11 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system is to comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.2 62.5/125-MICROMETER, MULTIMODE, OPTICAL FIBER CABLE (OM1)

A. Description: Multimode, 62.5/125-micrometer, 1-fiber, nonconductive, tight buffer, optical fiber cable.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Belden Inc.
2. Berk-Tek, a Leviton Company
3. CommScope, Inc
4. Corning Optical Communications; Corning Incorporated
5. General Cable; Prysmian Group North America

6. Hitachi Cable America Inc.
7. Mohawk; a division of Belden Networking, Inc.
8. Prysmian Cables and Systems; Prysmian Group North America
9. Superior Essex Inc.; subsidiary of LS Corp.

C. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

1. Belden Inc.
2. Berk-Tek, a Leviton Company
3. CommScope, Inc
4. Corning Optical Communications; Corning Incorporated
5. General Cable; Prysmian Group North America
6. Hitachi Cable America Inc.
7. Mohawk; a division of Belden Networking, Inc.
8. Prysmian Cables and Systems; Prysmian Group North America
9. Superior Essex Inc.; subsidiary of LS Corp.

D. Standards:

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with TIA-492AAAA for detailed specifications.

E. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.

F. Minimum Overfilled Modal Bandwidth-length Product: 200 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

G. Jacket:

1. Jacket Color: Orange.
2. Cable cordage jacket, fiber, unit, and group color is to be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

H. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive:

a. Type OFNP, complying with NFPA 262.

2.3 50/125 MICROMETER, MULTIMODE, OPTICAL FIBER CABLE (OM2)

A. Description: Multimode, 50/125-micrometer, 1-fiber, nonconductive, tight buffer, optical fiber cable.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to,

the following:

1. AMP NETCONNECT; a TE Connectivity Ltd. company
2. Belden Inc.
3. Berk-Tek, a Leviton Company
4. CommScope, Inc
5. Corning Optical Communications; Corning Incorporated
6. General Cable; Prysmian Group North America
7. Hitachi Cable America Inc.
8. Superior Essex Inc.; subsidiary of LS Corp.

C. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

1. AMP NETCONNECT; a TE Connectivity Ltd. company
2. Belden Inc.
3. Berk-Tek, a Leviton Company
4. CommScope, Inc
5. Corning Optical Communications; Corning Incorporated
6. General Cable; Prysmian Group North America
7. Hitachi Cable America Inc.
8. Superior Essex Inc.; subsidiary of LS Corp.

D. Standards:

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with TIA-492AAAB for detailed specifications.

E. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.

F. Minimum Overfilled Modal Bandwidth-length Product: 500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

G. Jacket:

1. Jacket Color: Orange.
2. Cable cordage jacket, fiber, unit, and group color are to be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

H. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive:

a. Type OFNP, complying with NFPA 262.
b. Type OFNP in listed plenum communications raceway.
c. Type OFNP or Type OFNR in metallic conduit.
d. Type OFNP, complying with NFPA 262; Type OFNP in listed plenum

communications raceway; or Type OFNP or Type OFNR in metallic conduit.

2.4 850 NANOMETER LASER-OPTIMIZED, 50/125 MICROMETER, MULTIMODE OPTICAL FIBER CABLE (OM3)

A. Description: Multimode, 50/125-micrometer, 1-fiber, nonconductive, tight buffer, optical fiber cable.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AMP NETCONNECT; a TE Connectivity Ltd. company
2. Belden Inc.
3. CommScope, Inc
4. Corning Optical Communications; Corning Incorporated
5. Hitachi Cable America Inc.
6. TE Connectivity Ltd.

C. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

1. AMP NETCONNECT; a TE Connectivity Ltd. company
2. Belden Inc.
3. CommScope, Inc
4. Corning Optical Communications; Corning Incorporated
5. Hitachi Cable America Inc.
6. TE Connectivity Ltd.

D. Standards:

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with TIA-492AAAC for detailed specifications.

E. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.

F. Minimum Overfilled Modal Bandwidth-length Product: 1500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

G. Minimum Effective Modal Bandwidth-length Product: 2000 MHz-km at 850 nm.

H. Jacket:

1. Jacket Color: Aqua.
2. Cable cordage jacket, fiber, unit, and group color are to be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

I. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive:

a. Type OFNP, complying with NFPA 262.
b. Type OFNP in listed plenum communications raceway.
c. Type OFNP or Type OFNR in metallic conduit.
d. Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFNP or Type OFNR in metallic conduit.

