CITY OF PETALUMA
PETALUMA, CALIFORNIA

CONTRACT DOCUMENTS FOR

ELLIS CREEK WATER RECYCLING FACILITY TERTIARY FILTRATION EXPANSION
-
FILTER ADDITIONS AND MISCELLANEOUS IMPROVEMENTS PROJECT
C66401416

Volume 1 of 2

(Notice Inviting Bids, Instructions to Bidders, Bid Forms, General Conditions, Special Provisions, Technical Specifications, Construction Agreement, Bond Forms, Project Drawings)

CITY OF PETALUMA - SONOMA COUNTY - CALIFORNIA

Questions concerning interpretation of improvement plans, special provisions, contract documents and bid items shall be directed to:

Department of Public Works and Utilities
202 N. McDowell Boulevard
Petaluma, CA. 94954
Phone: (707) 778-4546 Fax: (707) 206-6034

Attention: Josh Minshall

Office Hours: Monday thru Thursday – 8:00 to 5:00 p.m.
Friday – 8:00 to 4:00 p.m.

Bid Opening: June 8th, 2023 at 1:00 p.m.

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NOTICE INVITING BIDS

1. **RECEIPT OF BIDS**: Sealed Bids will be received at the office of the City Clerk of the City of Petaluma located at 11 English Street, Room 4, Petaluma, CA 94952-2610, until 1:00 PM (*enter time*) on Thursday June 8th, 2023, for the Ellis Creek Water Recycling Facility Tertiary Filtration Expansion – Filter Additions and Miscellaneous Improvements Project C66401416. Any Bids received after the specified time and date will not be considered. Fax and other electronically transmitted Bids will not be accepted.

2. **OPENING OF BIDS**: The Bids will be publicly opened and read at 1:00 PM (*enter time*) on Thursday June 8th, 2023 at the above-mentioned office of the CITY. The CITY reserves the right to postpone the date and time for opening of Bids at any time prior to the aforesaid date and time.

3. **COMPLETION OF WORK**: The WORK must be completed with 260 working days after the commencement date stated in the Notice to Proceed.

4. **DESCRIPTION OF WORK**: The WORK includes The work includes construction of two new tertiary filters number 6 and 7, improvements to the tertiary pump station, filter support building ventilation modifications, construction of a new storage building and modification to the existing maintenance building, construction of a waste storage canopy, along with associated miscellaneous piping, utility, electrical and controls improvements. A detailed description of the work is provided in the project specifications..

5. **SITE OF WORK**: The site of the WORK is located: Ellis Creek Water Recycling Facility, 3890 Cypress Dr. Petaluma CA 94954.

6. **OBTAINING CONTRACT DOCUMENTS**: The Contract Documents are entitled "llis Creek Water Recycling Facility Tertiary Filtration Expansion – Filter Additions and Miscellaneous Improvements Project C66401416".

   The Contract Documents may be obtained by 4:00 P.M., Monday through Thursday at the office of Public Works & Utilities, 202 North Mc Dowell Boulevard, Petaluma, CA 94954.

   If you would like to receive the bid document via the CITY's website, at no cost, please go to:

   - https://cityofpetaluma.org/bid-opportunities-2/
   - Fill out the Plan Holder's form by clicking on the Plan Holder's form link
   - Fill in all fields
   - Click on the submit button at the end of the form

   Submit the Plan Holder's form on-line automatically puts you on the CITY's Bidders List and you will be notified of any Addendums or information pertaining to the bis by email.

   If you would like to purchase bid documents, please call Phone No. (707) 778-4585, Attention: Tiffany Avila, upon payment of $25 (non-refundable) for each set of Contract

Documents (including technical specification and accompanying reduced scale drawings). The scale of the reduced drawings is about one-half of the original scale. At the Bidder's request and expense, the Contract Documents may be sent by overnight mail.

☐ Full-scale drawings are not available.

☐ If full-scale drawings are available and desired, they may be purchased at reproduction cost from Digitech, 1340 Commerce St, Ste K, Petaluma, CA, 94954, (707) 769-0410.

7. **BID SECURITY**: Each Bid shall be accompanied by a certified or cashier's check or Bid Bond executed by an admitted surety in the amount of 10% percent of the Total Bid Price payable to the City of Petaluma as a guarantee that the Bidder, if its Bid is accepted, will promptly execute the Agreement. A Bid shall not be considered unless one of the forms of Bidder's security is enclosed with it. Upon acceptance of the Bid, if the Bidder refuses to or fails to promptly execute the Agreement the Bidder's security shall be forfeited to the CITY.

8. **CONTRACTOR'S LICENSE CLASSIFICATION**: In accordance with the provisions of California Public Contract Code Section 3300, the CITY has determined that the CONTRACTOR shall possess a valid Class A license at the time that the Contract is awarded. Failure to possess the specified license shall render the Bid as non-responsive and shall act as a bar to award of the Contract to any bidder not possessing said license at the time of award pursuant to labor Code Section 1725.5, subject to limited legal exceptions.

9. **PREFERENCE FOR MATERIAL**: Any specification designating a material, product, thing, or service by specific brand or trade name, followed by the words "or equal" or "or equivalent" is intended only to indicate quality and type of item desired. Substitute products will be considered prior to award of the Contract in accordance with Section 3400 of the California Public Contract Code. The Bidder will submit data substantiating its request for a substitution of "an equal" item within 14 days following submission of its Bid. Substantiation date will conform to the requirements of the instructions for Proposed Substitutions of "or equal" items contained in the bid Forms. The ENGINEER will make a determination of approval of rejection of the proposed substitution prior to the award of the Contract. No request for substitution of "an equal" items will be considered by the ENGINEER after award of the Contract. This provision does not apply to materials, products, things, or services that may lawfully be designated by a specific brand or trade name under Public Contract Code Section 3400(c).

10. **REJECTION OF PROPOSALS**: The CITY reserves the right to reject all or any part of all bids submitted, waive informalities and irregularities, and will not, to the extent allowed by law, be bound to accept the lowest bid.

11. **BIDS TO REMAIN OPEN**: The Bidder shall guarantee the total bid price for a period of 90 calendar days from the date of bid opening.

12. **CALIFORNIA PREVAILING WAGE RATE REQUIREMENTS**: In accordance with the provisions of California Labor Code Sections 1770,1773, 1773.1, and 1773.7 as amended, the Director of the Department of Industrial Relations has determined the general prevailing rate of per diem wages in accordance with the standards set forth in Section 1773 for the locality in which the WORK is to be performed. A copy of said wage rates is on file at the office of the City Clerk and is available to any interested party upon request. A copy of the prevailing rate of per diem wages are also online at http://www.dir.ca.gov/DLSR. Each Contractor and Subcontractor must pay no less than the specified rates to all workers employed to work on the Project. The schedule of per diem wages is based upon a working day of eight hours. The rate for holiday and overtime work must be at least time and one-half. It shall be mandatory upon the CONTRACTOR to whom the WORK is awarded and upon any subcontractor under the CONTRACTOR to pay not less than said specified rates to all workers employed by them in the execution of the WORK. The Contract will be subject to compliance monitoring and enforcement by the Department of Industrial Relations under labor Code Section 1771.4. Additionally, CONTRACTOR shall post job sit notices s required by Labor Code section 1771.4.

13. **LABOR COMPLIANCE PURSUANT TO CALIFORNIA LABOR CODE §1771.1**: A contractor of subcontractor shall not be qualified to bid on, be listed in a bid proposal, subject to the requirement of Section 4104 of the Public Contract Code or engage in the performance of any contract for public work, as defined in Division 2, Part 7, Chapter 1 of the Labor Code, unless currently registered and qualified to perform public work pursuant to Section 1725.5. It is not a violation of this section for an unregistered contractor to submit a bid that is authorized by Section 7029.1 of the Business and Professions Code or by Section 10164 or 20103.5 of the Public Contract Code, provided the contractor is registered to perform public work pursuant to Section 1725.5 at the time contract is awarded.

14. **RETAINAGE FROM PAYMENTS**: The CONTRACTOR may elect to receive 100 percent of payments due under the Contract Documents from time to time, without retention of any portion of the payment by the CITY, by depositing securities of equivalent value with the CITY in accordance with the provisions of Section 22300 of the Public Contract Code. Alternatively, the CONTRACTOR may request, and the CITY shall make payment of retentions earned directly to the escrow agent at the expense of CONTRACTOR. At the expense of the CONTRACTOR, the CONTRACTOR may direct the investments of the payments into securities and the CONTRACTOR shall receive the interest earned on the investments upon the same terms as provided in Section 22300 of the Public Contract Code for securities deposited by the CONTRACTOR. The CONTRACTOR shall be responsible for paying all fees for the expense incurred by the escrow agent in administering the escrow account and all expenses of the CITY. These expenses and payment terms shall be determined by the CITY's Finance Director or their designee and the escrow agent. Upon satisfactory completion of the WORK, the CONTRACTOR shall receive from the escrow agent all securities, interest, and payments received by the escrow agent from the CITY, pursuant to the

terms of Section 22300 of the Public Contract Code. Such securities, if deposited by the CONTRACTOR, shall be valued by the CITY, whose decision on valuation of the securities shall be final. Securities eligible for investment under this provision shall be limited to those listed in Section 16430 of the Government Code, bank or savings and loan certificates of deposit, interest-bearing demand deposit accounts, standby letters or credit, or any other security mutually agreed to by the CONTRACTOR and the CITY.

15. **PAYMENT BOND**: Pursuant to and in accordance with California Civil Code Section 9550, a payment bond must be filed if the expenditure for the WORK is in excess of Twenty-Five Thousand Dollars ($25,000.00).

16. **PRE-BID CONFERENCE VISITS**: [At least one box below MUST be checked]

☐ Check if no pre-bid conference/site is to be held.

☒ Mandatory pre-bid conference/site visit to be held: Prospective bidders are required to attend a mandatory pre-bid conference/site visit at 10:00 AM (*enter time*) on Tuesday, May 16th, 2023, at the Ellis Creek Water Recycling Facility, offices at 3890 Cypress Dr. Petaluma, CA 94954 . Prospective bidders that fail to attend the mandatory pre-bid conference/site visit will be ineligible to bid on the project. Following the conference at City offices, City staff and prospective bidders will meet at the project Site.

Transportation to the project site will be the responsibility of prospective bidders. The purposes of the conference/site visit are to discuss the scope of the project and bidding requirements and to acquaint bidders with Site conditions.

No information communicated at the pre-bid conference/site visit may amend the project bidding requirements. Project bidding requirements may only be amended by addenda issued by authorized City officials. Following the pre-bid conference/site visit, prospective bidders may submit detailed technical questions in writing. If warranted, the City may respond to such questions by addenda.

☐ Non-Mandatory pre-bid conference/site visit to be held: Prospective bidders are invited to attend a non-mandatory pre-bid conference/site visit at (*enter time*) on at the . Following the conference City offices, City staff and prospective bidders will meet at the project Site. Transportation to the project site will be the responsibility of prospective bidders. The purposes of the conference/site visit are to discuss the scope of the project and bidding requirements, and to acquaint bidders with Site conditions.

No information communicated at the pre-bid conference/site visit may amend the project bidding requirements. Project bidding requirements may only be amended by addenda issued by authorized City officials.

Following the pre-bid conference/site visit, prospective bidders may submit detailed technical questions in writing. If warranted, the CITY may respond to such questions by addenda.

17. **PROJECT ADMINISTRATION**: All communications relative to the WORK shall be directed to the ENGINEER prior to opening of the Bids.

18. **FINDING OF SUBSTANTIAL COMPLEXITY:** Pursuant to Public Contract Code Section 7201(b)(3) the CITY's Public Work's Director has found that the WORK is substantially complex due to: the amount of technical and scientific knowledge needed to complete the project; the amount of resources needed to complete the project including amount of days, workers, and labor; the urgency for project completion; the amount of tasks needed to complete the project; the number of organizational stakeholders needed to satisfy; the environmental complexity of the conditions; and in particular the details of installing and upgrading the tertiary filtration treatment system; and the water recycling facility will remain active during construction; and the system is critical for providing recycled water to the community; and therefore this is a unique project that is not regularly performed and requires a higher retention amount than 5 percent.

    Notwithstanding Public Contract Code Section 7201 or any other law or regulation that purports to provide otherwise, public contracting is a quintessential municipal affair, subject to charter cities' home rule power, and the California Constitution grants charter cities supreme authority over municipal affairs, which include public Works, procurement, and the mode of municipal contracting (See, Public Contract Code Section 1100.7 and e.g., Bishop v. City of San Jose (1969) 1 C3rd 56)., and it is the courts, not the legislature, that determines which matters are municipal affairs (see, e.g., *California Federal Savings and Loan v. City of Los Angeles* (1991) 54 C3d 1): and

Article X, Section 67 of the Petaluma Charter provides in pertinent part:

> …no progressive payments can be provided for or made at any time which, with prior payments, if there have been such, shall exceed in amount at that time ninety percent of the value of the labor done and the materials used up to that time, and no contract shall provide for or authorize or permit or permit the payment of more than ninety percent of the contract price before the completion of the work done under said contract and the acceptance thereof…; and
>
> City charters are documents of limitation and a restriction on the City Council's powers imposed by the voters (see, e.g., *City of Glendale v. Trondsen* (1957) 48 C2d 93) and, as a result, the City Council's contracting power is limited by the retention requirement in Article X, Section 67, and the City Council and City Council and City staff lack the power to provide for public works contract retention other than as specified in the City Charter.

19. **GOVERNMENT CODE SECTION 1090:** The successful Bidder may be precluded from competing for, or participating in, subsequent contracts that result from or relate to the WORK performed pursuant to this Bid. The ethics laws that apply to the City and all its consultants, contractors, and vendors include California Government Code Section 1090 and following, which prohibits government officials, employees, and contractors from participating in making government contracts in which the official, employee or contractor has a financial interest. Because City contractors always have a financial interest in their City contracts, the Section 1090 prohibition regarding City contractors focuses on whether a contractor is or would be "making a government contract" in a quasi-governmental capacity for purposes of Section 1090. Section 1090 prohibits City contractors from using their role as a contractor to influence how the City spends the public's funds in a way that benefits the contractor. Penalties for violating Section 1090 are severe, and may include felony criminal penalties, permanent disqualification from holding public office in California, disgorgement of any benefit received by the financially interested contractor, civil and administrative penalties, and voiding of the prohibited contract.

NAME: Josh Minshall, PE

ADDRESS: 202 N McDowell Blvd

Petaluma CA 94954

PHONE: (707) 776-3785

20. **CITY'S RIGHTS RESERVED**: The CITY reserves the right to reject any or all bids, to waive any minor irregularity in a bid, and to make awards to the lowest responsive, responsible bidder as it may best serve the interest of the CITY.

CITY: Petaluma

BY:

DATE: April 24, 2023

END OF INVITING BIDS

INSTRUCTIONS TO BIDDERS

1. DEFINED TERMS. Terms used in these Instructions to Bidders and the Notice Inviting Bids which are defined in the General Conditions have the meanings assigned to them in the General Conditions. The term "Bidder" means one who submits a Bid directly to CITY, as distinct from a sub-bidder, who submits a price or quote to a Bidder.

2. LOCAL BUSINESS LICENSE. All CONTRACTORS, including subcontractors, not already having a local business license for the work contemplated, will be required to secure the appropriate license before a Contract can be executed.

3. INTERPRETATIONS AND ADDENDA.

3.1 All questions about the meaning or intent of the Contract Documents are to be directed to the ENGINEER. Additions, deletions, or revisions to the Contract Documents considered necessary by the ENGINEER in response to such questions will be issued by Addenda mailed or delivered to all parties recorded by the ENGINEER as having received the Contract Documents. Questions received less than 14 days prior to the date of Bids may not be answered. Only answers to such questions issued by formal written Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.

3.2 Addenda may also be issued to make other additions, deletions, or revisions to the Contract Documents.

3.3 Bidders shall make no special interpretation or inference of intent from differing formats in the Technical Specifications.

4. BIDDER'S EXAMINATION OF CONTRACT DOCUMENTS AND SITE.

4.1 It is the responsibility of each Bidder before submitting a Bid:

A. To examine thoroughly the Contract Documents and other related data identified in the Bidding Documents (including "technical" data referred to below);

B. To visit the site to become familiar with local conditions that may affect cost, progress, or performance of the WORK;

C. To consider federal, state, and local Laws and Regulations that may affect cost, progress, or performance of the WORK;

D. To study and carefully correlate the Bidder's observations with the Contract Documents; and

E. To notify the ENGINEER of all conflicts, errors, ambiguities, or discrepancies in or between the Contract Documents and such other related data.

4.2 Reference is made to the Supplementary General Conditions for identification of:

A. Those reports of explorations and tests of subsurface conditions at the site which have been utilized by the ENGINEER in the preparation of the Contract Documents.

B. Those drawings of physical conditions in or relating to existing surface and subsurface conditions (except Underground Utilities) which are at or contiguous to the site which have been utilized by the ENGINEER in the preparation of the Contract Documents.

C. Those environmental reports or drawings relating to Asbestos, Hazardous Waste, PCBs, Petroleum, and/or Radioactive Materials identified at the site which have been utilized by the ENGINEER in the preparation of the Contract Documents.

D. The ENGINEER makes no representation as to the completeness of the reports or drawings referred to in Paragraphs 4.2A, 4.2B, and 4.2C. above or the accuracy of any data or information contained therein. The Bidder may rely upon the accuracy of the technical data contained in such reports and drawings. However, the Bidder may not rely upon any interpretation of such technical data, including any interpretation or extrapolation thereof, or any non-technical data, interpretations, and opinions contained therein.

4.3 Copies of reports and drawings referred to in Paragraph 4.2 will be made available by the CITY to any Bidder on request, if said reports and drawings are not bound herein. Those reports and drawings are not part of the Contract Documents, but the technical data contained therein upon which the Bidder is entitled to rely, are incorporated herein by reference.

4.4 Information and data reflected in the Contract Documents with respect to Underground Utilities at or contiguous to the site are based upon information and data furnished to the ENGINEER by the owners of such Underground Utilities or others, and the CITY does not assume responsibility for the accuracy or completeness thereof unless it is expressly provided otherwise in the Supplementary General Conditions.

4.5 Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders on subsurface conditions, Underground Utilities, and other physical conditions, and possible changes in the Contract Documents due to differing conditions appear in Paragraphs 4.2, 4.3, and 4.4 of the General Conditions.

4.6 Before submitting a Bid, each Bidder will, at Bidder's own expense, make or obtain any additional examinations, investigations, explorations, tests, and studies and obtain any additional information and data which pertain to the physical conditions (surface,

subsurface, and Underground Utilities) at or contiguous to the site or otherwise which may affect cost, progress, or performance of the WORK and which the Bidder deems necessary to determine its Bid for performing the WORK in accordance with the time, price, and other terms and conditions of the Contract Documents.

4.7 On request a minimum of 2 working days in advance, the ENGINEER will provide each Bidder access to the site to conduct such examinations, investigations, explorations, tests, and studies as each Bidder deems necessary for submission of a Bid. Location of any excavation or boring shall be subject to prior approval of ENGINEER and applicable agencies. Bidder shall fill all holes, restore all pavement to match existing structural section, and shall clean up and restore the site to its former condition upon completion of such explorations. ENGINEER reserves the right to require Bidder to execute an Access Agreement with the CITY prior to accessing the site.

4.8 The lands upon which the WORK is to be performed, rights-of-way, and easements for access thereto and other lands designated for use by the CONTRACTOR in performing the WORK are identified in the Contract Documents. All additional lands and access thereto required for temporary construction facilities or storage of materials and equipment are to be provided by the CONTRACTOR. Easements for permanent structures or permanent changes in existing structures are to be obtained and paid for by the CITY unless otherwise provided in the Contract Documents.

4.9 The submission of a Bid will constitute an incontrovertible representation by the Bidder that the Bidder has complied with every requirement of this Paragraph 4 and the following:

A. That the Bid is premised upon performing the WORK required by the Contract Documents without exception and such means, methods, techniques, sequences, or procedures of construction (if any) as may be required by the Contract Documents;

B. That Bidder has given the ENGINEER written notice of all conflicts, errors, ambiguities, and discrepancies in the Contract Documents and the written resolution thereof by the ENGINEER is acceptable to the Bidder; and

C. That the Contract Documents are sufficient in scope and detail to indicate and convey understanding of all terms and conditions for performance of the WORK.

5. BID FORMS. The Bid shall be submitted on the Bid Forms provided by the City. All blanks on the Bid Forms shall be completed in ink. All names must be printed below the signatures. The Bid shall be submitted in a sealed envelope which shall be plainly marked in the upper left hand corner with the name and address of the Bidder and shall bear the words “BID FOR” followed by the title of the Contract Documents for the WORK, the name of the CITY, the address where Bids are to be delivered or mailed to, and the date and hour of opening of Bids.

5.2 The Bid must set forth the name and location of the place of business of each subcontractor who will perform work or labor or render service to the prime contractor in or about the construction of the WORK, or a subcontractor licensed by the State of California who, under subcontract to the prime contractor, specially fabricates and installs a portion of the WORK according to detailed Drawings contained in the plans and specifications, in an amount in excess of one-half of 1 percent of the prime contractor's total bid or, in the case of bids or offers for the construction of streets and highways, including bridges, in excess of one-half of 1 percent of the prime contractor's total bid or ten thousand dollars ($10,000), whichever is greater.

6. CERTIFICATES.

6.1 Bids by corporations must be executed in the corporate name by the president, a vice-president, or other corporate officer. Such Bid shall be accompanied by the enclosed Certificate of Authority to sign, attested by the secretary or assistant secretary, and with the corporate seal affixed. The corporate address and sate of incorporation must appear below the signature.

6.2 Bids by partnerships must be executed in the partnership name and be signed by a managing partner, accompanied by the enclosed Certificate of Authority to sign, and his/her title must appear under the signature and the official address of the partnership must appear below the signature.

6.3 Bids by joint venture must be executed in the joint venture name and be signed by a joint venture managing partner, accompanied by the enclosed Certificate of Authority to sign, and his/her title must appear under the signature and the official address of the joint venture must appear below the signature.

7. DISQUALIFICATION OF BIDDERS. More than one Bid from an individual, firm, partnership, corporation, or association under the same or different names will not be considered. If the CITY believes that any Bidder is interested in more than one Bid for the WORK contemplated, all Bids in which such Bidder is interested will be rejected. If the CITY believes that collusion exists among the Bidders, all Bids will be rejected. A party who has quoted prices to a bidder is not hereby disqualified from quoting prices to other Bidders, or from submitting a Bid directly for the WORK. If a Bidder is not registered with the Department of Industrial Relations pursuant to Labor Code Section 1725.5 and Section 1771.1, then the Bid may be rejected as non-responsive.

8. QUANTITIES OF WORK. The quantities of work or material stated in unit price items of the Bid are supplied only to give an indication of the general scope of the WORK; the OWNER does not expressly or by implication agree that the actual amount of work or material will correspond therewith, and reserves the right after award to increase or decrease the quantity of any unit price item of the WORK by an amount up to and including 25 percent of any Bid item in its entirety, or to add additional Bid items up to and including an aggregate total amount not to exceed 25 percent of the Bid price.

9. SUBSTITUTE OR "OR EQUAL" ITEMS. Whenever materials or equipment are specified or described in the Contract Documents by using the name of a particular manufacturer and the name is followed by the words "or equal", the Bidder may write the name of a substitute manufacturer (which the Bidder considers as an "or equal") in the List of Proposed Substitutions in the Bid Forms. The ENGINEER will make a determination of approval or rejection of the proposed substitution prior to award of the Contract. No request for substitution of an "or equal" item will be considered by the ENGINEER after award of the Contract. The procedure for the submittal of substitute or "or equal" products is contained in the Bid Forms. The Bidder shall not be relieved of any obligations of the Contract Documents or be entitled to an adjustment in the Contract Price in the event any proposed substitution is not approved.

10. COMPETENCY OF BIDDERS. In selecting the lowest responsive, responsible Bidder, consideration will be given not only to the financial standing but also to the general competency of the Bidder for the performance of the WORK covered by the Bid. To this end, each Bid shall be supported by a statement of the Bidder's experience as of recent date including: (a) all projects worked on by the Bidder over the past three (3) years including the contract amount for each project; (b) all complaints made against the Contractor's license in the past ten (10) years; and (c) all claims and lawsuits presented or filed in the last five (5) years, regardless of the form, regarding any public works project.

11. SUBMISSION OF BIDS. The Bid shall be delivered by the time and to the place stipulated in the Notice Inviting Bids. It is the Bidder's sole responsibility to see that its Bid is received in proper time and at the proper place.

12. BID SECURITY, BONDS, AND INSURANCE. Each Bid shall be accompanied by a certified or cashier's check or approved Bid Bond in the amount stated in the Notice Inviting Bids. Said check or bond shall be made payable to the CITY and shall be given as a guarantee that the Bidder, if awarded the WORK, will enter into an Agreement with the CITY and will furnish the necessary insurance certificates, Payment Bond, and Performance Bond. In case of refusal or failure to enter into said Agreement, the check or Bid Bond, as the case may be, shall be forfeited to the CITY. If the Bidder elects to furnish a Bid Bond as its Bid security, the Bidder shall use the Bid Bond form bound herein. Bid Bonds shall comply with the requirements applicable to payment and performance bonds in the General Conditions.

12.1 BIDDING CAPACITY. Each Bid shall be accompanied by a list of the projects currently being worked on by Bidder, their size, contract price, scheduled completion date, location, and owner. Additionally, Bidder shall provide certified evidence of its current bonding capacity.

13. DISCREPANCIES IN BIDS. In the event there is more than one Bid item in a Bid Schedule, the Bidder shall furnish a price for all Bid Items in the Schedule, and failure to do so will render the Bid non-responsive and shall cause its rejection. In the event there are unit price Bid items in a Bidding schedule and the amount indicated for a unit price Bid item does not equal the product of the unit price and quantity, the unit price shall

govern and the amount will be corrected accordingly, and the BIDDER shall be bound by said correction. In the event there is more than one Bid item in a Bid Schedule and the total indicated for the Schedule does not agree with the sum of the prices Bid on the individual items, the prices Bid on the individual items shall govern and the total for the Schedule will be corrected accordingly, and the BIDDER shall be bound by said correction.

14. MODIFICATIONS AND UNAUTHORIZED ALTERNATIVE BIDS. Unauthorized conditions, limitations, or provisos attached to the Bid shall render it informal and may cause its rejection as being non-responsive. The Bid forms shall be completed without interlineations, alterations, or erasures in the printed text. Alternative Bids will not be considered unless called for. Oral, telegraphic, or telephonic Bids or modifications will not be considered.

15. WITHDRAWAL OF BID. The Bid may be withdrawn by the Bidder by means of a written request, signed by the Bidder or its properly authorized representative. Such written request must be delivered to the place stipulated in the Notice Inviting Bids for receipt of Bids prior to the scheduled closing time for receipt of Bids.

16. BID PROTEST. Any Bid protest must be submitted in writing to the City Manager before 5:00 p.m. on the fifth (5^{th}) working day following Bid opening.

A. The initial protest document must contain a complete statement of the basis for the protest, and all supporting documentation.

B. The party filing the protest must have actually submitted a Bid for the WORK. A subcontractor of a party submitting a Bid for the WORK may not submit a Bid protest. A party may not rely on the Bid protest submitted by another Bidder, but must timely pursue its own protest.

C. The protest must refer to the specific portion of the bid document which forms the basis for the protest.

D. The protest must include the name, address and telephone number of the person representing the protesting party.

E. The party filing the protest must concurrently transmit a copy of the initial protest document and any attached documentation to all other parties with a direct financial interest which may be adversely affected by the outcome of the protest. Such parties shall include all other Bidders who appear to have a reasonable prospect of receiving an award depending upon the outcome of the protest.

F. The CITY will give the protested Bidder five (5) working days after the receipt of the protest to submit a written response. The responding Bidder shall transmit the response to the protesting Bidder concurrent with delivery to the CITY.

G. The procedure and time limits set forth in this paragraph are mandatory and are the Bidder's sole and exclusive remedy in the event of Bid protest. The Bidder's failure to comply with these procedures shall constitute a waiver of any right to further pursue the Bid protest, including filing a Government Code Claim or legal proceedings. A Bidder may not rely on a protest submitted by another Bidder, but must timely pursue its own protest.

H. If the CITY determines that a protest is frivolous, the protesting bidder may be determined to be non-responsible and that bidder may be determined to be ineligible for future contract awards.

17. AWARD OF CONTRACT. Award of the contract, if awarded, will be made to the lowest responsive, responsible Bidder whose Bid complies with the requirements of the Contract Documents. Unless otherwise specified, any such award will be made within the period stated in the Notice Inviting Bids that the bids are to remain open. Unless otherwise indicated, a single award will be made for all the Bid items in an individual Bid Schedule. In the event the WORK is contained in more than one Bid Schedule, the CITY may award Schedules individually or in combination. In the case of two Bid Schedules which are alternative to each other, only one of such alternative schedules will be awarded. The CITY may condition the award upon the Bidder's timely submission of all items required by the Contract Documents, including, but not limited to the executed Agreement, performance, labor and materials, and maintenance bonds, and required certificates of insurance and endorsements.

18. RETURN OF BID SECURITY. Within 14 days after award of the contract, the CITY will, if requested, return the Bid securities accompanying such Bids that are not being considered in making the award. All other Bid securities will be held until the Agreement has been finally executed. They will then be returned, if requested, to the respective Bidders whose Bids they accompany.

19. EXECUTION OF AGREEMENT. The Bidder to whom award is made shall execute a written Agreement with the CITY on the form of agreement provided, shall secure all insurance, and shall furnish all certificates and bonds required by the Contract Documents within five (5) working days after receipt of Notice of Award from the CITY. Failure or refusal to enter into an Agreement as herein provided or to conform to any of the stipulated requirements in connection therewith shall be just cause for annulment of the award and forfeiture of the Bid security. If the lowest responsive, responsible Bidder refuses or fails to execute the Agreement, the CITY may award the Contract to the second lowest responsive, responsible Bidder. If the second lowest responsive, responsible Bidder refuses or fails to execute the Agreement, the OWNER may award the contract to the third lowest responsive, responsible Bidder. On the failure or refusal of such second or third lowest Bidder to execute the Agreement, each such Bidder's Bid securities shall be likewise forfeited to the CITY.

20. LIQUIDATED DAMAGES. Provisions for liquidated damages, if any, are set forth in the Agreement.

21. WORKERS' COMPENSATION REQUIREMENT. The Bidder should be aware that in accordance with Section 3700 of the California Labor Code it will, if awarded the Contract, be required to secure the payment of compensation to its employees and execute the Workers' Compensation Certification in the form contained in these Contract Documents.

22. NON-COLLUSION AFFIDAVIT. Bidders must execute the following affidavit and submit the same with his/her bid:

23. MATERIALS SUPPLIERS LIST. Bidders and their subcontractors must complete the List of Materials Suppliers and Material Guarantee form provided with the Bid Forms and must submit the completed form with the Bid.

END OF INSTRUCTIONS TO BIDDERS

BID PROPOSAL CERTIFICATE
(if Corporation)

STATE OF CALIFORNIA)
) ss:
COUNTY OF)

I HEREBY CERTIFY that a meeting of the Board of Directors of the _____ _____, a corporation existing under the laws of the State of _____, held on _____, 20____, the following resolution was duly passed and adopted:

"RESOLVED, that _____, as _____ President of the Corporation, be and is hereby authorized to execute the Bid Proposal dated _____, 20____, for the _____ _____ project, in the City of Petaluma, and that his/her execution thereof, attested by the Secretary of the Corporation, and with the Corporate Seal affixed, shall be the official act and deed of this Corporation."

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the official seal of the corporation this _____, day of _____, 20____.

_____
Secretary

(SEAL)

BID PROPOSAL CERTIFICATE
(if Partnership)

STATE OF CALIFORNIA)
) ss:
COUNTY OF)

I HEREBY CERTIFY that a meeting of the Partners of the _____ _____, a partnership existing under the laws of the State of _____, held on _____, 20____, the following resolution was duly passed and adopted:

"RESOLVED, that _____, as the General Partner of the Partnership, be and is hereby authorized to execute the Bid Proposal dated _____, 20___, for the _____ project, in the City of Petaluma and that his/her execution thereof, attested by the _____ shall be the official act and deed of this Partnership."

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand this _____ day of _____, 20___.

_____
Partner

(SEAL)

BID PROPOSAL CERTIFICATE
(if Joint Venture)

STATE OF CALIFORNIA)
) ss:
COUNTY OF)

I HEREBY CERTIFY that a meeting of the Principals of the _____
_____
_____
a joint venture existing under the laws of the State of _____, held on _____, 20___, the following resolution was duly passed and adopted:

"RESOLVED, that _____, as _____ of the joint venture, be and is hereby authorized to execute the Bid Proposal dated _____, 20___, for the _____ _____ project, in the City of Petaluma, and that his/her execution thereof, attested by the _____ shall be the official act and deed of this Joint Venture."

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand this _____, day of _____, 20___.

_____
Managing Partner

(SEAL)

BID PROPOSAL CERTIFICATE
(if Proprietorship)

STATE OF CALIFORNIA)
) ss:
COUNTY OF)

I HEREBY CERTIFY that _____, as owner of _____ that I am authorized to execute the Bid Proposal dated _____, 20____, for the _____ _____ project, in the City of Petaluma, and that my execution thereof shall be the official act and deed of this proprietorship.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the official seal of the corporation this _____, day of _____, 20____.

_____
Owner

(SEAL)

SECTION I

BID FORMS
(TO BE SUBMITTED WITH BIDS)

BIDDER'S AFFIDAVIT OF NON-COLLUSION SUBMITTED WITH BID

_____, *[Contractor]* hereby declares that:

He or she is _____ *[title/position]* of _____, *[company name]* the party making the foregoing bid; that the bid is not made in the interest of, or on behalf of, any undisclosed person, partnership, company, association, organization, or corporation; that the bid is genuine and not collusive or sham; that the bidder has not directly or indirectly induced or solicited any other bidder to put in a false or sham bid, and has not directly or indirectly colluded, conspired, connived, or agreed with any bidder or anyone else to put in a sham bid, or that anyone shall refrain from bidding; that the bidder has not in any manner, directly or indirectly, sought by agreement, communication, or conference with anyone to fix the bid price of the bidder or any other bidder, or to fix any overhead, profit, or cost element of the bid price, or of that of any other bidder, or to secure any advantage against the public body awarding the contract or anyone interested in the proposed contract; that all statements contained in the bid are true; and, further, that the bidder has not, directly or indirectly, submitted his or her bid price or any breakdown thereof, or the contents thereof, or divulged information or date relative thereto, or paid, and will not pay, any fee to any corporation, partnership, company, association, organization, bid depository, or to any member or agent thereof to effectuate a collusive or sham bid.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct.

Dated: _____ _____

Signature

Public Contract Code section 7106
Code of Civil Procedure section 2015.5

END OF BIDDER'S AFFIDAVIT OF NON-COLLUSION SUBMITTED WITH BID

BID PROPOSAL CERTIFICATE
(if Corporation)

STATE OF CALIFORNIA)
) ss:
COUNTY OF)

I HEREBY CERTIFY that a meeting of the Board of Directors of the _____ _____, a corporation existing under the laws of the State of _____, held on _____, 20____, the following resolution was duly passed and adopted:

"RESOLVED, that _____, as _____ President of the Corporation, be and is hereby authorized to execute the Bid Proposal dated _____, 20____, for the _____ _____ project, in the City of Petaluma, and that his/her execution thereof, attested by the Secretary of the Corporation, and with the Corporate Seal affixed, shall be the official act and deed of this Corporation."

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the official seal of the corporation this _____, day of _____, 20____.

_____
Secretary

(SEAL)

BID PROPOSAL CERTIFICATE
(if Partnership)

STATE OF CALIFORNIA)
) ss:
COUNTY OF)

I HEREBY CERTIFY that a meeting of the Partners of the _____
_____,
a partnership existing under the laws of the State of _____, held on _____, 20____, the following resolution was duly passed and adopted:

"RESOLVED, that _____, as the General Partner of the Partnership, be and is hereby authorized to execute the Bid Proposal dated _____, 20___, for the _____ project, in the City of Petaluma and that his/her execution thereof, attested by the _____ shall be the official act and deed of this Partnership."

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand this _____ day of _____, 20___.

_____
Partner

(SEAL)

BID PROPOSAL CERTIFICATE
(if Joint Venture)

STATE OF CALIFORNIA)
) ss:
COUNTY OF)

I HEREBY CERTIFY that a meeting of the Principals of the _____
_____
_____
a joint venture existing under the laws of the State of _____, held on _____, 20___, the following resolution was duly passed and adopted:

"RESOLVED, that _____, as _____ of the joint venture, be and is hereby authorized to execute the Bid Proposal dated _____, 20___, for the _____ _____ project, in the City of Petaluma, and that his/her execution thereof, attested by the _____ shall be the official act and deed of this Joint Venture."

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand this _____, day of _____, 20___.

_____
Managing Partner

(SEAL)

BID PROPOSAL CERTIFICATE
(if Proprietorship)

STATE OF CALIFORNIA)
) ss:
COUNTY OF)

I HEREBY CERTIFY that _____, as owner of _____ that I am authorized to execute the Bid Proposal dated _____, 20____, for the _____ _____ project, in the City of Petaluma, and that my execution thereof shall be the official act and deed of this proprietorship.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the official seal of the corporation this _____, day of _____, 20____.

_____
Owner

(SEAL)

PROPOSAL

To the City Council of the City of Petaluma:

The undersigned declares that he/she has carefully examined the location of the proposed work, that he/she has examined the plans and specifications, and read the accompanying instructions to bidders, and hereby proposes to furnish all materials and do all the work required to complete the said work in accordance with said plans, specifications, and special provisions for the unit or lump sum prices set forth in the attached Bid Schedule.

It is understood and agreed that the undersigned shall complete the work of the contract within the time provided for in the Contract Documents and Specifications governing said work.

If awarded the contract, the undersigned hereby agrees to sign said contract and to furnish the necessary bonds, insurance certificates and agreements within five (5) working days after receipt of Notice of Award of said contract from the City.

The undersigned has examined the location of the proposed work and is familiar with the plans, specifications and other contract documents and the local conditions at the place where the work is to be done.

The undersigned has checked carefully all the figures on the attached Bid Schedule and understands that the City will not be responsible for any errors or omissions on the part of the undersigned in making up the bid.

Enclosed find bidder's bond, certified check, or cashier's check no. _____ of the _____ (Company) (Bank) for _____ Dollars ($_____).

This project requires a Class _____ California State Contractor's License.

Contractor's License No. _____ License Class _____

Expiration Date of Contractor's License _____

This project requires registration with the California State Department of Industrial Relations.

Public Works Contractor Registration No. _____

Registration Date _____ Expiration Date _____

A bid submitted to a public agency by a contractor who is not licensed and not registered shall be considered non-responsive and shall be rejected by the public agency. The undersigned contractor declares that the contractor's license number, public work contractor registration number, and expiration dates stated herein are made under penalty of perjury under the laws of the State of California.

Contractor: _____

Signed by: _____

Title: _____

Address: _____

_____

Phone: _____

Fax: _____

Email:_____

Dated this _____ day of _____, 20___.

END OF PROPOSAL

DOCUMENT 00410

BID FORM

The terms used in this Bid with initial capital letters have the meanings stated in the Instructions to Bidders, General Conditions, and Special Provisions.

ARTICLE 1 — OWNER AND BIDDER

1.01 This Bid is submitted to: City of Petaluma.

1.02 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with Owner in the form included in the Bidding Documents to perform all Work as specified or indicated in the Bidding Documents for the prices and within the times indicated in this Bid and in accordance with the other terms and conditions of the Bidding Documents.

ARTICLE 2 — ATTACHMENTS TO THIS BID

2.01 The following documents are submitted with and made a condition of this Bid:

A. Required Bid security in the form of cash, a certified or cashier's check, or a Bid Bond as specified herein.

ARTICLE 3 — BASIS OF BID—LUMP SUM BID AND UNIT PRICES

3.01 Lump Sum Bids

A. Bidder will complete the Work in accordance with the Contract Documents for the following lump sum (stipulated) price(s), together with any Unit Prices:
   1. Lump Sum Price (Base Bid).

Bid Item Number	Description	Price in Figures ($)
1.A	Mobilization.	$
1.B.1	Tertiary pump station improvements.	$
1.B.2	New cloth media disk filters 5 and 6 construction and improvements.	$
1.B.3	Existing continuous backwash filters 1 to 5 improvements.	$
1.C	Existing filter support building improvements.	$
1.D	New storage building construction.	$
1.E	New waste oil storage canopy construction.	$
1.F.1	Electrical power distribution improvements.	$
1.F.2	General instrumentation work not included in major work items.	$
1.G	Yard piping and paving and grading including new and existing filter piping modifications and improvements , and new drain swale, storm drain improvements and miscellaneous paving and paving repairs.	$

Bid Item Number	Description	Price in Figures ($)
1.H	Testing, commissioning, and assistance with regulatory testing.	$
1.I	Demobilization.	$
1.J	Temporary excavation support.	$
1.K	All other costs required to complete all Work in the Contract Documents not covered by the other Line Items listed above.	$
Total Lump Sum Bid Price		$

Total Lump Sum Bid Price (in Words): _____

3.02 Unit Price Bids – NOT USED.

ARTICLE 4 — TIME OF COMPLETION

4.01 Bidder agrees that the Work will be substantially complete and will be completed and ready for final payment before the dates or within the number of calendar days indicated in the Agreement.

4.02 Bidder accepts the provisions of the Agreement as to liquidated damages.

ARTICLE 5 — BIDDER'S ACKNOWLEDGEMENTS: ACCEPTANCE PERIOD, INSTRUCTIONS, AND RECEIPT OF ADDENDA

5.01 Bid Acceptance Period

A. This Bid will remain subject to acceptance for 60 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of Owner.

5.02 Instructions to Bidders

A. Bidder accepts all of the terms and conditions of the Instructions to Bidders, including without limitation those dealing with the disposition of Bid security.

5.03 Receipt of Addenda

A. Bidder hereby acknowledges receipt of the following Addenda:

Addendum Number	Addendum Date

ARTICLE 6 — BIDDER'S REPRESENTATIONS AND CERTIFICATIONS

6.01 Bidder's Representations

A. In submitting this Bid, Bidder represents the following:
   1. Bidder has examined and carefully studied the Bidding Documents, including Addenda.

2. Bidder has visited the Site, conducted a thorough visual examination of the Site and adjacent areas, and become familiar with the general, local, and Site conditions that may affect cost, progress, and performance of the Work.
3. Bidder is familiar with all Laws and Regulations that may affect cost, progress, and performance of the Work.
4. In accordance with California Public Contract Code Section 2200 et seq., ("Iran Contracting Act of 2010"), Bidder certifies that Bidder is not identified on the list created by the California Department of General Services (DGS) in accordance with California Public Contract Code Section 2203(b) as a Person engaging in investment activities in Iran.
5. In accordance with Texas Government Code Chapter 2252.152 Contracts With Companies Engaged In Business With Iran, Sudan, Or Foreign Terrorist Organization Prohibited, Bidder certifies that Bidder does not engage in business with Iran, Sudan or any foreign terrorist organization, that the Texas Comptroller does not list Bidder as a terrorist organization, and that the Bidder acknowledges the Prohibition of Contracts with Foreign Terrorist Organizations and with the Boycotting of Israel.
6. Bidder certifies that it does not boycott energy companies and will not boycott energy companies during the term of this contract.
7. Bidder certifies that it does not have a practice, policy, guidance, or directive that discriminates against a firearm entity or firearm trade association and will not discriminate during the term of the contract against a firearm entity or firearm trade association.
8. Bidder has carefully studied the reports of explorations and tests of subsurface conditions at or adjacent to the Site and the drawings of physical conditions relating to existing surface or subsurface structures at the Site that have been identified in the Contract Documents, with respect to the Technical Data in such reports and drawings.
9. Bidder has carefully studied the reports and drawings relating to Hazardous Environmental Conditions, if any, at or adjacent to the Site that have been identified in the Contract Documents, with respect to Technical Data in such reports and drawings.
10. Bidder has considered the information known to Bidder itself; information commonly known to contractors doing business in the locality of the Site; information and observations obtained from visits to the Site; the Bidding Documents; and the Technical Data identified in the Contract Documents or by definition, with respect to the effect of such information, observations, and Technical Data on (a) the cost, progress, and performance of the Work; (b) the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder, if selected as Contractor; and (c) Bidder's (Contractor's) safety precautions and programs.
11. Based on the information and observations referred to in the preceding paragraph, Bidder agrees that no further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract.
12. Bidder is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents.
13. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bidding Documents, and of

discrepancies between Site conditions and the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.

14. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.
15. The submission of this Bid constitutes an incontrovertible representation by Bidder that without exception the Bid and all prices in the Bid are premised upon performing and furnishing the Work required by the Bidding Documents.

6.02 Bidder's Certifications

A. The Bidder certifies the following:
   1. This Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any collusive agreement or rules of any group, association, organization, or corporation.
   2. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid.
   3. Bidder has not solicited or induced any individual or entity to refrain from bidding.
   4. Bidder has not engaged in corrupt, fraudulent, collusive, or coercive practices in competing for the Contract as defined below:
      a. Corrupt practice means the offering, giving, receiving, or soliciting of anything of value likely to influence the action of a public official in the bidding process.
      b. Fraudulent practice means an intentional misrepresentation of facts made (a) to influence the bidding process to the detriment of Owner, (b) to establish bid prices at artificial non-competitive levels, or (c) to deprive Owner of the benefits of free and open competition.
      c. Collusive practice means a scheme or arrangement between 2 or more Bidders, with or without the knowledge of Owner, a purpose of which is to establish bid prices at artificial, non-competitive levels.
      d. Coercive practice means harming or threatening to harm, directly or indirectly, persons or their property to influence their participation in the bidding process or affect the execution of the Contract.
   5. In accordance with California Public Contract Code, Section 7103.5(b), Contractor or Subcontractor shall offer and agree to assign to the awarding body all rights, title, and interest in and to all causes of action it may have under Section 4 of the Clayton Act (15 U.S.C. Sec. 15) or under the Cartwright Act (Chapter 2 (commencing with Section 16700) of Part 2 of Division 7 of the Business and Professions Code).
   6. Successful bidder shall pay not less than the prevailing rate of per diem wages in accordance with California Labor Code, Section 1770 et seq. as determined by the California Department of Industrial Relations.
   7. In accordance with California Labor Code, Section 1861, the Bidder states the following as its certification:
      a. "I am aware of the provisions of California Labor Code, Section 3700, which require every employer to be insured against liability for workers' compensation or to undertake self-insurance in accordance with the provisions of that code, and I will comply with such provisions before commencing the performance of the Work."

BIDDER hereby submits this Bid as set forth above:

Bidder:	
(typed or printed name of organization)	
Bidder's Contractor License No.:	
California DIR Registration No.:	
By:	
(*individual's signature*)	
Name:	
(typed or printed)	
Title:	
(typed or printed)	
Date:	
(typed or printed)	
If Bidder is a corporation, a partnership, or a joint venture, attach evidence of authority to sign.	
Attest:	
(individual's signature)	
Name:	
(typed or printed)	
Title:	
(typed or printed)	
Date:	
(typed or printed)	
Address for giving notices:	

Bidder's Contact:	
Name:	
	(typed or printed)
Title:	
	(typed or printed)
Phone:	
Email:	
Address:	

When proposing as a Corporation, Bidder swears and affirms by signing this Bid that the proposing Corporation is currently in existence, is currently authorized to do business in the State of Texas (or State of incorporation) and that no franchise tax reports or payments are delinquent as of the date of this Bid Proposal. The Bidder will provide a Certificate of Account Status with the signed Contract Documents. Forms may be obtained by the successful Contractor from the Texas (or other state) Comptroller of Public Accounts and submitted as part of the final, executed Contract Documents.

A Limited Liability Corporation

Limited Liability Corporation Name: _____

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

Name (typed or printed): _____

Business address: _____

END OF DOCUMENT

LIST OF SUBCONTRACTORS

In accordance with Section 4104 of the Public Contracting Code of the State of California, each bidder shall list below the name and location of place of business of each subcontractor who will perform a portion of the contract work in an amount in excess of one-half of one percent of the total contract price or, in the cases of bids or offers for the construction of streets or highways, including bridges, in excess of one-half of 1 percent of the prime contractor's total bid or ten thousand dollars ($10,000), whichever is greater. In each such instance, the nature and extent of the work to be performed shall be described.

If a prime contractor fails to specify a subcontractor or if a prime contractor specifies more than one subcontractor for the same portion of work to be performed under the contract in excess of one-half of one percent of the prime contractor's total bid, the prime contractor agrees that he or she is fully qualified to perform that portion himself or herself, and that the prime contractor shall perform that portion himself or herself. The subcontracting of work for which no subcontractor was designated in the original bid and which is in excess of one-half of one percent of the total contract price, will be allowed only with the written consent of the City.

Name of Subcontractor	**Address of Office, Mill, or Shop**	**Description of Work to be Performed (also show Bid Schedule Item Number)**	**Public Works Contractor Registration Number**

END OF LIST OF SUBCONTRACTORS

LIST OF MATERIAL SUPPLIERS AND MATERIAL GUARANTEE

The bidder is required to name the make and supplier of the material items listed below to be furnished under these specifications. The bidder shall name a manufacturer for each item and the supplier of the item if the supplier is not the manufacturer. The naming of more than one supplier for a single item or naming a supplier followed by the words "or equal" will not be acceptable. Substitution of any listed supplier following submission of this form with the Bid shall only be permitted as authorized by the Engineer pursuant to Section 6.3 of the General Conditions.

Failure to complete this form and submit it with the bid proposal may cause the proposal to be rejected as being incomplete and not responsive to the solicitation.

Item	**Supplier & Manufacturer**	**Address**
Cloth Media Filter (11366B) - AquaDisk (sole source, no other supplier)		
Sub. Large Capacity Centrifugal Pumps (11312G) - ITT Flygt (sole source, no other supplier)		
Sub. Process Liquid Sump Pumps (11312J)		
Electric Actuators (13447)		
Plug Valves (15116)		
Butterfly Valves (15112)		
Ductile Iron Pipe Couplings (15121)		

MATERIAL GUARANTEE

In addition to completion of the list of material suppliers on the Material Suppliers form, the bidder may be required to furnish prior to award of contract, a complete statement of the origin, composition and manufacturer of any or all materials to be used in the construction of the work, together with samples, which samples may be subjected to test, provided for in these specifications or in the Special Provisions to determine their quality and fitness for the work.

END OF
LIST OF MATERIAL SUPPLIERS AND MATERIAL GUARANTEE

QUESTIONNAIRE AND FINANCIAL ASSURANCE STATEMENT

The following statements as to experience and financial qualifications of the Proposer are submitted in conjunction with the proposal as a part thereof, and the truthfulness and accuracy of the information is guaranteed by the Proposer.

The Proposer has been engaged in the contracting business under the present business for _____ years. Experience in work of a nature similar to that covered in the proposal extends over a period of _____ years.

The Proposer, as a contractor, has never failed to satisfactorily complete a contract awarded to contractor, except as follows:

_____

_____

_____

List all claims and lawsuits presented or filed in the last five (5) years, regardless of the form, regarding any public works project:

_____

_____

_____

The following contracts for work have been completed in the last three (3) years for the persons, firm or authority indicated and to whom reference is made:

Year	Type of Work-Size, Length and Contract Amount	Location and For Whom Performed
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

The following complaints have been made against the Proposer's contractor's license within the past ten (10) years:

Date:_____ Nature of Complaint _____

_____

_____

Reference is hereby made to the following bank or banks as to the financial responsibility of the proposer:

NAME OF BANK ADDRESS

Reference is hereby made to the following surety companies as to the financial responsibility and general reliability of the proposer:

NAME OF SURETY COMPANY:

I, the undersigned, declare under penalty of perjury under the laws of the State of California, that the foregoing is true and correct.

SIGNATURE OF PROPOSER DATE

NAME OF PROPOSER

END OF
QUESTIONNAIRE AND FINANCIAL STATEMENT FORM

SITE VISIT AFFIDAVIT
TO BE EXECUTED
BY BIDDER, NOTARIZED AND SUBMITTED WITH BID

(To Accompany Bid)

State of California)
) ss.
County of)

_____, **being first duly sworn**, deposes and says that he or
(Contractor's Authorized Representative)

she is

_____of _____, the party making the foregoing
(Title of Representative) (Contractor's Name)

bid, has visited the Site of the Work as described in the Contract and has examined and familiarized themselves with the existing conditions, as well as all other conditions relating to the construction which will be performed. The submitting of a bid shall be considered an acknowledgement on the part of the Bidder of familiarity with conditions at the site of Work. The Bidder further acknowledges that the site examination has provided adequate and sufficient information related to existing conditions which may affect cost, progress or performance of the Work.

Signature Name of Bidder

STATEMENT OF QUALIFICATIONS

The apparent low Bidder shall submit a Statement of Qualifications as specified herein as a submittal to the City within 24 hours of the bid opening.

A. The following are minimum requirements for the Bidder to be found responsible to perform the Work. Bidder's compliance with the minimum qualification requirements will be measured by the experience of the supervisory personnel who will have responsible charge of the various major components of the Work. If Bidder subcontracts portions of the Work, City, in its determination of whether the minimum qualification requirements have been met, will consider the qualifications of the Subcontractor's supervisory personnel.

   1. Five years experience as a continuously operating entity engaged in the performance of similar work.
   2. Experience on public works projects, with no history of default termination.
   3. Sufficient financial strength, stability and resources as measured by Bidder's equity, debt-to-assets ratio, and capability to finance the Work to be performed.

B. Owner will notify Apparent Low Bidder in writing of any deficiencies found and will provide Bidder the opportunity to respond in writing with reasonable clarifications but will not allow any changes in the nature of Bidder as a business entity.

BID BOND

We, _____ as Principal, and _____ as Surety, jointly and severally, bind ourselves, our heirs, representatives, successors and assigns, as set forth herein, to the City of Petaluma (herein called "the Owner") for the payment of the penal sum of _____ Dollars ($_____), lawful money of the United States, which is ten (10) percent of the total amount bid by bidder to the Owner. Principal has submitted the accompanying bid for the construction of the _____ project.

If the Principal is awarded the contract and enters into a written contract, in the form prescribed by the Owner, at the price designated by his bid, and files the bonds required by the Agreement with the Owner, and carries all insurance in type and amount which conforms to the contract documents and furnishes required certificates and endorsements thereof, then this obligation shall be null and void; otherwise it shall remain in full force and effect.

Forfeiture of this bond, or any deposit made in lieu thereof, shall not preclude the Owner from seeking all other remedies provided by law to cover losses sustained as a result of the Principal's failure to do any of the foregoing.

Principal and Surety agree that if the Owner is required to engage the services of an attorney in connection with the enforcement of this bond, each shall pay the Owner's reasonable attorney's fees, witness fees and other costs incurred with or without suit.

Executed on _____, _____.

_____
PRINCIPAL

By_____
Signature

_____
Title

Any claims under this bond may be addressed to:

_____

_____

_____

_____

(Name and address of Surety's agent for service of process in California, if different from above)

(Telephone number of Surety's agent in California)

(Attach Acknowledgment)

_____
SURETY

By_____
(Attorney-in-Fact)

NOTICE:

No substitution or revision to this bond form will be accepted. Be sure that all bonds submitted have a certified copy of the bonding agent's power of attorney attached. Also verify that Surety is an "Admitted Surety" (i.e., qualified to do business in California), and attach proof of verification (website printout from the California Department of Insurance website (http://www.insurance.ca.gov/docs/index.html) or certificate from County Clerk).

END OF BID BOND

SECTION 00820

FEDERAL AND STATE FUNDING REQUIREMENTS

TABLE OF CONTENTS

ARTICLE 1 — GENERAL

1.01 This section comprises the construction contract provisions required by funding programs.

A. The provisions, regulations, code references, certifications and other items included apply to this Project.

ARTICLE 2 — DAVIS-BACON AND RELATED ACT REQUIREMENTS

2.01 In full in any contract in excess of $2,000 which is entered into for the actual construction, alteration and/or repair, including painting and decorating, of a public building or public work, or building or work financed in whole or in part from Federal funds or in accordance with guarantees of a Federal agency or financed from funds obtained by pledge of any contract of a Federal agency to make a loan, grant or annual contribution (except where a different meaning is expressly indicated), and which is subject to the labor standards provisions of any of the acts listed in § 5.1, the following clauses (or any modifications thereof to meet the particular needs of the agency, Provided, That such modifications are first approved by the Department of Labor):

A. Minimum wages:

1. All laborers and mechanics employed or working upon the site of the work (or under the United States Housing Act of 1937 or under the Housing Act of 1949 in the construction or development of the project), will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics. Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in Section 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: Provided, That the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under this section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the contractor and its subcontractors

at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

a. The Owner shall require, on behalf of the U.S. Environmental Protection Agency (EPA), that any class of laborers or mechanics, including helpers, which is not listed in the wage determination, and which is to be employed under the contract shall be classified in conformance with the wage determination. The contracting officer shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:
    1) The work to be performed by the classification requested is not performed by a classification in the wage determination; and
    2) The classification is utilized in the area by the construction industry; and
    3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

b. If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the Administrator of the Wage and Hour Division, U.S. Department of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

c. In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Administrator for determination. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

d. The wage rate (including fringe benefits where appropriate) determined pursuant to this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

2. Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

3. If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the

contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

B. Withholding:
   1. The Owner shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld from the contractor under this contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work (or under the United States Housing Act of 1937 or under the Housing Act of 1949 in the construction or development of the project), all or part of the wages required by the contract, the (Agency) may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

C. Payrolls and basic records:
   1. Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work (or under the United States Housing Act of 1937, or under the Housing Act of 1949, in the construction or development of the project). Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.
   2. The contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the Engineer if the agency is a party to the contract, but if the agency is not such a party, the contractor will submit the payrolls to the applicant, sponsor, or owner, as the case may be, for transmission to the agency. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on weekly transmittals. Instead the payrolls

shall only need to include an individually identifying number for each employee (e.g., the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH-347 is available for this purpose from the Wage and Hour Division Web site at http://www.dol.gov/esa/whd/forms/wh347instr.htm or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the Owner if the agency is a party to the contract, but if the agency is not such a party, the contractor will submit them to the applicant, sponsor, or owner, as the case may be, for transmission to the Owner, the contractor, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the sponsoring government agency or owner.

3. Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:
    a. That the payroll for the payroll period contains the information required to be provided under § 5.5 (a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under § 5.5 (a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;
    b. That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;
    c. That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.
4. The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by this section.
5. The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

D. The contractor or subcontractor shall make the records required under this section available for inspection, copying, or transcription by authorized representatives of the Owner or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the Federal agency may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

E. Apprentices and trainees:

1. Apprentices. Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.
2. Trainees. Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage

determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

3. Equal employment opportunity. The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.

F. Compliance with Copeland Act requirements. The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

G. Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR 5.5(a)(1) through (10) and such other clauses as the (write in the name of the Federal agency) may by appropriate instructions require, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

H. Contract termination: debarment. A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

I. Compliance with Davis-Bacon and Related Act requirements. All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.

J. Disputes concerning labor standards. Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and Owner, the U.S. Department of Labor, or the employees or their representatives.

K. Certification of eligibility:

1. By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

2. No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).
3. The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

2.02 Contract Work Hours and Safety Standards Act.

A. The Agency Head shall cause or require the contracting officer to insert the following clauses set forth in this section in full in any contract in an amount in excess of $100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by § 5.5(a) or § 4.6 of part 4 of this title. As used in this paragraph, the terms laborers and mechanics include watchmen and guards.
   1. Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.
   2. Violation; liability for unpaid wages; liquidated damages. In the event of any violation of the clause set forth in this section the contractor and any subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the Owner of Columbia or a territory, to such Owner or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in this section, in the sum of $27 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in this section.
   3. Withholding for unpaid wages and liquidated damages. The Owner shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in this section.
   4. Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses set forth in this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in this section.

2.03 In addition to the clauses contained in paragraphs above, in any contract subject only to the Contract Work Hours and Safety Standards Act and not to any of the other statutes cited in § 5.1, the Agency Head shall cause or require the contracting officer to insert a clause requiring that the contractor or subcontractor shall maintain payrolls and basic payroll records during the course of the work and shall preserve them for a period of three years from the completion of the contract for all laborers and mechanics, including guards and watchmen, working on the contract. Such records shall contain the name and address of each such employee, social security number, correct classifications, hourly rates of wages paid, daily and weekly number of hours worked, deductions made, and actual wages paid. Further, the Agency Head shall cause or require the contracting officer to insert in any such contract a clause providing that the records to be maintained under this paragraph shall be made available by the contractor or subcontractor for inspection, copying, or transcription by authorized representatives of the Owner and the Department of Labor, and the contractor or subcontractor will permit such representatives to interview employees during working hours on the job.

2.04 Compliance Reporting:

A. Each Contractor having a contract containing the provisions prescribed above shall file, and shall cause each of his subcontractors to file, Compliance Reports with the Owner or the Secretary of Labor as may be directed. Compliance Reports shall be filed within such times and shall contain such information as to the practices, policies, programs, and employment policies, programs, and employment statistics of the Contractor and each subcontractor, and shall be in such form, as the Secretary of Labor may prescribe.

B. The Contractor/Bidders or subcontractors may be required to state whether they have participated in any previous contract subject to the provisions of this Order, or any preceding similar Executive order, and in that event to submit, on behalf of themselves and their proposed subcontractors, Compliance Reports prior to or as an initial part of their bid or negotiation of a contract.

C. Whenever the Contractor or subcontractor has a collective bargaining agreement or other contract or understanding with a labor union or an agency referring workers or providing or supervising apprenticeship or training for such workers, the Compliance Report shall include such information as to such labor union's or agency's practices and policies affecting compliance as the Secretary of Labor may prescribe: Provided, that to the extent such information is within the exclusive possession of a labor union or an agency referring workers or providing or supervising apprenticeship or training and such labor union or agency shall refuse to furnish such information to the Contractor, the Contractor shall so certify to the Owner as part of its Compliance Report and shall set forth what efforts he has made to obtain such information.

D. The Owner or the Secretary of Labor may direct that any the Contractor/Bidder or subcontractor shall submit, as part of his Compliance Report, a statement in writing, signed by an authorized officer or agent on behalf of any labor union or any agency referring workers or providing or supervising apprenticeship or other training, with which the Contractor/Bidder deals, with supporting information, to the effect that the signer's practices and policies do not discriminate on the grounds of race, color, creed, or national origin, and that the signer either will affirmatively cooperate in the implementation of the policy and provisions of this Order or that it consents and agrees that recruitment, employment, and the terms and conditions of employment under the Contract shall be in accordance with the purposes and provisions of the

Order. In the event that the union, or the agency shall refuse to execute such a statement, the Compliance Report shall so certify and set forth what efforts have been made to secure such a statement and such additional factual material as the Owner or the Secretary of Labor may require.

2.05 Contractor shall comply with wage determinations.

A. As specified in Attachment A - Federal Wage Determinations.

B. The higher of either state or federal wages will be paid for comparable work classifications.

C. This contract is subject to enforcement by California Department of Industrial Relations (DIR) with regard, specifically but not limited to, the following.

D. Pursuant to Section 1773 of the Labor Code, the general prevailing wage rates in the county, or counties, in which the work is to be done have been determined by the DIR. These wages are available from the DIR website at https://www.dir.ca.gov. The effective general prevailing wage rates, which have been determined and are on file with the DIR are referenced but not printed in the Contract Documents.

E. Pursuant to Section 1725.5 of the Labor Code, no contractor or subcontractor may be listed on a bid proposal, or awarded a contract, for public work on a public works project unless registered with the DIR.

2.06 Contractor shall submit a signed copy of Attachment B - Davis-Bacon Act Certificate of Eligibility with executed Agreement.

ARTICLE 3 — DISADVANTAGED BUSINESS ENTERPRISES (DBE) REQUIREMENTS

3.01 The contractor must ensure that the DBE's six good faith efforts are used during the procurement of subcontractors for the Project.

A. The six good faith efforts are found at: https://www.epa.gov/grants/disadvantaged-business-enterprise-program-requirements#sixgoodfaithefforts.

3.02 Contractor shall maintain proper records demonstrating that the six good faith efforts were applied during contract procurement.

3.03 Contractor can refer to Attachment C - DBE Guidance Document.

ARTICLE 4 — DRUG FREE WORKPLACE REQUIREMENTS

4.01 Comply with 55 FR 21690, 21694, MAY 25, 1990.

4.02 Workplaces under grants, for contractors other than individuals, need not be identified on the certification. If known, they may be identified in the grant application. If the contractor does not identify the workplaces at the time of application, or upon award, if there is no application, the contractor must keep the identity of the workplace(s) on file in its office and make the information available for federal inspection. Failure to identify all known workplaces constitutes a violation of the contractor's drug-free workplace requirements.

4.03 Workplace identifications must include the actual address of buildings (or parts of buildings) or other sites where work under the grant takes place. Categorical descriptions may be used (e.g., all vehicles of a mass transit authority or state highway department while in operation, state employees in each local unemployment office, performers in concert halls or radio studios).

4.04 If the workplace identified to the board changes during the performance of the grant, the contractor shall inform the board of the change(s), if it previously identified the workplaces in question.

4.05 Definitions of terms in the non-procurement suspension and debarment common rule and drug-free workplace common rule apply to this certification. Contractors' attention is called, in particular, to the following definitions from these rules: controlled substance means a controlled substance in schedules i through v of the controlled substances act (21 U.S.C. 812) and as further defined by regulation (21 CFR 1308.11 through 1308.15);conviction means a finding of guilt (including a plea of nolo contendere) or imposition of sentence, or both, by any judicial body charged with the responsibility to determine violations of the federal or state criminal drug statutes; criminal drug statute means a federal or non-federal criminal statute involving the manufacture, distribution, dispensing, use, or possession of any controlled substance; employee means the employee of a contractor directly engaged in the performance of work under a grant, including: (i) all direct charge employees; (ii) all indirect charge employees unless their impact or involvement is insignificant to the performance of the grant; and, (iii) temporary personnel and consultants who are directly engaged in the performance of work under the grant and who are on the contractor's payroll. This definition does not include workers not on the payroll of the contractor (e.g., volunteers, even if used to meet a matching requirement; consultants or independent contractors not on the contractor's payroll; or employees of subrecipients or subcontractors in covered workplaces.

4.06 Certification regarding drug-free workplace requirements for alternate i. (contractors other than individuals).

A. The contractor certifies that it will or will continue to provide a drug-free workplace by:
   1. publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the contractor's workplace and specifying the actions that will be taken against employees for violation of such prohibition;
   2. establishing an ongoing drug-free awareness program to inform employees about:
      a. the dangers of drug abuse in the workplace;
      b. the contractor's policy of maintaining a drug-free workplace;
      c. any available drug counseling, rehabilitation, and employee assistance programs; and
      d. the penalties that may be imposed upon employees for drug abuse violations occurring in the workplace;
   3. making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the published statement;
   4. notifying the employee in the published statement that, as a condition of employment

5. Under the grant, the employee will:
    a. abide by the terms of the statement; and
    b. notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace no later than five calendar days after such conviction;
6. notifying the board in writing, within ten calendar days after receiving notice from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to every grant officer or other designee on whose grant activity the convicted employee was working, unless the federal agency has designated a central point for the receipt of such notices. Notice shall include the identification number(s) of each affected grant;
7. taking one of the following actions, within 30 calendar days of receiving notice, with respect to any employee who is so convicted—
    a. taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of the rehabilitation act of 1973, as amended; or
    b. requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a federal, state, or local health, law enforcement, or other appropriate agency;
8. making a good faith effort to continue to maintain a drug-free workplace through implementation of these requirements.

ARTICLE 5 — EEOC: AFFIRMATIVE ACTION REQUIREMENTS

5.01 Comply with Notice of Requirement for Affirmative Action to Ensure Equal Employment Opportunity (Executive Order 11246) located at 41 CFR § 60-4.2.

5.02 The Offeror's or Bidder's attention is called to the “Equal Opportunity Clause” and the “Standard Federal Equal Employment Specifications” set forth herein.

5.03 The goals and timetables for minority and female participation, expressed in percentage terms for the Contractor's aggregate workforce in each trade on all construction work in the covered area, are as follows:

Timetables	Goals for Minority Participation for Each Trade	Goals for Female Participation for Each Trade
2022 – 2023 (as scheduled)	25.6 percent	25.6 percent

A. These goals are applicable to all the Contractor's construction work (whether or not it is Federal or federally assisted) performed in the covered area. If the contractor performs construction work in a geographical area located outside of the covered area, it shall apply the goals established for such geographical area where the work is actually performed. With regard to this second area, the contractor also is subject to the goals for both its federally involved and non-federally involved construction.

B. The Contractor's compliance with the Executive Order and the regulations in 41 CFR part 60-4 shall be based on its implementation of the Equal Opportunity Clause, specific affirmative action obligations required by the specifications set forth in 41 CFR 60-4.3(a), and its efforts to meet the goals. The hours of minority and female employment and training must be substantially uniform throughout the length

of the contract, and in each trade, and the contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from Contractor to Contractor or from project to project for the sole purpose of meeting the Contractor's goals shall be a violation of the contract, the Executive Order and the regulations in 41 CFR part 60-4. Compliance with the goals will be measured against the total work hours performed.

C. The Contractor shall provide written notification to the Director of the Office of Federal Contract Compliance Programs within 10 working days of award of any construction subcontract in excess of $10,000 at any tier for construction work under the contract resulting from this solicitation. The notification shall list the name, address and telephone number of the subcontractor; employer identification number of the subcontractor; estimated dollar amount of the subcontract; estimated starting and completion dates of the subcontract; and the geographical area in which the subcontract is to be performed.

D. As used in this Notice, and in the contract resulting from this solicitation, the “covered area” is (insert description of the geographical areas where the contract is to be performed giving the state, county, and Owner, if any).

ARTICLE 6 — ENVIRONMENTAL COMPLIANCE

6.01 The Contractor, and all subcontractors at any tier, shall comply with all applicable standards, orders, or requirements issued under Section 306 of the Clean Air Act (42 U.S.C. 1857[h]), Section 508 of the Clean Water Act (33 U.S.C. 1368), Executive Order 11738 (Administration of the Clean Air Act and the Federal Water Pollution Control Act with Respect to Federal Contracts, Grants, or Loans), and 40 CFR Part 15.

ARTICLE 7 — EQUAL EMPLOYMENT OPPORTUNITY AUTHORITIES EO 11246

7.01 The Contractor shall comply with Executive Order 11246, entitled 'Equal Employment Opportunity,' as amended by Executive Order 11375, and as supplemented in Department of Labor regulations (41 CFR Part 60). (EO 11246, 30 FR 12319, September 28, 1965)

7.02 Contractor's compliance with Executive order 11246 shall be based on implementation of the Equal Opportunity Clause, and specific affirmative active obligations required by the Standard Federal Equal Employment Opportunity Construction Contract Specifications, as set forth in 41 CFR Part 60-4.

7.03 During the performance of this contract, the contractor agrees as follows:

A. The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, sexual orientation, gender identity, or national origin. The contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex, sexual orientation, gender identity, or national origin. Such action shall include, but not be limited to the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places,

available to employees and applicants for employment, notices to be provided by the contracting officer setting forth the provisions of this nondiscrimination clause.

B. The contractor will, in all solicitations or advancements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, or national origin.

C. The contractor will not discharge or in any other manner discriminate against any employee or applicant for employment because such employee or applicant has inquired about, discussed, or disclosed the compensation of the employee or applicant or another employee or applicant. This provision shall not apply to instances in which an employee who has access to the compensation information of other employees or applicants as a part of such employee's essential job functions discloses the compensation of such other employees or applicants to individuals who do not otherwise have access to such information, unless such disclosure is in response to a formal complaint or charge, in furtherance of an investigation, proceeding, hearing, or action, including an investigation conducted by the employer, or is consistent with the contractor's legal duty to furnish information.

D. The contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the agency contracting officer, advising the labor union or workers' representative of the contractor's commitments under Section 202 of Executive Order No. 11246 of September 24, 1965, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

E. The contractor will comply with all provisions of Executive Order No. 11246 of Sept. 24, 1965, and of the rules, regulations, and relevant orders of the Secretary of Labor.

F. The contractor will furnish all information and reports required by Executive Order No. 11246 of September 24, 1965, and by the rules, regulations, and orders of the Secretary of Labor, or pursuant thereto, and will permit access to his books, records, and accounts by the contracting agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

G. In the event of the contractor's noncompliance with the nondiscrimination clauses of this contract or with any of such rules, regulations, or orders, this contract may be cancelled, terminated, or suspended in whole or in part and the contractor may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order No. 11246 of Sept. 24, 1965, and such other sanctions may be imposed and remedies invoked as provided in Executive Order No. 11246 of September 24, 1965, or by rule, regulation, or order of the Secretary of Labor, or as otherwise provided by law.

H. The contractor will include the provisions of this section in every subcontract or purchase order unless exempted by rules, regulations, or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order No. 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. The contractor will take such action with respect to any subcontract or purchase order as may be directed by the Secretary of Labor as a means of enforcing such provisions including sanctions for noncompliance: Provided, however, that in the event the contractor becomes involved in, or is

threatened with, litigation with a subcontractor or vendor as a result of such direction, the contractor may request the United States to enter into such litigation to protect the interests of the United States. [Sec. 202 amended by EO 11375 of Oct. 13, 1967, 32 FR 14303, 3 CFR, 1966-1970 Comp., p. 684, EO 12086 of Oct. 5, 1978, 43 FR 46501, 3 CFR, 1978 Comp., p. 230, EO 13665 of April 8, 2014, 79 FR 20749, EO 13672 of July 21, 2014, 79 FR 42971.]

7.04 Standard Federal Equal Employment Opportunity Construction Contract Specifications. (41 CFR 60-4.3).

A. As used in these specifications:
   1. “Covered area” means the geographical area described in the solicitation from which this contract resulted;
   2. “Director” means Director, Office of Federal Contract Compliance Programs, United States Department of Labor, or any person to whom the Director delegates authority;
   3. “Employer identification number” means the Federal Social Security number used on the Employer's Quarterly Federal Tax Return, U.S. Treasury Department Form 941.
   4. “Minority” includes:
      a. Black (all persons having origins in any of the Black African racial groups not of Hispanic origin);
      b. Hispanic (all persons of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish Culture or origin, regardless of race);
      c. Asian and Pacific Islander (all persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands); and
      d. American Indian or Alaskan Native (all persons having origins in any of the original peoples of North America and maintaining identifiable tribal affiliations through membership and participation or community identification).

B. Whenever the Contractor, or any Subcontractor at any tier, subcontracts a portion of the work involving any construction trade, it shall physically include in each subcontract in excess of $10,000 the provisions of these specifications and the Notice which contains the applicable goals for minority and female participation and which is set forth in the solicitations from which this contract resulted.

C. If the Contractor is participating (pursuant to 41 CFR 60-4.5) in a Hometown Plan approved by the U.S. Department of Labor in the covered area either individually or through an association, its affirmative action obligations on all work in the Plan area (including goals and timetables) shall be in accordance with that Plan for those trades which have unions participating in the Plan. Contractors must be able to demonstrate their participation in and compliance with the provisions of any such Hometown Plan. Each Contractor or Subcontractor participating in an approved Plan is individually required to comply with its obligations under the EEO clause, and to make a good faith effort to achieve each goal under the Plan in each trade in which it has employees. The overall good faith performance by other Contractors or Subcontractors toward a goal in an approved Plan does not excuse any covered Contractor's or Subcontractor's failure to take good faith efforts to achieve the Plan goals and timetables.

D. The Contractor shall implement the specific affirmative action standards provided in this section. The goals set forth in the solicitation from which this contract resulted

are expressed as percentages of the total hours of employment and training of minority and female utilization the Contractor should reasonably be able to achieve in each construction trade in which it has employees in the covered area. Covered Construction contractors performing construction work in geographical areas where they do not have a Federal or federally assisted construction contract shall apply the minority and female goals established for the geographical area where the work is being performed. Goals are published periodically in the Federal Register in notice form, and such notices may be obtained from any Office of Federal Contract Compliance Programs office or from Federal procurement contracting officers. The Contractor is expected to make substantially uniform progress in meeting its goals in each craft during the period specified.

E. Neither the provisions of any collective bargaining agreement, nor the failure by a union with whom the Contractor has a collective bargaining agreement, to refer either minorities or women shall excuse the Contractor's obligations under these specifications, Executive Order 11246, or the regulations promulgated pursuant thereto.

F. In order for the nonworking training hours of apprentices and trainees to be counted in meeting the goals, such apprentices and trainees must be employed by the Contractor during the training period, and the Contractor must have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees must be trained pursuant to training programs approved by the U.S. Department of Labor.

G. The Contractor shall take specific affirmative actions to ensure equal employment opportunity. The evaluation of the Contractor's compliance with these specifications shall be based upon its effort to achieve maximum results from its actions. The Contractor shall document these efforts fully, and shall implement affirmative action steps at least as extensive as the following:
    1. Ensure and maintain a working environment free of harassment, intimidation, and coercion at all sites, and in all facilities at which the Contractor's employees are assigned to work. The Contractor, where possible, will assign two or more women to each construction project. The Contractor shall specifically ensure that all foremen, superintendents, and other on-site supervisory personnel are aware of and carry out the Contractor's obligation to maintain such a working environment, with specific attention to minority or female individuals working at such sites or in such facilities.
    2. Establish and maintain a current list of minority and female recruitment sources, provide written notification to minority and female recruitment sources and to community organizations when the Contractor or its unions have employment opportunities available, and maintain a record of the organizations' responses.
    3. Maintain a current file of the names, addresses and telephone numbers of each minority and female off-the-street applicant and minority or female referral from a union, a recruitment source or community organization and of what action was taken with respect to each such individual. If such individual was sent to the union hiring hall for referral and was not referred back to the Contractor by the union or, if referred, not employed by the Contractor, this shall be documented in the file with the reason therefor, along with whatever additional actions the Contractor may have taken.
    4. Provide immediate written notification to the Director when the union or unions with which the Contractor has a collective bargaining agreement has not referred to the Contractor a minority person or woman sent by the Contractor,

or when the Contractor has other information that the union referral process has impeded the Contractor's efforts to meet its obligations.

5. Develop on-the-job training opportunities and/or participate in training programs for the area which expressly include minorities and women, including upgrading programs and apprenticeship and trainee programs relevant to the Contractor's employment needs, especially those programs funded or approved by the Department of Labor. The Contractor shall provide notice of these programs to the sources compiled under 7b above.
6. Disseminate the Contractor's EEO policy by providing notice of the policy to unions and training programs and requesting their cooperation in assisting the Contractor in meeting its EEO obligations; by including it in any policy manual and collective bargaining agreement; by publicizing it in the company newspaper, annual report, etc.; by specific review of the policy with all management personnel and with all minority and female employees at least once a year; and by posting the company EEO policy on bulletin boards accessible to all employees at each location where construction work is performed.
7. Review, at least annually, the company's EEO policy and affirmative action obligations under these specifications with all employees having any responsibility for hiring, assignment, layoff, termination or other employment decisions including specific review of these items with onsite supervisory personnel such as Superintendents, General Foremen, etc., prior to the initiation of construction work at any job site. A written record shall be made and maintained identifying the time and place of these meetings, persons attending, subject matter discussed, and disposition of the subject matter.
8. Disseminate the Contractor's EEO policy externally by including it in any advertising in the news media, specifically including minority and female news media, and providing written notification to and discussing the Contractor's EEO policy with other Contractors and Subcontractors with whom the Contractor does or anticipates doing business.
9. Direct its recruitment efforts, both oral and written, to minority, female and community organizations, to schools with minority and female students and to minority and female recruitment and training organizations serving the Contractor's recruitment area and employment needs. Not later than one month prior to the date for the acceptance of applications for apprenticeship or other training by any recruitment source, the Contractor shall send written notification to organizations such as the above, describing the openings, screening procedures, and tests to be used in the selection process.
10. Encourage present minority and female employees to recruit other minority persons and women and, where reasonable, provide after school, summer and vacation employment to minority and female youth both on the site and in other areas of a Contractor's work force.
11. Validate all tests and other selection requirements where there is an obligation to do so under 41 CFR part 60-3.
12. Conduct, at least annually, an inventory and evaluation at least of all minority and female personnel for promotional opportunities and encourage these employees to seek or to prepare for, through appropriate training, etc., such opportunities.
13. Ensure that seniority practices, job classifications, work assignments and other personnel practices, do not have a discriminatory effect by continually monitoring all personnel and employment related activities to ensure that the

EEO policy and the Contractor's obligations under these specifications are being carried out.

14. Ensure that all facilities and company activities are non-segregated except that separate or single-user toilet and necessary changing facilities shall be provided to assure privacy between the sexes.
15. Document and maintain a record of all solicitations of offers for subcontracts from minority and female construction contractors and suppliers, including circulation of solicitations to minority and female contractor associations and other business associations.
16. Conduct a review, at least annually, of all supervisors' adherence to and performance under the Contractor's EEO policies and affirmative action obligations.
    a. Contractors are encouraged to participate in voluntary associations which assist in fulfilling one or more of their affirmative action obligations (7a through p). The efforts of a contractor association, joint contractor-union, contractor-community, or other similar group of which the contractor is a member and participant, may be asserted as fulfilling any one or more of its obligations under 7a through p of these Specifications provided that the contractor actively participates in the group, makes every effort to assure that the group has a positive impact on the employment of minorities and women in the industry, ensures that the concrete benefits of the program are reflected in the Contractor's minority and female workforce participation, makes a good faith effort to meet its individual goals and timetables, and can provide access to documentation which demonstrates the effectiveness of actions taken on behalf of the Contractor. The obligation to comply, however, is the Contractor's and failure of such a group to fulfill an obligation shall not be a defense for the Contractor's noncompliance.
    b. A single goal for minorities and a separate single goal for women have been established. The Contractor, however, is required to provide equal employment opportunity and to take affirmative action for all minority groups, both male and female, and all women, both minority and non-minority. Consequently, the Contractor may be in violation of the Executive Order if a particular group is employed in a substantially disparate manner (for example, even though the Contractor has achieved its goals for women generally, the Contractor may be in violation of the Executive Order if a specific minority group of women is underutilized).
    c. The Contractor shall not use the goals and timetables or affirmative action standards to discriminate against any person because of race, color, religion, sex, sexual orientation, gender identity, or national origin.
    d. The Contractor shall not enter into any Subcontract with any person or firm debarred from Government contracts pursuant to Executive Order 11246.
    e. The Contractor shall carry out such sanctions and penalties for violation of these specifications and of the Equal Opportunity Clause, including suspension, termination and cancellation of existing subcontracts as may be imposed or ordered pursuant to Executive Order 11246, as amended, and its implementing regulations, by the Office of Federal Contract Compliance Programs. Any Contractor who fails to carry out such sanctions and penalties shall be in violation of these specifications and Executive Order 11246, as amended.
    f. The Contractor, in fulfilling its obligations under these specifications, shall implement specific affirmative action steps, at least as extensive as those

standards prescribed in this section, so as to achieve maximum results from its efforts to ensure equal employment opportunity. If the Contractor fails to comply with the requirements of the Executive Order, the implementing regulations, or these specifications, the Director shall proceed in accordance with 41 CFR 60-4.8.

g. The Contractor shall designate a responsible official to monitor all employment related activity to ensure that the company EEO policy is being carried out, to submit reports relating to the provisions

h. hereof as may be required by the Government and to keep records. Records shall at least include for each employee the name, address, telephone numbers, construction trade, union affiliation if any, employee identification number when assigned, social security number, race, sex, status (e.g., mechanic, apprentice trainee, helper, or laborer), dates of changes in status, hours worked per week in the indicated trade, rate of pay, and locations at which the work was performed. Records shall be maintained in an easily understandable and retrievable form; however, to the degree that existing records satisfy this requirement, contractors shall not be required to maintain separate records.

7.05 Nothing herein provided shall be construed as a limitation upon the application of other laws which establish different standards of compliance or upon the application of requirements for the hiring of local or other area residents (e.g., those under the Public Works Employment Act of 1977 and the Community Development Block Grant Program).

END OF SECTION

ATTACHMENT A - FEDERAL WAGE DETERMINATIONS

"General Decision Number: CA20230007 04/21/2023

Superseded General Decision Number: CA20220007

State: California

Construction Types: Building, Heavy (Heavy and Dredging) and Highway

Counties: Alpine, Amador, Butte, Colusa, El Dorado, Glenn, Lassen, Marin, Modoc, Napa, Nevada, Placer, Plumas, Sacramento, Shasta, Sierra, Siskiyou, Solano, Sonoma, Sutter, Tehama, Trinity, Yolo and Yuba Counties in California.

BUILDING CONSTRUCTION PROJECTS (excluding Amador County only); DREDGING CONSTRUCTION PROJECTS (does not include hopper dredge work); HEAVY CONSTRUCTION PROJECTS (does not include water well drilling); AND HIGHWAY CONSTRUCTION PROJECTS

Note: Contracts subject to the Davis-Bacon Act are generally required to pay at least the applicable minimum wage rate required under Executive Order 14026 or Executive Order 13658. Please note that these Executive Orders apply to covered contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but do not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60).

If the contract is entered into on or after January 30, 2022, or the contract is renewed or extended (e.g., an option is exercised) on or after January 30, 2022:	. Executive Order 14026 generally applies to the contract. . The contractor must pay all covered workers at least $16.20 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in 2023.
If the contract was awarded on or between January 1, 2015 and January 29, 2022, and the contract is not renewed or extended on or after January 30, 2022:	. Executive Order 13658 generally applies to the contract. . The contractor must pay all covered workers at least $12.15 per hour (or the

	applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on that contract in 2023.

The applicable Executive Order minimum wage rate will be adjusted annually. If this contract is covered by one of the Executive Orders and a classification considered necessary for performance of work on the contract does not appear on this wage determination, the contractor must still submit a conformance request.

Additional information on contractor requirements and worker protections under the Executive Orders is available at http://www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/06/2023
1	01/13/2023
2	01/20/2023
3	02/03/2023
4	03/03/2023
5	03/10/2023
6	03/17/2023
7	03/31/2023
8	04/07/2023
9	04/14/2023
10	04/21/2023

ASBE0016-001 02/01/2023

AREA 1: MARIN, NAPA, SAN BENITO, SAN FRANCISCO, SOLANO, & SONOMA COUNTIES

AREA 2: ALPINE, AMADOR, BUTTE, COLUSA, EL DORADO, GLENN, MODOC, NEVADA, PLACER, PLUMAS, SACRAMENTO, SHASTA, SIERRA, SISKIYOU, SUTTER, TEHEMA, TRINITY, YOLO, & YUBA COUNTIES

	Rates	Fringes
Asbestos Workers/Insulator (Includes the application of all insulating materials, Protective Coverings, Coatings, and Finishes to all types of mechanical systems)		

Area 1.....$ 80.91 23.82
Area 2.....$ 62.26 23.82

ASBE0016-007 01/01/2021

AREA 1 : ALPINE, AMADOR, BUTTE, COLUSA, EL DORADO, GLENN, LASSEN, MODOC, NEVADA, PLACER, PLUMAS, SACRAMENTO, SHASTA, SIERRA, SISKIYOU, SOLANO, SONOMA, SUTTER, TEHAMA, TRINITY, YOLO & YUBA COUNTIES

AREA 2: MARIN & NAPA COUNTIES

	Rates	Fringes
Asbestos Removal worker/hazardous material handler (Includes preparation, wetting, stripping, removal, scrapping, vacuuming, bagging and disposing of all insulation materials from mechanical systems, whether they contain asbestos or not)		
AREA 1	$ 30.45	10.60
AREA 2	$ 36.53	9.27

BOIL0549-002 01/01/2021

	Rates	Fringes
BOILERMAKER		
(1) Marin & Solano Counties	$ 49.62	41.27
(2) Remaining Counties	$ 45.60	38.99

BRCA0003-001 08/01/2022

	Rates	Fringes
MARBLE FINISHER	$ 39.20	18.31

BRCA0003-004 05/01/2022

AREA 1: ALPINE, AMADOR, BUTTE, COLUSA, EL DORADO, GLENN, LASSEN, MODOC, NEVADA, PLACER, PLUMAS, SACRAMENTO, SHASTA, SIERRA, SUTTER, TEHAMA, YOLO AND YUBA COUNTIES

AREA 2: MARIN, NAPA, SISKIYOU, SOLANO, SONOMA AND TRINITY COUNTIES

	Rates	Fringes
BRICKLAYER		
AREA 1	$ 49.32	22.65
AREA 2	$ 53.69	26.03

SPECIALTY PAY:
(A) Underground work such as tunnel work, sewer work, manholes, catch basins, sewer pipes and telephone conduit shall be paid $1.25 per hour above the regular rate. Work in direct contact with raw sewage shall receive $1.25 per hour in addition to the above.
(B) Operating a saw or grinder shall receive $1.25 per hour above the regular rate.
(C) Gunite nozzle person shall receive $1.25 per hour above the regular rate.

BRCA0003-008 07/01/2022

	Rates	Fringes
TERRAZZO FINISHER	$ 41.93	18.98
TERRAZZO WORKER/SETTER	$ 56.84	27.53

BRCA0003-010 04/01/2022

	Rates	Fringes
TILE FINISHER		
Area 1	$ 31.12	16.11
Area 2	$ 30.90	17.87
Area 3	$ 33.86	17.74
Area 4	$ 31.89	17.18
Tile Layer		
Area 1	$ 51.02	19.35
Area 2	$ 50.66	20.77
Area 3	$ 55.41	20.87
Area 4	$ 52.28	20.79

AREA 1: Butte, Colusa, El Dorado, Glenn, Lassen, Modoc, Nevada, Placer, Plumas, Sacramento, Shasta, Sierra, Sutter, Tehema, Yolo, Yuba
AREA 2: Alpine, Amador
AREA 3: Marin, Napa, Solano, Siskiyou
AREA 4: Sonoma

BRCA0003-014 08/01/2022

	Rates	Fringes
MARBLE MASON	$ 56.98	28.54

CARP0034-001 07/01/2021

	Rates	Fringes
Diver		
Assistant Tender, ROV Tender/Technician	$ 54.10	34.69
Diver standby	$ 60.51	34.69
Diver Tender	$ 59.51	34.69
Diver wet	$ 103.62	34.69
Manifold Operator (mixed gas)	$ 64.51	34.69
Manifold Operator (Standby)	$ 59.51	34.69

DEPTH PAY (Surface Diving):

050 to 100 ft	$2.00 per foot
101 to 150 ft	$3.00 per foot
151 to 220 ft	$4.00 per foot
221 ft.-deeper	$5.00 per foot

SATURATION DIVING:
The standby rate shall apply until saturation starts. The saturation diving rate applies when divers are under pressure continuously until work task and decompression are complete. The diver rate shall be paid for all saturation hours.

DIVING IN ENCLOSURES:
Where it is necessary for Divers to enter pipes or tunnels, or other enclosures where there is no vertical ascent, the following premium shall be paid: Distance traveled from entrance 26 feet to 300 feet: $1.00 per foot. When it is necessary for a diver to enter any pipe, tunnel or other enclosure less than 48"" in height, the premium will be $1.00 per foot.

WORK IN COMBINATION OF CLASSIFICATIONS:
Employees working in any combination of classifications within the diving crew (except dive supervisor) in a shift are paid in the classification with the highest rate for that shift.

CARP0034-003 07/01/2021

	Rates	Fringes
Piledriver	$ 54.10	34.69

CARP0035-001 08/01/2020

AREA 1: MARIN, NAPA, SOLANO & SONOMA

AREA 3: SACRAMENTO, WESTERN EL DORADO (Territory west of an including highway 49 and the territory inside the city limits of Placerville), WESTERN PLACER (Territory west of and including highway 49), & YOLO

AREA 4: ALPINE, BUTTE, COLUSA, EASTERN EL DORADO, GLENN, LASSEN, MODOC, NEVADA, EASTERN PLACER, PLUMAS, SHASTA, SIERRA, SISKIYOU, SUTTER, TEHAMA, TRINITY, & YUBA

	Rates	Fringes
Drywall Installers/Lathers:		
Area 1	$ 52.65	31.26
Area 3	$ 47.27	31.26
Area 4	$ 45.92	31.26
Drywall Stocker/Scrapper		
Area 1	$ 26.33	18.22
Area 3	$ 23.64	18.22
Area 4	$ 22.97	18.22

CARP0035-009 07/01/2020

Marin County

	Rates	Fringes
CARPENTER		
Bridge Builder/Highway Carpenter	$ 52.65	30.82
Hardwood Floorlayer, Shingler, Power Saw Operator, Steel Scaffold & Steel Shoring Erector, Saw Filer	$ 52.80	30.82
Journeyman Carpenter	$ 52.65	30.82
Millwright	$ 52.75	32.41

CARP0035-010 07/01/2020

AREA 1: Marin, Napa, Solano & Sonoma Counties

AREA 2: Monterey, San Benito and Santa Cruz

AREA 3: Alpine, Butte, Colusa, El Dorado, Glenn, Lassen, Modoc, Nevada, Placer, Plumas, Sacramento, Shasta, Sierra, Siskiyou, Sutter, Tehama, Trinity, Yolo & Yuba counties

	Rates	Fringes
Modular Furniture Installer		
Area 1		
Installer	$ 28.76	22.53
Lead Installer	$ 32.21	23.03
Master Installer	$ 36.43	23.03
Area 2		
Installer	$ 26.11	22.53
Lead Installer	$ 29.08	23.03
Master Installer	$ 32.71	23.03
Area 3		
Installer	$ 25.16	22.53
Lead Installer	$ 27.96	23.03
Master Installer	$ 31.38	23.03

CARP0046-001 07/01/2021

El Dorado (West), Placer (West), Sacramento and Yolo Counties

	Rates	Fringes
Carpenters		
Bridge Builder/Highway Carpenter	$ 54.85	31.49
Hardwood Floorlayer, Shingler, Power Saw Operator, Steel Scaffold & Steel Shoring Erector, Saw Filer	$ 49.12	31.49
Journeyman Carpenter	$ 48.97	31.49
Millwright	$ 51.47	33.08

Footnote: Placer County (West) includes territory West of and including Highway 49 and El Dorado County (West) includes territory West of and including Highway 49 and territory inside the city limits of Placerville.