2.5 850 NANOMETER LASER-OPTIMIZED, 50/125 MICROMETER, MULTIMODE OPTICAL FIBER CABLE (OM4)

A. Description: Multimode, 50/125-micrometer, 1-fiber, nonconductive tight buffer, optical fiber cable.

B. Manufacturers: Subject to compliance with requirements, Highland Tank Fuel Oil Storage & Delivery:

1. Belden Inc.
2. CommScope, Inc
3. Corning Optical Communications; Corning Incorporated
4. Hitachi Cable America Inc.
5. Mohawk; a division of Belden Networking, Inc.
6. Superior Essex Inc.; subsidiary of LS Corp.
7. TE Connectivity Ltd.

C. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

1. Belden Inc.
2. CommScope, Inc
3. Corning Optical Communications; Corning Incorporated
4. Hitachi Cable America Inc.
5. Mohawk; a division of Belden Networking, Inc.
6. Superior Essex Inc.; subsidiary of LS Corp.
7. TE Connectivity Ltd.

D. Standards:

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with TIA-492AAAD for detailed specifications.

E. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.

F. Minimum Overfilled Modal Bandwidth-length Product: 3500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

G. Minimum Effective Modal Bandwidth-length Product: 4700 MHz-km at 850 nm.

H. Jacket:

1. Jacket Color: Aqua.
2. Cable cordage jacket, fiber, unit, and group color are to be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

I. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive:

a. Type OFNP, complying with NFPA 262.
b. Type OFNP in listed plenum communications raceway.
c. Type OFNP or Type OFNR in metallic conduit.
d. Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFN, Type OFNG, Type OFNP, or Type OFNR in metallic conduit.

2.6 9/125 MICROMETER SINGLE-MODE, INDOOR-OUTDOOR OPTICAL FIBER CABLE (OS1)

A. Description: Single mode, 9/125-micrometer, 1 fibers, tight buffered, nonconductive optical fiber cable.

B. Manufacturers: Subject to compliance with requirements, Highland Tank Fuel Oil Storage & Delivery:

1. 3M
2. Belden Inc.
3. Corning Opical Communications; Corning Incorporated
4. General Cable; Prysmian Group North America
5. Mohawk; a division of Belden Networking, Inc.
6. Superior Essex Inc.; subsidiary of LS Corp.
7. TE Connectivity Ltd.

C. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

1. 3M
2. Belden Inc.
3. Corning Optical Communications; Corning Incorporated
4. General Cable; Prysmian Group North America
5. Mohawk; a division of Belden Networking, Inc.
6. Superior Essex Inc.; subsidiary of LS Corp.
7. TE Connectivity Ltd.

D. Maximum Attenuation: 0.5 dB/km at 1310 nm; 0.5 dB/km at 1550 nm.

E. Jacket:

1. Jacket Color: Yellow.
2. Cable cordage jacket, fiber, unit, and group color are to be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

F. Standards:

1. Comply with TIA-492CAAA for detailed specifications.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with ICEA S-104-696 for mechanical properties.

G. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive:

a. Type OFNP, complying with NFPA 262.
b. Type OFNP in listed plenum communications raceway.
c. Type OFNP or Type OFNR in metallic conduit.
d. Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFN, Type OFNG, Type OFNP, or Type OFNR in metallic conduit.

2.7 9/125 MICROMETER, SINGLE-MODE, INDOOR-OUTDOOR OPTICAL FIBER CABLE (OS2)

A. Description: Single mode, 9/125-micrometer, 1 fibers, tight buffered, nonconductive optical fiber cable.

B. Manufacturers: Subject to compliance with requirementsHighland Tank Fuel Oil Storage & Delivery:

1. 3M
2. Belden Inc.
3. Berk-Tek, a Leviton Company
4. CommScope, Inc
5. Hitachi Cable America Inc.
6. Mohawk; a division of Belden Networking, Inc.
7. Superior Essex Inc.; subsidiary of LS Corp.

C. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:

1. 3M
2. Belden Inc.

3. Berk-Tek, a Leviton Company
4. CommScope, Inc
5. Hitachi Cable America Inc.
6. Mohawk; a division of Belden Networking, Inc.
7. Superior Essex Inc.; subsidiary of LS Corp.