CARP0046-002 07/01/2021

Alpine, Colusa, El Dorado (East), Nevada, Placer (East),

Sierra, Sutter and Yuba Counties

	Rates	Fringes
Carpenters		
Bridge Builder/Highway Carpenter	$ 54.85	31.49
Hardwood Floorlayer, Shingler, Power Saw Operator, Steel Scaffold & Steel Shoring Erector, Saw Filer	$ 47.77	31.49
Journeyman Carpenter	$ 47.62	31.49
Millwright	$ 50.12	33.08

CARP0152-003 07/01/2020

Amador County

	Rates	Fringes
Carpenters		
Bridge Builder/Highway Carpenter	$ 52.65	30.82
Hardwood Floorlayer, Shingler, Power Saw Operator, Steel Scaffold & Steel Shoring Erector, Saw Filer	$ 45.57	30.82
Journeyman Carpenter	$ 45.42	30.82
Millwright	$ 47.92	32.41

CARP0180-001 07/01/2021

Solano County

	Rates	Fringes
Carpenters		
Bridge Builder/Highway Carpenter	$ 54.85	31.49
Hardwood Floorlayer, Shingler, Power Saw Operator, Steel Scaffold & Steel Shoring Erector, Saw Filer	$ 55.00	31.49
Journeyman Carpenter	$ 54.85	31.49
Millwright	$ 54.95	33.08

CARP0751-001 07/01/2021

Napa and Sonoma Counties

	Rates	Fringes
Carpenters		
Bridge Builder/Highway Carpenter	$ 54.85	31.49
Hardwood Floorlayer, Shingler, Power Saw Operator, Steel Scaffold & Steel Shoring Erector, Saw Filer	$ 55.00	31.49
Journeyman Carpenter	$ 54.85	31.49
Millwright	$ 54.95	33.08

CARP1599-001 07/01/2020

Butte, Glenn, Lassen, Modoc, Plumas, Shasta, Siskiyou, Tehama and Trinity Counties

	Rates	Fringes
Carpenters		
Bridge Builder/Highway Carpenter	$ 52.65	30.82
Hardwood Floorlayer, Shingler, Power Saw Operator, Steel Scaffold & Steel Shoring Erector, Saw Filer	$ 45.57	30.82
Journeyman Carpenter	$ 45.42	30.82
Millwright	$ 47.92	32.41

ELEC0180-001 06/01/2021

NAPA AND SOLANO COUNTIES

	Rates	Fringes
CABLE SPLICER	$ 59.69	3%+24.38
ELECTRICIAN	$ 53.06	3%+24.38

ELEC0180-003 12/01/2022

NAPA AND SOLANO COUNTIES

	Rates	Fringes

Sound & Communications
Installer.....$ 46.64 25.30
Technician.....$ 53.64 25.51

SCOPE OF WORK INCLUDES-
SOUND & VOICE TRANSMISSION (Music, Intercom, Nurse Call, Telephone); FIRE ALARM SYSTEMS [excluding fire alarm work when installed in raceways (including wire and cable pulling) and when performed on new or major remodel building projects or jobs], TELEVISION & VIDEO SYSTEMS, SECURITY SYSTEMS, COMMUNICATIONS SYSTEMS that transmit or receive information and/or control systems that are intrinsic to the above.

EXCLUDES-
Excludes all other data systems or multiple systems which include control function or power supply; excludes installation of raceway systems, line voltage work, industrial work, life-safety systems (all buildings having floors located more than 75' above the lowest floor level having building access); excludes energy management systems.

ELEC0340-002 02/01/2018

ALPINE, AMADOR, BUTTE, COLUSA, EL DORADO, GLENN, LASSEN, NEVADA, PLACER, PLUMAS, SACRAMENTO, TRINITY, YOLO, YUBA COUNTIES

	Rates	Fringes
Communications System		
Sound & Communications Installer	$ 29.35	3%+15.35
Sound & Communications Technician	$ 33.75	3%+15.35

SCOPE OF WORK

Includes the installation testing, service and maintenance, of the following systems which utilize the transmission and/or transference of voice, sound, vision and digital for commercial, education, security and entertainment purposes for the following TV monitoring and surveillance, background-foreground music, intercom and telephone interconnect, inventory control systems, microwave transmission, multi-media, multiplex, nurse call system, radio page, school intercom and sound, burglar alarms, and

low voltage master clock systems.

A. SOUND AND VOICE TRANSMISSION/TRANSFERENCE SYSTEMS
Background foreground music Intercom and telephone interconnect systems, Telephone systems, Nurse call systems, Radio page systems, School intercom and sound systems, Burglar alarm systems, Low voltage master clock systems, Multi-media/multiplex systems, Sound and musical entertainment systems, RF systems, Antennas and Wave Guide.

B. FIRE ALARM SYSTEMS
Installation, wire pulling and testing

C. TELEVISION AND VIDEO SYSTEMS Television monitoring and surveillance systems, Video security systems, Video entertainment systems, Video educational systems, Microwave transmission systems, CATV and CCTV

D. SECURITY SYSTEMS Perimeter security systems Vibration sensor systems Card access systems Access control systems Sonar/infrared monitoring equipment

E. COMMUNICATIONS SYSTEMS THAT TRANSMIT OR RECEIVE INFORMATION AND/OR CONTROL SYSTEMS THAT ARE INTRINSIC TO THE ABOVE LISTED SYSTEMS SCADA (Supervisory Control and Data Acquisition) PCM (Pulse Code Modulation) Inventory Control Systems Digital Data Systems Broadband and Baseband and Carriers Point of Sale Systems VSAT Data Systems Data Communication Systems RF and Remote Control Systems Fiber Optic Data Systems WORK EXCLUDED Raceway systems are not covered (excluding Ladder-Rack for the purpose of the above listed systems). Chases and/or nipples (not to exceed 10 feet) may be installed on open wiring systems. Energy management systems. SCADA (Supervisory Control and Data Acquisition) when not intrinsic to the above listed systems (in the scope). Fire alarm systems when installed in raceways (including wire and cable pulling) shall be performed at the electrician wage rate, when either of the following two (2) conditions apply:
1. The project involves new or major remodel building trades construction.
2. The conductors for the fire alarm system are installed in conduit.

ELEC0340-003 08/01/2022

ALPINE (West of Sierra Mt. Watershed), AMADOR, BUTTE, COLUSA, EL DORADO (West of Sierra Mt. Watershed), GLENN, LASSEN, NEVADA

(West of Sierra Mt. Watershed), PLACER, PLUMAS, SACRAMENTO, SHASTA, SIERRA (West of Sierra Mt. Watershed), SUTTER, TEHAMA, TRINITY, YOLO & YUBA COUNTIES

	Rates	Fringes
ELECTRICIAN		
Remaining area	$ 45.06	34.09
Sierra Army Depot, Herlong	$ 48.83	18.54
Tunnel work	$ 41.01	18.54

CABLE SPLICER: Receives 110% of the Electrician basic hourly rate.

ELEC0401-005 01/01/2022

ALPINE (east of the main watershed divide), EL DORADO (east of the main watershed divide), NEVADA (east of the main watershed), PLACER (east of the main watershed divide) and SIERRA (east of the main watershed divide) COUNTIES:

	Rates	Fringes
ELECTRICIAN	$ 42.50	20.95

ZONE RATE:

70-90 miles - $8.00 per hour
91+ miles - $10.00 per hour

ELEC0551-004 06/01/2022

MARIN AND SONOMA COUNTIES

	Rates	Fringes
ELECTRICIAN	$ 55.60	28.06

ELEC0551-005 12/01/2022

MARIN & SONOMA COUNTIES

	Rates	Fringes
Sound & Communications		
Installer	$ 46.64	25.30

Technician	$ 53.64	25.65

SCOPE OF WORK INCLUDES-
SOUND & VOICE TRANSMISSION (Music, Intercom, Nurse Call, Telephone); FIRE ALARM SYSTEMS [excluding fire alarm work when installed in raceways (including wire and cable pulling) and when performed on new or major remodel building projects or jobs], TELEVISION & VIDEO SYSTEMS, SECURITY SYSTEMS, COMMUNICATIONS SYSTEMS that transmit or receive information and/or control systems that are intrinsic to the above.

EXCLUDES-
Excludes all other data systems or multiple systems which include control function or power supply; excludes installation of raceway systems, line voltage work, industrial work, life-safety systems (all buildings having floors located more than 75' above the lowest floor level having building access); excludes energy management systems.

ELEC0659-006 01/01/2023

DEL NORTE, MODOC and SISKIYOU COUNTIES

	Rates	Fringes
ELECTRICIAN	$ 43.97	19.26

ELEC0659-008 02/01/2023

DEL NORTE, MODOC & SISKIYOU COUNTIES

	Rates	Fringes
Line Construction		
(1) Cable Splicer	$ 67.80	4.5%+22.15
(2) Lineman, Pole Sprayer, Heavy Line Equipment Man	$ 60.54	4.5%+22.15
(3) Tree Trimmer	$ 37.84	4.5%+14.30
(4) Line Equipment Man	$ 53.82	4.5%+19.40
(5) Powdermen, Jackhammermen	$ 40.37	4.5%+14.30
(6) Groundman	$ 33.37	4.5%+14.30

ELEC1245-004 06/01/2022

ALL COUNTIES EXCEPT DEL NORTE, MODOC & SISKIYOU

	Rates	Fringes
LINE CONSTRUCTION		
(1) Lineman; Cable splicer	$ 64.40	22.58
(2) Equipment specialist (operates crawler tractors, commercial motor vehicles, backhoes, trenchers, cranes (50 tons and below), overhead & underground distribution line equipment)	$ 50.00	21.30
(3) Groundman	$ 38.23	20.89
(4) Powderman	$ 51.87	18.79

HOLIDAYS: New Year's Day, M.L. King Day, Memorial Day, Independence Day, Labor Day, Veterans Day, Thanksgiving Day and day after Thanksgiving, Christmas Day

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ELEV0008-001 01/01/2023

	Rates	Fringes
ELEVATOR MECHANIC	$ 77.61	37.335+a+b

FOOTNOTE:
a. PAID VACATION: Employer contributes 8% of regular hourly rate as vacation pay credit for employees with more than 5 years of service, and 6% for 6 months to 5 years of service.
b. PAID HOLIDAYS: New Year's Day, Memorial Day, Independence Day, Labor Day, Veterans' Day, Thanksgiving Day, Friday after Thanksgiving, and Christmas Day.

ENGI0003-008 08/01/2022

	Rates	Fringes
Dredging: (DREDGING: CLAMSHELL & DIPPER DREDGING; HYDRAULIC SUCTION DREDGING:)		
AREA 1:		
(1) Leverman	$ 55.15	35.46
(2) Dredge Dozer; Heavy duty repairman	$ 50.19	35.46
(3) Booster Pump Operator; Deck Engineer; Deck mate; Dredge Tender; Winch		

Operator	$ 49.07	35.46
(4) Bargeman; Deckhand; Fireman; Leveehand; Oiler	$ 45.77	35.46
AREA 2:		
(1) Leverman	$ 57.15	35.46
(2) Dredge Dozer; Heavy duty repairman	$ 52.19	35.46
(3) Booster Pump Operator; Deck Engineer; Deck mate; Dredge Tender; Winch Operator	$ 51.07	35.46
(4) Bargeman; Deckhand; Fireman; Leveehand; Oiler	$ 47.77	35.46

AREA DESCRIPTIONS

AREA 1: ALAMEDA,BUTTE, CONTRA COSTA, KINGS, MARIN, MERCED, NAPA, SACRAMENTO, SAN BENITO, SAN FRANCISCO, SAN JOAQUIN, SAN MATEO, SANTA CLARA, SANTA CRUZ, SOLANO, STANISLAUS, SUTTER, YOLO, AND YUBA COUNTIES

AREA 2: MODOC COUNTY

THE REMAINGING COUNTIES ARE SPLIT BETWEEN AREA 1 AND AREA 2 AS NOTED BELOW:

ALPINE COUNTY:
Area 1: Northernmost part
Area 2: Remainder

CALAVERAS COUNTY:
Area 1: Remainder
Area 2: Eastern part

COLUSA COUNTY:
Area 1: Eastern part
Area 2: Remainder

ELDORADO COUNTY:
Area 1: North Central part
Area 2: Remainder

FRESNO COUNTY:
Area 1: Remainder
Area 2: Eastern part

GLENN COUNTY:
Area 1: Eastern part
Area 2: Remainder

LASSEN COUNTY:
Area 1: Western part along the Southern portion of border with Shasta County
Area 2: Remainder

MADERA COUNTY:
Area 1: Except Eastern part
Area 2: Eastern part

MARIPOSA COUNTY
Area 1: Except Eastern part
Area 2: Eastern part

MONTERREY COUNTY
Area 1: Except Southwestern part
Area 2: Southwestern part

NEVADA COUNTY:
Area 1: All but the Northern portion along the border of Sierra County
Area 2: Remainder

PLACER COUNTY:
Area 1: Al but the Central portion
Area 2: Remainder

PLUMAS COUNTY:
Area 1: Western portion
Area 2: Remainder

SHASTA COUNTY:
Area 1: All but the Northeastern corner
Area 2: Remainder

SIERRA COUNTY:
Area 1: Western part
Area 2: Remainder

SISKIYOU COUNTY:
Area 1: Central part
Area 2: Remainder

SONOMA COUNTY:
Area 1: All but the Northwestern corner
Area 2: Remainder

TEHAMA COUNTY:
Area 1: All but the Western border with Mendocino & Trinity Counties

Area 2: Remainder

TRINITY COUNTY:
  Area 1: East Central part and the Northeastern border with
  Shasta County
Area 2: Remainder

TUOLUMNE COUNTY:
Area 1: Except Eastern part
Area 2: Eastern part

ENGI0003-019 06/29/2020

SEE AREA DESCRIPTIONS BELOW

	Rates	Fringes
OPERATOR: Power Equipment (LANDSCAPE WORK ONLY)		
GROUP 1		
AREA 1	$ 39.95	30.28
AREA 2	$ 41.95	30.28
GROUP 2		
AREA 1	$ 36.35	30.28
AREA 2	$ 38.35	30.28
GROUP 3		
AREA 1	$ 31.74	30.28
AREA 2	$ 33.74	30.28

GROUP DESCRIPTIONS:

  GROUP 1: Landscape Finish Grade Operator: All finish grade
  work regardless of equipment used, and all equipment with a
  rating more than 65 HP.

  GROUP 2: Landscape Operator up to 65 HP: All equipment with
  a manufacturer's rating of 65 HP or less except equipment
  covered by Group 1 or Group 3. The following equipment
  shall be included except when used for finish work as long
  as manufacturer's rating is 65 HP or less: A-Frame and
  Winch Truck, Backhoe, Forklift, Hydragraphic Seeder
  Machine, Roller, Rubber-Tired and Track Earthmoving
  Equipment, Skiploader, Straw Blowers, and Trencher 31 HP up
  to 65 HP.

  GROUP 3: Landscae Utility Operator: Small Rubber-Tired
  Tractor, Trencher Under 31 HP.

AREA DESCRIPTIONS:

AREA 1: ALAMEDA, BUTTE, CONTRA COSTA, KINGS, MARIN, MERCED, NAPA, SACRAMENTO, SAN BENITO, SAN FRANCISCO, SAN JOAQUIN, SAN MATEO, SANTA CLARA, SANTA CRUZ, SOLANO, STANISLAUS, SUTTER, YOLO, AND YUBA COUNTIES

AREA 2 - MODOC COUNTY

THE REMAINING COUNTIES ARE SPLIT BETWEEN AREA 1 AND AREA 2 AS NOTED BELOW:

ALPINE COUNTY:
Area 1: Northernmost part
Area 2: Remainder

CALAVERAS COUNTY:
Area 1: Except Eastern part
Area 2: Eastern part

COLUSA COUNTY:
Area 1: Eastern part
Area 2: Remainder

DEL NORTE COUNTY:
Area 1: Extreme Southwestern corner
Area 2: Remainder

ELDORADO COUNTY:
Area 1: North Central part
Area 2: Remainder

FRESNO COUNTY
Area 1: Except Eastern part
Area 2: Eastern part

GLENN COUNTY:
Area 1: Eastern part
Area 2: Remainder

HUMBOLDT COUNTY:
Area 1: Except Eastern and Southwestern parts
Area 2: Remainder

LAKE COUNTY:
Area 1: Southern part
Area 2: Remainder

LASSEN COUNTY:
Area 1: Western part along the Southern portion of border with Shasta County

Area 2: Remainder

MADERA COUNTY
Area 1: Remainder
Area 2: Eastern part

MARIPOSA COUNTY
Area 1: Remainder
Area 2: Eastern part

MENDOCINO COUNTY:
Area 1: Central and Southeastern parts
Area 2: Remainder

MONTEREY COUNTY
Area 1: Remainder
Area 2: Southwestern part

NEVADA COUNTY:
Area 1: All but the Northern portion along the border of Sierra County
Area 2: Remainder

PLACER COUNTY:
Area 1: All but the Central portion
Area 2: Remainder

PLUMAS COUNTY:
Area 1: Western portion
Area 2: Remainder

SHASTA COUNTY:
Area 1: All but the Northeastern corner
Area 2: Remainder

SIERRA COUNTY:
Area 1: Western part
Area 2: Remainder

SISKIYOU COUNTY:
Area 1: Central part
Area 2: Remainder

SONOMA COUNTY:
Area 1: All but the Northwestern corner
Area 2: Reaminder

TEHAMA COUNTY:
Area 1: All but the Western border with mendocino & Trinity Counties

Area 2: Remainder

TRINITY COUNTY:
  Area 1: East Central part and the Northeaster border with
  Shasta County
Area 2: Remainder

TULARE COUNTY;
Area 1: Remainder
Area 2: Eastern part

TUOLUMNE COUNTY:
Area 1: Remainder
Area 2: Eastern Part

ENGI0003-038 06/29/2020

""AREA 1"" WAGE RATES ARE LISTED BELOW

""AREA 2"" RECEIVES AN ADDITIONAL $2.00 PER HOUR ABOVE AREA 1 RATES.

SEE AREA DEFINITIONS BELOW

	Rates	Fringes
OPERATOR: Power Equipment (AREA 1:)		
GROUP 1	$ 51.42	31.15
GROUP 2	$ 49.89	31.15
GROUP 3	$ 48.41	31.15
GROUP 4	$ 47.03	31.15
GROUP 5	$ 45.76	31.15
GROUP 6	$ 44.44	31.15
GROUP 7	$ 43.30	31.15
GROUP 8	$ 42.16	31.15
GROUP 8-A	$ 39.95	31.15
OPERATOR: Power Equipment (Cranes and Attachments - AREA 1:)		
GROUP 1		
Cranes	$ 52.30	31.15
Oiler	$ 43.79	31.15
Truck crane oiler	$ 46.08	31.15
GROUP 2		
Cranes	$ 50.54	31.15
Oiler	$ 42.83	31.15
Truck crane oiler	$ 45.07	31.15

GROUP 3
Cranes.....$ 48.80 31.15
Hydraulic.....$ 44.44 31.15
Oiler.....$ 42.55 31.15
Truck crane oiler.....$ 44.83 31.15
GROUP 4
Cranes.....$ 45.76 31.15

OPERATOR: Power Equipment
(Piledriving - AREA 1:)
GROUP 1
Lifting devices.....$ 52.64 31.15
Oiler.....$ 43.38 31.15
Truck Crane Oiler.....$ 45.66 31.15
GROUP 2
Lifting devices.....$ 50.82 31.15
Oiler.....$ 43.11 31.15
Truck Crane Oiler.....$ 45.41 31.15
GROUP 3
Lifting devices.....$ 49.14 31.15
Oiler.....$ 42.89 31.15
Truck Crane Oiler.....$ 45.12 31.15
GROUP 4
Lifting devices.....$ 47.37 31.15
GROUP 5
Lifting devices.....$ 44.73 31.15
GROUP 6
Lifting devices.....$ 42.50 31.15

OPERATOR: Power Equipment
(Steel Erection - AREA 1:)
GROUP 1
Cranes.....$ 53.27 31.15
Oiler.....$ 43.72 31.15
Truck Crane Oiler.....$ 45.95 31.15
GROUP 2
Cranes.....$ 51.50 31.15
Oiler.....$ 43.45 31.15
Truck Crane Oiler.....$ 45.73 31.15
GROUP 3
Cranes.....$ 50.02 31.15
Hydraulic.....$ 45.07 31.15
Oiler.....$ 43.23 31.15
Truck Crane Oiler.....$ 45.46 31.15
GROUP 4
Cranes.....$ 48.00 31.15
GROUP 5
Cranes.....$ 46.70 31.15

OPERATOR: Power Equipment
(Tunnel and Underground Work
- AREA 1:)
SHAFTS, STOPES, RAISES:

GROUP 1	$ 47.52	31.15
GROUP 1-A	$ 49.99	31.15
GROUP 2	$ 46.26	31.15
GROUP 3	$ 44.93	31.15
GROUP 4	$ 43.79	31.15
GROUP 5	$ 42.65	31.15
UNDERGROUND:		
GROUP 1	$ 47.42	31.15
GROUP 1-A	$ 49.89	31.15
GROUP 2	$ 46.16	31.15
GROUP 3	$ 44.83	31.15
GROUP 4	$ 43.69	31.15
GROUP 5	$ 42.55	31.15

FOOTNOTE: Work suspended by ropes or cables, or work on a Yo-Yo Cat: $.60 per hour additional.

POWER EQUIPMENT OPERATOR CLASSIFICATIONS

GROUP 1: Operator of helicopter (when used in erection work); Hydraulic excavator, 7 cu. yds. and over; Power shovels, over 7 cu. yds.

GROUP 2: Highline cableway; Hydraulic excavator, 3-1/2 cu. yds. up to 7 cu. yds.; Licensed construction work boat operator, on site; Power blade operator (finish); Power shovels, over 1 cu. yd. up to and including 7 cu. yds. m.r.c.

GROUP 3: Asphalt milling machine; Cable backhoe; Combination backhoe and loader over 3/4 cu. yds.; Continuous flight tie back machine assistant to engineer or mechanic; Crane mounted continuous flight tie back machine, tonnage to apply; Crane mounted drill attachment, tonnage to apply; Dozer, slope brd; Gradall; Hydraulic excavator, up to 3 1/2 cu. yds.; Loader 4 cu. yds. and over; Long reach excavator; Multiple engine scraper (when used as push pull); Power shovels, up to and including 1 cu. yd.; Pre-stress wire wrapping machine; Side boom cat, 572 or larger; Track loader 4 cu. yds. and over; Wheel excavator (up to and including 750 cu. yds. per hour)

GROUP 4: Asphalt plant engineer/box person; Chicago boom; Combination backhoe and loader up to and including 3/4 cu. yd.; Concrete batch plant (wet or dry); Dozer and/or push cat; Pull- type elevating loader; Gradesetter, grade checker (GPS, mechanical or otherwise); Grooving and grinding machine; Heading shield operator; Heavy-duty drilling equipment, Hughes, LDH, Watson 3000 or similar;

Heavy-duty repairperson and/or welder; Lime spreader; Loader under 4 cu. yds.; Lubrication and service engineer (mobile and grease rack); Mechanical finishers or spreader machine (asphalt, Barber-Greene and similar); Miller Formless M-9000 slope paver or similar; Portable crushing and screening plants; Power blade support; Roller operator, asphalt; Rubber-tired scraper, self-loading (paddle-wheels, etc.); Rubber- tired earthmoving equipment (scrapers); Slip form paver (concrete); Small tractor with drag; Soil stabilizer (P & H or equal); Spider plow and spider puller; Tubex pile rig; Unlicensed constuction work boat operator, on site; Timber skidder; Track loader up to 4 yds.; Tractor-drawn scraper; Tractor, compressor drill combination; Welder; Woods-Mixer (and other similar Pugmill equipment)

GROUP 5: Cast-in-place pipe laying machine; Combination slusher and motor operator; Concrete conveyor or concrete pump, truck or equipment mounted; Concrete conveyor, building site; Concrete pump or pumpcrete gun; Drilling equipment, Watson 2000, Texoma 700 or similar; Drilling and boring machinery, horizontal (not to apply to waterliners, wagon drills or jackhammers); Concrete mixer/all; Person and/or material hoist; Mechanical finishers (concrete) (Clary, Johnson, Bidwell Bridge Deck or similar types); Mechanical burm, curb and/or curb and gutter machine, concrete or asphalt); Mine or shaft hoist; Portable crusher; Power jumbo operator (setting slip-forms, etc., in tunnels); Screed (automatic or manual); Self-propelled compactor with dozer; Tractor with boom D6 or smaller; Trenching machine, maximum digging capacity over 5 ft. depth; Vermeer T-600B rock cutter or similar

GROUP 6: Armor-Coater (or similar); Ballast jack tamper; Boom- type backfilling machine; Assistant plant engineer; Bridge and/or gantry crane; Chemical grouting machine, truck-mounted; Chip spreading machine operator; Concrete saw (self-propelled unit on streets, highways, airports and canals); Deck engineer; Drilling equipment Texoma 600, Hughes 200 Series or similar up to and including 30 ft. m.r.c.; Drill doctor; Helicopter radio operator; Hydro-hammer or similar; Line master; Skidsteer loader, Bobcat larger than 743 series or similar (with attachments); Locomotive; Lull hi-lift or similar; Oiler, truck mounted equipment; Pavement breaker, truck-mounted, with compressor combination; Paving fabric installation and/or laying machine; Pipe bending machine (pipelines only); Pipe wrapping machine (tractor propelled and supported); Screed (except asphaltic concrete paving); Self- propelled pipeline wrapping machine; Tractor;

Self-loading chipper; Concrete barrier moving machine

GROUP 7: Ballast regulator; Boom truck or dual-purpose A-frame truck, non-rotating - under 15 tons; Cary lift or similar; Combination slurry mixer and/or cleaner; Drilling equipment, 20 ft. and under m.r.c.; Firetender (hot plant); Grouting machine operator; Highline cableway signalperson; Stationary belt loader (Kolman or similar); Lift slab machine (Vagtborg and similar types); Maginnes internal full slab vibrator; Material hoist (1 drum); Mechanical trench shield; Pavement breaker with or without compressor combination); Pipe cleaning machine (tractor propelled and supported); Post driver; Roller (except asphalt); Chip Seal; Self-propelled automatically applied concrete curing mahcine (on streets, highways, airports and canals); Self-propelled compactor (without dozer); Signalperson; Slip-form pumps (lifting device for concrete forms); Tie spacer; Tower mobile; Trenching machine, maximum digging capacity up to and including 5 ft. depth; Truck- type loader

GROUP 8: Bit sharpener; Boiler tender; Box operator; Brakeperson; Combination mixer and compressor (shotcrete/gunite); Compressor operator; Deckhand; Fire tender; Forklift (under 20 ft.); Generator; Gunite/shotcrete equipment operator; Hydraulic monitor; Ken seal machine (or similar); Mixermobile; Oiler; Pump operator; Refrigeration plant; Reservoir-debris tug (self-propelled floating); Ross Carrier (construction site); Rotomist operator; Self-propelled tape machine; Shuttlecar; Self-propelled power sweeper operator (includes vacuum sweeper); Slusher operator; Surface heater; Switchperson; Tar pot firetender; Tugger hoist, single drum; Vacuum cooling plant; Welding machine (powered other than by electricity)

GROUP 8-A: Elevator operator; Skidsteer loader-Bobcat 743 series or smaller, and similar (without attachments); Mini excavator under 25 H.P. (backhoe-trencher); Tub grinder wood chipper

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ALL CRANES AND ATTACHMENTS

GROUP 1: Clamshell and dragline over 7 cu. yds.; Crane, over 100 tons; Derrick, over 100 tons; Derrick barge pedestal-mounted, over 100 tons; Self-propelled boom-type lifting device, over 100 tons

GROUP 2: Clamshell and dragline over 1 cu. yd. up to and

including 7 cu. yds.; Crane, over 45 tons up to and including 100 tons; Derrick barge, 100 tons and under; Self-propelled boom-type lifting device, over 45 tons; Tower crane

GROUP 3: Clamshell and dragline up to and including 1 cu. yd.; Cranes 45 tons and under; Self-propelled boom-type lifting device 45 tons and under;

GROUP 4: Boom Truck or dual purpose A-frame truck, non-rotating over 15 tons; Truck-mounted rotating telescopic boom type lifting device, Manitex or similar (boom truck) over 15 tons; Truck-mounted rotating telescopic boom type lifting device, Manitex or similar (boom truck) - under 15 tons;

PILEDRIVERS

GROUP 1: Derrick barge pedestal mounted over 100 tons; Clamshell over 7 cu. yds.; Self-propelled boom-type lifting device over 100 tons; Truck crane or crawler, land or barge mounted over 100 tons

GROUP 2: Derrick barge pedestal mounted 45 tons to and including 100 tons; Clamshell up to and including 7 cu. yds.; Self-propelled boom-type lifting device over 45 tons; Truck crane or crawler, land or barge mounted, over 45 tons up to and including 100 tons; Fundex F-12 hydraulic pile rig

GROUP 3: Derrick barge pedestal mounted under 45 tons; Self-propelled boom-type lifting device 45 tons and under; Skid/scow piledriver, any tonnage; Truck crane or crawler, land or barge mounted 45 tons and under

GROUP 4: Assistant operator in lieu of assistant to engineer; Forklift, 10 tons and over; Heavy-duty repairperson/welder

GROUP 5: Deck engineer

GROUP 6: Deckhand; Fire tender

STEEL ERECTORS

GROUP 1: Crane over 100 tons; Derrick over 100 tons; Self-propelled boom-type lifting device over 100 tons

GROUP 2: Crane over 45 tons to 100 tons; Derrick under 100 tons; Self-propelled boom-type lifting device over 45 tons to 100 tons; Tower crane

GROUP 3: Crane, 45 tons and under; Self-propelled boom-type lifting device, 45 tons and under

GROUP 4: Chicago boom; Forklift, 10 tons and over; Heavy-duty repair person/welder

GROUP 5: Boom cat

TUNNEL AND UNDERGROUND WORK

GROUP 1-A: Tunnel bore machine operator, 20' diameter or more

GROUP 1: Heading shield operator; Heavy-duty repairperson; Mucking machine (rubber tired, rail or track type); Raised bore operator (tunnels); Tunnel mole bore operator

GROUP 2: Combination slusher and motor operator; Concrete pump or pumpcrete gun; Power jumbo operator

GROUP 3: Drill doctor; Mine or shaft hoist

GROUP 4: Combination slurry mixer cleaner; Grouting Machine operator; Motorman

GROUP 5: Bit Sharpener; Brakeman; Combination mixer and compressor (gunite); Compressor operator; Oiler; Pump operator; Slusher operator

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AREA DESCRIPTIONS:

POWER EQUIPMENT OPERATORS, CRANES AND ATTACHMENTS,TUNNEL AND UNDERGROUND [These areas do not apply to Piledrivers and Steel Erectors]

AREA 1: DEL NORTE, HUMBOLDT, LAKE, MENDOCINO
AREA 2 -NOTED BELOW

THE REMAINING COUNTIES ARE SPLIT BETWEEN AREA 1 AND AREA 2 AS NOTED BELOW:

DEL NORTE COUNTY:

Area 1: Extreme Southwest corner
Area 2: Remainder

HUMBOLDT COUNTY:
Area 1: Except Eastern and Southwestern parts
Area 2: Remainder

LAKE COUNTY:
Area 1: Southern part
Area 2: Remainder

MENDOCINO COUNTY:
Area 1: Central and Southeastern Parts
Area 2: Remainder

IRON0118-012 01/01/2023

ALPINE, LASSEN, MODOC, SISKIYOU and TRINITY COUNTIES

	Rates	Fringes
IRONWORKER	$ 41.00	33.70

IRON0118-013 01/01/2023

AMADOR, BUTTE, COLUSA,EL DORADO, GLENN,MARIN, NAPA, NEVADA, PLACER,PLUMAS, SACRAMENTO, SHASTA, SIERRA, SOLANO, SONOMA, SUTTER, TEHAMA, YOLO and YUBA COUNTIES

	Rates	Fringes
IRONWORKER	$ 46.20	34.30

LABO0067-003 03/04/2023

AREA ""1"" - MARIN and NAPA COUNTIES

AREA ""2"" - ALPINE, AMADOR, BUTTE COLUSA EL DORADO, GLENN, LASSEN, MODOC, NEVADA, PLACER, PLUMAS, SACRAMENTO, SHASTA, SIERRA, SISKIYOU, SOLANO, SONOMA, SUTTER, TEHAMA, TRINITY, YOLO, AND YUBA COUNTIES

	Rates	Fringes
LABORER (ASBESTOS/MOLD/LEAD LABORER)		
Marin and Napa Counties	$ 35.25	27.09

Remaining Counties.....$ 34.25 27.09

LABO0067-005 06/27/2017

AREA ""A"" - ALAMEDA, CONTRA COSTA, SAN FRANCISCO, SAN MATEO AND SANTA CLARA COUNTIES

AREA ""B"" - ALPINE, AMADOR, BUTTE, CALAVERAS, COLUSA, DEL NORTE, EL DORADO, FRESNO, GLENN, HUMBOLDT, KINGS, LAKE, LASSEN, MADERA, MARIPOSA, MENDOCINO, MERCED, MODOC, MONTEREY, NEVADA, PLACER, PLUMAS, SANCREMENTO, SAN BENITO, SAN JOAQUIN, SANTA CRUZ, SIERRA, SHASTA, SISKIYOU, STANISLAUS, TEHAMA, TRINITY, TULARE, TUOLUMNE, YOLO AND YOUBA COUNTIES

	Rates	Fringes
LABORER (TRAFFIC CONTROL/LANE CLOSURE)		
Escort Driver, Flag Person		
Area A	$ 29.54	22.17
Area B	$ 28.54	22.17
Traffic Control Person I		
Area A	$ 29.84	22.17
Area B	$ 28.84	22.17
Traffic Control Person II		
Area A	$ 27.34	22.17
Area B	$ 26.34	22.17

TRAFFIC CONTROL PERSON I: Layout of traffic control, crash cushions, construction area and roadside signage.

TRAFFIC CONTROL PERSON II: Installation and removal of temporary/permanent signs, markers, delineators and crash cushions.

LABO0185-002 07/01/2022

ALPINE, AMADOR, BUTTE, COLUSA, EL DORADO, GLENN, LASSEN, MODOC, NEVADA, PLACER, PLUMAS, SACRAMENTO, SHASTA, SIERRA, SISKIYOU, SUTTER, TEHAMA, TRINITY, YOLO AND YUBA COUNTIES

	Rates	Fringes
LABORER		
Mason Tender-Brick	$ 35.29	25.21

LABO0185-005 07/01/2021

ALPINE, AMADOR, BUTTE, COLUSA, EL DORADO, GLENN, LASSEN, MODOC,
NEVADA, PLACER, PLUMAS, SACRAMENTO, SHASTA, SIERRA, SISKIYOU,
SUTTER, TEHAMA, TRINITY, YOLO AND YUBA COUNTIES

	Rates	Fringes
Tunnel and Shaft Laborers:		
GROUP 1	$ 42.00	25.71
GROUP 2	$ 41.77	25.71
GROUP 3	$ 41.52	25.71
GROUP 4	$ 41.07	25.71
GROUP 5	$ 40.53	25.71
Shotcrete Specialist	$ 42.52	25.71

TUNNEL AND SHAFT CLASSIFICATIONS

GROUP 1: Diamond driller; Groundmen; Gunite and shotcrete nozzlemen

GROUP 2: Rodmen; Shaft work & raise (below actual or excavated ground level)

GROUP 3: Bit grinder; Blaster, driller, powdermen, heading; Cherry pickermen - where car is lifted; Concrete finisher in tunnel; Concrete screedman; Grout pumpman and potman; Gunite & shotcrete gunman & potman; Headermen; High pressure nozzleman; Miner - tunnel, including top and bottom man on shaft and raise work; Nipper; Nozzleman on slick line; Sandblaster - potman, Robotic Shotcrete Placer, Segment Erector, Tunnel Muck Hauler, Steel Form raiser and setter; Timberman, retimberman (wood or steel or substitute materials therefore); Tugger (for tunnel laborer work); Cable tender; Chuck tender; Powderman - primer house

GROUP 4: Vibrator operator, pavement breaker; Bull gang - muckers, trackmen; Concrete crew - includes rodding and spreading, Dumpmen (any method)

GROUP 5: Grout crew; Reboundman; Swamper/ Brakeman

LABO0185-006 06/25/2018

ALPINE, AMADOR, BUTTE, COLUSA, EL DORADO, GLENN, LASSEN, MODOC,
NEVADA, PLACER, PLUMAS, SACRAMENTO, SHIASTA, SIERRA, SISKIYOU,
SUTTER, TEHAMA, TRINITY, YOLO, YUBA COUNTIES

	Rates	Fringes
LABORER (CONSTRUCTION CRAFT LABORERS - AREA B:)		
Construction Specialist Group	$ 30.49	23.20
GROUP 1	$ 29.79	23.20
GROUP 1-a	$ 30.01	23.20
GROUP 1-c	$ 30.01	23.20
GROUP 1-e	$ 30.34	23.20
GROUP 1-f	$ 30.37	23.20
GROUP 2	$ 29.64	23.20
GROUP 3	$ 29.54	23.20
GROUP 4	$ 23.23	23.20
See groups 1-b and 1-d under laborer classifications.		
LABORER (GARDENERS, HORTICULTURAL & LANDSCAPE LABORERS - AREA B:)		
(1) New Construction	$ 29.54	23.20
(2) Establishment Warranty Period	$ 23.23	23.20
LABORER (GUNITE - AREA B:)		
GROUP 1	$ 29.75	22.31
GROUP 2	$ 29.25	22.31
GROUP 3	$ 28.66	22.31
GROUP 4	$ 28.54	22.31
LABORER (WRECKING - AREA B:)		
GROUP 1	$ 29.79	23.20
GROUP 2	$ 29.64	23.20

FOOTNOTES:

Laborers working off or with or from bos'n chairs, swinging scaffolds, belts shall receive $0.25 per hour above the applicable wage rate. This shall not apply to workers entitled to receive the wage rate set forth in Group 1-a below.

LABORER CLASSIFICATIONS

CONSTRUCTION SPECIALIST GROUP: Asphalt ironer and raker; Chainsaw; Laser beam in connection with laborers' work; Cast-in- place manhole form setter; Pressure pipelayer; Davis trencher - 300 or similar type (and all small trenchers); Blaster; Diamond driller; Multiple unit drill; Hydraulic drill

GROUP 1: Asphalt spreader boxes (all types); Barko, Wacker

and similar type tampers; Buggymobile; Caulker, bander, pipewrapper, conduit layer, plastic pipelayer; Certified hazardous waste worker including Leade Abatement; Compactors of all types; Concrete and magnesite mixer, 1/2 yd. and under; Concrete pan work; Concrete sander; Concrete saw; Cribber and/or shoring; Cut granite curb setter; Dri-pak-it machine; Faller, logloader and bucker; Form raiser, slip forms; Green cutter; Headerboard, Hubsetter, aligner, by any method; High pressure blow pipe (1-1/2"" or over, 100 lbs. pressure/over); Hydro seeder and similar type; Jackhammer operator; Jacking of pipe over 12 inches; Jackson and similar type compactor; Kettle tender, pot and worker applying asphalt, lay-kold, creosote, lime, caustic and similar type materials (applying means applying, dipping or handling of such materials); Lagging, sheeting, whaling, bracing, trenchjacking, lagging hammer; Magnesite, epoxyresin, fiberglass, mastic worker (wet or dry); No joint pipe and stripping of same, including repair of voids; Pavement breaker and spader, including tool grinder; Perma curb; Pipelayer (including grade checking in connection with pipelaying); Precast-manhole setter; Pressure pipe tester; Post hole digger, air, gas and electric; Power broom sweeper; Power tampers of all types (except as shown in Group 2); Ram set gun and stud gun; Riprap stonepaver and rock-slinger, including placing of sacked concrete and/or sand (wet or dry) and gabions and similar type; Rotary scarifier or multiple head concrete chipping scarifier; Roto and Ditch Witch; Rototiller; Sandblaster, pot, gun, nozzle operators; Signalling and rigging; Tank cleaner; Tree climber; Turbo blaster; Vibrascreed, bull float in connection with laborers' work; Vibrator; Hazardous waste worker (lead removal); Asbestos and mold removal worker

GROUP 1-a: Joy drill model TWM-2A; Gardner-Denver model DH143 and similar type drills; Track driller; Jack leg driller; Wagon driller; Mechanical drillers, all types regardless of type or method of power; Mechanical pipe layers, all types regardless of type or method of power; Blaster and powder; All work of loading, placing and blasting of all powder and explosives of whatever type regardless of method used for such loading and placing; High scalers (including drilling of same); Tree topper; Bit grinder

GROUP 1-b: Sewer cleaners shall receive $4.00 per day above Group 1 wage rates. ""Sewer cleaner"" means any worker who handles or comes in contact with raw sewage in small diameter sewers. Those who work inside recently active, large diameter sewers, and all recently active sewer manholes shal receive $5.00 per day above Group 1 wage

rates.

GROUP 1-c: Burning and welding in connection with laborers' work; Synthetic thermoplastics and similar type welding

GROUP 1-d: Maintenance and repair track and road beds. All employees performing work covered herein shall receive $ .25 per hour above their regular rate for all work performed on underground structures not specifically covered herein. This paragraph shall not be construed to apply to work below ground level in open cut. It shall apply to cut and cover work of subway construction after the temporary cover has been placed.

GROUP 1-e: Work on and/or in bell hole footings and shafts thereof, and work on and in deep footings. (A deep footing is a hole 15 feet or more in depth.) In the event the depth of the footing is unknown at the commencement of excavation, and the final depth exceeds 15 feet, the deep footing wage rate would apply to all employees for each and every day worked on or in the excavation of the footing from the date of inception.

GROUP 1-f: Wire winding machine in connection with guniting or shot crete

GROUP 2: Asphalt shoveler; Cement dumper and handling dry cement or gypsum; Choke-setter and rigger (clearing work); Concrete bucket dumper and chute; Concrete chipping and grinding; Concrete laborer (wet or dry); Driller tender, chuck tender, nipper; Guinea chaser (stake), grout crew; High pressure nozzle, adductor; Hydraulic monitor (over 100 lbs. pressure); Loading and unloading, carrying and hauling of all rods and materials for use in reinforcing concrete construction; Pittsburgh chipper and similar type brush shredders; Sloper; Single foot, hand-held, pneumatic tamper; All pneumatic, air, gas and electric tools not listed in Groups 1 through 1-f; Jacking of pipe - under 12 inches

GROUP 3: Construction laborers, including bridge and general laborer; Dump, load spotter; Flag person; Fire watcher; Fence erector; Guardrail erector; Gardener, horticultural and landscape laborer; Jetting; Limber, brush loader and piler; Pavement marker (button setter); Maintenance, repair track and road beds; Streetcar and railroad construction track laborer; Temporary air and water lines, Victaulic or similar; Tool room attendant (jobsite only)

GROUP 4: Final clean-up work of debris, grounds and building

including but not limited to: street cleaner; cleaning and washing windows; brick cleaner (jobsite only); material cleaner (jobsite only). The classification ""material cleaner"" is to be utilized under the following conditions:
A: at demolition site for the salvage of the material.
B: at the conclusion of a job where the material is to be salvaged and stocked to be reused on another job.
C: for the cleaning of salvage material at the jobsite or temporary jobsite yard.

The material cleaner classification should not be used in the performance of ""form stripping, cleaning and oiling and moving to the next point of erection"".

GUNITE LABORER CLASSIFICATIONS

GROUP 1: Structural Nozzleman

GROUP 2: Nozzleman, Gunman, Potman, Groundman

GROUP 3: Reboundman

GROUP 4: Gunite laborer

WRECKING WORK LABORER CLASSIFICATIONS

GROUP 1: Skilled wrecker (removing and salvaging of sash, windows and materials)

GROUP 2: Semi-skilled wrecker (salvaging of other building materials)

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* LABO0185-008 07/01/2022

	Rates	Fringes
Plasterer tender	$ 38.02	28.25

Work on a swing stage scaffold: $1.00 per hour additional.

LABO0261-002 06/28/2021

MARIN COUNTY

	Rates	Fringes

LABORER (TRAFFIC CONTROL/LANE CLOSURE)

Escort Driver, Flag Person..	$ 34.48	26.21
Traffic Control Person I....	$ 34.78	26.21
Traffic Control Person II...	$ 32.28	26.21

TRAFFIC CONTROL PERSON I: Layout of traffic control, crash cushions, construction area and roadside signage.

TRAFFIC CONTROL PERSON II: Installation and removal of temporary/permanent signs, markers, delineators and crash cushions.

LABO0261-004 07/01/2021

MARIN COUNTY

	Rates	Fringes
Tunnel and Shaft Laborers:		
GROUP 1.....	$ 42.00	25.71
GROUP 2.....	$ 41.77	25.71
GROUP 3.....	$ 41.52	25.71
GROUP 4.....	$ 41.07	25.71
GROUP 5.....	$ 40.53	25.71
Shotcrete Specialist.....	$ 42.52	25.71

TUNNEL AND SHAFT CLASSIFICATIONS

GROUP 1: Diamond driller; Groundmen; Gunite and shotcrete nozzlemen

GROUP 2: Rodmen; Shaft work & raise (below actual or excavated ground level)

GROUP 3: Bit grinder; Blaster, driller, powdermen, heading; Cherry pickermen - where car is lifted; Concrete finisher in tunnel; Concrete screedman; Grout pumpman and potman; Gunite & shotcrete gunman & potman; Headermen; High pressure nozzleman; Miner - tunnel, including top and bottom man on shaft and raise work; Nipper; Nozzleman on slick line; Sandblaster - potman, Robotic Shotcrete Placer, Segment Erector, Tunnel Muck Hauler, Steel Form raiser and setter; Timberman, retimberman (wood or steel or substitute materials therefore); Tugger (for tunnel laborer work); Cable tender; Chuck tender; Powderman - primer house

GROUP 4: Vibrator operator, pavement breaker; Bull gang -

muckers, trackmen; Concrete crew - includes rodding and spreading, Dumpmen (any method)

GROUP 5: Grout crew; Reboundman; Swamper/ Brakeman

LABO0261-007 07/01/2022

MARIN COUNTY

	Rates	Fringes
LABORER		
Mason Tender-Brick	$ 36.54	25.21

LABO0261-010 06/25/2018

MARIN COUNTY

	Rates	Fringes
LABORER (CONSTRUCTION CRAFT LABORERS - AREA A:)		
Construction Specialist Group	$ 31.49	23.20
GROUP 1	$ 30.79	23.20
GROUP 1-a	$ 31.01	23.20
GROUP 1-c	$ 30.84	23.20
GROUP 1-e	$ 31.34	23.20
GROUP 1-f	$ 31.37	23.20
GROUP 2	$ 30.64	23.20
GROUP 3	$ 30.54	23.20
GROUP 4	$ 24.23	23.20
See groups 1-b and 1-d under laborer classifications.		
LABORER (GARDENERS, HORTICULTURAL & LANDSCAPE LABORERS - AREA A:)		
(1) New Construction	$ 30.54	23.20
(2) Establishment Warranty Period	$ 24.23	23.20
LABORER (GUNITE - AREA A:)		
GROUP 1	$ 30.75	22.31
GROUP 2	$ 30.25	22.31
GROUP 3	$ 29.66	22.31
GROUP 4	$ 29.54	22.31
LABORER (WRECKING - AREA A:)		
GROUP 1	$ 30.79	23.20
GROUP 2	$ 30.64	23.20

FOOTNOTES:

Laborers working off or with or from bos'n chairs, swinging scaffolds, belts shall receive $0.25 per hour above the applicable wage rate. This shall not apply to workers entitled to receive the wage rate set forth in Group 1-a below.

LABORER CLASSIFICATIONS

CONSTRUCTION SPECIALIST GROUP: Asphalt ironer and raker; Chainsaw; Laser beam in connection with laborers' work; Cast-in- place manhole form setter; Pressure pipelayer; Davis trencher - 300 or similar type (and all small trenchers); Blaster; Diamond driller; Multiple unit drill; Hydraulic drill

GROUP 1: Asphalt spreader boxes (all types); Barko, Wacker and similar type tampers; Buggymobile; Caulker, bander, pipewrapper, conduit layer, plastic pipelayer; Certified hazardous waste worker including Leade Abatement; Compactors of all types; Concrete and magnesite mixer, 1/2 yd. and under; Concrete pan work; Concrete sander; Concrete saw; Cribber and/or shoring; Cut granite curb setter; Dri-pak-it machine; Faller, logloader and bucker; Form raiser, slip forms; Green cutter; Headerboard, Hubsetter, aligner, by any method; High pressure blow pipe (1-1/2"" or over, 100 lbs. pressure/over); Hydro seeder and similar type; Jackhammer operator; Jacking of pipe over 12 inches; Jackson and similar type compactor; Kettle tender, pot and worker applying asphalt, lay-kold, creosote, lime, caustic and similar type materials (applying means applying, dipping or handling of such materials); Lagging, sheeting, whaling, bracing, trenchjacking, lagging hammer; Magnesite, epoxyresin, fiberglass, mastic worker (wet or dry); No joint pipe and stripping of same, including repair of voids; Pavement breaker and spader, including tool grinder; Perma curb; Pipelayer (including grade checking in connection with pipelaying); Precast-manhole setter; Pressure pipe tester; Post hole digger, air, gas and electric; Power broom sweeper; Power tampers of all types (except as shown in Group 2); Ram set gun and stud gun; Riprap stonepaver and rock-slinger, including placing of sacked concrete and/or sand (wet or dry) and gabions and similar type; Rotary scarifier or multiple head concrete chipping scarifier; Roto and Ditch Witch; Rototiller; Sandblaster, pot, gun, nozzle operators; Signalling and rigging; Tank cleaner; Tree climber; Turbo blaster; Vibrascreed, bull float in connection with laborers' work;

Vibrator; Hazardous waste worker (lead removal); Asbestos and mold removal worker

GROUP 1-a: Joy drill model TWM-2A; Gardner-Denver model DH143 and similar type drills; Track driller; Jack leg driller; Wagon driller; Mechanical drillers, all types regardless of type or method of power; Mechanical pipe layers, all types regardless of type or method of power; Blaster and powder; All work of loading, placing and blasting of all powder and explosives of whatever type regardless of method used for such loading and placing; High scalers (including drilling of same); Tree topper; Bit grinder

GROUP 1-b: Sewer cleaners shall receive $4.00 per day above Group 1 wage rates. ""Sewer cleaner"" means any worker who handles or comes in contact with raw sewage in small diameter sewers. Those who work inside recently active, large diameter sewers, and all recently active sewer manholes shal receive $5.00 per day above Group 1 wage rates.

GROUP 1-c: Burning and welding in connection with laborers' work; Synthetic thermoplastics and similar type welding

GROUP 1-d: Maintenance and repair track and road beds. All employees performing work covered herein shall receive $ .25 per hour above their regular rate for all work performed on underground structures not specifically covered herein. This paragraph shall not be construed to apply to work below ground level in open cut. It shall apply to cut and cover work of subway construction after the temporary cover has been placed.

GROUP 1-e: Work on and/or in bell hole footings and shafts thereof, and work on and in deep footings. (A deep footing is a hole 15 feet or more in depth.) In the event the depth of the footing is unknown at the commencement of excavation, and the final depth exceeds 15 feet, the deep footing wage rate would apply to all employees for each and every day worked on or in the excavation of the footing from the date of inception.

GROUP 1-f: Wire winding machine in connection with guniting or shot crete

GROUP 2: Asphalt shoveler; Cement dumper and handling dry cement or gypsum; Choke-setter and rigger (clearing work); Concrete bucket dumper and chute; Concrete chipping and grinding; Concrete laborer (wet or dry); Driller tender, chuck tender, nipper; Guinea chaser (stake), grout crew;

High pressure nozzle, adductor; Hydraulic monitor (over 100 lbs. pressure); Loading and unloading, carrying and hauling of all rods and materials for use in reinforcing concrete construction; Pittsburgh chipper and similar type brush shredders; Sloper; Single foot, hand-held, pneumatic tamper; All pneumatic, air, gas and electric tools not listed in Groups 1 through 1-f; Jacking of pipe - under 12 inches

GROUP 3: Construction laborers, including bridge and general laborer; Dump, load spotter; Flag person; Fire watcher; Fence erector; Guardrail erector; Gardener, horticultural and landscape laborer; Jetting; Limber, brush loader and piler; Pavement marker (button setter); Maintenance, repair track and road beds; Streetcar and railroad construction track laborer; Temporary air and water lines, Victaulic or similar; Tool room attendant (jobsite only)

GROUP 4: Final clean-up work of debris, grounds and building including but not limited to: street cleaner; cleaning and washing windows; brick cleaner (jobsite only); material cleaner (jobsite only). The classification ""material cleaner"" is to be utilized under the following conditions:
A: at demolition site for the salvage of the material.
B: at the conclusion of a job where the material is to be salvaged and stocked to be reused on another job.
C: for the cleaning of salvage material at the jobsite or temporary jobsite yard.

The material cleaner classification should not be used in the performance of ""form stripping, cleaning and oiling and moving to the next point of erection"".

GUNITE LABORER CLASSIFICATIONS

GROUP 1: Structural Nozzleman

GROUP 2: Nozzleman, Gunman, Potman, Groundman

GROUP 3: Reboundman

GROUP 4: Gunite laborer

WRECKING WORK LABORER CLASSIFICATIONS

GROUP 1: Skilled wrecker (removing and salvaging of sash,

windows and materials)

GROUP 2: Semi-skilled wrecker (salvaging of other building materials)

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* LABO0261-015 07/01/2022

	Rates	Fringes
Plasterer tender	$ 38.02	28.25

Work on a swing stage scaffold: $1.00 per hour additional.

LABO0324-004 06/28/2021

NAPA, SOLANO, AND SONOMA, COUNTIES

	Rates	Fringes
LABORER (TRAFFIC CONTROL/LANE CLOSURE)		
Escort Driver, Flag Person	$ 33.48	26.21
Traffic Control Person I	$ 33.78	26.21
Traffic Control Person II	$ 31.28	26.21

TRAFFIC CONTROL PERSON I: Layout of traffic control, crash cushions, construction area and roadside signage.

TRAFFIC CONTROL PERSON II: Installation and removal of temporary/permanent signs, markers, delineators and crash cushions.

LABO0324-008 06/25/2018

NAPA, SOLANO, AND SONOMA COUNTIES

	Rates	Fringes
Tunnel and Shaft Laborers:		
GROUP 1	$ 37.82	24.11
GROUP 2	$ 37.59	24.11
GROUP 3	$ 37.34	24.11
GROUP 4	$ 36.89	24.11
GROUP 5	$ 36.35	24.11
Shotcrete Specialist	$ 38.34	24.11

TUNNEL AND SHAFT CLASSIFICATIONS

GROUP 1: Diamond driller; Groundmen; Gunite and shotcrete nozzlemen

GROUP 2: Rodmen; Shaft work & raise (below actual or excavated ground level)

GROUP 3: Bit grinder; Blaster, driller, powdermen, heading; Cherry pickermen - where car is lifted; Concrete finisher in tunnel; Concrete screedman; Grout pumpman and potman; Gunite & shotcrete gunman & potman; Headermen; High pressure nozzleman; Miner - tunnel, including top and bottom man on shaft and raise work; Nipper; Nozzleman on slick line; Sandblaster - potman, Robotic Shotcrete Placer, Segment Erector, Tunnel Muck Hauler, Steel Form raiser and setter; Timberman, retimberman (wood or steel or substitute materials therefore); Tugger (for tunnel laborer work); Cable tender; Chuck tender; Powderman - primer house

GROUP 4: Vibrator operator, pavement breaker; Bull gang - muckers, trackmen; Concrete crew - includes rodding and spreading, Dumpmen (any method)

GROUP 5: Grout crew; Reboundman; Swamper/ Brakeman

LABO0324-010 07/01/2022

SOLANO AND SONOMA COUNTIES

	Rates	Fringes
LABORER		
Mason Tender-Brick	$ 35.84	25.91

LABO0324-013 06/25/2018

NAPA, SOLANO, AND SONOMA COUNTIES

	Rates	Fringes
LABORER (CONSTRUCTION CRAFT LABORERS - AREA B:)		
Construction Specialist Group	$ 30.49	23.20
GROUP 1	$ 29.79	23.20
GROUP 1-a	$ 30.01	23.20
GROUP 1-c	$ 29.84	23.20
GROUP 1-e	$ 30.34	23.20
GROUP 1-f	$ 29.37	23.20
GROUP 2	$ 29.64	23.20

GROUP 3.....$ 29.54 23.20
GROUP 4.....$ 23.23 23.20
See groups 1-b and 1-d under laborer classifications.
LABORER (GARDENERS,
HORTICULTURAL & LANDSCAPE
LABORERS - AREA B:)
(1) New Construction.....$ 29.54 23.20
(2) Establishment Warranty
Period.....$ 23.23 23.20
LABORER (GUNITE - AREA B:)
GROUP 1.....$ 29.75 22.31
GROUP 2.....$ 29.25 22.31
GROUP 3.....$ 28.66 22.31
GROUP 4.....$ 28.54 22.31
LABORER (WRECKING - AREA B:)
GROUP 1.....$ 29.79 23.20
GROUP 2.....$ 29.64 23.20

FOOTNOTES:
Laborers working off or with or from bos'n chairs, swinging scaffolds, belts shall receive $0.25 per hour above the applicable wage rate. This shall not apply to workers entitled to receive the wage rate set forth in Group 1-a below.

LABORER CLASSIFICATIONS

CONSTRUCTION SPECIALIST GROUP: Asphalt ironer and raker; Chainsaw; Laser beam in connection with laborers' work; Cast-in- place manhole form setter; Pressure pipelayer; Davis trencher - 300 or similar type (and all small trenchers); Blaster; Diamond driller; Multiple unit drill; Hydraulic drill

GROUP 1: Asphalt spreader boxes (all types); Barko, Wacker and similar type tampers; Buggymobile; Caulker, bander, pipewrapper, conduit layer, plastic pipelayer; Certified hazardous waste worker including Leade Abatement; Compactors of all types; Concrete and magnesite mixer, 1/2 yd. and under; Concrete pan work; Concrete sander; Concrete saw; Cribber and/or shoring; Cut granite curb setter; Dri-pak-it machine; Faller, logloader and bucker; Form raiser, slip forms; Green cutter; Headerboard, Hubsetter, aligner, by any method; High pressure blow pipe (1-1/2"" or over, 100 lbs. pressure/over); Hydro seeder and similar type; Jackhammer operator; Jacking of pipe over 12 inches; Jackson and similar type compactor; Kettle tender, pot and

worker applying asphalt, lay-kold, creosote, lime, caustic and similar type materials (applying means applying, dipping or handling of such materials); Lagging, sheeting, whaling, bracing, trenchjacking, lagging hammer; Magnesite, epoxyresin, fiberglass, mastic worker (wet or dry); No joint pipe and stripping of same, including repair of voids; Pavement breaker and spader, including tool grinder; Perma curb; Pipelayer (including grade checking in connection with pipelaying); Precast-manhole setter; Pressure pipe tester; Post hole digger, air, gas and electric; Power broom sweeper; Power tampers of all types (except as shown in Group 2); Ram set gun and stud gun; Riprap stonepaver and rock-slinger, including placing of sacked concrete and/or sand (wet or dry) and gabions and similar type; Rotary scarifier or multiple head concrete chipping scarifier; Roto and Ditch Witch; Rototiller; Sandblaster, pot, gun, nozzle operators; Signalling and rigging; Tank cleaner; Tree climber; Turbo blaster; Vibrascreed, bull float in connection with laborers' work; Vibrator; Hazardous waste worker (lead removal); Asbestos and mold removal worker

GROUP 1-a: Joy drill model TWM-2A; Gardner-Denver model DH143 and similar type drills; Track driller; Jack leg driller; Wagon driller; Mechanical drillers, all types regardless of type or method of power; Mechanical pipe layers, all types regardless of type or method of power; Blaster and powder; All work of loading, placing and blasting of all powder and explosives of whatever type regardless of method used for such loading and placing; High scalers (including drilling of same); Tree topper; Bit grinder

GROUP 1-b: Sewer cleaners shall receive $4.00 per day above Group 1 wage rates. ""Sewer cleaner"" means any worker who handles or comes in contact with raw sewage in small diameter sewers. Those who work inside recently active, large diameter sewers, and all recently active sewer manholes shal receive $5.00 per day above Group 1 wage rates.

GROUP 1-c: Burning and welding in connection with laborers' work; Synthetic thermoplastics and similar type welding

GROUP 1-d: Maintenance and repair track and road beds. All employees performing work covered herein shall receive $ .25 per hour above their regular rate for all work performed on underground structures not specifically covered herein. This paragraph shall not be construed to apply to work below ground level in open cut. It shall apply to cut and cover work of subway construction after

the temporary cover has been placed.

GROUP 1-e: Work on and/or in bell hole footings and shafts thereof, and work on and in deep footings. (A deep footing is a hole 15 feet or more in depth.) In the event the depth of the footing is unknown at the commencement of excavation, and the final depth exceeds 15 feet, the deep footing wage rate would apply to all employees for each and every day worked on or in the excavation of the footing from the date of inception.

GROUP 1-f: Wire winding machine in connection with guniting or shot crete

GROUP 2: Asphalt shoveler; Cement dumper and handling dry cement or gypsum; Choke-setter and rigger (clearing work); Concrete bucket dumper and chute; Concrete chipping and grinding; Concrete laborer (wet or dry); Driller tender, chuck tender, nipper; Guinea chaser (stake), grout crew; High pressure nozzle, adductor; Hydraulic monitor (over 100 lbs. pressure); Loading and unloading, carrying and hauling of all rods and materials for use in reinforcing concrete construction; Pittsburgh chipper and similar type brush shredders; Sloper; Single foot, hand-held, pneumatic tamper; All pneumatic, air, gas and electric tools not listed in Groups 1 through 1-f; Jacking of pipe - under 12 inches

GROUP 3: Construction laborers, including bridge and general laborer; Dump, load spotter; Flag person; Fire watcher; Fence erector; Guardrail erector; Gardener, horticultural and landscape laborer; Jetting; Limber, brush loader and piler; Pavement marker (button setter); Maintenance, repair track and road beds; Streetcar and railroad construction track laborer; Temporary air and water lines, Victaulic or similar; Tool room attendant (jobsite only)

GROUP 4: Final clean-up work of debris, grounds and building including but not limited to: street cleaner; cleaning and washing windows; brick cleaner (jobsite only); material cleaner (jobsite only). The classification ""material cleaner"" is to be utilized under the following conditions:
A: at demolition site for the salvage of the material.
B: at the conclusion of a job where the material is to be salvaged and stocked to be reused on another job.
C: for the cleaning of salvage material at the jobsite or temporary jobsite yard.

The material cleaner classification should not be used in the performance of ""form stripping, cleaning and oiling

and moving to the next point of erection"".

GUNITE LABORER CLASSIFICATIONS

GROUP 1: Structural Nozzleman

GROUP 2: Nozzleman, Gunman, Potman, Groundman

GROUP 3: Reboundman

GROUP 4: Gunite laborer

WRECKING WORK LABORER CLASSIFICATIONS

GROUP 1: Skilled wrecker (removing and salvaging of sash, windows and materials)

GROUP 2: Semi-skilled wrecker (salvaging of other building materials)

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* LABO0324-019 07/01/2022

	Rates	Fringes
Plasterer tender	$ 38.02	28.25

Work on a swing stage scaffold: $1.00 per hour additional.

PAIN0016-004 01/01/2023

MARIN, NAPA, SOLANO & SONOMA COUNTIES

	Rates	Fringes
Painters:	$ 47.42	27.28

PREMIUMS:
EXOTIC MATERIALS - $1.25 additional per hour.
SPRAY WORK: - $0.50 additional per hour.
INDUSTRIAL PAINTING - $0.25 additional per hour
[Work on industrial buildings used for the manufacture and processing of goods for sale or service; steel construction (bridges), stacks, towers, tanks, and similar structures]

HIGH WORK:

over 50 feet - $2.00 per hour additional
100 to 180 feet - $4.00 per hour additional
Over 180 feet - $6.00 per houir additional

PAIN0016-005 01/01/2023

ALPINE, BUTTE, COLUSA, EL DORADO (west of the Sierra Nevada Mountains), GLENN, LASSEN (west of Hwy. 395, excluding Honey Lake); MARIN, MODOC, NAPA, NEVADA (west of the Sierra Nevada Mountains), PLACER (west of the Sierra Nevada Mountains), PLUMAS, SACRAMENTO, SHASTA, SIERRA (west of the Sierra Nevada Mountains), SISKIYOU, SOLANO, SONOMA, SUTTER, TEHAMA, TRINITY, YOLO AND YUBA COUNTIES

	Rates	Fringes
DRYWALL FINISHER/TAPER	$ 53.03	28.84

PAIN0016-007 01/01/2023

ALPINE, AMADOR, BUTTE, COLUSA. EL DORADO (west of the Sierra Nevada Mountains), GLENN, LASSEN (west of Highway 395, excluding Honey Lake), MODOC, NEVADA (west of the Sierra Nevada Mountains), PLACER (west of the Sierra Nevada Mountains), PLUMAS, SACRAMENTO, SHASTA, SIERRA (west of the Sierra Nevada Mountains), SISKIYOU, SUTTER, TEHAMA, TRINITY, YOLO & YUBA COUNTIES

	Rates	Fringes
Painters:	$ 38.23	22.05

SPRAY/SANDBLAST: $0.50 additional per hour.
EXOTIC MATERIALS: $1.25 additional per hour.
  HIGH TIME: Over 50 ft above ground or water level $2.00 additional per hour. 100 to 180 ft above ground or water level $4.00 additional per hour. Over 180 ft above ground or water level $6.00 additional per hour.

PAIN0016-008 01/01/2023

MARIN, NAPA, SOLANO AND SONOMA COUNTIES

	Rates	Fringes
SOFT FLOOR LAYER	$ 55.25	32.63

PAIN0169-004 01/01/2023

MARIN , NAPA & SONOMA COUNTIES; SOLANO COUNTY (west of a line defined as follows: Hwy. 80 corridor beginning at the City of Fairfield, including Travis Air Force Base and Suisun City; going north of Manakas Corner Rd., continue north on Suisun Valley Rd. to the Napa County line; Hwy. 80 corridor south on Grizzly Island Rd. to the Grizzly Island Management area)

	Rates	Fringes
GLAZIER	$ 55.77	32.45

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* PAIN0567-001 07/01/2022

EL DORADO COUNTY (east of the Sierra Nevada Mountains); LASSEN COUNTY (east of Highway 395, beginning at Stacey and including Honey Lake); NEVADA COUNTY (east of the Sierra Nevada Mountains); PLACER COUNTY (east of the Sierra Nevada Mountains); AND SIERRA COUNTY (east of the Sierra Nevada Mountains)

	Rates	Fringes
Painters:		
Brush and Roller	$ 33.15	14.29
Spray Painter & Paperhanger	$ 34.81	14.29

PREMIUMS:
Special Coatings (Brush), and Sandblasting = $0.50/hr
Special Coatings (Spray), and Steeplejack = $1.00/hr
Special Coating Spray Steel = $1.25/hr
Swing Stage = $2.00/hr

*A special coating is a coating that requires the mixing of 2 or more products.

PAIN0567-007 07/01/2022

EL DORADO COUNTY (east of the Sierra Nevada Mountains); LASSEN COUNTY (east of Highway 395, beginning at Stacey and including Honey Lake); NEVADA COUNTY (east of the Sierra Nevada Mountains); PLACER COUNTY (east of the Sierra Nevada Mountains) AND SIERRA COUNTY (east of the Sierra Nevada Mountains)

	Rates	Fringes
SOFT FLOOR LAYER	$ 34.27	16.47

PAIN0567-010 07/01/2022

EL DORADO COUNTY (east of the Sierra Nevada Mountains); LASSEN COUNTY (east of Highway 395, beginning at Stacey and including Honey Lake); NEVADA COUNTY (east of the Sierra Nevada Mountains); PLACER COUNTY (east of the Sierra Nevada Mountains); AND SIERRA COUNTY (east of the Sierra Nevada Mountains)

	Rates	Fringes
Drywall		
(1) Taper	$ 38.92	14.99
(2) Steeplejack - Taper, over 40 ft with open space below	$ 40.42	14.99

PAIN0767-004 01/01/2023

ALPINE, AMADOR, BUTTE, COLUSA, EL DORADO, GLENN, LASSEN, MODOC, NEVADA, PLACER, PLUMAS, SACRAMENTO, SHASTA, SIERRA, SISKIYOU, SOLANO (Remainder), SUTTER, TEHAMA, TRINITY, YOLO, YUBA

	Rates	Fringes
GLAZIER	$ 43.15	33.72

PAID HOLIDAYS: New Year's Day, Martin Luther King, Jr. Day, President's Day, Memorial Day, Independence Day, Labor Day, Veteran's Day, Thanksgiving Day, and Christmas Day.

Employee required to wear a body harness shall receive $1.50 per hour above the basic hourly rate at any elevation.

PAIN1176-001 07/01/2022

HIGHWAY IMPR0VEMENT

	Rates	Fringes
Parking Lot Striping/Highway Marking:		
GROUP 1	$ 40.83	17.62

GROUP 2	$ 34.71	17.62
GROUP 3	$ 35.11	17.62

CLASSIFICATIONS

GROUP 1: Striper: Layout and application of painted traffic stripes and marking; hot thermo plastic; tape, traffic stripes and markings

GROUP 2: Gamecourt & Playground Installer

GROUP 3: Protective Coating, Pavement Sealing

PAIN1237-001 01/01/2023

ALPINE; COLUSA; EL DORADO (west of the Sierra Nevada Mountains); GLENN; LASSEN (west of Highway 395, beginning at Stacey and including Honey Lake); MODOC; NEVADA (west of the Sierra Nevada Mountains); PLACER (west of the Sierra Nevada Mountains); PLUMAS; SACRAMENTO; SHASTA; SIERRA (west of the Sierra Nevada Mountains); SISKIYOU; SUTTER; TEHAMA; TRINITY; YOLO AND YUBA COUNTIES

	Rates	Fringes
SOFT FLOOR LAYER	$ 46.24	25.96

PLAS0300-003 07/01/2018

	Rates	Fringes
PLASTERER		
AREA 295: Alpine, Amador, Butte, Colusa, El Dorado, Glenn, Lassen, Modoc, Nevada, Placer, Plumas, Sacramento, Shasta, Sierra, Siskiyou, Solano, Sutter, Tehema, Trinity, Yolo & Yuba Counties	$ 32.70	31.68
AREA 355: Marin	$ 36.73	31.68
AREA 355: Napa & Sonoma Counties	$ 32.70	31.68

PLAS0300-005 07/01/2016

	Rates	Fringes

CEMENT MASON/CONCRETE FINISHER...$ 32.15 23.27

PLUM0038-002 07/01/2022

MARIN AND SONOMA COUNTIES

	Rates	Fringes
PLUMBER (Plumber, Steamfitter, Refrigeration Fitter)		
(1) Work on wooden frame structures 5 stories or less excluding high-rise buildings and commercial work such as hospitals, prisons, hotels, schools, casinos, wastewater treatment plants, and resarch facilities as well as refrigeration pipefitting, service and repair work - MARKET RECOVERY RATE	$ 69.70	46.38
(2) All other work - NEW CONSTRUCTION RATE	$ 82.00	48.18

PLUM0038-006 07/01/2022

MARIN & SONOMA COUNTIES

	Rates	Fringes
Landscape/Irrigation Fitter (Underground/Utility Fitter)	$ 69.70	33.15

PLUM0228-001 01/01/2023

BUTTE, COLUSA, GLENN, LASSEN, MODOC, PLUMAS, SHASTA, SIERRA, SISKIYOU, SUTTER, TEHAMA, TRINITY & YUBA COUNTIES

	Rates	Fringes
PLUMBER	$ 44.75	37.89

PLUM0343-001 07/01/2022

NAPA AND SOLANO COUNTIES

	Rates	Fringes
PLUMBER/PIPEFITTER		
Light Commercial	$ 30.85	20.40
All Other Work	$ 58.00	40.48

DEFINITION OF LIGHT COMMERICIAL:
Work shall include strip shopping centers, office buildings, schools and other commercial structures which the total plumbing bid does not exceed Two Hundred and Fifty Thousand ($250,000) and the total heating and cooling does not exceed Two Hundred Fifty Thousand ($250,000); or Any projects bid in phases shall not qualify unless the total project is less than Two Hundred Fifty Thousand ($250,000) for the plumbing bid; and Two Hundred Fifty Thousand ($250,000) for the heating and cooling bid. Excluded are hospitals, jails, institutions and industrial projects, regardless size of the project

FOOTNOTES: While fitting galvanized material: $.75 per hour additional. Work from trusses, temporary staging, unguarded structures 35' from the ground or water: $.75 per hour additional. Work from swinging scaffolds, boatswains chairs or similar devices: $.75 per hour additional.

PLUM0350-001 08/01/2021

EL DORADO COUNTY (Lake Tahoe area only); NEVADA COUNTY (Lake Tahoe area only); AND PLACER COUNTY (Lake Tahoe area only)

	Rates	Fringes
PLUMBER/PIPEFITTER	$ 47.54	17.11

PLUM0355-001 07/01/2022

ALPINE, AMADOR, BUTTE, COLUSA, EL DORADO, GLENN, LASSEN, MODOC, NAPA, NEVADA, PLACER, PLUMAS, SACRAMENTO, SHASTA, SIERRA, SISKIYOU, SOLANO, SUTTER, TEHAMA, TRINITY, YOLO, AND YUBA COUNTIES

	Rates	Fringes
Underground Utility Worker /Landscape Fitter	$ 32.22	17.55

PLUM0442-003 01/01/2023

AMADOR (South of San Joaquin River) and ALPINE COUNTIES

	Rates	Fringes
PLUMBER	$ 50.75	35.14

PLUM0447-001 07/01/2022

AMADOR (north of San Joaquin River), EL DORADO (excluding Lake Tahoe area), NEVADA (excluding Lake Tahoe area); PLACER (excluding Lake Tahoe area), SACRAMENTO AND YOLO COUNTIES

	Rates	Fringes
PLUMBER/PIPEFITTER		
Journeyman	$ 58.37	28.00
Light Commercial Work	$ 36.23	17.72

ROOF0081-006 08/01/2022

MARIN, NAPA, SOLANO AND SONOMA COUNTIES

	Rates	Fringes
Roofer	$ 50.27	20.66

ROOF0081-007 08/01/2022

ALPINE, BUTTE, COLUSA, EL DORADO, GLENN,LASSEN, MODOC, NEVADA, PLACER, PLUMAS, SACRAMENTO, SHASTA, SIERRA, SISKIYOU, SUTTER, TEHAMA, TRINITY, YOLO, AND YUBA COUNTIES

	Rates	Fringes
Roofer	$ 43.13	19.71

SFCA0483-003 01/01/2023

MARIN, NAPA, SOLANO AND SONOMA COUNTIES

	Rates	Fringes
SPRINKLER FITTER (Fire Sprinklers)	$ 72.59	36.95

SFCA0669-003 04/01/2023

ALPINE, BUTTE, COLUSA, EL DORADO, GLENN, LASSEN, MODOC, NEVADA, PLACER, PLUMAS, SACRAMENTO, SHASTA, SIERRA, SISKIYOU, SUTTER, TEHAMA, TRINITY, YOLO AND YUBA COUNTIES

	Rates	Fringes
SPRINKLER FITTER	$ 46.46	27.39

SHEE0104-006 06/29/2020

MARIN, NAPA, SOLANO SONOMA & TRINITY COUNTIES

	Rates	Fringes
Sheet Metal Worker		
Mechanical Contracts		
$200,000 or less	$ 55.92	45.29
All other work	$ 64.06	46.83

SHEE0104-009 07/01/2021

AMADOR, COLUSA, EL DORADO, NEVADA, PLACER, SACRAMENTO, SUTTER, YOLO AND YUBA COUNTIES

	Rates	Fringes
SHEET METAL WORKER	$ 47.85	41.90

SHEE0104-010 07/01/2020

AlPINE COUNTY

	Rates	Fringes
SHEET METAL WORKER	$ 43.50	37.42

SHEE0104-011 07/01/2020

BUTTE, COLUSA, EL DORADO, GLENN, LASSEN, MODOC, NEVADA, PLACER, PLUMAS, SACRAMENTO, SHASTA, SIERRA, SISKIYOU, SUTTER, TEHAMA, YOLO AND YUBA COUNTIES

	Rates	Fringes
Sheet Metal Worker (Metal decking and siding only)	$ 44.45	35.55

SHEE0104-014 07/01/2020

MARIN, NAPA, SOLANO, SONOMA AND TRINITY COUNTIES

	Rates	Fringes
SHEET METAL WORKER (Metal Decking and Siding only)	$ 44.45	35.55

SHEE0104-019 07/01/2020

BUTTE, GLENN, LASSEN, MODOC, PLUMAS, SHASTA, SIERRA, SISKIYOU AND TEHAMA COUNTIES

	Rates	Fringes
SHEET METAL WORKER		
Mechanical Jobs $200,000 & under	$ 35.16	35.88
Mechanical Jobs over $200,000	$ 46.60	40.21

TEAM0094-001 07/01/2022

	Rates	Fringes
Truck drivers:		
GROUP 1	$ 36.95	31.14
GROUP 2	$ 37.25	31.14
GROUP 3	$ 37.55	31.14
GROUP 4	$ 37.90	31.14
GROUP 5	$ 38.25	31.14

FOOTNOTES:

Articulated dump truck; Bulk cement spreader (with or without auger); Dumpcrete truck; Skid truck (debris box); Dry pre-batch concrete mix trucks; Dumpster or similar type; Slurry truck: Use dump truck yardage rate.

Heater planer; Asphalt burner; Scarifier burner; Industrial lift truck (mechanical tailgate); Utility and clean-up truck: Use appropriate rate for the power unit or the equipment utilized.

TRUCK DRIVER CLASSIFICATIONS

GROUP 1: Dump trucks, under 6 yds.; Single unit flat rack (2-axle unit); Nipper truck (when flat rack truck is used appropriate flat rack shall apply); Concrete pump truck

(when flat rack truck is used appropriate flat rack shall apply); Concrete pump machine; Fork lift and lift jitneys; Fuel and/or grease truck driver or fuel person; Snow buggy; Steam cleaning; Bus or personhaul driver; Escort or pilot car driver; Pickup truck; Teamster oiler/greaser and/or serviceperson; Hook tender (including loading and unloading); Team driver; Tool room attendant (refineries)

GROUP 2: Dump trucks, 6 yds. and under 8 yds.; Transit mixers, through 10 yds.; Water trucks, under 7,000 gals.; Jetting trucks, under 7,000 gals.; Single-unit flat rack (3-axle unit); Highbed heavy duty transport; Scissor truck; Rubber-tired muck car (not self-loaded); Rubber-tired truck jumbo; Winch truck and ""A"" frame drivers; Combination winch truck with hoist; Road oil truck or bootperson; Buggymobile; Ross, Hyster and similar straddle carriers; Small rubber-tired tractor

GROUP 3: Dump trucks, 8 yds. and including 24 yds.; Transit mixers, over 10 yds.; Water trucks, 7,000 gals. and over; Jetting trucks, 7,000 gals. and over; Vacuum trucks under 7500 gals. Trucks towing tilt bed or flat bed pull trailers; Lowbed heavy duty transport; Heavy duty transport tiller person; Self- propelled street sweeper with self-contained refuse bin; Boom truck - hydro-lift or Swedish type extension or retracting crane; P.B. or similar type self-loading truck; Tire repairperson; Combination bootperson and road oiler; Dry distribution truck (A bootperson when employed on such equipment, shall receive the rate specified for the classification of road oil trucks or bootperson); Ammonia nitrate distributor, driver and mixer; Snow Go and/or plow

GROUP 4: Dump trucks, over 25 yds. and under 65 yds.; Water pulls - DW 10's, 20's, 21's and other similar equipment when pulling Aqua/pak or water tank trailers; Helicopter pilots (when transporting men and materials); Lowbedk Heavy Duty Transport up to including 7 axles; DW10's, 20's, 21's and other similar Cat type, Terra Cobra, LeTourneau Pulls, Tournorocker, Euclid and similar type equipment when pulling fuel and/or grease tank trailers or other miscellaneous trailers; Vacuum Trucks 7500 gals and over and truck repairman

GROUP 5: Dump trucks, 65 yds. and over; Holland hauler; Low bed Heavy Duty Transport over 7 axles

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WELDERS - Receive rate prescribed for craft performing

operation to which welding is incidental.

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Note: Executive Order (EO) 13706, Establishing Paid Sick Leave for Federal Contractors applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2017. If this contract is covered by the EO, the contractor must provide employees with 1 hour of paid sick leave for every 30 hours they work, up to 56 hours of paid sick leave each year. Employees must be permitted to use paid sick leave for their own illness, injury or other health-related needs, including preventive care; to assist a family member (or person who is like family to the employee) who is ill, injured, or has other health-related needs, including preventive care; or for reasons resulting from, or to assist a family member (or person who is like family to the employee) who is a victim of, domestic violence, sexual assault, or stalking. Additional information on contractor requirements and worker protections under the EO is available at https://www.dol.gov/agencies/whd/government-contracts.

Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of ""identifiers"" that indicate whether the particular rate is a union rate (current union negotiated rate for local), a survey rate (weighted average rate) or a union average rate (weighted union average rate).

Union Rate Identifiers

A four letter classification abbreviation identifier enclosed in dotted lines beginning with characters other than ""SU"" or ""UAVG"" denotes that the union classification and rate were prevailing for that classification in the survey. Example: PLUM0198-005 07/01/2014. PLUM is an abbreviation identifier of the union which prevailed in the survey for this classification, which in this example would be Plumbers. 0198

indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. 07/01/2014 is the effective date of the most current negotiated rate, which in this example is July 1, 2014.

Union prevailing wage rates are updated to reflect all rate changes in the collective bargaining agreement (CBA) governing this classification and rate.

Survey Rate Identifiers

Classifications listed under the ""SU"" identifier indicate that no one rate prevailed for this classification in the survey and the published rate is derived by computing a weighted average rate based on all the rates reported in the survey for that classification. As this weighted average rate includes all rates reported in the survey, it may include both union and non-union rates. Example: SULA2012-007 5/13/2014. SU indicates the rates are survey rates based on a weighted average calculation of rates and are not majority rates. LA indicates the State of Louisiana. 2012 is the year of survey on which these classifications and rates are based. The next number, 007 in the example, is an internal number used in producing the wage determination. 5/13/2014 indicates the survey completion date for the classifications and rates under that identifier.

Survey wage rates are not updated and remain in effect until a new survey is conducted.

Union Average Rate Identifiers

Classification(s) listed under the UAVG identifier indicate that no single majority rate prevailed for those classifications; however, 100% of the data reported for the classifications was union data. EXAMPLE: UAVG-OH-0010 08/29/2014. UAVG indicates that the rate is a weighted union average rate. OH indicates the state. The next number, 0010 in the example, is an internal number used in producing the wage determination. 08/29/2014 indicates the survey completion date for the classifications and rates under that identifier.

A UAVG rate will be updated once a year, usually in January of each year, to reflect a weighted average of the current negotiated/CBA rate of the union locals from which the rate is based.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

* an existing published wage determination
* a survey underlying a wage determination
* a Wage and Hour Division letter setting forth a position on a wage determination matter
* a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour National Office because National Office has responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

The request should be accompanied by a full statement of the interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board

U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISIO"

ATTACHMENT B - DAVIS-BACON ACT CERTIFICATE OF ELIGIBILITY

DAVIS-BACON ACT CERTIFICATE OF ELIGIBILITY

(submit with executed Agreement)

In accordance with Davis-Bacon and Related Acts (DBRA) and I certify as stated below.

(i) By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the Contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(ii) No part of this Contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

THE UNDERSIGNED CERTIFIES THAT THE CONTRACTOR WILL COMPLY WITH THE ABOVE REQUIREMENTS.

CONTRACTOR OR

SUBCONTRACTOR NAME: _____

CERTIFIED BY:

NAME: TITLE:

SIGNATURE :_____ DATE:_____

ATTACHMENT C - DBE GUIDANCE DOCUMENT

California State
Water Resources
Control Board
Division of Financial
Assistance

1001 I Street • Sacramento, California 95814 • (916)
341-5700 FAX (916) 341-5707Mailing Address: P. O.
Box 944212 • Sacramento, California • 94244-2120

Internet Address:
http://www.waterboa
rds.ca.gov

Guidelines for Meeting the California State Revolving Fund (CASRF) Programs (Clean Water and Drinking Water SRF) Disadvantaged Business Enterprise Requirements

The Disadvantaged Business Enterprise (DBE) Program is an outreach, education, and objectives program designed to increase the participation of DBEs in the Clean Water State Revolving Fund (CWSRF) and DrinkingWater State Revolving Fund (DWSRF) Programs.

How to Achieve the Purpose of the Program

Recipients of CWSRF/DWSRF financing that are subject to the DBE requirements (recipients) are required to seek, and are encouraged to use, DBEs for their procurement needs. Recipients should award a "fair share" of sub-agreements to DBEs. This applies to all sub-agreements for equipment, supplies, construction, and services.

The key functional components of the DBE Program are as follows:

- Fair Share Objectives
- DBE Certification
- Six Good Faith Efforts
- Contract Administration Requirements
- DBE Reporting

Disadvantaged Business Enterprises are:

- Entities owned and/or controlled by socially and economically disadvantaged individuals as describedby Title X of the Clean Air Act Amendments of 1990 (42 U.S.C. 7601 note) (10% statute), and Public Law 102-389 (42 U.S.C. 4370d) (8% statute), respectively;
- Minority Business Enterprise (MBE) - entities that are at least 51% owned and/or controlled by a sociallyand economically disadvantaged individual as described by Title X of the Clean Air Act Amendments of 1990 (42 U.S.C. 7601 note), and Public Law 102-389 (42 U.S.C. 4370d), respectively;
- Women Business Enterprise (WBE) - entities that are at least 51% owned and/or controlled by women;
- Small Business Enterprise (SBE);

- Small Business in a Rural Area (SBRA);
- Labor Surplus Area Firm (LSAF); or
- Historically Underutilized Business (HUB) Zone Small Business Concern or a concern under asuccessor program.

Certifying DBE Firms:

Under the DBE Program, entities can no longer self-certify and contractors and sub-contractors must be certifiedat bid opening. Contractors and sub-contractors must provide to the CASRF recipient proof of DBE certification. Certifications will be accepted from the following:

- The U.S. Environmental Protection Agency (USEPA)
- The Small Business Administration(SBA)
- The Department of Transportation's State implemented DBE Certification Program (with U.S. citizenship)
- Tribal, State and Local governments
- Independent private organization certifications

If an entity holds one of these certifications, it is considered acceptable for establishing status under the DBEProgram.

Six Good Faith Efforts (GFE)

All CWSRF/DWSRF financing recipients are required to complete and ensure that the prime contractor complieswith the GFE below to ensure that DBEs have the opportunity to compete for financial assistance dollars.

1. Ensure DBEs are made aware of contracting opportunities to the fullest extent practical through outreach and recruitment activities. For Tribal, State and Local Government Recipients, this will includeplacing DBEs on solicitation lists and soliciting them whenever they are potential sources.
2. Make information on forthcoming opportunities available to DBEs. Posting solicitations for bids orproposals for a minimum of 30 calendar days in a local newspaper, before the bid opening date.
3. Consider in the contracting process whether firms competing for large contracts could subcontract withDBEs.
4. Encourage contracting with a group of DBEs when a contract is too large for one firm to handleindividually.
5. Use the services of the SBA **and/or** Minority Business Development Agency (MBDA) of theUS Department of Commerce.
6. If the prime contractor awards subcontracts, require the prime contractor to take the above steps.

The forms listed in the table below and attached to these guidelines; must be completed and submitted with theGFE:

FORM NUMBER	FORM NAME	REQUIREMENT	PROVIDED BY	COMPLETED BY	SUBMITTED TO
SWRCB Form 4500-2 or EPA Form	**DBE Sub-Contractor Participation Form**	**As Needed to Report Issues**	**Recipient**	**Sub-contractor**	**EPA DBE Coordinator**
SWRCB Form 4500-3 or EPA Form	**DBE Sub-Contractor Performance Form**	**Include with Bid or Proposal Package**	**Prime Contractor**	**Sub-Contractor**	**SWRCB by Recipient**
SWRCB Form 4500-4 or EPA Form	**DBE Sub-Contractor Utilization Form**	**Include with Bid or Proposal Package**	**Recipient**	**Prime Contractor**	**SWRCB by Recipient**

The completed forms must be submitted with each Bid or Proposal. The recipient shall review the bidder'sdocuments closely to determine that the GFE was performed **prior** to bid or proposal opening date. Failure to complete the GFE and to substantiate completion of the GFE before the bid opening date could jeopardize CWSRF/DWSRF financing for the project. The following situations and circumstances require action as indicated:

1. If the apparent successful low bidder was rejected, a complete explanation must be provided.

2. Failure of the apparent low bidder to **perform** the GFE **prior** to bid opening constitutes a non- responsive bid. The construction contract may then be awarded to the next low, responsive, andresponsible bidder that meets the requirements or the Recipient may re-advertise the project.

3. If there is a bid dispute, all disputes shall be settled **prior** to submission of the Final Budget ApprovalForm.

Administration Requirements

- A recipient of CWSRF/DWSRF financing must require entities receiving funds to create and maintain aBidders List if the recipient of the financing agreement is subject to, or chooses to follow, competitive bidding requirements.
- The Bidders list must include all firms that bid or quote on prime contracts, or bid or quote onsubcontracts, including both DBEs and non-DBEs.
- Information retained on the Bidder's List must include the following:
    1. Entity's name with point of contact;
    2. Entity's mailing address and telephone number;
    3. The project description on which the entity bid or quoted and when;
    4. Amount of bid/quote; and
    5. Entity's status as a DBE or non-DBE.

- The Bidders List must be kept until the recipient is no longer receiving funding under the agreement.
- The recipient shall include Bidders List as part of the Final Budget Approval Form.
- A recipient must require its prime contractor to pay its subcontractor for satisfactory performance nomore than 30 days from the prime contractor's receipt of payment from the Recipient.
- A recipient must be notified in writing by its prime contractor prior to any termination of a DBEsubcontractor by the prime contractor.
- If a DBE subcontractor fails to complete work under the subcontract for any reason, the recipient mustrequire the prime contractor to employ the six GFEs if soliciting a replacement subcontractor.
- A recipient must require its prime contractor to employ the six GFEs even if the prime contractor hasachieved its fair share objectives.

Reporting Requirements

For the duration of the construction contract(s), the recipient is required to submit to the State Water ResourcesControl Board DBE reports annually by October 10 of each fiscal year on the attached Utilization Report form (UR-334). Failure to provide this information as stipulated in the financial agreement language may be cause forwithholding disbursements.

CONTACT FOR MORE INFORMATION

SWRCB, CASRF - Barbara August (916) 341-6952

barbara.august@waterboards.ca.gov

US EPA, Region 9 - Joe Ochab (415) 972-3761

ochab.joe@epa.gov

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Participation Form

A Financial Assistance Agreement Recipient must require its prime contractors to provide this form to its DBE subcontractors. This form gives a DBE[1] subcontractor[2] the opportunity to describe work received and/or reportany concerns regarding the funded project (e.g., in areas such as termination by prime contractor, late payments, etc.). The DBE subcontractor can, as an option, complete and submit this form to the DBE Coordinator at any time during the project period of performance.

Subcontractor Name	Project Name	
Bid / Proposal No.	Assistance Agreement ID No. (if known)	Point of Contact
Address		
Telephone No.	Email Address	
Prime Contractor Name	Issuing/Funding Entity	

Contract Item Number	**Description of Work Received from the Prime Contractor InvolvingConstruction, Services, Equipment or Supplies**	**Amount Receivedby Prime Contractor**

[1] A DBE is a Disadvantaged, Minority, or Woman Business Enterprise that has been certified by an entity from which EPAaccepts certifications as described in 40 CFR 33.204-33.2015 or certified by EPA. EPA accepts certifications from entities that meet or exceed EPA certification standards as described in 40 CFR 33.202.

[2] Subcontractor is defined as a company, firm, joint venture, or individual who enters into an agreement with a contractorto provide services pursuant to an award of financial assistance.

FORM 4500-2 (DBE Subcontractor Participation Form)

Please use the space below to report any concerns regarding the above funded project:

Subcontractor Signature	Print Name
Title	Date

The public reporting and record keeping burden for this collection of information is estimated to average three (3) hours per response. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques to the Director, Collection Strategies Division, U.S. Environmental Protection Agency (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Do not send the completed form to this address.

Send completed Form 4500-2 to:
Mr. Joe Ochab, DBE Coordinator
US EPA, Region 9
75 Hawthorne Street
San Francisco, CA 94105

FORM 4500-2 (DBE Subcontractor Participation Form)

Disadvantaged Business Enterprise (DBE) Program
DBE Subcontractor Performance Form

This form is intended to capture the DBE[1] subcontractor's[2] description of work to be performed and the price ofthe work submitted to the prime contractor. A Financial Assistance Agreement Recipient must require its primecontractor to have its DBE subcontractors complete this form and include all completed forms in the prime contractor's bid or proposal package.

Subcontractor Name	Project Name	
Bid / Proposal No.	Assistance Agreement ID No. (if known)	Point of Contact
Address		
Telephone No.	Email Address	
Prime Contractor Name	Issuing/Funding Entity	

Contract Item Number	Description of Work Submitted from the Prime Contractor InvolvingConstruction, Services, Equipment or Supplies	Price of Work Submitted to the Prime Contractor
DBE Certified By: _ DOT _ SBA Other: _____	Meets/exceeds EPA certification standards? YES NO Unknown	

[1] A DBE is a Disadvantaged, Minority, or Woman Business Enterprise that has been certified by an entity from which EPA accepts certifications as described in 40 CFR 33.204-33.2015 or certified by EPA. EPA accepts certifications from entities that meet or exceed EPA certification standards as described in 40 CFR 33.202.

[2] Subcontractor is defined as a company, firm, joint venture, or individual who enters into an agreement with a contractor to provide services pursuant to an award of financial assistance.

FORM 4500-3 (DBE Subcontractor Performance Form)

I certify under penalty of perjury that the forgoing statements are true and correct. Signing this form does notsignify a commitment to utilize the subcontractors above. I am aware that in the event of a replacement of a subcontractor, I will adhere to the replacement requirements set forth in 40 CFR Part 33 Section 33.302 (c).

Prime Contractor Signature	Print Name
Title	Date

Subcontractor Signature	Print Name
Title	Date

The public reporting and record keeping burden for this collection of information is estimated to average three (3) hours perresponse. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques tothe Director, Collection Strategies Division, U.S. Environmental Protection Agency (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Do not send the completed form to this address.