D. Maximum Attenuation: 0.5 dB/km at 1310 nm; 0.5 dB/km at 1550 nm.

E. Jacket:

1. Jacket Color: Yellow.
2. Cable cordage jacket, fiber, unit, and group color are to be according to TIA-598-D.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

F. Standards:

1. Comply with TIA-492CAAB for detailed specifications.
2. Comply with TIA-568-C.3 for performance specifications.
3. Comply with ICEA S-104-696 for mechanical properties.

G. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

1. Plenum Rated, Nonconductive:

a. Type OFNP, complying with NFPA 262.
b. Type OFNP in listed plenum communications raceway.
c. Type OFNP or Type OFNR in metallic conduit.
d. Type OFNP, complying with NFPA 262; Type OFNP in listed plenum communications raceway; or Type OFN, Type OFNG, Type OFNP, or Type OFNR in metallic conduit.

2.8 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. American Technology Systems Industries, Inc
2. Belden Inc.
3. Berk-Tek, a Leviton Company
4. CommScope, Inc
5. Corning Optical Communications; Corning Incorporated
6. Dynacom Corporation
7. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated
8. Molex Premise Networks
9. Optical Cable Corporation (OCC)

10. Siemon Co. (The)
11. Stewart Connector, a Bel group company; Bel Fuse Inc.

B. Basis-of-Design Product: Subject to compliance with requirements, provide Highland Tank Fuel Oil Storage & Delivery or comparable product by one of the following:

1. American Technology Systems Industries, Inc
2. Belden Inc.
3. Berk-Tek, a Leviton Company
4. CommScope, Inc
5. Corning Optical Communications; Corning Incorporated
6. Dynacom Corporation
7. Hubbell Premise Wiring; brand of Hubbell Electrical Solutions; Hubbell Incorporated
8. Molex Premise Networks
9. Optical Cable Corporation (OCC)
10. Siemon Co. (The)
11. Stewart Connector, a Bel group company; Bel Fuse Inc.

C. Standards:

1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
2. Comply with TIA-568-C.3.

D. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

E. Patch Cords: Factory-made, single-fiber cables in 36-inch lengths.

F. Connector Type: Type SC complying with TIA-604-3-B connectors.

G. Plugs and Plug Assemblies:

1. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than 0.25 dB.
3. Marked to indicate transmission performance.

H. Jacks and Jack Assemblies:

1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than 0.25 dB.
3. Marked to indicate transmission performance.
4. Designed to snap-in to a patch panel or faceplate.

2.9 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.10 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.11 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test multimode optical fiber cables according to TIA-526-14-B and TIA-568-C.3.

C. Factory test preterminated optical fiber cable assemblies according to TIA-526-14-B and TIA-568-C.3.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method, Raceways: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for pathways specified in Section 270528 "Pathways for Communications Systems."

B. Wiring Method, Concealed: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

A. Comply with NECA 1, and NECA/BICSI 568.

B. General Requirements for Optical Fiber Cabling Installation:

1. Comply with TIA-568-C.1 and TIA-568-C.3.
2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
3. Terminate all cables; no cable is to contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
6. Bundle, lace, and train cable to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps are not to be used for heating.
9. In the communications equipment room, provide a 10-foot-long service loop on each end of cable.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
11. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Cable is not to be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Installation of Cable Routed Exposed under Raised Floors:

1. Install plenum-rated cable only.
2. Install cabling after the flooring system has been installed in raised floor areas.
3. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.

E. Group connecting hardware for cables into separate logical fields.

3.3 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI ITSIMM, "Firestopping" Chapter.

3.4 INSTALLATION OF GROUNDING

A. Install grounding according to BICSI ITSIMM, "Grounding (Earthing), Bonding, and Electrical Protection" Chapter.

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Administration Class: Class 2.
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Paint and label colors for equipment identification are to comply with TIA-606-B for Class 2 level of administration.

C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, horizontal pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

E. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.

3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
4. Label each unit and field within distribution racks and frames.
5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

F. Labels are to be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA 606-B, for the following:

1. Flexible vinyl or polyester that flexes as cables are bent.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

D. Tests and Inspections:

1. Visually inspect optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Optical Fiber Cable Tests:

    a. Test instruments are to meet or exceed applicable requirements in TIA-568-C.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Horizontal and Multimode Horizontal Link Measurements: Test at 850 or 1300 nm in one direction according to TIA-526-14-B, Method B, One Reference Jumper.
        2) Attenuation test results for horizontal links are to be less than 2.0 dB. Attenuation test results are to be less than those calculated according to equation in TIA-568-C.1.