FORM 4500-3 (DBE Subcontractor Performance Form)

Disadvantaged Business Enterprise(DBE) Program
DBE Subcontractor Utilization Form

This form is intended to capture the prime contractor's actual and/or anticipated use of identified certified DBE[1] subcontractor's[2] and the estimated dollar amount of each subcontract. A Financial Assistance Agreement Recipient must require its prime contractors to complete this form and include it in the bid or proposal package. Prime contractors should also maintain a copy of this form on file.

Prime Contractor Name		Project Name
Bid / Proposal No.	Assistance Agreement ID No. (if known)	Point of Contact
Address		
Telephone No.		Email Address
Issuing/Funding Entity		

I have identified potential DBE certified subcontractors. YES NO If *yes*, please complete the table below. If *no*, please explain:

Subcontractor Name/Company Name	**Company Address / Phone / Email**	**Estimated Dollar Amount**	**Currently DBE Certified?**

--Continue on back if needed--

[1] A DBE is a Disadvantaged, Minority, or Woman Business Enterprise that has been certified by an entity from which EPA accepts certifications as described in 40 CFR 33.204-33.2015 or certified by EPA. EPA accepts certifications from entities that meet or exceed EPA certification standards as described in 40 CFR 33.202.

[2] Subcontractor is defined as a company, firm, joint venture, or individual who enters into an agreement with a contractor to provide services pursuant to an award of financial assistance.

FORM 4500-4 (DBE Subcontractor Utilization Form)

I certify under penalty of perjury that the forgoing statements are true and correct. Signing this form does notsignify a commitment to utilize the subcontractors above. I am aware that in the event of a replacement of a subcontractor, I will adhere to the replacement requirements set forth in 40 CFR Part 33 Section 33.302 (c).

Prime Contractor Signature	Print Name
Title	Date

The public reporting and record keeping burden for this collection of information is estimated to average three (3) hours perresponse. Send comments on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques tothe Director, Collection Strategies Division, U.S. Environmental Protection Agency (2822T), 1200 Pennsylvania Ave., NW, Washington, D.C. 20460. Do not send the completed form to this address.

FORM 4500-4 (DBE Subcontractor Utilization Form)

STATE WATER RESOURCES CONTROL BOARD - DIVISION OF FINANCIAL ASSISTANCE
DISADVANTAGED BUSINESS ENTERPRISE (DBE) UTILIZATION
CALIFORNIA STATE REVOLVING FUNDS (CASRF)FORM UR-334

1. Grant/Finance Agreement Number:	2. Annual Reporting Period 10/1/___through 09/30/	3. Purchase Period of Financing Agreement:
4. Total Payments Paid to Prime Contractor or Sub-Contractors During Current Reporting Period: $		
5. Recipient's Name and Address:	6. Recipient's Contact Person and Phone Number:	

7. List All DBE Payments Paid by Recipient or Prime Contractor During Current Reporting Period:

Payment or Purchase Paid by Recipient or Prime Contractor	Amount Paid to Any DBE Contractor orSub-Contractor For Service Provided to Recipient		Date of Payment (MM/DD/YY)	Procurement Type Code** (see below)	Name and Address of DBE Contractor ofSub-Contractor or Vendor
	MBE	**WBE**			

8. Initial here if no DBE contractors or sub-contractors paid during current reporting period:
9. Initial here if all procurements for this contract are completed:
10. Comments:

11. Signature and Title of Recipient's Authorized Representative	12. Date

****Procurement Type:**

1. Construction
2. Supplies
3. Services (includes business services; professional services; repair services and personnel services)
4. Equipment

Email Form UR-334 to:

DrinkingWaterSRF@waterboards.ca.gov OR CleanWaterSRF@waterboards.ca.gov

Questions may be directed to:

Barbara August, SWRCB
Barbara.August@waterboards.ca.gov

Phone:(916) 341-6952
Fax: (916) 327-7469

STATE WATER RESOURCES CONTROL BOARD - DIVISION OF FINANCIAL ASSISTANCE
DISADVANTAGED BUSINESS ENTERPRISE (DBE) UTILIZATION
CALIFORNIA STATE REVOLVING FUNDS INSTRUCTIONS

FOR COMPLETING FORM UR-334

Box 1 Grant or Financing Agreement Number.

Box 2 Annual reporting period.

Box 3 Enter the dates between which you made procurements under this financing agreement or grant.

Box 4 Enter the total amount of payments paid to the contractor or sub-contractors during this reporting period.

Box 5 Enter Recipient's Name and Address.

Box 6 Enter Recipient's Contact Name and Phone Number.

Box 7 Enter details for the **DBE purchases only** and be sure to limit them to the current period.

1) Use either an "R" or a "C" to represent "Recipient" or "Contractor." 2) Enter a dollar totalfor DBE and total the two columns at the bottom of the section. 3) Provide the payment date. 4) Enter a product type choice from those at the bottom of the page. 5) List the vendor name and address in the right-hand column

Box 8 Initial here if no DBE contractors or sub-contractors were paid during this reporting period.

Box 9 Initial this box only if all purchases under this financing agreement or grant have been completed during this reporting period or a previous period. If you initial this box, we will no longer send you a survey.

Box 10 This box is for explanatory information or questions.

Box 11 Provide an authorized representative signature.

Box 12 Enter the date form completed.

DEBARMENT AND SUSPENSION CERTIFICATION

TITLE 49, CODE OF FEDERAL REGULATIONS, PART 29

The bidder, under penalty of perjury, certifies that, except as noted below, he/she or any other person associated therewith in the capacity of owner, partner, director, officer, manager:

- is not currently under suspension, debarment, voluntary exclusion, or determination of ineligibility by any Federal agency;
- has not been suspended, debarred, voluntarily excluded or determined ineligible by any Federal agency within the past 3 years;
- does not have a proposed debarment pending; and
- has not been indicted, convicted, or had a civil judgment rendered against it by a court of competent jurisdiction in any matter involving fraud or official misconduct within the past 3 years.

If there are any exceptions to this certification, insert the exceptions in the following space.

Exceptions will not necessarily result in denial of award, but will be considered in determining bidder responsibility. For any exception noted above, indicate below to whom it applies, initiating agency, and dates of action.

Notes: Providing false information may result in criminal prosecution or administrative sanctions.

The above certification is part of the Proposal. Signing this Proposal on the signature portion thereof shall also constitute signature of this Certification.

EQUAL EMPLOYMENT OPPORTUNITY CERTIFICATION

The bidder_____, proposed subcontractor _____, hereby certifies that he has ___ , has not _____, participated in a previous contract or subcontract subject to the equal opportunity clauses, as required by Executive Orders 10925, 11114, or 11246, and that, where required, he has filed with the Joint Reporting Committee, the Director of the Office of Federal Contract Compliance, a Federal Government contracting or administering agency, or the former President's Committee on Equal Employment Opportunity, all reports due under the applicable filling requirements.

Note: The above certification is required by the Equal Employment Opportunity Regulations of the Secretary of Labor (41 CFR 60-1.7(b) (1)), and must be submitted by bidders and proposed subcontractors only in connection with contracts and subcontracts which are subject to the equal opportunity clause. Contracts and subcontracts which are exempt from the equal opportunity clause are set forth in 41 CFR 60-1.5. (Generally only contracts or subcontracts of $10,000 or under are exempt.)

Currently, Standard Form 100 (EEO-1) is the only report required by the Executive Orders or their implementing regulations.

Proposed prime contractors and subcontractors who have participated in a previous contract or subcontract subject to the Executive Orders and have not filed the required reports should note that 41 CFR 60-1.7(b) (1) prevents the award of contracts and subcontracts unless such contractor submits a report covering the delinquent period or such other period specified by the Federal Highway Administration or by the Director, Office of Federal Contract Compliance, U.S. Department of Labor.

NONLOBBYING CERTIFICATION
FOR FEDERAL-AID CONTRACTS

The prospective participant certifies, by signing and submitting this bid or proposal, to the best of his or her knowledge and belief, that:

(l) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

(2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any Federal agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure of Lobbying Activities," in conformance with its instructions.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by Section 1352, Title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

The prospective participant also agrees by submitting his or her bid or proposal that he or she shall require that the language of this certification be included in all lower tier subcontracts, which exceed $100,000 and that all such subrecipients shall certify and disclose accordingly.

DISCLOSURE OF LOBBYING ACTIVITIES

COMPLETE THIS FORM TO DISCLOSE LOBBYING ACTIVITIES PURSUANT TO 31 U.S.C. 1352

1. Type of Federal Action:

☐ a. contract
b. grant
c. cooperative agreement
d. loan
e. loan guarantee
f. loan insurance

2. Status of Federal Action:

☐ a. bid/offer/application
b. initial award
c. post-award

3. Report Type:

☐ a. initial
b. material change

For Material Change Only:
year ____ quarter_____
date of last report _____

4. Name and Address of Reporting Entity

☐ Prime ☐ Subawardee
Tier _____, if known

Congressional District, if known

5. If Reporting Entity in No. 4 is Subawardee, Enter Name and Address of Prime:

Congressional District, if known

6. Federal Department/Agency:

7. Federal Program Name/Description:

CFDA Number, if applicable _____

8. Federal Action Number, if known:

9. Award Amount, if known:

10. a. Name and Address of Lobby Entity
(If individual, last name, first name, MI)

b. Individuals Performing Services (including address if different from No. 10a)
(last name, first name, MI)

(attach Continuation Sheet(s) if necessary)

11. Amount of Payment (check all that apply)

$_____ ☐ actual ☐ planned

12. Form of Payment (check all that apply):

☐ a. cash
☐ b. in-kind; specify: nature_____
value _____

13. Type of Payment (check all that apply)

☐ a. retainer
☐ b. one-time fee
☐ c. commission
☐ d. contingent fee
☐ e deferred
☐ f. other, specify _____

14. Brief Description of Services Performed or to be performed and Date(s) of Service, including officer(s), employee(s), or member(s) contacted, for Payment Indicated in Item 11:

(attach Continuation Sheet(s) if necessary)

15. Continuation Sheet(s) attached: **Yes** ☐ **No** ☐

16. Information requested through this form is authorized by Title 31 U.S.C. Section 1352. This disclosure of lobbying reliance was placed by the tier above when his transaction was made or entered into. This disclosure is required pursuant to 31 U.S.C. 1352. This information will be reported to Congress semiannually and will be available for public inspection. Any person who fails to file the required disclosure shall be subject to a civil penalty of not less than

Signature: _____

Print Name: _____

Title: _____

$10,000 and not more than $100,000 for each such failure. Telephone No.: _____Date: _____

Authorized for Local Reproduction
Standard Form - LLL

Federal Use Only:

INSTRUCTIONS FOR COMPLETION OF SF-LLL, DISCLOSURE OF LOBBYING ACTIVITIES

This disclosure form shall be completed by the reporting entity, whether subawardee or prime Federal recipient, at the initiation or receipt of covered Federal action or a material change to previous filing pursuant to title 31 U.S.C. section 1352. The filing of a form is required for such payment or agreement to make payment to lobbying entity for influencing or attempting to influence an officer or employee of any agency, a Member of Congress an officer or employee of Congress or an employee of a Member of Congress in connection with a covered Federal action. Attach a continuation sheet for additional information if the space on the form is inadequate. Complete all items that apply for both the initial filing and material change report. Refer to the implementing guidance published by the Office of Management and Budget for additional information.

1. Identify the type of covered Federal action for which lobbying activity is and/or has been secured to influence, the outcome of a covered Federal action.
2. Identify the status of the covered Federal action.
3. Identify the appropriate classification of this report. If this is a follow-up report caused by a material change to the information previously reported, enter the year and quarter in which the change occurred. Enter the date of the last, previously submitted report by this reporting entity for this covered Federal action.
4. Enter the full name, address, city, state and zip code of the reporting entity. Include Congressional District if known. Check the appropriate classification of the reporting entity that designates if it is or expects to be a prime or subaward recipient. Identify the tier of the subawardee, e.g., the first subawardee of the prime is the first tier. Subawards include but are not limited to subcontracts, subgrants and contract awards under grants.
5. If the organization filing the report in Item 4 checks "Subawardee" then enter the full name, address, city, state and zip code of the prime Federal recipient. Include Congressional District, if known.
6. Enter the name of the Federal agency making the award or loan commitment. Include at least one organization level below agency name, if known. For example, Department of Transportation, United States Coast Guard.
7. Enter the Federal program name or description for the covered Federal action (item 1). If known, enter the full Catalog of Federal Domestic Assistance (CFDA) number for grants, cooperative agreements, loans and loan commitments.
8. Enter the most appropriate Federal identifying number available for the Federal action identification in item 1 (e.g., Request for Proposal (RFP) number, Invitation for Bid (IFB) number, grant announcement number, the contract grant. or loan award number, the application/proposal control number assigned by the Federal agency). Include prefixes, e.g., "RFP-DE-90-001."
9. For a covered Federal action where there has been an award or loan commitment by the Federal agency, enter the Federal amount of the award/loan commitments for the prime entity identified in item 4 or 5.
10. (a) Enter the full name, address, city, state and zip code of the lobbying entity engaged by the reporting entity identified in item 4 to influenced the covered Federal action.
    (b) Enter the full names of the individual(s) performing services and include full address if different from 10 (a). Enter Last Name, First Name and Middle Initial (Ml).
11. Enter the amount of compensation paid or reasonably expected to be paid by the reporting entity (item 4) to the lobbying entity (item 10). Indicate whether the payment has been made (actual) or will be made (planned). Check all boxes that apply. If this is a material change report, enter the cumulative amount of payment made or planned to be made.
12. Check the appropriate box. Check all boxes that apply. If payment is made through an in-kind contribution, specify the nature and value of the in-kind payment.
13. Check the appropriate box. Check all boxes that apply. If other, specify nature.

14. Provide a specific and detailed description of the services that the lobbyist has performed or will be expected to perform and the date(s) of any services rendered. Include all preparatory and related activity not just time spent in actual contact with Federal officials. Identify the Federal officer(s) or employee(s) contacted or the officer(s) employee(s) or Member(s) of Congress that were contacted.
15. Check whether or not a continuation sheet(s) is attached.
16. The certifying official shall sign and date the form, print his/her name title and telephone number.

Public reporting burden for this collection of information is estimated to average 30 minutes per response, including time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0046), Washington, D.C. 20503. SF-LLL-Instructions Rev. 06-04-90«ENDIF»

SECTION II

GENERAL CONDITIONS

CITY OF PETALUMA - GENERAL CONDITIONS

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ARTICLE 1 - DEFINITIONS

Whenever used in these General Conditions or in the other Contract Documents, the following terms have the meanings indicated in this Article 1 which meanings are applicable to both the singular and plural thereof. If a word which is entirely in upper case in these definitions is found in lower case in the Contract Documents, then the lower case word will have its ordinary meaning.

Addenda - Written or graphic instruments issued prior to the opening of Bids which make additions, deletions, or revisions to the Contract Documents.

Agreement - The written contract between the CITY and the CONTRACTOR covering the WORK to be performed; other documents are attached to the Agreement and made a part thereof as provided therein.

Application for Payment - The form accepted by the ENGINEER which is to be used by the CONTRACTOR to request progress payments or final payment and which is to be accompanied by such supporting documentations as is required by the Contract Documents.

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

Bid - The offer or proposal of the bidder submitted on the prescribed form setting forth the price or prices for the WORK.

Bonds - Bid, Performance, and Labor and Materials, and Maintenance Bonds and other instruments of security.

Change Order - A document recommended by the ENGINEER, which is signed by the CONTRACTOR and the CITY, and authorizes an addition, deletion, or revision in the WORK, or an adjustment in the Contract Price or the Contract Times, issued on or after the Effective Date of the Agreement.

CITY - The City of Petaluma.

Clarification - A document issued by the ENGINEER to the CONTRACTOR that clarifies the requirements(s) and/or design intent of the Contract Documents, which may not represent an addition, deletion, or revision in the WORK or an adjustment in the Contract Price or the Contract Times.

Contract Documents - The Notice Inviting Bids, Instructions to Bidders, Bid Forms (including the Bid, Bid Schedule(s), Information Required of Bidder, Bid Bond, and all required certificates, affidavits and other documentation), Agreement, Performance Bond, Labor and Materials Bond, Maintenance Bond, General Conditions, any Supplementary General

Conditions, Special Provisions, Specifications, Drawings, all Addenda, and Change Orders executed pursuant to the provisions of the Contract Documents. Shop Drawings are not Contract Documents.

Contract Price - The total monies payable by the CITY to the CONTRACTOR under the terms and conditions of the Contract Documents.

Contract Times - The number or numbers of successive calendar days or dates stated in the Contract Documents for the completion of the WORK.

CONTRACTOR - The individual, partnership, corporation, joint-venture, or other legal entity with whom the CITY has executed the Agreement.

Day - A calendar day of 24 hours measured from midnight to the next midnight.

Defective Work - Work that is unsatisfactory, faulty, or deficient; or that does not conform to the Contract Documents; or that does not meet the requirements of any inspection, reference standard, test, or approval referred to in the Contract Documents; or work that has been damaged prior to the ENGINEER's recommendation of final payment.

Drawings - The drawings, plans, maps, profiles, diagrams, and other graphic representations which indicate the character, location, nature, extent, and scope of the WORK and which have been prepared by the ENGINEER and are included and/or referred to in the Contract Documents. Shop Drawings are not Drawings as so defined.

Effective Date of the Agreement - The date indicated in the Agreement on which it becomes effective, but if no such date is indicated it means the date which the Agreement is signed and delivered by the last of the two parties to sign and deliver.

ENGINEER - The City Manager or his/her designee.

Field Order - A written order issued by the ENGINEER which may or may not involve a change in the WORK.

Hazardous Waste - The term Hazardous Waste shall have the meaning provided in Section 1004 of the Solid Waste Disposal Act (42 U.S.C. Section 6906) as amended from time to time.

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

Lien or Mechanic's Lien - A form of security, an interest in real property, which is held to secure the payment of an obligation. When related to public works construction, Lien or Mechanic's Lien may be called Stop Notice.

Milestone - A principal event specified in the Contract Documents relating to an intermediate completion date of a separately identifiable part of the WORK or a period of time within which the separately identifiable part of the WORK should be performed prior to completion of all the WORK.

Notice of Award - The written notice by the CITY to the apparent successful bidder stating that upon compliance by the apparent successful bidder with the conditions precedent enumerated therein within the time specified, the CITY will enter into an Agreement.

Notice of Completion - A form signed by the ENGINEER and the CONTRACTOR recommending to the CITY that the WORK is Complete and fixing the date of completion. After acceptance of the WORK by the CITY Council, the form is signed by the CITY and filed with the County Recorder. This filing starts the 30 day lien filing period on the WORK.

Notice to Proceed - The written notice issued by the CITY to the CONTRACTOR authorizing the CONTRACTOR to proceed with the WORK for the purpose for which it is intended prior to completion of all the WORK.

Partial Utilization - Use by the CITY of a completed part of the WORK for the purpose for which it is intended prior to completion of all the WORK.

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

Project - The total construction project of which the WORK to be provided under the Contract Documents may be the whole, or as part as indicated elsewhere in the Contract Documents.

Record Drawings - Drawings generated by marking a set of Drawings to reflect all of the changes that have occurred during construction of the Project.

Resident Project Representative - The authorized representative of the ENGINEER who is assigned to the Site or any part thereof.

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

Shop Drawings - All drawings, diagrams, illustrations, schedules, and other data which are specifically prepared by or for the CONTRACTOR and submitted by the CONTRACTOR to illustrate some portion of WORK.

Site - Lands or other areas designated in the Contract Documents as being furnished by the CITY for the performance of the construction, storage, or access.

Special Provisions - Specific clauses setting forth conditions or requirements peculiar to the work and supplementary to the Standard Specifications.

Specifications - The directions, provisions and requirements set forth in the Standard Specifications as supplemental and modified by the special provisions.

Stop Notice - A legal remedy for subcontractors and suppliers who contribute to public works, but who are not paid for their work, which secures payment from construction funds possessed by the CITY. In some states, for public property, the Stop Notice remedy is designed to substitute for a mechanic's lien.

Subcontractor - An individual, partnership, corporation, joint-venture, or other legal entity having a direct contract with the CONTRACTOR or with any other subcontractor for the performance of a part of the WORK at the Site.

Supplementary General Conditions - The part of the Contract Documents which make additions, deletions, or revisions to these General Conditions.

Supplier - A manufacturer, fabricator, distributor, materialman, or vendor having a direct contract with the CONTRACTOR or with any Subcontractor to furnish materials, equipment, or product to be incorporated in the WORK by the CONTRACTOR or any Subcontractor.

Utilities - All pipelines, conduits, ducts, cables, wires, tracks, manholes, vaults, tanks, tunnels, or other such facilities or attachments, and any encasements containing such facilities which have been installed underground or above the ground to furnish any of the following services or materials; water, sewage, sludge, drainage, fluids, electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, traffic control, or other control systems.

WORK - The entire completed construction or the various separately identifiable parts thereof required to be furnished under the Contract Documents. WORK is the result of performing or furnishing labor and furnishing and incorporating materials and equipment into the construction, and performing or furnishing services and furnishing documents, all as required by the Contract Documents.

Working day - Any day except Saturdays, Sundays and CITY holidays.

ARTICLE 2 – PRELIMINARY MATTERS

2.1 DELIVERY OF BONDS AND INSURANCE CERTIFICATES

A. When the CONTRACTOR delivers the signed Agreement to the CITY, the CONTRACTOR shall also deliver to the CITY such Bonds and insurance policies and certificates as the CONTRACTOR may be required to furnish in accordance with the Contract Documents.

2.2 COPIES OF DOCUMENTS

A. The CITY will furnish to the CONTRACTOR the required number of copies of the Contract Documents specified in the Supplementary General Conditions.

2.3 COMMENCEMENT OF CONTRACT TIMES; NOTICE TO PROCEED

A. The Contract Times will start to run on the commencement date stated in the Notice to Proceed.

2.4 STARTING THE WORK

A. The CONTRACTOR shall begin to perform the WORK on the commencement date stated in the Notice to Proceed, but no work shall be done at the Site prior to said commencement date.

B. Before undertaking each part of the WORK, the CONTRACTOR shall review the Contract Documents in accordance with Paragraph 3.3.

2.5 PRECONSTRUCTION CONFERENCE

A. The CONTRACTOR is required to attend a preconstruction conference. This conference will be attended by the CITY, ENGINEER, and others as appropriate in order to discuss the WORK.

B. The CONTRACTOR's initial schedule submittals for shop drawings, obtaining permits, and Plan of Operation and CPM Schedule will be reviewed and finalized. At a minimum, the CONTRACTOR's representatives shall include its project manager, project superintendent and schedule expert. If the submittals are not finalized at the end of the meeting, additional meetings will be held so that the submittals can be finalized prior to the submittal of the first Application for Payment. No Application for Payment will be processed prior to receiving acceptable initial submittals from the CONTRACTOR.

ARTICLE 3 – INTENT AND USE OF CONTRACT DOCUMENTS

3.1 INTENT

A. The Contract Documents comprise the entire agreement between the CITY and the CONTRACTOR concerning the WORK. The Contract Documents are complementary; what is called for by one is as binding as if called for by all. The Contract Documents will be construed in accordance with the law of the State of California .

B. It is the intent of the Contract Documents to describe the WORK, functionally complete, to be constructed in accordance with the Contract Documents. Any

labor, documentation, services, materials, or equipment that may reasonably be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the intended result will be provided whether or not called for specifically.

C. When words or phrases which have a well-known technical or construction industry or trade meaning are used to describe work, materials, or equipment such words or phrases shall be interpreted in accordance with that meaning unless a definition has been provided in Article 1 of the General Conditions.

3.2 REFERENCE TO STANDARDS

A. Reference to standard specifications, manuals, or codes of any technical society, organization, or association, or to the Laws or Regulations of any governmental authority, whether such reference be specific or by implication, shall mean the latest standard specification, manual, code, or Laws or Regulations in effect at the time of opening of Bids, except as may be otherwise specifically stated. However, no provision of any referenced standard specification, manual or code shall be effective to change the duties and responsibilities of the CITY or the CONTRACTOR or any of their consultants, agents or employees, from those set forth in the CONTRACT Documents, nor shall it be effective to assign to CITY any duty or authority to direct the performance of the WORK or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract Documents.

3.3 REVIEW OF CONTRACT DOCUMENTS

A. If, during the performance of the WORK, CONTRACTOR discovers any conflict, error, ambiguity or discrepancy within the Contract Documents or between the Contract Documents and any provision of any such Law or Regulation applicable to the performance of the WORK or of any such standard, specification, manual, or code, or of any instruction of any Supplier, CONTRACTOR shall report it to ENGINEER in writing at once, and CONTRACTOR shall not proceed with the work affected thereby (except in an emergency as authorized by Paragraph 6.13 until a Clarification, Field Order, or Change Order to the Contract Documents has been issued.

3.4 ORDER OF PRECEDENCE OF CONTRACT DOCUMENTS

A. Unless otherwise noted herein, conflicts or inconsistencies between parts of the Contract will be resolved by the ENGINEER with a Change Order or an Addendum, if required. Addenda and Change Orders bearing the most recent date shall prevail over Addenda or Change Orders bearing earlier dates. Any reference to addenda-changed specifications or drawings shall be considered to have been changed accordingly. In resolving conflicts resulting from errors or discrepancies in any of the Contract Documents, the order of precedence shall be as follows:

1. Change Orders/Addenda (most recent in time take precedence)
2. Agreement and Bond Forms
3. Referenced Standard Specifications
4. Special Provisions
5. Drawings
6. General Conditions
7. Instructions to Bidders
8. Contractor's Bid (Bid Form)
9. Notice Inviting Bids
10. Supplementary General Conditions (if any)
11. Permits from other agencies as may be required by law

B. With reference to the Drawings the order of precedence is as follows:

1. Figures govern over scaled dimensions
2. Detail drawings govern over general drawings
3. Addenda/Change Order drawings govern over any other drawings
4. Drawings govern over standard drawings

3.5 AMENDING CONTRACT DOCUMENTS

A. The Contract Documents may be amended to provide for additions, deletions, and revisions in the WORK or to modify the terms and conditions thereof by a Change Order (pursuant to Article 10).

3.6 REUSE OF DOCUMENTS

A. Neither the CONTRACTOR, nor any Subcontractor or Supplier, nor any other person or organization performing any of the WORK under a contract with the CITY shall have or acquire any title to or ownership rights in any of the Drawings, Technical Specifications, or other documents used on the WORK, and they shall no reuse any of them on the extensions of the Project or any other project without written consent of CITY.

ARTICLE 4 – SITE OF THE WORK

4.1 AVAILABILITY OF LANDS

A. The CITY will furnish, as indicated in the Contract Documents, the lands upon which the WORK is to be performed, rights-of-way and easements for access thereto, and such other lands which are designated for the use of the CONTRACTOR. Easements for permanent structures or permanent changes in existing facilities will be obtained and paid for by the CITY, unless otherwise provided in the Contract Documents. Nothing contained in the Contract Documents shall be interpreted as giving the CONTRACTOR exclusive occupancy of the lands or rights-of-way provided. The CONTRACTOR shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment; provided, that the CONTRACTOR shall not enter upon nor use any property not under the control of the CITY until a written temporary construction easement agreement has been executed by the CONTRACTOR and the property owner, and a copy of said easement furnished to the ENGINEER prior to said use; and the CITY will not be liable for any claims or damages resulting from the CONTRACTOR's trespass on or use of any such properties. The CONTRACTOR shall provide the CITY with a signed release from the property owner confirming that the lands have been satisfactorily restored upon completion of the WORK.

4.2 REPORTS OF PHYSICAL CONDITIONS

A. **Subsurface Explorations**: Reference is made to any Supplementary General Conditions for identification of those reports of explorations and tests of subsurface conditions at the Site that have been utilized by the ENGINEER in the preparation of the Contract Documents.

B. **Existing Structures**: Reference is made to any Supplementary General Conditions for identification of those drawings of physical conditions in or relating to existing surface and subsurface structures (except underground Utilities referred to in Paragraph 4.3 herein) which are at or contiguous to the Site that have been utilized in the preparation of the Contract Documents.

C. The CITY makes no representation as to the completeness of the reports or drawings referred to in Paragraph 4.2 A or B above or the accuracy of any data or information contained therein. The CONTRACTOR may rely upon the accuracy of the technical data contained in such reports and drawings. However, the CONTRACTOR may not rely upon any interpretation of such technical data, including any interpolation or extrapolation thereof, or any non-technical data, interpretations, and opinions contained therein.

4.3 PHYSICAL CONDITIONS - UNDERGROUND UTILITIES

A. **Indicated**: The information and data indicated in the Contract Documents with respect to existing underground Utilities at or contiguous to the Site are based on information and data furnished to the CITY or the ENGINEER by the owners of such underground Utilities or by others. Unless it is expressly provided in any Supplementary General Conditions the CITY will not be responsible for the accuracy or completeness of any such information or data, and the CONTRACTOR shall have full responsibility for reviewing and checking all such information and data, for locating all underground Utilities indicated in the Contract Documents, for coordination of the WORK with the owners of such underground Utilities during construction, for the safety and protection thereof and repairing any damage thereto resulting from the WORK, the cost of all of which are deemed to have been included in the Contract Price.

B. **Not Indicated**: If an underground Utility is uncovered or revealed at or contiguous to the Site which was not indicated in the Contract Documents and which the CONTRACTOR could not reasonably have been expected to be aware of, the CONTRACTOR shall identify the owner of such underground Utility and give written notice thereof to that owner and shall notify the ENGINEER.

4.4 DIFFERING SITE CONDITIONS

A. The CONTRACTOR shall notify the ENGINEER, in writing, of the following unforeseen conditions, hereinafter called differing Site conditions, promptly upon their discovery (but in no event later than 14 days after their discovery) and before they are disturbed:

1. Subsurface or latent physical conditions at the Site of the WORK differing materially from those indicated, described, or delineated in the Contract Documents, including those reports discussed in Paragraph 4.2, 4.3, and 4.5.

B. The ENGINEER will review the pertinent conditions, determine the necessity of obtaining additional explorations or tests with respect thereto.

C. If the ENGINEER concludes that because of newly discovered conditions a change in the Contract Documents is required, a Change Order will be issued as provided in Article 10 to reflect and document the consequences of the difference.

D. In each such case, an increase or decrease in the Contract Price or an extension or shortening the Contract Times, or any combination thereof, will be allowable to the extent that they are attributable to any such difference. If the ENGINEER and the CONTRACTOR are unable to agree as to the amount or length thereof, a claim may be made therefor as provided in Articles 11 and 12.

E. The CONTRACTOR's failure to give notice of differing Site conditions within 14 days of their discovery and before they are disturbed shall constitute a waiver of all claims in connection therewith, whether direct or consequential in nature.

4.5 HAZARDOUS MATERIALS

A. CITY shall be responsible for any Asbestos, Hazardous Waste, Petroleum, or Radioactive Material uncovered or revealed at the Site which was not shown or indicated in Drawings or Specifications or identified in the Contract Documents to be within the scope of the WORK and which may present a substantial danger to persons or property exposed thereto in connection with the WORK at the Site. CITY will not be responsible for any such material brought to the Site by CONTRACTOR, Subcontractors, Suppliers, or anyone else for whom CONTRACTOR is responsible.

1. Upon discovery of any Asbestos, Hazardous Waste, Petroleum, or Radioactive Material, the CONTRACTOR shall immediately stop all work in any area affected thereby (except in an emergency as required by Paragraph 6.13) and notify ENGINEER (and therefore confirm such notice in writing). CONTRACTOR shall not be required to resume any work in any such affected area until after CITY has obtained any required permits related thereto and delivered to CONTRACTOR special written notice. Such written notice will specify that such condition and any affected area is or has been rendered safe for the resumption of the work or specify any special conditions under which the work may be resumed safely. If ENGINEER and CONTRACTOR cannot agree as to entitlement to or the amount or extent of adjustment, if any, in Contract Price or Contract Times as a result of such work stoppage or such special conditions under which work is agreed by CONTRACTOR to be resumed, either party may make a claim therefor as provided in Articles 11 and 12.

2. If, after receipt of such special written notice, CONTRACTOR does not agree to resume such WORK based on a reasonable belief it is unsafe, or does not agree to resume such WORK under special conditions, ENGINEER may order such portion of the WORK that is in connection with such hazardous condition or in such affected area to be deleted from the WORK. If ENGINEER and CONTRACTOR cannot agree as to entitlement to or the amount or extent of an adjustment, if any, in Contract Price or Contract Times as a result of deleting such portion of the WORK then either party may make a claim therefor as provided in Articles 11 and 12. CITY may have such deleted portion of the WORK performed by CITY's own forces or others in accordance with Article 7.

B. The provisions of Paragraphs 4.2, 4.3, and 4.4 are not intended to apply to Asbestos, Petroleum, Hazardous Waste, or Radioactive Material uncovered or revealed at the Site.

4.6 REFERENCE POINTS

A. The ENGINEER will provide the location and elevation of one bench mark, near or on the Site of the WORK, for use by the CONTRACTOR for alignment and elevation control. Unless otherwise specified in any Supplementary General Conditions, the CONTRACTOR shall furnish all other lines, grades, and bench marks required for proper execution of the WORK.

B. The CONTRACTOR shall preserve or replace any and all bench marks, section corners, witness corners, stakes, and other survey marks, and in case of their removal or destruction by any party, the CONTRACTOR shall be responsible for the accurate replacement of such reference points by surveyor licensed under the applicable state codes governing land surveyors.

ARTICLE 5 – BONDS AND INSURANCE

5.1 BONDS

A. The CONTRACTOR shall furnish Performance and Labor and Materials Bonds, each in the amount of one hundred percent (100%) of the contract price, as security for the faithful performance and payment of all the CONTRACTOR's obligations under the Contract Documents. These Bonds shall remain in effect at least until one year after the date of completion, except as otherwise provided by Law or Regulation or by the Contract Documents. The CONTRACTOR shall also furnish such other Bonds as are required by the Supplementary General Conditions.

B. The CONTRACTOR shall guarantee the WORK to be free of defects in material and workmanship for a period of one (1) year following the CITY's acceptance of the WORK. The CONTRACTOR shall agree to make, at the CONTRACTOR's own expense, any repairs or replacements made necessary by defects in material or workmanship which become evident within the one-year guarantee period. The CONTRACTOR's guarantee against defects required by this provision shall be secured by a Maintenance Bond, in the amount of ten percent (10%) of the contract price, which shall be delivered by the CONTRACTOR to the CITY prior to acceptance of the WORK. The Maintenance Bond shall remain in force for one (1) year from the date of acceptance of the contracted WORK. The CONTRACTOR shall make all repairs and replacements within the time required during the guarantee period upon receipt of written order from the ENGINEER. If the CONTRACTOR fails to make the repairs and replacements within the required time, the CITY may do the work and the CONTRACTOR and the CONTRACTOR's surety for the Maintenance Bond shall be liable to the CITY for the cost. The expiration of the Maintenance Bond during the one-year guarantee period does not operate to waive or void the one-year guarantee, as set forth herein and in paragraph 6.16 of these General Conditions.

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

D. If the surety on any Bond furnished by the CONTRACTOR is declared a bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the WORK is located, the CONTRACTOR shall within 7 days thereafter substitute another Bond and surety, which must be acceptable to the CITY.

E. All Bonds required by the Contract Documents to be purchased and maintained by CONTRACTOR shall be obtained from surety companies that are duly licensed or authorized in the State of California to issue Bonds for the limits so required. Such surety companies shall also meet such additional requirements and qualifications as may be provided in the Supplementary General Conditions.

5.2 INSURANCE

Contractor and any subcontractor shall not commence work under this Agreement until Contractor shall have obtained all insurance required under this paragraph and such insurance shall have been approved by the City Attorney as to form and carrier and the City Manager as to sufficiency, nor shall Contractor allow any contractor or subcontractor to commence work on this contract or subcontract until all similar insurance required of the contractor and/or subcontractor shall have been so obtained and approved. All requirements herein provided shall appear either in the body of the insurance policies or as endorsements and shall specifically bind the insurance carrier.

CONTRACTOR shall procure and maintain for the duration of the contract all necessary insurance against claims for injuries to persons or damages to property which may arise from or in connection with the performance of the work hereunder by the Contractor, the Contractor's agents, representatives, employees or subcontractors.

A. **Minimum Scope of Insurance**

Coverage shall be at least as broad as:

1. Insurance Services Office Commercial General Liability coverage.

2. Insurance Services Office form number CA covering Automobile Liability, code 1 (any auto).

3. Workers' Compensation insurance as required by the State of California and Employer's Liability Insurance.

4. [Optional] Such other insurance coverages and limits as may be required by the CITY as follows: _____.

B. **Minimum Limits of Insurance**

CONTRACTOR shall maintain limits no less than:

1. General Liability: $2,000,000 per occurrence for bodily injury, personal injury and property damage. If Commercial General Liability Insurance or other form with a general aggregate liability is used, either the general aggregate limit shall apply separately to this project/location or the general aggregate limit shall be twice the required occurrence limit.

2. Automobile Liability: $1,000,000 per accident for bodily injury and property damage.

3. Employer's Liability: Bodily Injury by Accident - $1,000,000 each accident
   Bodily Injury by Disease - $1,000,000 policy limit
   Bodily Injury by Disease - $1,000,000 each employee

C. **Deductibles and Self-Insured Retentions**

Any deductibles or self-insured retentions must be declared to and approved by the CITY. At the option of the CITY, either: the insurer shall reduce or eliminate such deductibles or self-insured retentions as respects the CITY, its officers, officials, employees, and volunteers; or the CONTRACTOR shall procure a bond guaranteeing payment of losses and related investigations, claim administration and defense expenses.

D. **Other Insurance Provisions**

The required general liability and automobile policies are to contain, or be endorsed to contain the following provisions:

1. The CITY, its officers, officials, employees, agents and volunteers are to be covered as insureds as respects: liability arising out of activities performed by or on behalf of the CONTRACTOR; products and completed operations of the CONTRACTOR; premises owned, occupied or used by the CONTRACTOR; or automobiles owned, leased, hired or borrowed by the CONTRACTOR. The coverage shall contain no special limitations on the scope of protection afforded to the CITY, its officers, officials, employees, agents or volunteers.

2. For any claims related to this project, the CONTRACTOR's insurance coverage shall be primary insurance as respects the CITY, its officers, officials, employees, agents and volunteers. Any insurance or self-insurance maintained by the CITY, its officers, officials, employees, agents or volunteers shall be excess of the CONTRACTOR's insurance and shall not contribute with it.

3. Any failure to comply with reporting or other provisions of the policies including breaches of warranties shall not affect coverage provided to the CITY, its officers, officials, employees, agents or volunteers.

4. The CONTRACTOR's insurance shall apply separately to each insured against whom claim is made or suit is brought except, with respect to the limits of the insurer's liability.

5. Each insurance policy required by this clause shall be endorsed to state that coverage shall not be suspended, voided, canceled by either party, reduced in coverage or in limits except after thirty (30) days' prior written notice by certified mail, return receipt requested, has been given to the CITY.

E. **Acceptability of Insurers**

Insurance is to be placed with insurers with a current A.M. Best's ration of no less than A:VII.

F. **Verification of Coverage**

CONTRACTOR shall furnish the CITY with original endorsements effecting coverage required by this clause. The endorsements are to be signed by a person authorized by that insurer to bind coverage on its behalf. The endorsements are to be on forms provided by the CITY. All endorsements are to be received and

approved by the CITY before work commences. As an alternative to the CITY's forms, the CONTRACTOR's insurer may provide complete, certified copies of all required insurance policies, including endorsements effecting the coverage required by these specifications.

ARTICLE 6 – CONTRACTOR'S RESPONSIBILITIES

6.1 COMMUNICATIONS

A. Written communications with the CITY shall be only through or as directed by the ENGINEER.

6.2 SUPERVISION AND SUPERINTENDENCE

A. The CONTRACTOR shall supervise, inspect, and direct the WORK competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the WORK in accordance with the Contract Documents. The CONTRACTOR shall be solely responsible for the means, methods, techniques, sequences, and procedures of construction and all safety precautions and programs incidental thereto. The CONTRACTOR shall be responsible to see that the completed WORK complies accurately with the Contract Documents.

B. The CONTRACTOR shall designate in writing and keep on the Site at all times during the performance of the WORK a technically qualified, English-speaking superintendent, who is an employee of the CONTRACTOR and who shall not be replaced without written notice to the ENGINEER. The superintendent will be the CONTRACTOR's representative at the Site and shall have authority to act on behalf of the CONTRACTOR. All communications given to the superintendent shall be as binding as if given to the CONTRACTOR.

C. The CONTRACTOR's superintendent shall be present at the Site at all times while work is in progress and shall be available by phone for emergencies 24 hours per day, 7 days per week. Failure to observe this requirement shall be considered suspension of the WORK by the CONTRACTOR until such time as such superintendent is again present at the Site.

6.3 LABOR, MATERIALS, AND EQUIPMENT

A. The CONTRACTOR shall provide competent, suitably qualified personnel to survey and lay out the WORK and perform construction as required by the Contract Documents. The CONTRACTOR shall furnish, erect, maintain, and remove the construction plant and any required temporary works. The CONTRACTOR shall at all times maintain good discipline and order at the Site. Except in connection with the safety or protection of persons or the WORK or property at the Site or adjacent thereto, and except as otherwise indicated in the

Contract Documents, all work at the Site shall be performed during regular working hours, and the CONTRACTOR will not permit overtime work or the performance of work on Saturday, Sunday, or any federally observed holiday without the CITY's written consent. The CONTRACTOR shall apply for this consent through the ENGINEER in writing a minimum of 24 hours in advance.

B. Except as otherwise provided in this Paragraph, the CONTRACTOR shall receive no additional compensation for overtime work, i.e., work in excess of 8 hours in any one calendar day or hours in any one calendar week, even though such overtime work may be required under emergency conditions and may be ordered by the ENGINEER in writing. Additional compensation will be paid to the CONTRACTOR for overtime work only in the event extra work is ordered by the ENGINEER and the Change Order specifically authorizes the use of overtime work and then only to such extent as overtime wages are regularly being paid by the CONTRACTOR for overtime work of a similar nature in the same locality.

C. All increased costs of inspection and testing performed during overtime work by the CONTRACTOR which is allowed solely for the convenience of the CONTRACTOR shall be borne by the CONTRACTOR. The CITY has the authority to deduct the cost of all such inspection and testing from any partial payments otherwise due to the CONTRACTOR.

D. Unless otherwise specified in the Contract Documents, the CONTRACTOR shall furnish and assume full responsibility for all materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, lubricants, power, light, heat, telephone, water, sanitary facilities, and all other facilities, consumables, and incidentals necessary for the furnishing, performance, testing, start-up, and completion of the WORK.

E. All materials and equipment incorporated into the WORK shall be of specified quality and new, except as otherwise provided in the Contract Documents. All warranties and guarantees specifically called for by the Specifications shall expressly run to the benefit of the CITY. If required by the ENGINEER, the CONTRACTOR shall furnish satisfactory evidence (including reports of required tests) as to the source, kind and quality of materials and equipment. All materials and equipment shall be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with the instructions of the applicable Supplier except as otherwise provided in the Contract Documents; but no provisions of any such instructions will be effective to assign to the CITY or any of its consultants, agents, or employees, any duty or authority to supervise or direct the furnishing or performance of the WORK or any duty or authority to undertake responsibility contrary to the provisions of Paragraph 9.9 C.

F. The work, unless otherwise permitted or approved by the ENGINEER, shall be completed with the incorporated use of equipment, materials, and/or products where such are specified. Substitutions and equal alternatives will be permitted as

provided in this article; however, neither the request for substitution nor the offer of alternatives shall in any way by their submittal obligate the CITY to assent to any request or offer. Failure of the CONTRACTOR awarded the work to either submit requests for substitutions or to offer alternatives within the required times provided in this General Condition will be considered as evidence that the work shall be accomplished with trade-named equipment, materials, and/or products as identified in the Specifications and/or the Drawings.

G. Unless otherwise provided elsewhere in the Contract, all equipment, materials, and/or products incorporated into the work shall be new and, where not specified, shall be of the highest quality of the respective kinds for the intended use, and all workmanship shall meet or exceed applicable construction industry standards and practices. If equipment, materials, and/or products are designated by listing named manufacturers of particular equipment, materials, and/or products followed by the words "or equal," then the CONTRACTOR may furnish the named equipment, materials, and/or products or any equal equipment, materials, and/or products. The first-named manufacturer of particular equipment, materials, and/or products is the basis for the design shown on the Project Drawings. A subsequently named manufacturer or particular equipment, materials, and/or products has been determined to be an acceptable substitution but may require modifications in the Project's design and its ultimate construction to accommodate its use. If such subsequently named items are selected by the CONTRACTOR for incorporation into the work, the CONTRACTOR shall assume all costs required for modifications to the equipment, materials, and/or products, and Project design and construction as may be required for said items' use. Substitutions for an unnamed "equal" item of material shall be permitted upon compliance of the procedures set forth in Paragraph I of this article. If a CONTRACTOR makes use of an unnamed "equal" product as a substitute for a specifically named material or product, the CONTRACTOR shall assume all costs required to make the necessary revisions or modifications to accommodate the use of said unnamed product.

H. Before beginning the work and within thirty-five (35) calendar days after award of the Contract, the CONTRACTOR shall submit a List of Materials to the ENGINEER for review. The List shall include all items of equipment, materials, and/or products to be incorporated into the work and the names of suppliers with whom purchase orders have been placed. The names on the List shall be arranged in the same order as in the specifications, and shall contain sufficient data to identify precisely the items of equipment, materials, and/or products the CONTRACTOR proposes to furnish. The List shall include Specifications or Drawing references. Once the submission is determined to be acceptable to the ENGINEER, it shall be returned to the CONTRACTOR.

I. Substitution for those equipment, materials, and/or products specified shall only be permitted when the proposed unnamed "equal" product or material to be furnished is both equal in quality and utility and after the CONTRACTOR has

complied with the following provisions: (1) All substitutions shall be reviewed by the ENGINEER. (2) The ENGINEER must approve such substitution in writing prior to its incorporation into the work. (3) Unless otherwise authorized in writing by the CITY, the CONTRACTOR shall, within thirty-five (35) calendar days of award and prior to placing any purchase orders, but at least thirty (30) calendar days before it requires approval of any such alternative item, submit to the CITY sufficient data, drawings, samples, literature, or other detailed information as will demonstrate to the ENGINEER that the proposed substitute is equal in quality and utility to the equipment, materials and/or products specified.

1. Within thirty (30) calendar days following receipt of all requested information from the CONTRACTOR, the ENGINEER will determine whether the proposed alternative is equal in quality and utility and meets the requirements of the Contract and will inform the CONTRACTOR in writing of such determination. The burden of substantiating the quality and utility of alternatives shall be upon the CONTRACTOR, and the CONTRACTOR shall furnish all necessary information requested and required by the ENGINEER. The ENGINEER will be the sole judge as to the quality and utility of alternative equipment, materials, and/or products, and the ENGINEER's decision shall be final. An acceptance by the ENGINEER of a substitution shall not relieve the CONTRACTOR from complying with the requirements of the Drawings and Specifications. Acceptance by the ENGINEER shall not relieve the CONTRACTOR from full responsibility for the efficiency, sufficiency, and quality and performance of the substitute equipment, materials, and/or products, in the same manner and degree as the equipment, materials, and/or products specified by name.