E. Data for each measurement are to be documented. Data for submittals are to be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and

submitted.

F. Remove and replace cabling where test results indicate that it does not comply with specified requirements.

G. End-to-end cabling will be considered defective if it does not pass tests and inspections.

H. Prepare test and inspection reports.

END OF SECTION 271523

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for **changes in the Work**].

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other fabricated stationary features constructed above or below the ground surface.

I. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

J. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.2 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Material Test Reports: For each **on-site** soil material proposed for fill and backfill as follows:

1. Classification according to ASTM D2487.
2. Laboratory compaction curve according to **ASTM D1557**.

1.3 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E329 and ASTM D3740 for testing indicated.

1.4 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving 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 Owner or authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification **Groups GW, GP, GM, SW, SP, and SM according to ASTM D2487**]**Groups A-1, A-2-4, A-2-5, and A-3 according to AASHTO M 145**], or a combination of these groups; free of rock or gravel larger than **3 inches**]<**Insert dimension**> in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

1. Liquid Limit: <**Insert value**>.
2. Plasticity Index: <**Insert value**>.

C. Unsatisfactory Soils: Soil Classification **Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487**]**Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145**], or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a **1-1/2-inch** sieve and not more than 12 percent passing a **No. 200**

sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 95 percent passing a **1-1/2-inch** sieve and not more than 8 percent passing a **No. 200** sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; with at least 90 percent passing a **1-1/2-inch** sieve and not more than 12 percent passing a **No. 200** sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940/D2940M; except with 100 percent passing a **1-inch** sieve and not more than 8 percent passing a **No. 200** sieve.

H. Drainage Course: Narrowly graded mixture of **washed**]crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a **1-1/2-inch** sieve and zero to 5 percent passing a **No. 8** sieve.

I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D448; coarse-aggregate grading Size 67; with 100 percent passing a **1-inch** sieve and zero to 5 percent passing a **No. 4** sieve.

J. Sand: ASTM C33/C33M; fine aggregate.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

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 earth-moving operations.

B. Protect and maintain erosion and sedimentation controls during earth-moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Provide 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.

B. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

D. 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.

3.3 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus **1 inch**. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
2. Pile Foundations: Stop excavations **6 to 12 inches** above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus **1 inch**. Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.4 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip

line of remaining trees.

3.5 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring, bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.6 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.7 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than **8 inches**]<**Insert dimension**> in loose depth for material compacted by heavy compaction equipment and not more than **4 inches** in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to **ASTM D698**]**ASTM D1557**]:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top **12 inches** of existing subgrade and each layer of backfill or fill soil material at **98** percent.
2. Under walkways, scarify and recompact top **6 inches** below subgrade and compact each layer of backfill or fill soil material at **92** percent.

3. Under turf or unpaved areas, scarify and recompact top **6 inches** below subgrade and compact each layer of backfill or fill soil material at **85** percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at **85** percent.

3.8 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:

1. Turf or Unpaved Areas: Plus or minus **1 inch**.
2. Walks: Plus or minus **1 inch**.
3. Pavements: Plus or minus **1/2 inch**.

C. Grading inside Building Lines: Finish subgrade to a tolerance of **1/2 inch** when tested with a **10-foot** straightedge.

3.9 SUBSURFACE DRAINAGE

A. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a **6-inch** course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of **12 inches** of filter material, placed in compacted layers **6 inches** thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least **6 inches**.

3.10 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

3.11 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
2. Determine that fill material classification and maximum lift thickness comply with requirements.
3. Determine, during placement and compaction, that in-place density of compacted fill complies with requirements.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing

agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

E. Compaction Testing: Testing agency will test compaction of soils in place according to ASTM D1556, ASTM D2167, ASTM D2937, and ASTM D6938, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every **2000 sq. ft.**]<**Insert area**> or less of paved area or building slab but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every **100 feet**]<**Insert dimension**> or less of wall length but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every **150 feet**]<**Insert dimension**> or less of trench length but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.12 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.13 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000