2. Failure of the CONTRACTOR to submit proposed substitutions for review in the manner described above and within the time prescribed shall be sufficient cause for rejection by the CITY of any other proposed substitutions.

3. In determining whether a proposed product is equal in quality and utility, the ENGINEER is not restricted to such basic issues as performance and durability, but may consider any other issues that the ENGINEER, in the discretion of the ENGINEER, deems appropriate. Said issues may, but are not required to include, nor are they limited to, such additional factors as comparable performance, reliability, efficiency of operation, ease of operation, adaptability, ease of maintenance, capital costs, life-cycle costs, operational characteristics, costs of training personnel, maintenance history, warranties, problems created by the resulting overall warranty system, availability of qualified service, availability of parts, the history of any supplier and compatibility with existing facilities.

4. No one factor or group of factors, including such issues as savings on capital costs, shall be determinative of whether the proposed product or material is equal in quality and utility. The decision of the ENGINEER shall be based on those factors deemed by the ENGINEER to be relevant and any data, drawings, samples, literature, or other detailed information furnished by the CONTRACTOR with respect to the proposed substitution. Each decision as to whether a product or material is equal in quality and utility shall be made by the ENGINEER on a case-by-case basis.

5. The CONTRACTOR shall be responsible for any and all costs, including consultant costs, incurred by the CITY with respect to the proposed substitution that exceed the costs inherent in the normal and reasonable review of drawings and other standard data, information, and documents concerning any proposed substitution. The CONTRACTOR shall be responsible for this cost, regardless of whether or not the substitution is approved by the ENGINEER.

J. Unless otherwise provided in the Contract, the title and interest in the right to the use of all water, and the title to all soil, stone, gravel, sand, minerals, timber, and all other materials developed or obtained within the Project limits from operations by the CONTRACTOR or any of its subcontractors, of any of their representatives or employees, and the right to use or dispose of the same are hereby expressly reserved in the CITY; and neither the CONTRACTOR nor any of its subcontractors, nor any of their representatives or employees, shall have any right, title, or interest in or to any part thereof.

K. All material used under the Contract after it has been attached or affixed to the work or soil and after partial payment has been made therefore shall become the property of the CITY.

L In the event that any Indian relics or items possessing archaeological or historical value are discovered by the CONTRACTOR or any of its subcontractors or any of their representatives or employees, the CONTRACTOR shall immediately notify the ENGINEER and await the ENGINEER's decision before proceeding with any work. The CONTRACTOR shall have no property right in such relics and items.

M. The CONTRACTOR shall be satisfied as to the quantity of acceptable materials or products which may be produced or obtained at local sources, and the CITY will not assume any responsibility as to the quantities or quality of acceptable materials or products available.

N. The CONTRACTOR, with the permission of the ENGINEER, may use in the proposed construction such stone, gravel, sand, or other material suitable in the opinion of the ENGINEER as may be found in excavation.

O. Existing equipment, materials, and/or products to be salvaged shall remain the property of the CITY. Salvage to be reinstalled in the work shall be refurbished as required before reinstallation. Other work to be salvaged shall be carefully removed and handled in such a manner as to avoid damage and shall be delivered to storage at a location designated by the ENGINEER.

6.4 SCHEDULE

A. The CONTRACTOR shall comply with the schedule requirements in the Special Provisions or as otherwise provided in the Contract Documents.

6.5 SUBSTITUTES OR "OR EQUAL" ITEMS

A. The CONTRACTOR shall submit proposed substitutes or "or equal" items in accordance with the Bidding Requirements. No request for substitution of an "or equal" item will be considered by the ENGINEER after award of the Contract, except as provided in Paragraph 6.3I herein.

6.6 CONCERNING SUBCONTRACTORS, SUPPLIERS, AND OTHERS

A. The CONTRACTOR shall be responsible to the CITY for the acts and omissions of its Subcontractors, Suppliers, and their employees to the same extent as CONTRACTOR is responsible for the acts and omissions of its own employees. Nothing contained in this Paragraph shall create any contractual relationship between any Subcontractor and the CITY nor relieve the CONTRACTOR of any liability or obligation under the Contract Documents. The CONTRACTOR shall include these General Conditions and the Supplementary General Conditions as part of all its subcontract and supply agreements.

6.7 PERMITS

A. Unless otherwise provided in any Supplementary General Conditions, the CONTRACTOR shall obtain and pay for all constructions permits and licenses from the agencies having jurisdiction, including the furnishing of insurance and bonds if required by such agencies. The enforcement of such requirements shall not be made the basis for claims for additional compensation by CONTRACTOR. When necessary, the CITY will assist the CONTRACTOR, in obtaining such permits and licenses. The CONTRACTOR shall pay all charges of utility owners for inspection or connections to the WORK.

6.8 PATENT FEES AND ROYALTIES

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

process, product, or device is specified in the Contract Documents for use in the performance of the WORK and if to the actual knowledge of the ENGINEER its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights will be disclosed by the ENGINEER in the Contract Documents. The CONTRACTOR's indemnification obligation under this Paragraph 6.8 A. for all claims and liabilities arising out of any infringement of patent rights or copyrights incident to the use in the performance of the WORK or resulting from the incorporation in the WORK of any invention, design, process, product or device not specified in the Contract Documents shall be in accordance with Paragraph 6.16 of these General Conditions.

6.9 LAWS AND REGULATIONS

A. The CONTRACTOR shall observe and comply with all Laws and Regulations which in any manner affect those engaged or employed on the WORK, the materials used in the WORK, or the conduct of the WORK including, but not limited to, all applicable safety Laws and Regulations. If any discrepancy or inconsistency should be discovered between the Contract Documents and any such Laws or Regulations, the CONTRACTOR shall report the same in writing to the ENGINEER. Any particular Law or Regulation specified or referred to elsewhere in the Contract Documents shall not in any way limit the obligation of the CONTRACTOR to comply with al other provisions of federal, state, and local laws and regulations. The CONTRACTOR's indemnification obligations for all claims or liability arising from violation of any such law, ordinance, code, order, or regulation, whether by CONTRACTOR or by its employees, Subcontractors or Suppliers shall be in accordance with Paragraph 6.16 of these General Conditions.

6.10 TAXES

A. The CONTRACTOR shall pay all sales, consumer, use, and other similar taxes required to be paid by the CONTRACTOR in accordance with the laws and regulations of the place of the Project which are applicable during the performance of the WORK.

6.11 USE OF PREMISES

A. The CONTRACTOR shall confine construction equipment, the storage of materials and equipment, and the operations of workers to the Site, the land and areas identified in and permitted by the Contract Documents, and the other land and areas permitted by Laws and Regulations, rights-of-way, permits, and easements. The CONTRACTOR shall assume full liability and responsibility for any damage to any such land or area, or to the owner or occupant thereof or of any land or areas contiguous thereto, resulting from the performance of the WORK. Should any claim be made against the CITY by any such owner or occupant because of the performance of the WORK, the CONTRACTOR shall

promptly attempt to settle with such other party by agreement or otherwise resolve the claim through litigation at the CONTRACTOR's sole liability expense. The CONTRACTOR's indemnification obligations for all claims and liability, arising directly, indirectly, or consequentially out of any action, legal or equitable, brought by any such owner or occupant against the CITY, its consultants, subconsultants, and the officers, directors, employees and agents of each and any of them to the extent caused by or based upon the CONTRACTOR's performance of the WORK shall be in accordance with Paragraph 6.16 of these General Conditions.

6.12 SAFETY AND PROTECTION

A. The CONTRACTOR shall be solely responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the WORK. The CONTRACTOR shall be responsible for the direction and control of the work assigned and for assuring that all workers on the project understand the hazards of the work involved and the safe work procedures required for each job. The CONTRACTOR shall assure that its subcontractors of all tiers shall, without expense to the CITY, comply with this safety responsibility. No work shall proceed until each worker and subcontractor understands the scope of the work and all safety rules and work procedures to be followed. The CONTRACTOR shall not allow a new employee or new subcontractor to begin work on CITY projects without a full and proper safety orientation. The CONTRACTOR shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage to prevent damage, injury or loss to:

1. All persons at the Site and other persons and organizations who may be affected thereby;

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

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

B. The CONTRACTOR shall comply with all applicable Laws and Regulations relating to the safety of persons or property or to the protection of persons or property from damage, injury, or loss and shall erect and maintain all necessary safeguards for such safety and protection. The CONTRACTOR shall notify owners of adjacent property and utilities when prosecution of the WORK may effect them, and shall cooperate with them in the protection, removal, relocation, and replacement of their property. CONTRACTOR'S duties and responsibilities for safety and for protection of the WORK shall continue until such time as all the

WORK is completed and ENGINEER has issued a notice to the CONTRACTOR in accordance with Paragraph 14.7 B. that the WORK is acceptable.

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

D. Materials that contain hazardous substances or mixtures may be required on the WORK. A Material Safety Data Sheet shall be made available at the Site by the CONTRACTOR for every hazardous product used.

E. Material usage shall strictly conform to OSHA safety requirements and all manufacturer's warnings and application instructions listed on the Material Safety Data Sheet and on the product container label.

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

G. The CONTRACTOR shall notify the ENGINEER if it considers a specified product or its intended use to be unsafe. This notification must be given to the ENGINEER prior to the product being ordered, or if provided by some other party, prior to the product being incorporated in the WORK.

H. Before starting work, the CONTRACTOR shall submit a written safety program to the CITY. The objective of the safety program shall be accident prevention. Such program shall include, but not be limited to, the following:

1. An organization chart and accompanying narrative which describes the responsibility for employee and public safety of those individuals who control each phase of operations and set forth in writing the policies and procedures to be followed by all personnel. The chart shall also show the CONTRACTOR's internal lines of communication (including subcontractors) for the program.

2. A specific program for communication between the CONTRACTOR and CITY on safety matters. The CONTRACTOR shall also designate one person with whom official contact can be made by the CITY on safety matters.

3. Evidence that the CONTRACTOR has become thoroughly familiar with the potential hazards of the work and applicable federal and state regulations.

4. Specific safety procedures and guidelines for conduct of the Work.

5. The CITY's review, comment upon, and/or acceptance of the CONTRACTOR's safety program and/or plan does not in any way negate the responsibilities of the CONTRACTOR for safety or place any responsibility upon the CITY for such safety. Such review comment and/or acceptance shall not be construed as limiting in any manner the CONTRACTOR's obligation to undertake any action which may be necessary or required to establish and maintain safe working conditions at the site.

6.13 EMERGENCIES

A. In emergencies affecting the safety or protection of persons or the WORK or property at the Site or adjacent thereto, CONTRACTOR, without special instruction or authorization from ENGINEER, is obligated to immediately act to prevent threatened damage, injury, or loss. CONTRACTOR shall give ENGINEER prompt written notice if CONTRACTOR believes that any significant changes in the WORK or variations from the Contract Documents have been caused thereby. If ENGINEER determines that a change in the Contract Documents have been caused thereby. If ENGINEER determines that a change in the Contract Documents is required because of the action taken by CONTRACTOR in response to such an emergency, a Change Order will be issued to document the consequences of such action.

6.14 SUBMITTALS

A. After checking and verifying all field measurements and after complying with applicable procedures specified in the Special Provisions, the CONTRACTOR shall submit to the ENGINEER for review all Shop Drawings and details of all structural and reinforcing steel, equipment, electrical controls, structural fabrications, pipe, pipe joints, special pipe sections, and other appurtenances in accordance with the accepted schedule of Shop Drawing submittals specified in the Special Provisions or as otherwise provided in the Contract Documents.

B. The ENGINEER’S review will be only to determine if the items covered by the submittals will, after installation or incorporation in the WORK, generally conform to the Contract Documents and with the design concept of the completed Project. The ENGINEER's favorable review shall be obtained before any such items are manufactured or used in the work. The favorable review of Drawings by the ENGINEER shall apply in general design only and shall in no way relieve the CONTRACTOR from responsibility for errors or omissions contained therein. Favorable review by the ENGINEER shall not relieve the CONTRACTOR of its obligation to meet safety requirements and all other requirements of law. The ENGINEER will start reviewing the CONTRACTOR's submittals only after the

Notice to Proceed is issued by the CITY with the exception of some unusual long lead items which may require submittals prior to issuing the Notice to Proceed.

C. The CONTRACTOR shall also submit to the ENGINEER for review all Samples in accordance with the accepted schedule of Sample submittals specified in the Special Provisions or as otherwise provided in the Contract Documents.

D. Before submittal of each Shop Drawing or Sample, the CONTRACTOR shall have determined and verified all quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers, and similar data with respect thereto and reviewed or coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the WORK and the Contract Documents. The CONTRACTOR shall provide submittals in accordance with the requirements of the Special Provisions or as otherwise provided in the Contract Documents.

E. Shop-drawing submittal and coordination are the responsibility of the prime contractor; this responsibility shall not be delegated in whole or in part to subcontractors or suppliers. Any designation of work "by others," shown on Shop Drawings, shall mean that the work will be the responsibility of the CONTRACTOR rather than the subcontractor or supplier who has prepared the Shop Drawings.

Submittals shall be prepared in such form that data can be identified with the applicable Specification paragraph. The data shall demonstrate clearly compliance with the Drawings and Specifications and shall relate to the specific equipment to be furnished. Where manufacturer's standard drawings are employed, they shall be marked clearly to show what portions of the data are applicable to this Project.

F. Review of shop-drawing submittals by the ENGINEER has as its primary objective the completion for the CITY of a Project in full conformance with the Drawings and Specifications, unmarred by field corrections, and within the time provided. In addition to this primary objective, shop-drawing review as a secondary objective will assist the CONTRACTOR in its procurement of equipment that will meet all requirements of the Drawings and Specifications, will fit the structures detailed on the Drawings, will be complete with respect to piping, electrical, and control connections, will have the proper functional characteristics, and will become an integral part of a complete operating facility. Acceptance of Shop Drawings and submittals does not constitute a change order to the Contract requirements.

G. Where the CONTRACTOR is required by these Specifications to make submittals, they shall be submitted to the ENGINEER with a letter of transmittal and in sufficient number of copies to allow a distribution of at least one (1) copy to all parties needing a copy to carry out the provisions of the Specifications, including three (3) copies to be retained by the ENGINEER. The ENGINEER

shall determine the appropriate number of such copies required at the time of the preconstruction conference.

H. Within twenty-five (25) calendar days of receipt by the ENGINEER of each of the CONTRACTOR's submissions and all appurtenant data required for their review, the appropriate number of copies will be returned to the CONTRACTOR with one of the following notations:

1. Resubmittal not required; correction, if any, noted.

2. Correct and resubmit; corrections noted.

Returned copies of Drawings marked with Notation "1" authorize the CONTRACTOR to proceed with the operations covered by such returned copies, provided that such operations be subject to the comments, if any, shown on such returned copies. Returned copies of Drawings marked with Notation "2" shall be corrected, as necessary and required, and shall be submitted in the same manner as before.

I. When submittals are favorably reviewed, the ENGINEER will retain three (3) copies and will return all other copies to the CONTRACTOR. When submittals are not favorably reviewed, the ENGINEER will retain only two (2) copies and will return all others to the CONTRACTOR. It is considered reasonable that the CONTRACTOR shall make a complete and acceptable submission to the ENGINEER at least by the second submission of data. The CITY reserves the right to deduct monies from payments due the CONTRACTOR to cover additional costs of the ENGINEER's review beyond the second submission.

J. Favorable review by the ENGINEER will not constitute acceptance by the ENGINEER of any responsibility for the accuracy, coordination, and completeness of the Shop Drawings or the items of equipment represented on the Drawings. Accuracy, coordination, and completeness of Shop Drawings shall be the sole responsibility of the CONTRACTOR, including responsibility to back check comments, corrections, and modifications from the ENGINEER's review before fabrication. Supplemental, specific requirements for Shop Drawings and details are contained in the applicable technical sections of these Specifications.

K. Copies of schedules and Shop Drawings submitted to the ENGINEER for review shall be such as to provide three (3) copies for the ENGINEER's files, and such additional copies as the CONTRACTOR may desire for its own office files and/or for distribution by it to subcontractors or vendors. Exceptions will be noted in specific sections of Specifications. All Shop Drawings and supporting data, catalogs, and schedules shall be submitted as the instruments of the CONTRACTOR, who shall be responsible for their accuracy and completeness. These submittals may be prepared by the CONTRACTOR, subcontractors, or suppliers, but the CONTRACTOR shall ascertain that submittals meet all of the

requirements of the Contract, while conforming to structural, space, and access conditions at the point of installation. The CONTRACTOR shall check all submittals before submitting them to the ENGINEER.

L. The ENGINEER shall check and review schedules, drawings, etc., submitted by the CONTRACTOR only for general design conformance with the concept of the Project and compliance with the Contract. Shop Drawings shall not be used to order products' fabrication or delivery for construction or installation unless submitted to and favorably reviewed by the ENGINEER. Acceptance by the ENGINEER of any drawings, method of work, or any information regarding materials and equipment the CONTRACTOR proposes to furnish shall not relieve the CONTRACTOR of its responsibility for any errors therein and shall not be regarded as an assumption of risks or liability by the Design ENGINEER or the CITY, or any officer or employee thereof, and the CONTRACTOR shall have no recourse against the CITY under the Contract on account of the failure or partial failure or inefficiency or insufficiency of any plan or method of work or material and equipment so accepted. Such acceptance shall be considered to mean merely that the ENGINEER has no objection to the CONTRACTOR using, upon its own full responsibility, the plan or method of work proposed or furnishing the materials and equipment proposed.

6.15 CONTINUING THE WORK

A. The CONTRACTOR shall carry on the WORK and adhere to the progress schedule during all disputes or disagreements with the CITY. No WORK shall be delayed or postponed pending resolution of any disputes or disagreements, except as the CONTRACTOR and the CITY may otherwise agree in writing.

6.16 CONTRACTOR’S GENERAL WARRANTY AND GUARANTEE

A. CONTRACTOR warrants and guarantees that all WORK will be in accordance with the Contract Documents and will not be defective. The CONTRACTOR represents that the WORK performed pursuant to the Contract shall be of the quality specified or of the highest quality if no quality is specified, and shall conform to the Contract Documents. The CONTRACTOR warrants all equipment, material, products, and workmanship furnished and all work performed under the Contract against defects for a period of one (1) year after final acceptance regardless of whether the same were furnished or performed by the CONTRACTOR or by any of its subcontractors or suppliers of any tier.

B. The CONTRACTOR shall make, at its own expense, all repairs and/or replacements necessitated by defects in the equipment, materials, and/or products and in the workmanship provided by the CONTRACTOR or any of its subcontractors that become evident within the warranty period.

C. Upon receipt of written notice from the CITY of any breach of warranty during the applicable warranty period, the affected item shall be redesigned, repaired, or replaced by the CONTRACTOR and the CONTRACTOR shall perform such tests as the CITY may require to verify that such redesign, repair, and replacement comply with the requirements of the Contract. The CITY shall have the right to operate and use such equipment, materials, and/or products until they can, without damage to the CITY, be taken out of service for correction or replacement by the CONTRACTOR. As to the redesigned, repaired, or replaced work, the CONTRACTOR warrants such redesigned, repaired, or replaced work against defective design, equipment, materials, products, and workmanship for a period of one (1) year from and after the date of satisfactory completion of such redesigned, repaired, or replaced work. The CITY reserves the right to require that the CONTRACTOR performs such repair or replacement work.

D. The CITY also reserves the right to make such repairs or replacements, if, within seven (7) calendar days after the mailing of a notice in writing to the CONTRACTOR and Surety, the CONTRACTOR shall neglect to make or undertake with due diligence the aforesaid repairs or replacements and that Surety within seven (7) calendar days after mailing of a notice in writing of such negligence of the CONTRACTOR shall neglect to make or undertake with due diligence the aforesaid repairs or replacements itself, provided, however, that in the case of an emergency where in the opinion of the CITY delay would cause hazard to health or serious loss or damage, repair may be made without notice being sent to the CONTRACTOR or Surety, and the CONTRACTOR shall pay the cost thereof.

E. All costs including workforce and materials incidental to such redesign, repair, replacement, and testing, including the removal, replacement, and reinstallation of equipment necessary to gain access and all other costs incurred as the result of a breach of warranty shall be borne by the CONTRACTOR whether performed by the CITY or the CONTRACTOR.

F. Nothing in this section shall be construed to limit, relieve, or release the CONTRACTOR, subcontractor's, and equipment, materials, and/or products suppliers, and other service providers' liability to the CITY for damages sustained as the result of latent defects in the workmanship, equipment, materials, and/or products done and/or furnished by the CONTRACTOR, its subcontractors, suppliers and/or other service providers.

G. The Performance Bond shall extend for a period of one (1) year after acceptance of the Contract by the CITY and shall cover the CONTRACTOR’s obligations resulting from the warranty requirements herein specified.

H. CONTRACTOR’s warranty and guarantee hereunder excludes defects or damage caused by:

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

2. Normal wear and tear under normal usage.

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

1. Observations by ENGINEER;

2. Recommendation by ENGINEER or payment by CITY of any progress or final payment;

3. The issuance of a Certificate of Completion by the CITY;

4. Use or occupancy of the WORK or any part thereof by the CITY;

5. Any acceptance by CITY or any failure to do so;

6. Any review and approval of a Shop Drawing or Sample submittal or the issuance of a notice or acceptability by ENGINEER pursuant to Paragraph 14.7 B.;

7. Any inspection, test, or approval by others; or

8. Any correction of Defective Work by CITY.

6.17 INDEMNIFICATION

A. Contractor shall indemnify, defend with counsel acceptable to City, and hold harmless to the full extent permitted by law, City and its officers, officials, employees, agents and volunteers from and against any and all liability, loss, damage, claims, expenses and costs (including, without limitation, attorney fees and costs and fees of litigation) (collectively, "Liability") of every nature arising out of or in connection with Contractor's performance of the WORK or its failure to comply with any of its obligations contained in this Agreement, except such Liability caused by the active negligence, sole negligence or willful misconduct of the City. Such indemnification by the CONTRACTOR shall include, but not be limited to, the following:

1. Liability or claims resulting directly or indirectly from the negligence or carelessness of the CONTRACTOR, its subcontractors, employees, or

agents in the performance of the WORK, or in guarding or maintaining the same, or from any improper materials, implements, or appliances used in its construction, or by or on account of any act or omission of the CONTRACTOR, its employees, or agents;

2. Liability or claims arising directly or indirectly from bodily injury, occupational sickness or disease, or death of the CONTRACTOR's, or Supplier's own employees, or agents engaged in the WORK resulting in actions brought by or on behalf of such employees against the CITY and/or the ENGINEER;

3. Liability or claims arising directly or indirectly from or based on the violation of any Laws or Regulations, whether by the CONTRACTOR, its subcontractors, employees, or agents;

4. Liability or claims arising directly or indirectly from the use or manufacture by the CONTRACTOR, its subcontractors, employees, or agents in the performance of this Agreement of any copyrighted or uncopyrighted composition, secret process, patented or unpatented invention, article, or appliance, unless otherwise specified stipulated in this Agreement;

5. Liability or claims arising directly or indirectly from the breach of any warranties, whether express or implied, made to the CITY or any other parties by the CONTRACTOR, its subcontractors, employees, or agents;

6. Liability or claims arising directly or indirectly from the willful misconduct of the CONTRACTOR, its subcontractors, employees, or agents;

7. Liability or claims arising directly or indirectly from any breach of the obligations assumed in this Agreement by the CONTRACTOR;

8. Liability or claims arising directly or indirectly from, relating to, or resulting from a hazardous condition created by the CONTRACTOR, Subcontractors, Suppliers, or any of their employees or agents, and;

9. Liability or claims arising directly, or indirectly, or consequentially out of any action, legal or equitable, brought against the CITY, the ENGINEER, their consultants, subconsultants, and the officers, directors, employees and agents of each or any of them, to the extent caused by the CONTRACTOR's use of any premises acquired by permits, rights of way, or easements, the Site, or any land or area contiguous thereto or its performance of the WORK thereon.

B. The CONTRACTOR shall reimburse the CITY for all costs and expenses, (including but not limited to fees and charges of engineers, architects, attorneys, and other professionals and court costs of appeal) incurred by said CITY in enforcing the provisions of this Paragraph.

C. The indemnification obligation under this Article 11 shall not be limited in any way by any limitation on the amount or type of insurance carried by CONTRACTOR or by the amount or type of damages, compensation, or benefits payable by or for the CONTRACTOR or any Subcontractor or other person or organization under workers' compensation acts, disability benefit acts, or other employee benefit acts.

D. Pursuant to California Public Contract Code Section 9201, City shall timely notify Contractor of receipt of any third-party claim relating to this Agreement.

6.18 CONTRACTOR'S DAILY REPORTS

A. The CONTRACTOR shall complete a daily report indicating location worked, total manpower for each construction trade, major equipment on Site, each Subcontractor's manpower and equipment, weather conditions, and other related information involved in the performance of the WORK. These components will be decided by the ENGINEER.

6.19 CONTRACT DOCUMENTS AND RECORD DRAWINGS

A. The CONTRACTOR shall keep on the work site a copy of the Contract Documents and shall at all times give the ENGINEER access thereto. Any drawings included in the Specifications shall be regarded as part thereto and of the Contract. Anything mentioned in these Specifications and not shown on the Project Drawings, or shown on the Project Drawings and not mentioned in these Specifications, shall be of like effect as though shown or mentioned in both. The ENGINEER will furnish from time to time such detail drawings, plans, profiles, and information as he may consider necessary for the CONTRACTOR's guidance. It shall be the duty of the CONTRACTOR to see that the provisions of the Contract Documents are complied with in detail irrespective of the inspection given the work during its progress by the ENGINEER. Any failure on the part of the CONTRACTOR to observe the requirements contained in the Contract Documents will be sufficient cause for the rejection of the work at any time before its acceptance.

B. The CONTRACTOR shall maintain, at the jobsite, one record set of Drawings in good order and clearly marked to show any deviations which have been made from the Drawings, including concealed construction and utility features which are revealed during the course of construction. Marked prints shall be updated at least once each week and shall be available to the ENGINEER for review as to

currency prior to developing partial payment estimates. Upon completion of the work, the marked set of prints shall be delivered to the ENGINEER.

C. In the case of those drawings which depict the detail requirement for equipment to be assembled and wired in the factory, such as motor control centers and the like, the Record Drawings shall be updated by indicating those portions which are superseded by change order drawings or final shop drawings, and by including appropriate reference information describing the change orders by number and the shop drawings by manufacturer, drawing, and revision numbers.

D. Requests for partial payments will not be approved if the updated set of Drawings is not in good order or is not kept current. Request for final payment will not be approved until the complete and correct Record Drawings are delivered to the ENGINEER.

6.20 CLEAN UP

The CONTRACTOR shall, at all times, keep the premises, occupied by it in relation to this Contract, in a neat, clean, and safe condition and at all times provide reasonable access thereto. The CONTRACTOR shall, as a minimum, conduct daily inspections to verify that requirements of this Article are being met.

A. During the progress of the WORK, the CONTRACTOR shall:

1. Retain all stored items in an orderly arrangement allowing maximum access, not impeding drainage or traffic, and providing the required protection of material.

2. Provide adequate storage of all items awaiting removal from the jobsite, observing all requirements for fire protection and protection of the environment.

3. Remove any accumulation of scrap, debris, waste material, and other items not required for construction of this work.

4. Dispose of existing materials and equipment to be demolished and removed and all trash such as broken concrete, wood blocking, shipping containers, etc., resulting from the contract work off the premises occupied by the CONTRACTOR, including CITY property, at the CONTRACTOR's expense. CITY-leased dumpsters and other disposal containers on CITY’s property, unless specifically provided by the CONTRACTOR, shall not be used by the CONTRACTOR.

5. Maintain all excavation, embankments, haul roads, permanent access roads, Plant site, waste disposal areas, borrow areas, and all other work areas within contract work limits free from dust, as determined by the

ENGINEER. Industry-accepted methods of dust control suitable for the area involved, such as sprinkling, chemical treatment, light bituminous treatment, or similar methods, will be permitted. No separate payment will be made to the CONTRACTOR for dust control.

B. If the CONTRACTOR fails to comply with any of the foregoing, the CITY will transmit written notification of noncompliance. If, within five (5) calendar days of the written notification, the CONTRACTOR fails to comply, cleanup may be undertaken by the CITY at the expense of the CONTRACTOR.

C. Upon completion of any portion of any WORK, the CONTRACTOR shall promptly remove all of its equipment, temporary structures, and surplus construction and other materials not to be used at or near the same location during later stages of work. Upon completion of any WORK and before final inspection is made, the CONTRACTOR shall unless otherwise specifically directed by the ENGINEER:

1. Remove from the job site all plant, buildings, tools, surplus materials, equipment, forms, rubbish, scrap, debris, and waste.

2. Clean all paved areas on the site. Completely remove all resultant debris.

3. Visually inspect all interior surfaces, and remove all traces of soil, waste material, smudges, and other foreign matter. Remove all traces of splashed materials from adjacent surfaces. Remove all paint droppings, spots, stains, and dirt from finished surfaces. Use only approved cleaning materials and equipment.

4. Restore any improved area used for the CONTRACTOR's work or material storage to its condition at the time the CONTRACTOR moved onto the site or to the satisfaction of the ENGINEER.

5. Schedule final cleaning and improvement restoration to enable the CITY to accept a completely clean and restored project.

6.21 STORM WATER POLLUTION PREVENTION

A. <u>General</u>

1. Prevention - The CONTRACTOR shall prevent the pollution of storm drain systems and creeks on or near the construction project site(s) resulting from the construction operation. The CONTRACTOR shall keep pollution out of storm drains by reducing the possibility of accidental discharge of materials and wastes, by reducing erosion and sedimentation, and by any action as required. The CONTRACTOR shall train all employees and subcontractors on the storm water pollution prevention

requirements contained in these Specifications and ensure that all employees and subcontractors are aware of the consequences as described in subsection A.3. below. The CONTRACTOR shall include appropriate subcontract provisions to ensure that these requirements are met by all subcontractors.

2. Notification - If the CONTRACTOR causes or permits the spillage or overflow of any sewage, oil, or petroleum product, hazardous substance, contaminant, or waste that may result in the fluid or substance being discharged directly or indirectly into any storm drains, creeks, wetlands, or other manmade or natural waterways the CONTRACTOR shall notify the CITY as soon as possible to the extent notification can be provided without substantially impeding cleanup or other emergency measures. In no event shall such notification be later than one hour after knowledge of the occurrence.

3. Cleanup - Immediately upon gaining knowledge of such spillage, overflow, or discharge, the CONTRACTOR shall eliminate the cause of the spillage, overflow, or discharge and take action to minimize any damages. The CONTRACTOR shall also immediately implement a cleanup program. The cleanup, including sampling and testing required by regulatory agencies to determine the nature and level of contamination shall be performed and completed to the satisfaction of the various regulatory agencies involved and the CITY, at the expense of the CONTRACTOR. Any fines, penalties, and/or subsequent actions imposed upon the CITY and/or the CONTRACTOR by regulatory agencies related to the spillage, overflow, or discharge and any subsequent monitoring, testing, and reporting, as required by regulatory agencies, shall also be at the expense of the CONTRACTOR. The CONTRACTOR shall keep a stockpile of spill cleanup materials, such as rags or absorbents, readily accessible on site. The quantity of cleanup materials shall be appropriate in consideration of the risk of an occurrence of a spill, overflow or discharge.

B. Management of Nonhazardous Material and/or Waste

1. Designated Area - The CONTRACTOR shall propose designated areas of the project site, for approval by the ENGINEER, suitable for material delivery, storage, and waste collection that to the maximum extent practicable are near construction entrances and away from catch basins, gutters, drainage courses, and creeks.

2. Backfill or Excavated Material - The CONTRACTOR shall not allow backfill or excavated material to enter the storm drains or creeks. When rain is forecast within 24 hours or during wet weather, the

CONTRACTOR may be required to cover such material with a tarpaulin and to surround the material with sand bags.

3. Street Sweeping - At least once per week or more frequently as directed by the ENGINEER, the CONTRACTOR shall clean and sweep roadways and on-site paved areas of all materials attributed to or involved in the work. The CONTRACTOR shall not use water to flush down streets in place of street sweeping.

4. Disposal - At the end of each working day, the CONTRACTOR shall collect all scrap, debris, and waste material, and dispose of such materials properly. The materials may be stored in the CONTRACTOR's yard in stockpiles or placed in dumpsters. The CONTRACTOR shall inspect dumpsters for leaks and replace or repair dumpsters that leak. The CONTRACTOR shall not discharge water from cleaning dumpsters on site. The CONTRACTOR shall arrange for regular waste collection before dumpsters overflow.

C. Management of Hazardous Material and/or Waste

1. Storage - The CONTRACTOR shall label and store all hazardous materials, such as pesticides, paints, thinners, solvents, and fuels, and all hazardous wastes, such as waste oil and antifreeze in accordance with all applicable state and federal regulations. The CONTRACTOR shall store all hazardous materials and all hazardous wastes in accordance with secondary containment regulations. All such materials and wastes shall be covered, as needed, to avoid rainwater becoming polluted with hazardous constituents which could result in potential management of collected rain water as a hazardous waste. The CONTRACTOR shall keep an accurate, up-to-date inventory, including Material Safety Data Sheets (MSDSs), of hazardous materials and hazardous wastes stored on site.

2. Usage - When rain is forecast within 24 hours or during wet weather, the CONTRACTOR shall refrain from applying chemicals in outside areas. The CONTRACTOR shall follow material manufacturer's instructions regarding uses, protective equipment, ventilation, flammability, and mixing of chemicals. The CONTRACTOR shall post warning signs in areas treated with chemicals.

3. Disposal - The CONTRACTOR shall arrange for regular hazardous waste collection to comply with time limits on storage of hazardous wastes. The CONTRACTOR shall dispose of hazardous waste in accordance with all applicable local, state and federal regulations. The CONTRACTOR shall not wash any spilled material into streets, gutters, storm drains, or creeks and shall not bury spilled hazardous materials. The CONTRACTOR shall

report any hazardous materials spill to the CITY in accordance with Section A.2 above.

D. Vehicle/Equipment Cleaning, Maintenance, and Fueling

1. General - The CONTRACTOR shall inspect vehicles and equipment arriving on site for leaking fluids and shall promptly repair leaking vehicles and equipment. Drip pans shall be used to catch leaks until repairs are made.

   The CONTRACTOR shall comply with federal, state, and city requirements for aboveground storage tanks.

2. Cleaning - The CONTRACTOR shall perform vehicle or equipment cleaning with water only in a designated, bermed area that will not allow rinse water to run off site into streets, gutters, storm drains, or creeks. Soaps, solvents, degreasers, steam-cleaning equipment, or equivalent methods shall not be allowed.

3. Maintenance and Fueling - The CONTRACTOR shall perform maintenance and fueling of vehicles or equipment in areas that will not allow run-on of storm water or runoff of spills to storm drains and provide for confined clean-up. Examples are working in bermed areas or utilizing drip pans. The CONTRACTOR shall not contaminate the soils or groundwater with such maintenance and fueling activities.

   The CONTRACTOR shall use secondary containment, such as a drip pan, to catch leaks or spills any time that vehicle or equipment fluids are dispensed, changed, or poured, and shall clean up leaks and spills of vehicle or equipment fluids immediately and dispose of the waste and cleanup materials as hazardous waste, as described in Section C.3 above.

E. Dewatering Operations

1. Sediment Control - The CONTRACTOR shall route water through a control measure, such as a sediment trap, sediment basin, or Baker tank, to remove settleable solids prior to discharge to the storm drain system. Straw bales shall be placed in front of storm drain inlets as required. Filtration of the water following the control measure may be required on a case-by-case basis. Approval of the control measure shall be obtained in advance from the ENGINEER. If the ENGINEER determines that the dewatering operation would not generate an appreciable amount of settleable solids, the control measure requirement above may be waived.

2. Contaminated Groundwater - If the project is within an area of known groundwater contamination or if contamination is found, water from

dewatering operations shall be tested prior to discharge. If the water quality meets Regional Water Quality Control Board (RWQCB) standards, it may be discharged to a storm drain or creek. Otherwise, the water shall be hauled off site for proper disposal.

F. Paving or Oiling Operations

1. When rain is forecast within 24 hours or during wet weather, the ENGINEER may prevent the CONTRACTOR from paving or oiling the street. The ENGINEER may direct the CONTRACTOR to protect drainage courses by using control measures, such as earth dike, straw bale, and sand bag, to divert runoff or trap and filter sediment.

2. The CONTRACTOR shall prevent saw-cut slurry from entering catch basins and storm drains by limiting the area over which the slurry may spread.

3. The CONTRACTOR shall cover catch basins and manholes when paving or applying seal coat, tack coat, slurry seal, or fog seal.

4. The CONTRACTOR shall not sweep or wash down excess sand (placed as part of a sand seal or to absorb excess oil) into gutters, storm drains, or creeks. The CONTRACTOR shall either collect the sand and return it to the stockpile or dispose of it in a trash container.

G. Concrete, Grout, and Mortar Waste Management

1. Concrete Truck/Equipment Washout - The CONTRACTOR shall not wash out concrete trucks or equipment into streets, gutters, storm drains, or creeks. The CONTRACTOR shall perform washout of concrete trucks or equipment off site or in a designated area on site where the water will flow onto dirt or into a temporary pit in a dirt area. The CONTRACTOR shall let the water percolate into the soil and dispose of the hardened concrete in a trash container. If a suitable dirt area is not available, the CONTRACTOR shall collect the wash water and remove it off site.

2. Exposed Aggregate Concrete Wash Water - The CONTRACTOR shall avoid creating runoff by draining water from washing of exposed aggregate concrete to a dirt area. If a suitable dirt area is not available, the CONTRACTOR shall filter the wash water through straw bales or equivalent material before discharging to a storm drain. The CONTRACTOR shall collect sweepings from exposed aggregate concrete for disposal.

H. Paint Disposal and Clean-up

1. Disposal of Unused Paint - The CONTRACTOR shall carefully use, store and dispose of paint, solvents, chemicals, and waste materials in compliance with all applicable state and federal regulations. The CONTRACTOR shall not dispose of paint to sanitary sewer systems or storm drains. The CONTRACTOR shall utilize other recycling and disposal services as follows:

   a. "Recycling Centers" and "Waste Disposals" as may be listed in the yellow pages.

   b. Local household hazardous waste facility if appropriate.

   The CONTRACTOR may dispose of small amounts of leftover latex (water-based) paint by applying the paint to the surface of an item to be discarded and allowing it to dry thoroughly, then disposing of it in a dumpster.

   The CONTRACTOR shall store these materials and conduct cleaning of painting equipment and tools in a designated area that will not allow run-on of storm water or runoff of spills. The CONTRACTOR shall not allow wash water from cleaning of painting equipment and tools into streets, gutters, storm drains, or creeks.

2. Disposal of Paint Clean-up Waste - The CONTRACTOR shall remove as much excess paint as possible from brushes, rollers, and equipment before starting cleanup.

   a. The CONTRACTOR shall not discharge cleaning wastes from oil-based paints, buckets, brushes or tools to the sanitary sewer system. The CONTRACTOR shall retain a certified waste hauler to recycle or to dispose of cleaning wastes from oil-based paints at the CONTRACTOR's expense.

   b. The CONTRACTOR may discharge very small amounts of cleaning wastes from brushes, rollers, buckets, and tools contaminated with latex (water-based) paints to the sanitary sewer system provided they do not contain additives with pollutants of concern (e.g., mercury, tributyltin). Brushes, rollers, and tools containing latex paints may be washed over a sink with plenty of water. Buckets containing latex paints shall first be emptied into the original can or discarded as specified in paragraph 1 above. Should excessive amounts of paint or solvent be found in the wastewater discharged, the CONTRACTOR may be subject to

enforcement action by the CITY in accordance with the City Codes.

c. The CONTRACTOR shall not discharge any of these paint clean-up wastes to storm drains, streets, gutters, or creeks.

d. Waste Disposal - The CONTRACTOR shall dispose of waste thinner, solvent, and sludge from cleaning of equipment and tools as hazardous waste, as described in Section C.3 above. The CONTRACTOR shall dispose of excess thinners, solvents, and oil- and water-based paint as hazardous waste.

I. Contaminated Soil - If the project is within an area of known soil contamination or evidence of soil contamination is found, the CONTRACTOR shall comply with the requirements of all applicable local, state and federal regulations.

ARTICLE 7 – OTHER WORK

7.1 RELATED WORK AT SITE

A. The CITY may perform other work related to the Project at the Site by the CITY's own forces, have other work performed by utility owners, or let other direct contracts for such other work. If the fact that such other work is to be performed was not noted in the Contract Documents, written notice thereof will be given to the CONTRACTOR prior to starting any such other work.

B. The CONTRACTOR shall afford each person who is performing the other work (including the CITY's employees) proper and safe access to the Site and a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work, and shall properly coordinate the WORK with theirs. The CONTRACTOR shall do all cutting, fitting, and patching of the WORK that may be required to properly connect or otherwise make its several parts come together and properly integrate with such other work. The CONTRACTOR shall not endanger any work of others by cutting, excavating, or otherwise altering their work and will not only cut or alter their work with the written consent of the ENGINEER and the others whose work will be affected.

C. If the proper execution or results of any part of the CONTRACTOR's work depends upon such other work by another, the CONTRACTOR shall inspect and report to the ENGINEER in writing any delays, defects, or deficiencies in such other work that render it unavailable or unsuitable for such proper execution and results. The CONTRACTOR's failure to report such delays, defects, or deficiencies will constitute an acceptance of the other work as fit and proper for integration with the CONTRACTOR's work except for latent or nonapparent defects and deficiencies in the other work.

7.2 COORDINATION

A. If the CITY contracts with others for the performance of other work at the Site, CITY will have sole authority and responsibility in respect of such coordination, unless otherwise provided in the Supplementary General Conditions.

ARTICLE 8 – CITY'S RESPONSIBILITIES

8.1 COMMUNICATIONS

A. Except as may be otherwise provided in these General Conditions or the Supplementary General Conditions, the CITY will issue all its communications to the CONTRACTOR through the ENGINEER.

8.2 PAYMENTS

A. The CITY will make payments to the CONTRACTOR as provided in Article 14.

8.3 LANDS, EASEMENTS, AND SURVEYS

A. The CITY's duties in respect of providing lands and easements and providing engineering surveys to establish reference points are set forth in Paragraphs 4.1 and 4.6.

8.4 REPORTS AND DRAWINGS

A. The CITY will identify and make available to the CONTRACTOR copies of reports of physical conditions at the Site and drawings of existing structures which have been utilized in preparing the Contract Documents as set forth in Paragraph 4.2.

8.5 CHANGE ORDERS

A. The CITY will execute Change Orders as indicated in Article 10.

8.6 INSPECTIONS AND TESTS

A. The CITY'S responsibility for inspections and tests is set forth in Paragraph 13.3.

8.7 SUSPENSION OF WORK

A. The CITY's right to stop work or suspend work is set forth in Paragraphs 13.4 and 15.1.

8.8 TERMINATION OF AGREEMENT

A. The CITY's right to terminate services of the CONTRACTOR is set forth in Paragraphs 15.2 and 15.3.

8.9 LIMITATION ON CITY'S RESPONSIBILITIES

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

8.10 UNDISCLOSED HAZARDOUS ENVIRONMENTAL CONDITIONS

A. CITY's responsibility in respect to an undisclosed hazardous environmental condition is set forth in Paragraph 4.5.

ARTICLE 9 – ENGINEER'S STATUS DURING CONSTRUCTION

9.1 CITY'S REPRESENTATIVE

A. The ENGINEER will be the CITY'S representative during the construction period. The ENGINEER shall decide any and all questions which may arise as to the quality or acceptability of materials furnished and work performed, and as to the manner of performance and rate of progress of the work; all questions which arise as to the interpretation of the plans and specifications, the proposal and the contract documents therefor; all questions as to the acceptable fulfillment of the contract on the part of the CONTRACTOR; and all questions as to claim and compensation.

9.2 OBSERVATIONS ON THE SITE

A. The ENGINEER will make observations on the Site during construction to monitor the progress and quality of the WORK and to determine, in general, if the WORK is proceeding in accordance with the Contract Documents. The ENGINEER will not be required to make exhaustive or continuous inspections to check the quality or quantity of the WORK.

9.3 PROJECT REPRESENTATION

A. The ENGINEER may furnish a Resident Project Representative to assist in observing the performance of the WORK. The duties, responsibilities, and limitations of authority of any such Resident Project Representative will be as provided in the Supplementary General Conditions.

9.4 CLARIFICATIONS

A. The ENGINEER will issue with reasonable promptness such written Clarifications of the requirements of the Contract Documents as the ENGINEER may determine necessary, which shall be consistent with or reasonably inferable from the overall intent of the Contract Documents.

9.5 AUTHORIZED VARIATIONS IN WORK

A. The ENGINEER may authorize variations in the WORK from the requirements of the Contract Documents. These may be accomplished by a Field Order and will require the CONTRACTOR to perform the WORK involved in a manner that minimizes the impact to the WORK and the Contract Times. If the CONTRACTOR believes that a Field Order justifies an increase in the Contract Price or an extension of the Contract Times, the CONTRACTOR may make a claim therefor as provided in Article 11 or 12.

9.6 REJECTING DEFECTIVE WORK

A. The ENGINEER will have authority to reject Defective Work and will also have authority to require special inspection or testing of the WORK as provided in Article 13.

9.7 CONTRACTOR SUBMITTALS, CHANGE ORDERS, AND PAYMENTS

A. In accordance with the procedures set forth in the General Requirements, the ENGINEER will review all CONTRACTOR submittals.

B. The ENGINEER's responsibilities for Change Orders are set forth in Articles 10, 11, and 12.

C. The ENGINEER's responsibilities for Applications for payment are set forth in Article 14.

9.8 DECISIONS ON DISPUTES

A. The ENGINEER will be the initial interpreter of the requirements of the Contract Documents and of the acceptability of the WORK thereunder. Claims, disputes, and other matters relating to the acceptability of the WORK and interpretation of the requirements of the Contract Document pertaining to the performance of the work shall be determined by the ENGINEER. Any claims in respect to changes in the Contract Price or Contract Times shall be resolved in accordance with the requirements set forth in Articles 10, 11, and 12.

9.9 LIMITATIONS ON ENGINEER'S RESPONSIBILITIES

A. Neither the ENGINEER's authority to act under this Article 9 or other provisions of the Contract Documents nor any decision made by the ENGINEER in good faith either to exercise or not exercise such authority shall give rise to any duty or responsibility of the ENGINEER to the CONTRACTOR, any Subcontractor, any Supplier, any surety for any of them, or any other person or organization performing any of the WORK.

B. Whenever in the Contract Documents the terms "as ordered," "as directed," "as required," "as allowed," "as reviewed," "as approved," or terms of like effect or import are used, or the adjectives "reasonable," "suitable," "acceptable," "proper," or "satisfactory," or adjectives of like effect or import are used to describe a requirement, direction, review, or direction, review, or judgment will be solely to evaluate the WORK for compliance with the requirements of the Contract Documents, and conformance with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents, unless there is a specific statement indicating otherwise. The use of any such term or adjective shall not be effective to assign to the ENGINEER any duty or authority

to supervise or direct the performance of the WORK or any duty or authority to undertake responsibility contrary to the provisions of Paragraph 9.9 C.

C. The ENGINEER will not supervise, direct, control, or have authority over or be responsible for the CONTRACTOR's means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of the CONTRACTOR to comply with Laws and Regulations applicable to the performance of the WORK. The ENGINEER will not be responsible for the CONTRACTOR's failure to perform the WORK in accordance with the Contract Documents. The ENGINEER will not be responsible for the acts or omissions of the CONTRACTOR nor of any Subcontractor, Supplier, or any other person or organization performing any of the WORK.

ARTICLE 10 – CHANGES IN THE WORK

10.1 GENERAL

A. Without invalidating the Agreement and without notice to any surety, the CITY may at any time or from time to time, order additions, deletions, or revisions in the WORK. Such additions, deletions or revisions will be authorized by a Change Order or Field Order. Upon receipt of any such document, CONTRACTOR shall promptly proceed to implement the additions, deletions, or revisions in the WORK in accordance with the applicable conditions of the Contract Documents.

B. The CONTRACTOR shall not be entitled to an increase in the contract Price nor an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents as amended, modified, or supplemented by Change Order, except in the case of an emergency and except in the case of uncovering work as provided in Paragraph 13.3.F and G.

C. The CITY and the CONTRACTOR shall execute appropriate Change Orders covering:

1. Changes in the WORK which are ordered by the CITY pursuant to Paragraph 10.1 A.;

2. Changes required because of acceptance of Defective Work under Paragraph 13.6; and

3. Changes in the Contract Price or Contract Times which are agreed to by the parties under Articles 11 and/or 12, respectively.

D. If notice of any change in the WORK is required to be given to a surety, the giving of any such notice shall be the CONTRACTOR's responsibility. If the change in the WORK affects the Contract Price, the CITY may require an

adjustment to the amount of any applicable Bond and the amount of each applicable Bond shall be adjusted accordingly.

E. If the CITY and CONTRACTOR agree as to the extent, if any, of an increase in the Contract Price or an extension or shortening of the Contract Times that should be allowed as a result of a Field Order, the CONTRACTOR shall proceed so as to minimize the impact on and delays to the WORK pending the issuance of a Change Order.

F. If the CITY and the CONTRACTOR are unable to agree as to the extent, if any, of an increase in the Contract Price or an extension or shortening of the Contract Times that should be allowed as a result of a Field Order, the ENGINEER can direct the CONTRACTOR to proceed on the basis of time and materials so as to minimize the impact on and delays to the WORK, and the CONTRACTOR may make a claim as provided in Articles 11 and 12.

10.2 ALLOWABLE QUANTITY VARIATIONS

A. In the event of an increase or decrease in the quantity of any bid item under a unit price contract, the total amount of work actually done or materials or equipment furnished will be paid for according to the unit price established for such work under the Contract Documents, wherever such unit price has been established; provided, that an adjustment in the Contract Price may be made for changes which result in an increase or decrease in excess of 25 percent of the estimated quantity of any unit price bid item of the WORK.

B. In the event a part of the WORK is to be entirely eliminated and no lump sum or unit price is named in the Contract Documents to cover such eliminated work, the price of the eliminated work shall be agreed upon by the CITY and the CONTRACTOR by Change Order.

ARTICLE 11 – CHANGE OF CONTRACT PRICE

11.1 GENERAL

A. The Contract Price constitutes the total compensation payable to the CONTRACTOR FOR PERFORMING THE work. All duties, responsibilities, and obligations assigned to or undertaken by the CONTRACTOR to complete the WORK shall be at its expense without change in the Contract Price.

B. The Contract Price may only be changed by a Change Order. The value of any work covered by a Change Order or of any claim for an increase or decrease in the Contract Price shall be determined in one of the following ways:

1. Where the work involved is covered by unit prices contained in the Contract Documents, by application of unit prices to the qualities o the items involved.

2. By mutual acceptance of a lump sum, which may include an allowance for overhead and profit not necessarily in accordance with Paragraph 11.4; or

3. On the basis of the cost of work (determined as provided in Paragraph 11.3) plus the CONTRACTOR's overhead and profit (determined as provided in Paragraph 11.4).

C. Any claim for an increase in the Contract Price shall be based on written notice delivered by the CONTRACTOR to the ENGINEER promptly (but in no event later than 10 days) after the start of the event giving rise to the claim and shall state the general nature of the claim. Notice of the amount of the claim with supporting data shall be delivered within 60 days after the start of such event (unless the ENGINEER allows an additional period of time to ascertain more accurate data in support of the claim) and shall be accompanied by the CONTRACTOR's written statement that the amount claimed covers all known amounts (direct, indirect, and consequential) to which the CONTRACTOR is entitled as a result of such event. All claims for adjustment in the Contract Price will be determined by the ENGINEER. No claim for an adjustment in the Contract Price will be valid if not submitted in accordance with this Paragraph 11.1 C.

11.2 COSTS RELATING TO WEATHER

A. The CONTRACTOR shall have no claims against the CITY for damages for any injury to work, materials, or equipment, resulting from the action of the elements. If, however, in the opinion of the ENGINEER, the CONTRACTOR has made all reasonable efforts to protect the materials, equipment, and work, the CONTRACTOR may be granted a reasonable extension of Contract Times to make proper repairs, renewals, and replacements of the work, materials, or equipment.

11.3 COST OF WORK (BASED ON TIME AND MATERIALS)

A. **General**: The term "cost of work" means the sum of all costs necessarily incurred and paid by the CONTRACTOR for labor, materials, and equipment in the proper performance of extra work. Except as otherwise may be agreed to in writing by the CITY, such costs shall be in amounts no higher than those prevailing in the locality of the Project, shall include only the following items and shall not include any of the costs itemized in Paragraph 11.5.

B. **Labor**: The costs of labor will be the actual cost for wages prevailing for each craft or type of workers performing the extra work at the time the extra work is

done, plus employer payments of payroll taxes, workers compensation insurance, liability insurance, health and welfare, pension, vacation, apprenticeship funds, and other direct costs resulting from federal, state or local laws, as well as assessments or benefits required by lawful collective bargaining agreements. Labor costs for equipment operators and helpers will be paid only when such costs are not included in the invoice for equipment rental. The labor costs for foremen shall be proportioned to all of their assigned work and only that applicable to extra work shall be paid. Nondirect labor costs including superintendence shall be considered part of the markup set out in Paragraph 11.4.

C. **Materials**: Materials must be specifically authorized by the ENGINEER. The cost of materials reported shall be at invoice or lowest current price at which materials are locally available and delivered to the Site in the quantities involved, plus the cost of freight, delivery and storage, subject to the following:

1. All trade discounts and rebaters shall accrue to the CITY, and the CONTRACTOR shall make provisions so that they may be obtained;

2. For materials secured by other than a direct purchase and direct billing to the purchaser, the cost shall be deemed to be the price paid to the actual supplier as determined by the ENGINEER. Except for actual costs incurred in the handling of such materials, markup will not be allowed;

3. Payment for materials from sources owned wholly or in part by the purchaser shall not exceed the price paid by the purchaser for similar materials from said sources on extra work items or the current wholesale price for such materials delivered to the Site, whichever price is lower; and

4. If in the opinion of the ENGINEER the cost of material is excessive, or the CONTRACTOR does not furnish satisfactory evidence of the cost of such material, then the cost shall be deemed to be the lowest current wholesale price for the quantity concerned delivered to the Site less trade discount. The CITY reserves the right to furnish materials for the extra work and no claim will be allowed by the CONTRACTOR for costs and profit on such materials.

D. **Equipment**: The CONTRACTOR will be paid for the use of equipment at the rental rate listed for such equipment specified in the current California Department of Transportation publication entitled "Labor Surcharge and Equipment Rental Rates." Such rental rate will be used to compute payments for equipment whether the equipment is under the CONTRACTOR's control through direct ownership, leasing, renting, or another method of acquisition. The rental rate to be applied for use of each item of equipment will be the rate resulting in the least total cost to the CITY for the total period of use. If it is deemed necessary by the CONTRACTOR to use equipment not listed in the above-

referenced publication, an equitable rental rate for the equipment will be established by the ENGINEER. The CONTRACTOR may furnish cost data which might assist the ENGINEER in the establishment of the rental rate. Payment for equipment shall be subject to the following:

1. All equipment shall, in the opinion of the ENGINEER, be in good working condition and suitable for the purpose for which the equipment is to be used;

2. Before construction equipment is used on the extra work, the CONTRACTOR shall plainly stencil or stamp an identifying number thereon at a conspicuous location, and shall furnish to the ENGINEER, in duplicate, a description of the equipment and its identifying number;

3. Unless otherwise specified, manufacturer's ratings and manufacturer approved modifications shall be used to classify equipment for determination of applicable rental rates. Equipment which has no direct power unit shall be powered by a unit of at least the minimum rating recommended by the manufacturer;

4. Individual pieces of equipment or tools having a replacement value of $500 or less, whether or not consumed by use, will be considered to be small tools and no payment will be made therefore.

E. **Equipment Rental Time**: The rental time to be paid for equipment on the Site will be the time the equipment is in productive operation on the extra work being performed and, in addition, will include the time required to move the equipment to the location of the extra work and return it to the original location or to another location requiring no more time than that required to return it to its original location; except, that moving time will not be paid if the equipment is used on other than the extra work, even though located at the Site of the extra work. Loading and transporting costs will be allowed, in lieu of moving time, when the equipment is moved by means other than its own power, except that no payment will be made for loading and transporting costs when the equipment is used at the Site of the extra work on other than the extra work. Rental time will not be allowed while equipment is inoperative due to breakdowns. The rental time of equipment on the work Site will be computed subject to the following:

1. When hourly rates are listed, any part of an hour less than 30 minutes of operation will be considered to be half-hour of operation, and any part of an hour in excess of 30 minutes will be considered one hour of operation;

2. When daily rates are listed, any part of a day less than 4 hours operation will be considered to be half-day of operation. When owner-operated equipment is used to perform extra work to be paid for on a time and

materials basis, the CONTRACTOR will be paid for the equipment and operator, as set forth in Paragraphs 3, 4, and 5, following;

3. Payment for the equipment will be made in accordance with the provisions in Paragraph 11.3 D., herein;

4. Payment for the cost of labor and subsistence or travel allowance will be made at the rates paid by the CONTRACTOR to other workers operating similar equipment already on the Site, or in the absence of such labor, established by collective bargaining agreements for the type of workmen and location of the extra work, whether or not the operator is actually covered by such an agreement. A labor surcharge will be added to the cost of labor described herein accordance with the provisions of Paragraph 11.3 B., herein, which surcharge shall constitute full compensation for payments imposed by state and federal laws and all other payments made to or on behalf of workers other than actual wages; and

5. To the direct cost of equipment rental and labor, computed as provided herein, will be added the allowances for equipment rental and labor as provided in Paragraph 11.4, herein.

F. **Special Services**: Special work or services are defined as that work characterized by extraordinary complexity, sophistication, innovation, or a combination of the foregoing attributes which are unique to the construction industry. The ENGINEER will make estimates for payment for special services and may consider the following:

1. When the ENGINEER and the CONTRACTOR, determine that a special service or work is required which cannot be performed by the forces of the CONTRACTOR or those of any of its Subcontractors, the special service or work may be performed by an entity especially skilled in the work to be performed. After validation of invoices and determination of market values by the ENGINEER, invoices for special services or work based upon the current fair market value thereof may be accepted without complete itemization of labor, material, and equipment rental costs;

2. When the CONTRACTOR is required to perform work necessitating special fabrication or matching process in a fabrication or a machine shop facility away from the Site, the charges for that portion of the work performed at the off-site facility may, by agreement, be accepted as a special service and accordingly, the invoices for the work may be accepted without detailed itemization; and

3. All invoices for special services will be adjusted by deducting all trade discounts. In lieu of the allowances for overhead and profit specified in

Paragraph 11.4, herein, an allowance of 15 percent will be added to invoices for special services.

G. **Sureties**; All work performed hereunder shall be subject to all provisions of the Contract Documents and the CONTRACTOR's sureties shall be bound with reference thereto as under the original Agreement. Copies of all amendments to Bonds or supplemental Bonds shall be submitted to the CITY for review prior to the performance of any work hereunder.

11.4 CONTRACTOR'S OVERHEAD AND PROFIT

A. Extra work ordered on the basis of time and materials will be paid for at the actual necessary cost as determined by the ENGINEER, plus allowances for overhead and profit. No additional mark-ups and/or surcharges will be added to the cost. The allowance for overhead and profit will include full compensation for superintendence, taxes, field office expense, extended overhead, home office overhead, and all other items of expense or cost not included in the cost of labor, materials, or equipment provided for under Paragraph 11.3. The allowance for overhead and profit will be made in accordance with the following schedule:

Overhead and Profit Allowance

Labor.....20 percent
Materials.....15 percent
Equipment....15 percent

To the sum of the costs and markups provided for in this Article, an additional 2 percent of the sum will be added as compensation for Bonds and insurance.

B. It is understood that labor, materials, and equipment for extra work may be furnished by the CONTRACTOR or by the Subcontractor on behalf of the CONTRACTOR. When all or any part of the extra work is performed by a Subcontractor, the allowance specified herein will be applied to the labor, materials, and equipment costs of the Subcontractor, to which the CONTRACTOR may add 5 percent of the Subcontractor's total cost for the extra work. Regardless of the number of hierarchical tiers of Subcontractors, the 5 percent increase above the Subcontractor's total cost which includes the allowances for overhead and profit specified herein may be applied one time only.

11.5 EXCLUDED COSTS

A. The term "cost of the work" shall not include any of the following:

1. Payroll costs and other compensation of CONTRACTOR's officers, executives, proprietors, partners, principals, general managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and

contracting agents, expediters, timekeepers, clerks, and other personnel employed by CONTRACTOR whether at the Site or in CONTRACTOR's principal or a branch office for general administration of the WORK all of which are to be considered administrative costs covered by the CONTRACTOR's allowance for overhead and profit;

2. Non-direct labor costs, including superintendence, shall be considered part of the markup for overhead and profit, and no additional payment will be allowed for such;

3. Expenses of CONTRACTOR's principal and branch offices other than CONTRACTOR's office at the Site;

4. Any part of CONTRACTOR's capital expenses, including interest on CONTRACTOR's capital employed for the WORK and charges against CONTRACTOR for delinquent payments;

5. Cost of premiums for all Bonds and for all insurance whether or no CONTRACTOR is required by the Contract Documents to purchase and maintain the same (except as provided by Paragraph 11.4 above);

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

7. Other overhead or general expense costs of any kind and the cost of any item not specifically and expressly included in Paragraph 11.4.

11.6 CONTRACTOR'S EXTRA WORK REPORT

A. In order to be paid for extra work, the CONTRACTOR must submit a daily extra work report on the form furnished by the ENGINEER. The form must be completely filled out based on the provisions of Paragraphs 11.3 through 11.5 and signed by the CONTRACTOR and ENGINEER at the end of each work day. Failure to complete the form and obtain appropriate signatures by the next working day after the extra work of the previous day was completed will result in CONTRACTOR's costs for extra work being disallowed.

ARTICLE 12 – CHANGE OF CONTRACT TIMES

12.1 GENERAL

A. The Contract Times may only be changed by a Change Order. Any claim for an extension of the Contract Times shall be based on written notice delivered by the CONTRACTOR to the ENGINEER promptly (but in no event later than 10 days) after the start of the event giving rise to the claim and stating the general nature of the claim. Notice of the extent of the claim with supporting data shall be delivered within 30 days after the start of such event (unless the ENGINEER allows an additional period of time for the submission of additional or more accurate data in support of the claim) and shall be accompanied by the CONTRACTOR's written statement that the adjustment claimed is the entire adjustment to which the CONTRACTOR is entitled as a result of said event. All claims for adjustment in the Contract Times will be determined by the ENGINEER. No claim for an adjustment in the Contract Times will be valid if not submitted in accordance with the requirements of this Paragraph 12.1 A. An increase in Contract Times does not mean that the CONTRACTOR is due an increase in Contract Price. Only compensable time extensions will result in an increase in Contract Price.

B. All time limits stated in the Contract Documents are of the essence of the Agreement.

C. When CONTRACTOR is prevented from completing any part of the WORK within the Contract Times (or Milestones) due to delay beyond the control of CONTRACTOR, the Contract Times (or Milestones) will be extended in an amount equal to the time lost on the critical path of the WORK due to such delay, if a claim is made therefor as provided in Paragraph 12.1.A. Delays beyond the control of CONTRACTOR shall include, but not be limited to, acts or neglect by CITY; acts or neglect of those performing other work as contemplated by Article 7; and fires, floods, epidemics, abnormal weather conditions, or acts of God. Delays attributable to and within the control of any Subcontractor or Supplier shall be deemed to be delays within the control of the CONTRACTOR.

D. In no event will CITY be liable to CONTRACTOR, any Subcontractor, any Supplier, any other person or organization, or to any surety for or employee or agent of any of them, for any increase in the Contract Price or other damages arising out of or resulting from the following:

1. Delays caused by or within the control of CONTRACTOR; or

2. Delays beyond the control of both CITY and CONTRACTOR including but not limited to fires, floods, epidemics, abnormal weather conditions, acts of God, or acts or neglect by those performing other work as contemplated by Article 7.

12.2 EXTENSIONS OF CONTRACT TIMES FOR DELAY DUE TO WEATHER

A. The CONTRACTOR's construction schedule shall anticipate delay due to unusually severe weather. The number of days of anticipated delay is set forth in the Supplementary General Conditions.

B. Contract Times may be extended by the ENGINEER because of delays in excess of the anticipated delay. The CONTRACTOR shall , within 10 days of the beginning of any such delay, notify the ENGINEER in writing and request an extension of Contract Times. The ENGINEER will ascertain the facts and the extent of the delay and extend the Contract Times when, in its judgment, the findings of the fact justify such an extension.

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

13.1 NOTICE OF DEFECTIVE WORK

A. Prompt notice of Defective Work known to the ENGINEER will be given to the CONTRACTOR. All Defective Work, whether or not in place, may be rejected, corrected, or accepted as provided in this Article 13. Defective Work may be rejected even if approved by prior inspection.

13.2 ACCESS TO WORK

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

13.3 INSPECTIONS AND TESTS

A. The CONTRACTOR shall give the ENGINEER not less than 24 hours notice of readiness of the WORK for all required inspections, tests, or approvals, and shall cooperate with inspection and testing personnel to facilitate required inspections or tests.

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

1. For inspection, tests, or approvals covered by Paragraphs 13.3C. and 13.3D. below;

2. That costs incurred in connection with tests or inspections conducted pursuant to Paragraph 13.3G. shall be paid as provided in said Paragraph 13.3G.; and

3. As otherwise provided in the Contract Documents.

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

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

E. The ENGINEER will make, or have made, such inspections and tests as the ENGINEER deems necessary to see that the WORK is being accomplished in accordance with the requirements of the Contract Documents. Unless otherwise specified in any Supplementary General Conditions, the cost of such inspection and testing will be borne by the CITY. In the event such inspections or tests reveal non-compliance with the requirements of the Contract Documents, the CONTRACTOR shall bear the cost of corrective measures deemed necessary by the ENGINEER, as well as the cost of subsequent reinspection and retesting. Neither observations by the ENGINEER nor inspections, tests, or approvals by others shall relieve the CONTRACTOR from the CONTRACTOR's obligation to perform the WORK in accordance with the Contract Documents.

F. If any WORK (including the work of others) that is to be inspected, tested, or approved is covered without written concurrence of the ENGINEER, it must, if requested by the ENGINEER, be uncovered for observation. Such uncovering shall be at the CONTRACTOR's expense unless the CONTRACTOR has given the ENGINEER not less than 24 hours notice of the CONTRACTOR's intention to perform such test or to cover the same and the ENGINEER has not acted with reasonable promptness in response to such notice.

G. If any WORK is covered contrary to the written request of the ENGINEER, it must, if requested by the ENGINEER, be uncovered for the ENGINEER's observation and recovered at the CONTRACTOR's expense.

H. If the ENGINEER considers it necessary or advisable that covered WORK be observed by the ENGINEER or inspected or tested by others, the CONTRACTOR, at the ENGINEER's request shall uncover, expose, or otherwise make available for observation, inspection, or testing as the ENGINEER may require, that portion of the WORK in question, furnishing all necessary labor, material, and equipment. If it is found that such work is Defective Work, the CONTRACTOR shall bear all direct, indirect, and consequential costs and damages of such uncovering, exposure, observation, inspection, and testing and of satisfactory reconstruction, including but not limited to, fees and charges of engineers, architects, attorneys, and other professionals. However, if such work is not found to be Defective Work, the CONTRACTOR will be allowed an increase in the Contract Price or an extension of the Contract Time, or both, directly attributable to such uncovering, exposure, observation, inspection, testing, and reconstruction; and, if the parties are unable to agree as to the amount or extent thereof, the CONTRACTOR may make a claim therefor as provided in Articles 11 and 12.

I. No acceptance of equipment, materials, or work shall be construed to result from such inspections by the ENGINEER. Any inspections or tests or waivers thereof shall not relieve the CONTRACTOR of its responsibility for meeting the requirement of the Contract.

13.4 CITY MAY STOP THE WORK

A. If Defective Work is identified, the ENGINEER may order the CONTRACTOR to stop performance of the WORK, or any portion thereof, until the cause for such order has been eliminated; however, this right of the ENGINEER to stop the WORK shall not give rise to any duty on the part of the ENGINEER to exercise this right for the benefit of the CONTRACTOR or any other party.

13.5 CORRECTION OR REMOVAL OF DEFECTIVE WORK

A. If required by the ENGINEER, the CONTRACTOR shall promptly either correct all Defective Work, whether or not fabricated, installed, or completed, or, if the work has been rejected by the ENGINEER, remove it from the Site and replace it with non-defective WORK. The CONTRACTOR shall bear all direct, indirect, and consequential costs and damages of such correction or removal, including but not limited to fees and charges of engineers, architects, attorneys, and other professionals made necessary thereby.

13.6 ACCEPTANCE OF DEFECTIVE WORK

A. If, instead of requiring correction or removal and replacement of Defective Work, the CITY prefers to accept the Defective Work, the CITY may do so. The CONTRACTOR shall bear all direct, indirect, and consequential costs attributable to the CITY's evaluation of and determination to accept such Defective Work. If

any such acceptance occurs prior to final payment, a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the WORK, and the CITY shall be entitled to an appropriate decrease in the Contract Price.

13.7 CITY MAY CORRECT DEFECTIVE WORK

A. If the CONTRACTOR fails within a reasonable time after written notice from the ENGINEER to correct Defective Work, or to remove and replace Defective Work as required by the ENGINEER in accordance with Paragraph 13.5A., or if the CONTRACTOR fails to perform the WORK in accordance with the Contract Documents, or if the CONTRACTOR fails to comply with any other provision of the Contract Documents, the CITY may, after seven days written notice to the CONTRACTOR, correct and remedy any such deficiency.

B. In exercising the rights and remedies under this paragraph, the CITY shall proceed with corrective and remedial action. In connection with such corrective and remedial action, the CITY may exclude the CONTRACTOR from all or part of the Site, take possession of all or part of the WORK, and suspend the CONTRACTOR's services related thereto and incorporate in the WORK all materials and equipment for which the CITY has paid the CONTRACTOR whether stored at the Site or elsewhere. The CONTRACTOR shall provide the CITY and its ENGINEER, access to the Site to enable CITY to exercise the rights and remedies under this paragraph.

C. All direct, indirect, and consequential cost and damages incurred by the CITY in exercising the rights and remedies under this paragraph will be charged against the CONTRACTOR and a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the WORK; and the CITY shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount of the adjustment, the CITY may make a claim therefor as provided in Article 11. Such claim will include, but not be limited to, all costs of repair or replacement of work of others, destroyed or damaged by correction, removal, or replacement of CONTRACTOR's Defective Work and all direct, indirect, and consequential damages associated therewith.

D. The CONTRACTOR shall not be allowed an extension of Contract Times (or Milestones) because of any delay in the performance of the WORK attributable to the exercise by CITY of CITY's rights and remedies under this paragraph.

13.8 CORRECTION PERIOD

A. The correction period for Defective Work shall be the longer of:

1. One year after the date of final acceptance;

2. Such time as may be prescribed by Laws and Regulations;

3. Such time as specified by the terms of any applicable special guarantee required by the Contract Documents; or

4. Such time as specified by any specific provision of the Contract Documents.

B. If, during the correction period as defined in Paragraph 13.8A above, any work is found to be Defective Work, the CITY shall have the same remedies as set forth in Paragraphs 13.5, 13.6, and 3.7 above.

C. Where Defective Work (and damage to other work resulting therefrom) has been corrected, removed, or replaced under this paragraph, the correction period hereunder with respect to such work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

ARTICLE 14 – PAYMENTS TO CONTRACTOR AND COMPLETION

14.1 SCHEDULE OF VALUES (LUMP SUM PRICE BREAKDOWN)

A. The schedule of values or lump sum price breakdown established as provided in the General Requirements shall serve as the basis for progress payments and shall be incorporated into a form of "Application for Payment acceptable to the ENGINEER.

14.2 UNIT PRICE BID SCHEDULE

A. Progress payments on account of unit price work will be based on the number of units completed.

14.3 APPLICATION FOR PROGRESS PAYMENT

A. Unless otherwise prescribed by law, on the 25th of each month, the CONTRACTOR shall submit to the ENGINEER for review, the Application for Payment filled out and signed by the CONTRACTOR covering the WORK completed as of the Application for Payment and accompanied by such supporting documentation as is required by the Contract Documents.

B. The Application for Payment shall identify, as a subtotal, the amount of the CONTRACTOR total earnings to date; plus the value of materials stored at the Site which have not yet been incorporated in the WORK; and less a deductive adjustment for materials installed which were not previously incorporated in the WORK, but for which payment was allowed under the provisions for payment for materials stored at the Site, but not yet incorporated in the WORK.

C. The net payment due the CONTRACTOR shall be the above-mentioned subtotal from which shall be deducted the amount of retainage specified in the Supplementary General Conditions and the total amount of all previous payments made to the CONTRACTOR.

D. The value of materials stored at the Site shall be an amount equal to the specified percent of the value of such materials as set forth in any Supplementary General Conditions. Said amount shall be based upon the value of all acceptable materials and equipment not incorporated in the WORK but delivered and suitably stored at the Site or at another location agreed to in writing; provided, each such individual item has a value of more than $5,000 and will become a permanent part of he WORK. The Application for Payment shall also be accompanied by a bill of sale, invoice, or other documentation warranting that the CONTRACTOR has received the materials and equipment free and clear of all Liens and evidence that the materials and equipment are covered by appropriate property insurance and other arrangements to protect the CITY's interest therein, all of which will be satisfactory to the CITY.

E. A ten percent (10%) retention of payment amount shall be held by the CITY from the amount of each Application for Payment.

F. **OPTIONAL:** Partial payments for mobilization/demobilization costs shall be as follows:

1. Thirty-five percent (35%) of the amount bid for mobilization/ demobilization or 1.75 percent of the original Contract Price, whichever is less, shall be paid in each of the first two progress payments.

2. The balance of the amount bid for mobilization/demobilization shall be paid upon completion of all WORK on the project.

14.4 CONTRACTOR'S WARRANTY OF TITLE

A. The CONTRACTOR warrants and guarantees that title to all WORK, materials, and equipment covered by an Application for Payment, whether incorporated in the WORK or not, will pass to the CITY no later than the time of payment, free and clear of all Liens.

14.5 REVIEW OF APPLICATIONS FOR PROGRESS PAYMENT

A. The ENGINEER will, within 7 days after receipt of each Application for Payment, either indicate in writing a recommendation of payment and present the application to the CITY, or return the application to the CONTRACTOR indicating in writing the ENGINEER'S REASONS FOR REFUSING TO RECOMMEND PAYMENT. In the latter case, the CONTRACTOR may make

the necessary corrections and resubmit the application. If the ENGINEER still disagrees with a portion of the application, it will submit the application recommending the undisputed portion of the application to the CITY for payment and provide reasons for recommending non-payment of the disputed amount. Thirty days after presentation of the Application for Payment with the ENGINEER'S recommendation, the amount recommended will (subject to the provisions of Paragraph 14.5B.) become due and when due will be paid by the CITY to the CONTRACTOR.

B. The ENGINEER, in its discretion, may refuse to recommend the whole or any part of any payment. ENGINEER may also refuse to recommend any such payment, or, because of subsequently discovered evidence or the results of subsequent inspections or tests, nullify any such payment previously recommended, to such extent as may be necessary in ENGINEER's opinion to protect CITY from loss because:

1. The work is Defective Work or the completed WORK has been damaged requiring correction or replacement.

2. The Contract Price has been reduced by written amendment or Change Order.

3. The CITY has been required to correct Defective Work or complete WORK in accordance with Paragraph 13.7.

4. ENGINEER has actual knowledge of the occurrence of any of the events enumerated in Paragraph 15.1 through 15.4 inclusive.

5. Third party claims filed or reasonable evidence indicating probable filing of such claims; or

6. Failure of the Contractor to make payments properly to subcontractors or for labor, materials, or equipment; or

7. Reasonable evidence that the work cannot be completed for the unpaid balance of the contract sum; or

8. Failure of the Contractor to submit an acceptable construction schedule or failure to update the schedule; or

9. Damage to the City or another contractor; or

10. Reasonable evidence that the work will not be completed within the time provided for in the Contract; or

11. Contractor's failure or inability to obtain or maintain insurance coverage and bonds as required by the Contract throughout the course of the job; or

12. Persistent failure to carry out the work in accordance with the Contract; or

13. Failure to deliver copies of certified payrolls, as specified in Section 17.11, General Conditions.

14. In addition, the City may deduct from any such payments due the Contractor any amounts the City may be currently or in the future authorized to retain pursuant to federal, state, or local laws or regulations, any amounts due the City from the Contractor, and any other amounts which the City is otherwise authorized to retain as specified in Special Provisions.

C. The CITY may refuse to make payment of the full amount recommended by the ENGINEER because:

1. Claims have been made against CITY on account of CONTRACTOR's performance or furnishing of the WORK.

2. Liens have been filed in connection with the WORK, except where CONTRACTOR has delivered a specific Bond satisfactory to CITY to secure the satisfaction and discharge of such Liens.

3. There are other items entitling CITY to set-off against the amount recommended, or

4. CITY has actual knowledge of the occurrence of any of the events enumerated in Paragraphs 14.5B. through 14.5C and 15.1 through 15.4 inclusive.

The CITY must give the CONTRACTOR immediate written notice stating the reasons for such action and promptly pay the CONTRACTOR the amount so withheld, or any adjustment thereto agreed to by CITY and CONTRACTOR, when CONTRACTOR corrects to CITY's satisfaction the reasons for such action.

14.6 COMPLETION

A. When the CONTRACTOR considers the WORK ready for its intended use, the CONTRACTOR shall notify the ENGINEER in writing that the WORK is complete. The CONTRACTOR shall attach to this request a list of all work items that remain to be completed and a request that the ENGINEER prepare a Notice of Completion. Within a reasonable time thereafter, the CONTRACTOR, and the ENGINEER shall make an inspection of the WORK to determine the status of completion. If the ENGINEER considers the WORK complete, the ENGINEER

will prepare and execute and deliver for City Council approval and recordation the Notice of Completion signed by the ENGINEER and CONTRACTOR, which shall fix the date of completion.

14.7 PARTIAL UTILIZATION

A. The CITY shall have the right to utilize or place into service any item of equipment or other usable portion of the WORK prior to completion of the WORK. Whenever the CITY plans to exercise said right, the CONTRACTOR will be notified in writing by the ENGINEER, identifying the specific portion or portions of the WORK to be so utilized or otherwise placed into service.

B. It shall be understood by the CONTRACTOR that until such written notification is issued, all responsibility for care and maintenance of all of the WORK shall be borne by the CONTRACTOR. Upon issuance of said written notice of Partial Utilization, the CITY will accept responsibility for the protection and maintenance of all such items or portions of the WORK described in the written notice.

C. The CONTRACTOR shall retain full responsibility for satisfactory completion of the WORK, regardless of whether a portion thereof has been partially utilized by the CITY prior to completion of the WORK.

14.8 FINAL APPLICATION FOR PAYMENT

A. After the CONTRACTOR has completed all of the remaining work items referred to in Paragraph 14.6 and delivered all maintenance and operating instructions, schedules, guarantees, Bonds, certificates of inspection, marked-up record documents (as provided in the General Requirements), and other documents, all as required by the Contract Documents, and after the ENGINEER has indicated that the WORK is acceptable, the CONTRACTOR may make application for final payment following the procedure for progress payments. The final Application for Payment shall be accompanied by all documentation called for in the Contract Documents, together with complete and legally effective releases or waivers (satisfactory to the CITY) of all Liens arising out of or filed in connection with the WORK.

14.9 FINAL PAYMENT AND ACCEPTANCE

A. If, on the basis of the ENGINEER's observation of the WORK during construction and final inspection, and the ENGINEER's review of the final Application for Payment and accompanying documentation, all as required by the Contract Documents, the ENGINEER is satisfied that the WORK has been completed and the CONTRACTOR's other obligations under the Contract Documents have been fulfilled, the ENGINEER will, within 14 days after receipt

of the final Application for Payment, indicate in writing the ENGINEER's recommendation of payment and present the application to the CITY for payment.

B. After acceptance of the WORK by the City Council, the CITY will make final payment to the CONTRACTOR of the amount remaining after deducting all prior payments and all amounts to be kept or retained under the provisions of the Contract Documents, including the following items:

1. Liquidated damages, as applicable;

2. Amounts withheld by CITY under Paragraph 14.5B. and C. which have not been released; and

3. In accordance with Section 17.6, one-and-one-half times the value of outstanding items of correction work or punch list items yet uncompleted or uncorrected, as applicable. All such work shall be completed or corrected to the satisfaction of the ENGINEER as required by the Contract Documents, otherwise the CONTRACTOR does hereby waive any and all claims to all monies withheld by the CITY to cover the value of all such uncompleted or uncorrected items.

C. Prior to final payment by the CITY, the CONTRACTOR must provide the CITY a fully-executed Conditional Waiver and Release Upon Final Payment in accordance with California Civil Code Section 3262.

ARTICLE 15 – SUSPENSION OF WORK AND TERMINATION

15.1 SUSPENSION OF WORK BY CITY

A. The CITY may, at any time and without cause, suspend the WORK or any portion thereof for a period of not more than 90 days by notice in writing to the CONTRACTOR. The CONTRACTOR shall resume the WORK on receipt of a notice of resumption of work. The CONTRACTOR will be allowed an increase in the Contract Price or an extension of the Contract Time, or both directly attributable to any suspension if the CONTRACTOR makes an approval claim therefor as provided in Articles 11 and 12.

15.2 TERMINATION OF AGREEMENT BY ENGINEER FOR DEFAULT

A. In the event of default by the CONTRACTOR, the ENGINEER may give seven days written notice to the CONTRACTOR and the CONTRACTOR's surety of CITY's intent to terminate the Agreement and provide the CONTRACTOR an opportunity to remedy the conditions constituting the default within a specified period of time. It will be considered a default by the CONTRACTOR whenever CONTRACTOR shall:

1. Declare bankruptcy, become insolvent, or assign its assets for the benefit of its creditors;

2. Disregard or violate the Laws or Regulations of any public body having jurisdiction;

3. Fail to provide materials or workmanship meeting the requirements of the Contract Documents;

4. Disregard or violate provisions of the Contract Documents or ENGINEER's instructions;

5. Fail to prosecute the WORK according to the approved progress schedule;

6. Fail to provide a qualified superintendent, competent workmen, or materials or equipment meeting the requirements of the Contract Documents;

7. Disregard the authority of the ENGINEER; or

8. Assign or subcontract any part of the work without the ENGINEER's consent.

B. If the CONTRACTOR fails to remedy the conditions constituting default within the time allowed, the ENGINEER may then issue the notice of termination.

C. In the event the Agreement is terminated in accordance with Paragraph 15.2A., herein, the CITY may take possession of the WORK and may complete the WORK by whatever method or means the CITY may select. The cost of completing the WORK will be deducted from the balance which would have been due the CONTRACTOR had the Agreement not been terminated and the WORK completed in accordance with the Contract Documents. If such cost exceeds the balance which would have been due, the CONTRACTOR shall pay the excess amount to the CITY. If such cost is less than the balance which would have been due, the CONTRACTOR shall not have claim to the difference.

15.3 TERMINATION OF AGREEMENT BY CITY FOR CONVENIENCE

A. Upon seven days' written notice to the CONTRACTOR, the CITY may, without cause and without prejudice to any other right or remedy of the CITY, elect to terminate the Agreement. In such case, the CONTRACTOR shall be paid (without duplication of any items):

1. For completed and acceptable WORK executed in accordance with the Contract Documents, prior to the effective date of termination, including fair and reasonable sums for overhead and profit of such WORK;

2. For expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted WORK, plus fair and reasonable sums or overhead and profit on such expenses;

3. For all reasonable claims, costs, losses, and damages incurred in settlement of terminated contracts with Subcontractors, Suppliers, and others; and

4. For reasonable expenses directly attributable to termination.

CONTRACTOR shall not be paid on account of loss of anticipated profits or revenue or other economic loss arising out of or resulting from such termination.

15.4 TERMINATION OF AGREEMENT BY CONTRACTOR

A. The CONTRACTOR may terminate the Agreement upon 14 days written notice to the ENGINEER whenever:

1. The WORK has been suspended under the provisions of Paragraph 15.1, herein, for more than 90 consecutive days through no fault or negligence of the CONTRACTOR, and notice to resume work or to terminate the

Agreement has not been received from the ENGINEER within this time period; or

2. The CITY should fail to pay the CONTRACTOR any monies due him in accordance with the terms of the Contract Documents and within 60 days after presentation to the ENGINEER by the CONTRACTOR of a request therefor, unless within said 14-day period the CITY shall have remedied the condition upon which the payment delay was based.

B. In the event of such termination, the CONTRACTOR shall have no claims against the CITY except for those claims specifically enumerated n Paragraph 15.3, herein, and as determined in accordance with the requirements of said paragraph.

ARTICLE 16 – GENERAL TERMS

16.1 GIVING NOTICE

A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if 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 at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice.

16.2 TITLE TO MATERIALS FOUND ON THE WORK

A. The CITY reserves the right to retain title to all soils, stone, sand, gravel, and other materials developed and obtained from excavations and other operations connected with the WORK. Unless otherwise specified in the Contract Documents, neither the CONTRACTOR nor any Subcontractor shall have any right, title, or interest in or to any such materials. The CONTRACTOR will be permitted to use in the WORK, without charge, any such materials which meet the requirements of the Contract Documents.

16.3 RIGHT TO AUDIT

A. If the CONTRACTOR submits a claim to the ENGINEER for additional compensation, the CITY shall have the right, as a condition to considering the claim, and as a basis for evaluation of the claim, and until the claim has been settled, to audit the CONTRACTOR's books to the extent they are relevant. This right shall include the right to examine books, records, documents, and other evidence and accounting procedures and practices, sufficient to discovery and verify all direct and indirect costs of whatever nature claimed to have been incurred or anticipated to be incurred and for which the claim has been submitted. The right to audit shall include the right to inspect the CONTRACTOR's plant or such parts thereof, as may be or have been engaged in the performance of the WORK. The CONTRACTOR further agrees that the right to audit encompasses

all subcontracts and is binding upon Subcontractors. The rights to examine and inspect herein provided for shall be exercisable through such representatives as the CITY deems desirable during the CONTRACTOR's normal business hours at the office of the CONTRACTOR. The CONTRACTOR shall make available to the ENGINEER for auditing, all relevant accounting records and documents, and other financial data, and upon request, shall submit true copies of requested records to the ENGINEER.

16.4 SURVIVAL OF OBLIGATIONS

A. All representations, indemnifications, warranties, and guaranties made in, required by or given in accordance with the Contract Documents, as well as all continuing obligations indicated in the Contract Documents, will survive final payment, completion and acceptance of the WORK or termination or completion of the Agreement.

16.5 CONTROLLING LAW

A. This Agreement is to be governed by the law of the state in which the Project is located.

16.6 SEVERABILITY

A. If any term or provision of this Agreement is declared invalid or unenforceable by any court of lawful jurisdiction, the remaining terms and provisions of the Agreement shall not be affected thereby and shall remain in full force and effect.

16.7 WAIVER

A. The waiver by the CITY of any breach or violation of any term, covenant or condition of this Agreement or of any provision, ordinance, or law shall not be deemed to be a waiver of any other term, covenant, condition, ordinance, or law or of any subsequent breach or violation of the same or of any other term, covenant, condition, ordinance, or law. The subsequent payment of any monies or fee by the CITY which may become due hereunder shall not be deemed to be a waiver of any preceding breach or violation by CONTRACTOR or any term, covenant, condition of this Agreement or of any applicable law or ordinance.

ARTICLE 17 – CALIFORNIA STATE REQUIREMENTS

17.1 STATE WAGE DETERMINATIONS

A. As required by Section 1770 and following, of the California Labor Code, the CONTRACTOR shall pay not less than the prevailing rate of per diem wages as determined by the Director of the California Department of Industrial Relations. Copies of such prevailing rate of per diem wages available file at the office of the City Clerk, which copies shall be made available to any interested party on request. The CONTRACTOR shall post a copy of such determination at each job site.

B. In accordance with Section 1775 of the California Labor Code, the CONTRACTOR shall, as a penalty to the CITY, forfeit not more than **$200.00** for each calendar day or portion thereof, for each worker paid less than the prevailing rates as determined by the Director for the work or craft in which the worker is employed for any public work done under the contract by him or her or by any subcontractor under him or her.

17.2 WORKERS' COMPENSATION

A. In accordance with the provisions of Section 3700 of the California Labor Code, the CONTRACTOR shall secure the payment of compensation to its employees.

B. Prior to beginning work under the Contract, the CONTRACTOR shall sign and file with the ENGINEER the following certification:

> "I am aware of the provisions of Section 3700 of the Labor Code, which require every employer to be insured against liability for workers' compensation or to undertake self-insurance in accordance with the provisions of that code, and I will comply with such provisions before commencing the performance of the WORK of this Contract."

C. Notwithstanding the foregoing provisions, before the Contract is executed on behalf of the CITY, a bidder to whom a contract has been awarded shall furnish satisfactory evidence that it has secured in the manner required and provided by law the payment of workers' compensation.

17.3 APPRENTICES ON PUBLIC WORKS

A. The CONTRACTOR shall comply with all applicable provisions of Section 1777.5 of the California Labor Code relating to employment of apprentices on public works.

17.4 WORKING HOURS

A. The CONTRACTOR shall comply with all applicable provisions of Section 1810 to 1815, inclusive, of the California Labor Code relating to working hours. The CONTRACTOR shall, as a penalty to the CITY, forfeit $25.00 for each worker employed in the execution of the Contract by the CONTRACTOR or by any subcontractor for each calendar day during which such worker is required or permitted to work more than 8 hours in any one calendar day and 40 hours in any one calendar week, unless such worker receives compensation for all hours worked in excess of 8 hours at not less than 1-1/2 times the basic rate of pay.

17.5 CONTRACTOR NOT RESPONSIBLE FOR DAMAGE RESULTING FROM CERTAIN ACTS OF GOD

A. As provided in Section 7105 of the California Public Contract Code, the CONTRACTOR shall not be responsible for the cost of repairing or restoring damage to the WORK which damage is determined to have been proximately caused by an act of God, in excess of 5 percent of the contracted amount, provided, that the WORK damaged was built in accordance with accepted and applicable building standards and the plans and specifications of the CITY. The CONTRACTOR shall obtain insurance to indemnify the CITY for any damage to the WORK caused by an act of God if the insurance premium is a separate bid item in the bidding schedule for the WORK. For purposes of this Section, the term “acts of God” shall include only the following occurrences or conditions and effects: earthquakes in excess of a magnitude of 3.5 on the Richter Scale and tidal waves.

17.6 NOTICE OF COMPLETION

A. In accordance with the Sections 3086 and 3093 of the California Civil Code, within 10 days after date of acceptance of the WORK BY THE City Council the ENGINEER will file, in the County Recorder’s office, a Notice of Completion of the WORK.

17.7 UNPAID CLAIMS

A. If, at any time prior to the expiration of the period for service of a stop notice, there is served upon the CITY a stop notice as provided in Sections 3179 and 3210 of the California Civil Code, the CITY shall, until the discharge thereof, withhold from the monies under its control so much of said monies due or to become due to the CONTRACTOR under this Contract as shall be sufficient to answer the claim stated in such stop notice and to provide for the reasonable cost of any litigation thereunder; provided, that if the ENGINEER shall, in its discretion, permit CONTRACTOR to file with the ENGINEER the bond referred to in Section 3196 of the Civil Code of the State of California, said monies shall not thereafter be withheld on account of such stop notice.

17.8 RETAINAGE FROM MONTHLY PAYMENTS

A. Pursuant to Section 22300 of the California Public Contract Code, the CONTRACTOR may substitute securities for any money withheld by the CITY to insure performance under the Contract. At the request and expense of the CONTRACTOR, securities equivalent to the amount withheld shall be deposited with the CITY or with a state or federally chartered bank in California as to the escrow agent, who shall return such securities to the CONTRACTOR upon satisfactory completion of the Contract.

B. Alternatively, the CONTRACTOR may request and the CITY shall make payment of retentions earned directly to the escrow agent at the expense of the CONTRACTOR. At the expense of the CONTRACTOR, the CONTRACTOR may direct the investment of the payments into securities and the CONTRACTOR shall receive the interest earned on the investments upon the same terms provided in Section 22300 of the Public Contract Code securities deposited by the CONTRACTOR. The CONTRACTOR shall be responsible for paying all fees for the expenses incurred by the escrow agent in administering the escrow account and all expenses of the CITY. These expenses and payment terms shall be determined by the CITY's Finance Director or his/her designee and the escrow agent. Upon satisfactory completion of the Contract, the CONTRACTOR shall receive from the escrow agent all securities, interest, and payments received by the escrow agent from the CITY, pursuant to the terms of Section 22300 of the Public Contract Code. The CONTRACTOR shall pay to each subcontractor, not later than 20 days of receipt of the payment, the respective amount of interest earned, net of costs attributed to retention withheld from each subcontractor, on the amount of retention withheld to insure the performance of the CONTRACTOR.

C. Securities eligible for investment under Section 22300 shall be limited to those listed in Section 16430 of the Government Code and to bank or savings and loan certificates of deposit, interest bearing demand deposit accounts, standby letters of credit, or any other security mutually agreed to by the CONTRACTOR and the CITY.

17.9 PUBLIC WORKS CONTRACTS; ASSIGNMENT TO AWARDING BODY

A. In accordance with Section 7103.5 of the California Public Contract Code, the CONTRACTOR and Subcontractors shall conform to the following requirements. In entering into a public works contract or a subcontract to supply goods, services, or materials pursuant to a public works contract, the CONTRACTOR or subcontractor offers and agrees to assign to the CITY all rights, title, and interest in and to all causes of action it may have under Section 4 of the Clayton Act (15 U.S.C. 15) or under the Cartwright Act (Chapter 2 (commencing with Section 16700) of Part 2 of Division 7 of the Business and Professions Code), arising

from purchases of goods, services, or materials pursuant to the public works contract or the subcontract. This assignment shall be made and become effective at the time the awarding body tenders final payment to the CONTRACTOR, without further acknowledgment by the parties.

17.10 PAYROLL RECORDS; RETENTION; INSPECTION; NONCOMPLIANCE PENALTIES; RULES AND REGULATIONS

A. In accordance with Section 1776 of the California Labor Code the CONTRACTOR and each Subcontractor shall keep an accurate payroll record, showing the name, address, social security number, work classification, straight time and overtime hours worked each day and week, and the actual per diem wages paid to each journeyman, apprentice, worker, or other employee employed by him or her in connection with the public work. Each payroll record shall contain or be verified by a written declaration that it is made under penalty of perjury, stating both of the following:

1. The information contained in the payroll record is true and correct.

2. The employer has complied with the requirements of Sections 1771, 1811, and 1815 for any work performed by his or her employees on the public works project.

B. The payroll records shall be certified and shall be available for inspection at all reasonable hours at the principal office of the CONTRACTOR on the following basis:

1. A certified copy of an employee's payroll record shall be made available for inspection or furnished to the employee or his or her authorized representative on request as well as submitted electronically online to the Department of Industrial Relations Labor Commissioner: https://apps.dir.ca.gov/ecpr/DAS/AltLogin.

2. A certified copy of all payroll records shall be made available for inspection or furnished upon request to a representative of the body awarding the contract, the Division of Labor Standards Enforcement, and the Division of Apprenticeship Standards of the Department of Industrial Relations.

3. A certified copy of all payroll records shall be made available upon request by the public for inspection or copies thereof made; provided, however, that a request by the public shall be made through either the body awarding the contract, the Division of Apprenticeship Standards, or the Division of Labor Standards Enforcement. If the requested payroll records have not been provided the requesting party shall, prior to being provided the records, reimburse the costs of preparation by the

CONTRACTOR, Subcontractors, and the entity through which the request was made. The public shall not be given access to the records at the principal office of the CONTRACTOR.

C. The certified payroll records shall be on forms provided by the Division of Labor Standards Enforcement or shall contain the same information as the forms provided by the division.

D. Any copy of records made available for inspection as copies and furnished upon request to the public or any public agency by the awarding body, the Division of Apprenticeship Standards, or the Division of Labor Standards Enforcement shall be marked or obliterated in such a manner as to prevent disclosure of an individual's name, address, and social security number. The name and address of the CONTRACTOR awarded the contract or performing the contract shall not be marked or obliterated.

E. The CONTRACTOR shall inform the ENGINEER of the location of the records including the street address, city and county, and shall, within 5 working days, provide a notice of change of location and address.

F. The CONTRACTOR shall have 10 days in which to comply subsequent to receipt of written notice specifying in what respects the CONTRACTOR must comply with this Section. In the event that the CONTRACTOR fails to comply within the 10-day period, he or she shall, as a penalty to the state or political subdivision on whose behalf the contract is made or awarded, forfeit twenty-five dollars ($25.00) for each calendar day, or portion thereof, for each worker, until strict compliance is effectuated. Upon the request of the Division of Apprenticeship Standards or the Division of Labor Standards Enforcement, these penalties shall be withheld from progress payments then due. A contractor is not subject to a penalty assessment pursuant to this section due to the failure of a subcontractor to comply with this section.

17.11 CULTURAL RESOURCES

A. The CONTRACTOR's attention is directed to the provisions of the Clean Water Grant Program Bulletin 76A which augments the National Historic Preservation Act of 1966 (16 U.S.C. 470) as specified under Section 01560 - Temporary Environmental Controls, of the General Requirements.

17.12 PROTECTION OF WORKERS IN TRENCH EXCAVATIONS

A. As required by Section 6705 of the California Labor Code and in addition thereto, whenever work under the Contract involves the excavation of any trench or trenches 5 feet or more in depth, the CONTRACTOR shall submit for acceptance by the ENGINEER, to whom authority to accept has been delegated, in advance of excavation, a detailed plan showing the design of shoring, bracing, sloping, or

other provisions to be made for worker protection from the hazard of caving ground during the excavation, of such trench or trenches. If such plan varies from the shoring system standards established by the Construction Safety Orders of the Division of Occupational Safety and Health, the plan shall be prepared by a registered civil or structural engineer employed by the CONTRACTOR, and all costs therefore shall be included in the price named in the Contract for completion of the WORK as set forth in the Contract Documents. Nothing in this Section shall be deemed to allow the use of a shoring, sloping, or other protective system less effective than that required by the Construction Safety Orders. Nothing in this Section shall be construed to impose tort liability on the CITY or any of its officers, agents, representatives, or employees.

B. Excavation shall not start until the CONTRACTOR has obtained a permit from the California Division of Industrial Safety and has posted it at the site.

17.13 CONCRETE FORMS, FALSEWORK, AND SHORING

A. The CONTRACTOR shall comply fully with the requirements of Section 1717 of the Construction Safety Orders, State of California, Department of Industrial Relations, regarding the design of concrete forms, falsework and shoring, and the inspection of same prior to placement of concrete. Where the said Section 1717 requires the services of a civil engineer registered in the State of California to approve design calculations and working drawings of the falsework or shoring system, or to inspect such system prior to placement of concrete, the CONTRACTOR shall employ a registered civil engineer for these purposes, and all costs therefore shall be included in the price named in the Contract for completion of the WORK as set forth in the Contract Documents.

17.14 REMOVAL, RELOCATION, OR PROTECTION OF EXISTING UTILITIES

A. In accordance with the provisions with the provisions of Section 4215 of the California Government Code, the CITY shall assume the responsibility for the timely removal, relocation, or protection of existing main or trunkline utility facilities located on the site of any construction project that is a subject of the Contract, if such utilities are not identified by the CITY in the plans and specifications made a part of the invitation for bids. The CITY will compensate CONTRACTOR for the costs of locating, repairing damage not due to the failure of the CONTRACTOR to exercise reasonable care, and removing or relocating such utility facilities not indicated in the plans and specifications with reasonable accuracy, and for equipment on the project necessarily idled during such work.

B. The CONTRACTOR shall not be assessed liquidated damages for delay in completion of the project, when such delay was caused by the failure of the public agency or the owner of the utility to provide for removal or relocation of such utility facilities.

C. Nothing herein shall be deemed to require the public agency to indicate the presence of existing service laterals or appurtenances when the presence of such utilities on the site of the construction project can be inferred from the presence of other visible facilities, such as buildings, meter and junction boxes, on or adjacent to the site of construction; provided however, nothing herein shall relieve the public agency from identifying main or trunklines in the plans and specifications.

D. If the CONTRACTOR while performing the Contract discovers utility facilities not identified by the public agency in the Contract Documents it shall immediately notify the public agency and utility in writing.

E. The public utility, where they are the owner, shall have the sole discretion to perform such repairs or relocation work or permit the CONTRACTOR to do such repairs or relocation work at a reasonable price.

17.15 CONTRACTOR LICENSE REQUIREMENTS

A. In accordance with Section 7028.15 of the California Business and Professions Code:

B. It is a misdemeanor for any person to submit a bid to a public agency in order to engage in the business or act in the capacity of a contractor within this state without having a license therefor, except in any of the following cases:

1. The person is particularly exempted from this chapter.

2. The bid is submitted on a state project governed by Section 10164 of the Public Contract Code or any local agency project governed by Section 20103.5 of the Public Contract Code.

C. If a person has previously been convicted of the offense described in this section, the court shall impose a fine of 20 percent of the price of the contract under which the unlicensed person performed contract work, or four thousand five hundred dollars ($4,500), whichever is greater, or imprisonment in the county jail for not less than 10 days nor more than six months, or both.

D. In the event the person performing the contracting work has agreed to furnish materials and labor on an hourly basis, “the price of the contract” for the purpose of this subdivision means the aggregate sum of the cost of materials and labor furnished and the cost of completing the work to be performed.

E. This section shall not apply to a joint venture license, as required by Section 7029.1 of the California Business and Professions Code. However, at the time of making a bid as a joint venture, each person submitting the bid shall be subject to this section with respect to his or her individual licensure.

F. This section shall not affect the right or ability of a licensed architect, land surveyor, or registered professional engineer to form joint ventures with licensed contractors to render services within the scope of their respective practices.

G. Unless one of the foregoing exceptions applies, a bid submitted to a public agency by a contractor who is not licensed in accordance with this chapter shall be considered nonresponsive and shall be rejected by the public agency. Unless one of the foregoing exceptions applies, a local public agency shall, before awarding a contract or issuing a purchase order, verify that the contractor was properly licensed when the contractor submitted the bid. Notwithstanding any other provision of law, unless one of the foregoing exceptions applies, the registrar may issue a citation to any public officer or employee of a public entity who knowingly awards a contract or issues a purchase order to a contractor who is not licensed pursuant to this chapter. The amount of civil penalties, appeal, and finality of such citations shall be subject to Sections 7028.7 and 7028.13 inclusive of the California Business and Professions Code. Any contract awarded to, or any purchase order issued to, a contractor who is not licensed pursuant to this chapter is void.

H. Any compliance or noncompliance with subdivision (G) of this paragraph shall not invalidate any contract or bid awarded by a public agency during which time that subdivision was in effect.

I. A public employee or officer shall not be subject to a citation pursuant to this section if the public employee, officer, or employing agency mad an inquiry to the board for the purposes of verifying the license status of any person or contractor and the board failed to respond to the inquiry within three business days. For the purposes of this section, a telephone response by the board s hall be deemed sufficient.

17.16 DIGGING TRENCHES OR EXCAVATIONS; NOTICE ON DISCOVERY OF HAZARDOUS WASTE OR OTHER UNUSUAL CONDITIONS; INVESTIGATIONS; CHANGE ORDERS; EFFECT ON CONTRACT

A. If this Contract involves digging trenches or other excavations that extend deeper than four feet below the surface, the following shall apply:

1. The CONTRACTOR shall promptly, and before the following conditions are disturbed, notify the ENGINEER in writing, of any:

a. Material that the CONTRACTOR believes may be material that is hazardous waste, as defined in Section 25117 of the Health and Safety Code, that is required to be removed to a Class I, Class II, or Class III disposal site in accordance with provisions of existing law.

b. Subsurface or latent physical conditions at the site differing from those indicated.

c. Unknown physical conditions at the site of any unusual nature, different materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in the contract.

d. The ENGINEER shall promptly investigate the conditions, and if it finds that the conditions do materially so differ, or do involve hazardous waste, and cause a decrease or increase in the CONTRACTOR'S cost of, or the time required for, performance of any part of the work shall issue a change order the procedures described in the Contract.

e. In the event that a dispute arises between the ENGINEER and the CONTRACTOR whether the conditions materially differ, or involve hazardous waste, or cause a decrease or increase in the CONTRACTOR'S cost of, or time required for, performance of any part of the work, the CONTRACTOR shall not be excused from any scheduled completion date provided for by the Contract, but shall proceed with all work to be performed under the Contract. The CONTRACTOR shall retain any and all rights provided either by contract or by law which pertain to the resolution of disputes and protests between the contracting parties.

17.17 RETENTION PROCEEDS; WITHHOLDING; DISBURSEMENT

A. In accordance with Section 7107 of the Public Contract Code with respects to all contracts entered into on or after January 1, 1993 relating to the construction of any public work of improvement the following shall apply:

1. The retention proceeds withheld from any payment by the CITY from the original CONTRACTOR, or by the original CONTRACTOR from any subcontractor, shall be subject to this paragraph 17.18.

2. Within 60 days after the date of completion of the WORK, including any punch-list WORK, the retention withheld by the CITY shall be released. In the event of a dispute between the ENGINEER and the original CONTRACTOR, the CITY may withhold from the final payment an amount not to exceed 150 percent of the disputed amount. For the purposes of this paragraph, "completion" means any of the following:

a. The occupation, beneficial use, and enjoyment of a work of improvement, excluding any operation only for testing, startup, or

commissioning, by the CITY, accompanied by cessation of labor on the work of improvement.

b. The acceptance by the City Council of the work of improvement.

c. After the commencement of a work of improvement, a cessation of labor on the work of improvement for a continuous period of 100 days or more, due to factors beyond the control of the CONTRACTOR.

d. After the commencement of a work of improvement, a cessation of labor on the work of improvement for a continuous period of 30 days or more, if the ENGINEER files for record a notice of cessation or a notice of completion.

3. Subject to subparagraph 17.18 A.4, within 10 days from the time that all or any portion of the retention proceeds are received by the original CONTRACTOR, the original CONTRACTOR shall pay each of its subcontractors from whom retention has been withheld, each subcontractor's share of the retention received. However, if a retention payment received by the original CONTRACTOR is specifically designated for a particular subcontractor, payment of the retention shall be made to the designated subcontractor, if the payment is consistent with the terms of the subcontract.

4. The original CONTRACTOR may withhold from a subcontractor its portion of the retention proceeds if a bona fide dispute exists between the subcontractor and the original CONTRACTOR. The amount withheld from the retention payment shall not exceed 150 percent of the estimated value of the disputed amount.

5. In the event that retention payments are not made within the time periods required by this paragraph 17.18, the CITY or original CONTRACTOR shall be subject to a charge of 2 percent per month on the improperly withheld amount, in lieu of any interest otherwise due. Additionally, in any action for the collection of funds wrongfully withheld, the prevailing party shall be entitled to attorney's fees and costs.

6. Any attempted waiver of the provisions of this section shall be void as against the public policy of this state.

17.18 TIMELY PROGRESS PAYMENTS; INTEREST; PAYMENT REQUESTS

A. If the CITY fails to make any progress payment within 30 days after receipt of an undisputed and properly submitted payment request from the CONTRACTOR, the CITY shall pay interest to the CONTRACTOR equivalent to the legal rate set forth in subdivision (a) of Section 685.010 of the Code of Civil Procedure.

B. Upon receipt of a payment request, the ENGINEER shall act in accordance with both of the following:

1. Each payment request shall be reviewed by the ENGINEER as soon as practicable after receipt for the purpose of determining that the payment request is a proper payment request.

2. Any payment request determined not to be a proper payment request suitable for payment shall be returned to the CONTRACTOR as soon as practicable, but not later than seven days, after receipt. A request returned pursuant to this paragraph shall be accompanied by a document setting forth in writing the reasons why the payment request is not proper.

C. The number of days available to the CITY to make a payment without incurring interest pursuant to this paragraph shall be reduced by the number of days by which the CITY exceeds the seven-day requirement set forth above.

D. For purposes of this paragraph:

1. A "progress payment" includes all payments due the CONTRACTOR, except that portion of the final payment designated by the contract as retention earnings.

2. A payment request shall be considered properly executed if funds are available for payment of the payment request, and payments is not delayed due to an audit inquiry by the financial officer of the CITY.

17.19 PREFERENCE FOR MATERIAL

A. In accordance with Section 3400 of the California Public Contract Code, the CONTRACTOR will be provided a period prior to award of the contract for submission of data substantiating a request for a substitution of "as equal" item.

17.20 RESOLUTION OF CONSTRUCTION CLAIMS

A. In accordance with Section 20104 et Seq. of the California Public Contract Code. This paragraph applies to all claims of $375,000 or less which arise between the CONTRACTOR and the CITY under this Contract for:

1. A time extension;

2. Payment of money or damages arising from work done by or on behalf of, the CONTRACTOR pursuant to this CONTRACT and payment of which is not otherwise expressly provided for or the CONTRACTOR is not otherwise entitled to; or

3. An amount the payment of which is disputed by the ENGINEER.

B. For any claim set out in Paragraphs A.1, 2, or 3 above, the following requirements apply:

1. The claim shall be in writing and include the documents necessary to substantiate the claim and be accompanied by the following certification:

> "CONTRACT PROVISION REQUIRING PERSONAL CERTIFICATION OF ALL CLAIMS:
>
> I, _____, BEING THE _____ (MUST BE AN OFFICER) OF _____ (GENERAL CONTRACTOR), DECLARE UNDER PENALTY OF PERJURY UNDER THE LAWS OF THE STATE OF CALIFORNIA, AND DO PERSONALLY CERTIFY AND ATTEST THAT: I HAVE THOROUGHLY REVIEWED THE ATTACHED CLAIM FOR ADDITIONAL COMPENSATION AND/OR EXTENSION OF TIME, AND KNOW ITS CONTENTS, AND SAID CLAIM IS MADE IN GOOD FAITH; THE SUPPORTING DATA IS TRUTHFUL AND ACCURATE; THAT THE AMOUNT REQUESTED ACCURATELY REFLECTS THE CONTRACT ADJUSTMENT FOR WHICH THE CONTRACTOR BELIEVES THE CITY IS LIABLE; AND, FURTHER THAT I AM FAMILIAR WITH CALIFORNIA PENAL CODE SECTION 12650, ET SEQ. PERTAINING TO FALSE CLAIMS, AND FURTHER KNOW AND UNDERSTAND THAT SUBMISSION OR CERTIFICATION OF A FALSE CLAIM MAY LEAD TO FINES, IMPRISONMENT AND/OR OTHER SEVERE LEGAL CONSEQUENCES."

Claims must be filed on or before the date of final payment. Nothing herein is intended to extend the time limit or supersede notice requirements otherwise provided by Contract for the filing of claims.

The claim must include an actual cost documentation, including hours of work performed, equipment operation costs, and labor and overhead costs, which should be established at a standard percentage. Any overhead costs listed when paid, shall provide full and complete payment for any and all overhead, including jobsite overhead, home office overhead, as well as additional costs arising from disruption, resequencing or acceleration. A notice of POTENTIAL CLAIM shall be submitted in advance of the performance of any work, regardless of type, in which the CONTRACTOR may claim an additional cost. CONTRACTOR shall provide prompt notification of any disagreement in quantities of work performed along with a detailed accounting by means of a schedule update demonstrating any delays incurred.

2. For claims of less than fifty thousand dollars ($50,000), the ENGINEER shall respond in writing to any written claim within 45 days of receipt of the claim, or may request, in writing, within 30 days of receipt of the claim, any additional documentation supporting the claim or relating to defenses to the claim the CITY may have against the CONTRACTOR.

   If additional information is thereafter required, it shall be requested and provided upon mutual agreement of the ENGINEER and the CONTRACTOR.

   The ENGINEER's written response to the claim, as further documented, shall be submitted to the CONTRACTOR within 15 days after receipt of further documentation or within a period of time no greater than that taken by the CONTRACTOR in producing the additional information, whichever is greater.

3. For claims of over fifty thousand dollars ($50,000) and less than or equal to three hundred seventy-five thousand dollars ($375,000), the ENGINEER shall respond in writing to all written claims within 60 days of receipt of the claim, or may request, in writing, within 30 days of receipt of the claim, any additional documentation supporting the claim or relating to defenses to the claim the CITY may have against the CONTRACTOR.

   If additional information is thereafter required, it shall be requested and provided upon mutual agreement of the ENGINEER and the CONTRACTOR.

The ENGINEER's written response to the claim, as further documented, shall be submitted to CONTRACTOR within 30 days after receipt of the further documentation, or within a period of time no greater than that taken by the CONTRACTOR in producing the additional information or requested documentation, whichever is greater.

4. If the CONTRACTOR disputes the ENGINEER's written response, or the ENGINEER fails to respond within the time prescribed, the CONTRACTOR may notify the ENGINEER, in writing, either within 15 days of receipt of the ENGINEER's response or within 15 days of the ENGINEER's failure to respond within the time prescribed, respectively, and demand an informal conference to meet and confer for settlement of the issues in dispute. Upon a demand, the ENGINEER shall schedule a meet and confer conference within 30 days for settlement of the dispute.

5. Following the meet and confer conference, if the claim or any portion remains in dispute, the CONTRACTOR may file a claim pursuant to Chapter 1 (commencing with Section 900) and Chapter 2 (commencing with Section 910) of Part 3 of Division 3.6 of Title 1 of the Government Code. For purposes of those provisions, the running of the period of time within which a claim must be filed shall be tolled from the time CONTRACTOR submits its written claim pursuant to subdivision (a) until the time the claim is denied as a result of the meet and confer process, including any period of time utilized by the meet and confer process.

C. The following procedures are established for all civil actions filed to resolve claims subject to this article:

1. Within 60 days, but no earlier than 30 days, following the filing or responsive pleadings, the court shall submit the matter to nonbinding mediation unless waived by mutual stipulation of both parties. The mediation process shall provide for the selection within 15 days by both parties of a disinterested third person as mediator, shall be commenced within 30 days of the submittal, and shall be concluded within 15 days from the commencement of the mediation unless a time requirement is extended upon a good cause showing to the court or by stipulation of both parties. If the parties fail to select a mediator within the 15-day period, any party may petition the court to appoint the mediator.

2. If the matter remains in dispute, the case shall be submitted to judicial arbitration pursuant to Chapter 2.5 (commencing with Section 1141.10) of Title 3 of Part 3 of the Code of Civil Procedure, notwithstanding Section 1141.11 of that code. The Civil Discovery Act of 1986 (Article 3 (commencing with Section 2016) of Chapter 3 of Title 3 of Part 4 of the Code of Civil Procedure) shall apply to any proceeding brought under this subdivision consistent with the rules pertaining to judicial arbitration.

Notwithstanding any other provision of law, upon stipulation of the parties, arbitrators appointed for purposes of Article 1.5 of Chapter 1 of Part 3 of Division 2 of the California Public Contract Code shall be experienced in construction law, and, upon stipulation of the parties, mediators and arbitrators shall be paid necessary and reasonable hourly rates of pay not to exceed their customary rate, and such fees and expenses shall be paid equally by the parties, except in the case of arbitration where the arbitrator, for good cause, determines a different division. In no event shall these fees or expenses be paid by state or county funds.

In addition to Chapter 2.5 (commencing with Section 1141.10 of Title 3 of Part 3 of the Code of Civil Procedure any party who after receiving an arbitration award requests a trial de novo but does not obtain a more favorable judgment shall, in addition to payment of costs and fees under that chapter, also pay the attorney's fees of the other party arising out of the trial de novo .

3. The CITY shall not fail to pay money as to any portion of a claim which is undisputed except as otherwise provided in this Contract.

4. In any suit filed under Section 20104.4 of the California Public Contract Code, the CITY shall pay interest at the legal rate on any arbitration award or judgment. The interest shall begin to accrue on the date the suit is filed in a court of law.

END OF GENERAL CONDITIONS

file name:

SECTION III

SPECIAL PROVISION

SECTION III.

SPECIAL PROVISIONS

3-1. DESCRIPTION OF WORK – The project includes construction of two new tertiary filters number 6 and 7, improvements to the tertiary pump station, filter support building ventilation modifications, construction of a new storage building and modification to the existing maintenance building, construction of a waste storage canopy, along with associated miscellaneous piping, utility, electrical and controls improvements. A detailed description of the work is provided herein and summarized in Technical Specifications Section 01110.

3-2. ULTRAVIOLET (UV) DISINFECTION SYSTEM – The UV disinfection system project is currently under construction by C. Overaa & Co. for the replacement of UV equipment and installation of a canopy at the nearby UV treatment channels. These projects have the potential to overlap in timing and/or location. The CONTRACTOR shall coordinate with the CITY and C. Overaa & Co. to avoid conflicts with ongoing construction and facility operations.

3-3. ORDER OF PRECEDENCE OF CONTRACT DOCUMENTS – If the CONTRACTOR discovers any errors, omissions, discrepancies, or conflicts in the Contract, he/she shall immediately inform the ENGINEER in writing. The ENGINEER will promptly resolve such matters by issuing addenda or change orders. Failure or delay to act on the part of the ENGINEER shall not constitute a waiver of any right afforded the CITY or the ENGINEER by the Contract or constitute an implied approval. Any work affected by such discoveries that is performed by the CONTRACTOR prior to authorization by the CITY shall be at the CONTRACTOR'S risk.

Unless otherwise noted below, conflicts or inconsistencies between parts of the Contract will be resolved by the ENGINEER with a change order or an addendum, if required. Addenda and change orders bearing the most recent date shall prevail over addenda or change orders bearing earlier dates. Any reference to addenda-changed specifications or drawings shall be considered to have been changed accordingly.

In resolving conflicts, errors, or discrepancies, the order of precedence shall be as follows:

1) Change Orders/Addenda (most recent in time takes precedence)
2) Agreement and Bond Forms
3) Special Provisions
4) Drawings
5) Technical Specifications
6) Standard Specifications (Current Caltrans Standard Specifications)
7) General Conditions
8) Instructions to Bidders

9) CONTRACTOR'S Bid (Bid Form)

10) Notice Inviting Bids

11) Permits from other agencies as may be required by law.

3-4. COOPERATION – The Ellis Creek Water Recycling Facility is in active and continuous use. CONTRACTOR shall coordinate with operations staff to ensure that timing of changes in the treatment system operations occur with adequate notice and minimized disruption. Detailed sequencing and limitations are included in the technical specifications.

3-5. ORDER OF WORK – The CONTRACTOR shall submit a work plan to the City for review and shall identify proposed order of work to maximize efficiency of construction, minimize impact to the facility and maintain safety.

3-6. PROJECT AND CONSTRUCTION AREA SIGNS – Project sign and construction area signs shall be furnished, installed, maintained, and removed when no longer required in

Replacement of the project signs with a dimension of 4' to 8' wide and 3' to 5' tall shall be furnished and installed. The sign information shall be updated according to grant funding requirements.

The signs shall be approved prior to fabrication and posted as directed by the Engineer.

All costs involved for completing all work described in this section shall be considered to be included in the contract price paid for line item 1.J. and no additional compensation shall be allowed therefore.

3-7. PROGRESS SCHEDULE – The CONTRACTOR shall submit a schedule which includes all major tasks and milestones to the City of Petaluma, Public Works and Utilities Department for review **at least** ten (10) working days prior to start of work.

After beginning of work, updated schedules shall be submitted. No progress payments will be processed without accepted updated schedules.

Payment for the original schedule and updated, weekly schedules shall be considered to be included in the various items of work and no additional compensation will be allowed therefore.

3-8. SUPERINTENDENCE – The CONTRACTOR shall designate in writing and submit to the Project Engineer two (2) working days before starting work, an authorized representative who shall have the authority to represent and act for the CONTRACTOR for the duration of the contract. Any change in the designation shall require prior approval of the ENGINEER.

When the CONTRACTOR is comprised of two (2) or more persons, firms, partnerships or corporations functioning on a joint venture basis, said CONTRACTOR shall designate in writing before starting work, the name of one authorized representative who shall have the authority to represent and act for the CONTRACTOR.

Said authorized representative shall be present at the site of work at all times while work is actually in progress on the contract. When work is not in progress and during periods when work is suspended, arrangements acceptable to the ENGINEER shall be made for any emergency work, which may be required.

If work is in progress and the authorized representative is not on site, the City reserves the right to stop the work at no cost to the City.

Once the work begins, the Superintendent shall keep the ENGINEER informed of the CONTRACTOR's daily schedule. The ENGINEER shall have at least twenty-four (24 hour advance notice of all work, on a daily basis, including SUBCONTRACTOR's work. If the CONTRACTOR fails to notify the ENGINEER, the ENGINEER reserves the right to stop the work at no cost to the City.

In the case of urgency or emergency where the CONTRACTOR's authorized representative is not present on any particular part of the work and where the ENGINEER wishes to give notification or direction, it will be given to and be obeyed by the superintendent or foreperson who may have charge of the particular work or it will be given to and be obeyed by any worker in the area should the superintendent or foreperson not be immediately available.

All costs involved in superintendence shall be included in the contract prices paid for various items of work and no additional payment will be allowed therefore.

3-9. SAFETY REQUIREMENT – The CONTRACTOR shall comply with all CAL/OSHA safety requirements. It shall be the CONTRACTOR's sole responsibility for making sure these safety requirements are met and the CONTRACTOR shall fully assume all liabilities for any damages and/or injuries resulting from his or her failure to comply with the safety requirements. Failure on the City's part to stop unsafe practices shall, in no way, relieve the CONTRACTOR of his/her responsibility.

The CONTRACTOR shall first call City of Petaluma Emergency Center at 911, from a regular telephone, and (707) 762-2727 or from a cellular phone (707) 762-4545, if any gas lines or electrical power lines are broken or damaged.

3-10. PROJECT APPEARANCE – The CONTRACTOR shall maintain a neat appearance to the work area.

When practicable, debris developed during construction shall be disposed of concurrently with its removal. Stockpiling on the street shall not be allowed. The CONTRACTOR shall apply for a “stockpiling” permit from the City’s Community Development Department prior to stockpiling more than fifty (50) cubic yards of materials on private

property. The CONTRACTOR shall solely be responsible for securing staging and/or stockpiling areas.

The CONTRACTOR shall provide dust control as often as required during the construction, and shall clean the roads/streets with street sweepers at least once a day at the end of each working day or more often if safety or appearance conditions warrant. Failure to maintain dust control, street cleaning and/or any required work specified in this section shall result in the City performing the work with other forces and back charge the CONTRACTOR for the costs.

Full compensation for conforming to the provisions in this section, not otherwise provided for, shall be considered as included in prices paid for the various contract items of work involved and no additional compensation will be allowed therefore.

3-11. RESPONSIBILITY FOR DAMAGE – The CONTRACTOR shall indemnify, hold harmless, release and defend the City of Petaluma, its officers, officials, employees and agents from and against any and all liabilities, claims, demands, losses, damages, expenses, costs (including without limitation costs and fees of litigation) of every nature arising out of or in connection with the activities of the CONTRACTOR, his/her subcontractors, employees and agents, except such loss or damage which was caused by the sole negligence or willful misconduct of the CITY, its employees or agents. The CITY may retain so much of the money due the CONTRACTOR as shall be considered necessary, until disposition has been made of claims or suits for damages as aforesaid.

3-12. GUARANTEE OF WORK – Neither the final certificate of payment nor any provision in the contract nor partial or entire use of the improvements embraced in this contract by the City or the public shall constitute an acceptance of work not done in accordance with the contract or relieve the CONTRACTOR of liability in respect to any warranties or responsibility for faulty materials or workmanship. The CONTRACTOR's attention is directed to Article 5, "Bonds and Insurance", of the General Conditions.

3-13. NOTICE TO PROCEED, BEGINNING OF WORK, CONTRACT TIME, TIME OF COMPLETION, AND LIQUIDATED DAMAGES – Article 2.3, "Commencement of Contract Times; Notice To Proceed" of the General Conditions is amended to read:

The CONTRACTOR shall begin work within ten (10) working days from the date of Notice To Proceed (NTP) and shall diligently prosecute the same to completion before the expiration of total allocated working days as specified in the Construction Agreement and/or Invitation to Bid, from the date of starting work. The CONTRACTOR shall complete all of the work directed by the ENGINEER in all parts and requirements within the time set forth. A working day is defined in these specifications.

The CONTRACTOR is on notice that it may take approximately eight (8) weeks from the bid opening to obtain the City Council's award of the contract, to process the construction agreement, and to issue the Notice to Proceed.

The CONTRACTOR shall pay to the City of Petaluma the sum of $1,500 per calendar day delay in finishing the work in excess of the number of days prescribed

above (and/or in excess of the number of days prescribed for any scheduled operations or works described in the Special Provisions). Additional penalties are listed in Technical Specifications Section 01140 as related to work sequencing, are separate and may be in addition to liquidated damages.

A working day is defined as any day, except as follows:

a. Saturdays, Sundays, and legal holidays
b. Days on which the CONTRACTOR is prevented by inclement weather or conditions resulting immediately therefrom adverse to the current controlling operation or operations, as determined by the ENGINEER, from proceeding with at least 75 percent of the normal labor and equipment force engaged on that operation or operations for at least 60 percent of the total daily time being currently spent on the controlling operation or operations. 30 days anticpated.

Should the CONTRACTOR prepare to begin work at the regular starting time of any day on which inclement weather, or the conditions resulting from the weather, or the condition of the work, prevents the work from beginning at the usual starting time and the crew is dismissed as a result thereof and the CONTRACTOR does not proceed with at least 75 percent of the normal labor and equipment force engaged in the current controlling operation or operations for at least 60 percent of the total daily time being currently spent on the controlling operation or operations, the CONTRACTOR will not be charged for a working day whether or not conditions should change thereafter during that day and the major portion of the day could be considered to be suitable for those construction operations.

Determination that a day is a non-working day by reason of inclement weather or conditions resulting immediately therefrom shall be made by the ENGINEER. The CONTRACTOR will be allowed 10 days from the issuance of the weekly statement of working days in which to file a written protest setting forth in what respects the CONTRACTOR differs from the ENGINEER; otherwise, the decision of the ENGINEER shall be deemed to have been accepted by the CONTRACTOR as correct. The ENGINEER will furnish the CONTRACTOR a weekly statement showing the number of working days charged to the contract for the preceding week, the number of working days of time extensions being considered or approved, the number of working days originally specified for the completion of the contract, and the number of working days remaining to complete the contract and any time extensions thereof.

3-14. HOURS OF WORK

Weekdays – Weekdays (Monday through Friday) hours shall be from 7:00 a.m. to 5:00 p.m. for all required work except those hours approved by the City of Petaluma or specified in "Order of Work" Section of these special provisions. Work hours for County of Sonoma and Caltrans right of way shall be governed by their respective permit conditions.

Night Hours – Other than emergency work, there will be no night hours allowed on this project.

Liquidated Damages in the sum of Fifteen Hundred Dollars ($1,500) per day will be assessed against the CONTRACTOR if he fails to comply with any of the daily conditions or operations such as maintaining erosion control facilities, job site/street cleanliness and daily cleanup, as described in the General Conditions, these Special Provisions, and the Technical Specifications.

If the CONTRACTOR conducts a shut down or interrupts operations without prior notice and approval of the ENGINEER within 24 hours, the associated operation will be shutdown at the CONTRACTOR's expense.

Holidays – Designated legal holidays are: January 1st, the third Monday in January, the third Monday in February, March 31st, the last Monday in May, June 19th, July 4th, the first Monday in September, November 11th, Thanksgiving Day, the day after Thanksgiving, December 24th and December 25th. When a designated legal holiday falls on a Sunday, the following Monday shall be a designated legal holiday. When November 11th falls on a Saturday, the preceding Friday shall be a designated legal holiday. The Contractor shall not work on the legal holidays unless approved in writing by the Engineer.

3-15. RECORD ("AS-BUILT") DRAWINGS – The CONTRACTOR shall furnish Record Drawings of the complete project and procure from the Director of Public Works a full sized set of Contract Drawings. Construction drawings shall be on the construction site at all times while the work is in progress. Drawings shall show approved substitutions, if any, of material including manufacturer's name and catalog number. The Drawings shall be to scale and all indications shall be neat and legible. All information noted on the CONTRACTOR's job-site print shall be transferred to the Record Drawings by CONTRACTOR and all indications shall be recorded in a neat, legible and orderly way. The Record Drawings shall be signed by the CONTRACTOR and turned over to the Director of Public Works before the final acceptance of the project. If the CONTRACTOR fails to provide the City with an acceptable "Record Drawings", the City shall deduct $2,000 from the amount due CONTRACTOR.

3-16. NOTICE OF POTENTIAL CLAIM – If for any reason the CONTRACTOR deems that additional compensation is due him/her for work or materials not clearly provided for in the contract, plans, or specifications or previously authorized extra work, a Notice of Potential Claim shall be made. The CONTRACTOR shall give the ENGINEER a written Notice of Potential Claim for such additional compensation before work begins on the items on which the claim is based. The notice shall set forth the reasons for which the CONTRACTOR believes additional compensation will or may be due and the nature of the costs involved. The CONTRACTOR shall afford the ENGINEER every opportunity and facility for keeping records of the actual cost of the work. The CONTRACTOR shall keep records of the disputed work in accordance with Contract General Conditions, Section 11.3, "Cost of Work (Based on Time and Materials)."

If such notification is not given or the ENGINEER is not afforded proper opportunity by the CONTRACTOR for keeping strict account of actual cost as required, then the CONTRACTOR hereby agrees to waive any claim for such additional compensation.

Such notice by the CONTRACTOR and the fact that the ENGINEER has kept account of the cost of the work shall not in any way be construed as proving or substantiating the validity of the claim. When the work on which the claim for additional compensation is based has been completed, the CONTRACTOR shall, within 10 calendar days, submit his/her written claim to the ENGINEER who will present it to the City for consideration in accordance with local laws or ordinances. The CONTRACTOR is directed to Section 17.20 "Resolution of Construction Claims" of the General Conditions.

Any claim for overhead type expenses or costs, in addition to being certified as stated above, shall be supported by an audit report of an independent Certified Public Accountant. Any claim for overhead shall also be subject to audit by the City at its discretion.

Any costs or expenses incurred by the City in reviewing or auditing any claims that are not supported by the CONTRACTOR's cost accounting or other records shall be deemed to be damages incurred by the City within the meaning of the California False Claims Act.

Nothing in this subsection shall be construed as a waiver of the CONTRACTOR's right to dispute final payment based on differences in in-place quantity measurements or computations of unit priced pay items.

3-17. PAYMENT FOR MATERIALS ON HAND – At the discretion of the ENGINEER, partial payments may be made to the extent of the delivered cost of materials to be incorporated in the work, provided that such materials meet the requirements of the contract, plans, and specifications. Such delivered costs of stored or stockpile materials may be included in the next partial payment after the following conditions are met:

1. The material has been stored or stockpiled and protected at the sole expense of the CONTRACTOR at a location acceptable to the City and in a manner acceptable to the ENGINEER.

2. The CONTRACTOR has furnished the ENGINEER with acceptable evidence of the quantity and quality of such stored or stockpiled materials.

3. The CONTRACTOR has furnished the ENGINEER with satisfactory evidence that the material and transportation costs have been paid.

4. The CONTRACTOR has furnished the City legal title (free of liens or encumbrances of any kind) to the material so stored or stockpiled.

5. The CONTRACTOR has furnished the City evidence that the material so stored or stockpiled is insured against loss by damage to or disappearance of such materials at anytime prior to use in the work.

6. The CONTRACTOR shall bear all costs associated with the partial payment of stored or stockpiled materials in accordance with the provisions of this subsection.

It is understood and agreed that the transfer of title and the City's payment for such stored or stockpiled materials shall in no way relieve the CONTRACTOR of his/her responsibility for furnishing and placing such materials in accordance with the requirements of the contract, plans, and specifications. In no case will the amount of partial payments for materials on hand exceed 70% of the contract price for the contract items in which the material is intended to be used.

3-18. ACCESS TO DRIVEWAYS – All accesses for facility operations shall be maintained at all times. The Contractor shall coordinate with facility operations staff as needed.

3-19. ARCHAEOLOGICAL MONITORING – In the event that archaeological materials are found during construction, CONTRACTOR shall notify the ENGINEER immediately and shall temporarily cease work in the area until a determination or investigation of the site can be made by a qualified archaeologist. Archaeologist services shall be provided by the City at no cost to the CONTRACTOR.

3-20. STORM WATER MANAGEMENT, AND SEDIMENT AND EROSION CONTROL – CONTRACTOR shall prepare storm water management, and sediment and erosion control measures for implementation and shall maintain these measures during the construction period as required by the Regional Water Quality Control Board (RWQCB) permit.

If the area to be disturbed by construction activities is more than one acre, the CONTRACTOR shall be required to file a Notice of Intention (NOI), pay the fee, prepare the SWPPP, BMP, etc. as required by RWQCB permit.

The CONTRACTOR shall comply with all Federal, State and local regulations and ordinances governing storm water pollution prevention.

All costs involved for completing all work described in this section shall be considered to be included in the contract price paid for line item 1.J. and no additional compensation shall be allowed therefore.

3-21. ITEM INCREASES AND DECREASES

All items on the bid schedule are lump sum and are inclusive of the work described herein.

3-22. WAGE RATES – The General Prevailing Wage Determination Made by the Director of Industrial Relations Pursuant to California Labor Code Part 7, Chapter 1, Article 2, Sections 1770, 1773 and 1773.2. The CONTRACTOR can download this information from the web site: http://www.dir.ca.gov/dlsr/PWD/

The most current prevailing wage rates available at the time of bid opening shall be used.

SECTION IV

TECHNICAL SPECIFICATIONS

FILTER ADDITIONS AND MISCELLANEOUS IMPROVEMENTS PROJECT

CITY PROJECT NUMBER C66401416

Volume 1 of 2

TECHNICAL SPECIFICATIONS

CITY OF PETALUMA - SONOMA COUNTY - CALIFORNIA

Department of Public Works and Utilities
202 N. McDowell Blvd., Petaluma, CA 94954
Phone: (707) 778-4546 Fax: (707) 778-4508

Questions concerning interpretation of improvement plans, special provisions, contract documents and bid items shall be directed to:

City of Petaluma - Public Works and Utilities
Attention: Josh Minshall

APRIL 2023

Digitally signed by Douglas W. Wing
Contact Info: Carollo Engineers, Inc.
Date: 2023.04.26 14:04:03-07'00'

REGISTERED PROFESSIONAL ENGINEER
DOUGLAS W. WING
No. 38950
CIVIL
STATE OF CALIFORNIA

carollo
Engineers...Working Wonders With Water®

CITY OF PETALUMA

FILTER ADDITIONS AND MISCELLANEOUS IMPROVEMENTS PROJECT

TECHNICAL SPECIFICATIONS

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VOLUME 1 OF 2

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DIVISION 02 - SITE CONSTRUCTION

DIVISION 16 - ELECTRICAL

DIVISION 17 - INSTRUMENTATION AND CONTROLS

SECTION 01110

SUMMARY OF WORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Identification and summary description of the Project, the Work, location, activities by others, coordination, and early occupancy by Owner.

1.02 THE WORK

A. The Work consists of construction, furnishing, installing, testing, and starting up the following major components and appurtenances to construct a complete and operable project as specified in these Contract Documents.
   1. General:
      a. Mobilization and demobilization.
      b. Paving and grading in the area of construction, as shown and specified.
      c. Construction of yard piping, and yard structures as shown and specified.
      d. Construction of electrical duct bank.
      e. Sheeting, shoring, bracing, or equivalent methods for protection of life and limb in trenches and open excavation.
   2. Area 06 – Tertiary Pump Station:
      a. Procurement and installation of two additional submersible pumps including associated piping, supports, and fittings to increase pumping capacity.
      b. Modifications and replacement of common discharge header to increase pump station capacity.
      c. Concrete slab extension to accommodate new concrete pipe saddle for discharge header.
      d. Electrical power distribution improvements including modification to 20-MCC-A and other appurtenance as shown and specified.
      e. Associated electrical, control and instrumentation system improvements.
   3. Area 06 – Tertiary Filters:
      a. Construction of new Tertiary Filter Nos. 6 and 7, including associated equipment and piping on the west side of the existing tertiary filter influent channel including:
         1) Site work for new filters including modifications to area grading.
         2) New filter cast-in-place structure construction as shown and specified.
         3) Procurement and installation of Aqua-Aerobics cloth media disk filters as shown and specified.
         4) Modification of existing yard filter piping, and procurement and installation of new yard filter piping as shown and specified.
         5) Installation of new filter effluent flow meter vaults for new and existing filters and other appurtenances as shown and specified.
         6) Associated electrical, control and instrumentation improvements.
      b. Process modifications at existing Tertiary Filter Nos. 1 through 5, including:
         1) Modifications to filter reject water (FRW) flow metering.

2) Flocculation tanks and influent channel drainage improvements.
3) New spray piping and nozzles in the influent channel.
4) Replacement filter piping gallery sump pumps, and associated modifications for a new installation.
5) Associated electrical, control and instrumentation system improvements.

c. Electrical power distribution improvements including modifications to 07-MCC-A, and other appurtenance as shown and specified.

4. Area 07 – Filter Support Building air compressor room ventilation modifications including:
   a. New wall mounted exhaust fan with existing ductwork as shown and specified.
   b. New fully louvered interior door into compressor room as shown and specified.
   c. Associated electrical, control and instrumentation system improvements.
5. Area 22 – New Storage Building and Area 19 – Maintenance Building:
   a. Demolish existing covered storage, as shown and specified.
   b. Demolish existing interior CMU walls in the Area 19 maintenance building.
   c. Provide and install the new pre-engineered metal storage building, including structure as shown and associated construction for a complete new storage building structure.
   d. New storefront type entrance for entrance from existing operations and maintenance building into the new storage building.
   e. New storefront type entrance into the existing maintenance building wash down bay.
   f. Complete new building ventilation and improvements to provide ventilation for this unoccupied structure.
   g. Electrical power distribution improvements including modification to 09-MCC-A and other appurtenance as shown and specified associated with new storage building improvements.
   h. Associated electrical improvements.
6. Area 22 – New Waste Oil Storage area canopy:
   a. Provide and install the new pre-engineered metal waste oil storage canopy with roof sand two sides, including structure as shown and associated construction for a complete new waste oil storage canopy structure.
7. Complete all miscellaneous improvements for a complete and useable tertiary addition improvements project.

B. Except as specifically noted otherwise, provide and pay for:
   1. Insurance and bonds.
   2. Labor, materials, and equipment.
   3. Tools, equipment, and machinery required for construction.
   4. Utilities required for construction.
   5. Temporary facilities including sheeting and shoring.
   6. Traffic control and dust control measures.
   7. Other facilities and services necessary for proper execution and completion of the Work.

C. Secure and pay for all permits including OSHA excavation permits, Department of Transportation permits, government fees, and licenses.

D. Comply with codes, ordinances, regulations, orders, and other legal requirements of public authorities having bearing on the performance of the Work.

1.03 LOCATION OF PROJECT

A. The Work is located at the Ellis Creek Water Recycling Facility, 3890 Cypress Drive, Petaluma, CA 94954.

1.04 OWNER ASSIGNED SUBCONTRACTORS

A. Assignment of subcontractors by Owner is not anticipated.

1.05 ACTIVITIES BY OTHERS

A. Owner, utilities, and others may perform activities within Project area while the Work is in progress:
   1. Schedule the Work with Owner, utilities, and others to minimize mutual interference.

B. Activities by others which may affect performance of work include:
   1. Normal daily operation of the wastewater treatment plant by Owner.

C. Cooperate with others to minimize interference and delays:
   1. When cooperation fails, submit recommendations and perform Work in coordination with work of others.

D. When the Work depends upon proper execution or results upon work performed by others, inspect and promptly report apparent discrepancies or defects in work performed by others:
   1. Assume responsibility for work performed by others, except for defects reported as specified in this paragraph and defects which may become apparent in work performed by others after execution of the Work.

1.06 PARTIAL USE OR OCCUPANCY

A. Substantial Completion on the following portions of Work for Owner's occupancy including specified testing, training of Owner's personnel, and other preparations necessary for Owner's occupancy or use:
   1. Not Used.

B. Following occupancy, Owner will:
   1. Provide power to operate equipment and systems.
   2. Repair damage caused by Owner's occupancy.

C. Following occupancy, Contractor will:
   1. Continue to work on other areas that are not yet completed.

1.07 COORDINATION OF WORK

A. Maintain overall coordination of the Work.

B. Obtain construction schedules from each subcontractor and require each subcontractor to maintain schedules and coordinate modifications.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01116

CONTRACT DOCUMENT LANGUAGE

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Explanation of arrangement, language, reference standards and format.

1.02 REFERENCES

A. Construction Specifications Institute (CSI):
   1. MasterFormat™.
   2. SectionFormat™.
   3. PageFormat™.

1.03 PROJECT MANUAL ARRANGEMENT

A. Document and Section numbers used in Project Manual, and Project Manual arrangement are in accordance with CSI MasterFormat™, except where departures have been deemed necessary.

B. Sections are written in CSI SectionFormat™, Three-Part Section Format, except where departures have been deemed necessary.

C. Page format for Sections in the Project Manual is in PageFormat™, except where departures have been deemed necessary.

1.04 CONTRACT DOCUMENT LANGUAGE

A. Specification Section Paragraphs entitled "Section Includes" summarize briefly what is generally included in the section.
   1. Requirements of Contract Documents are not limited by "Section Includes" paragraphs.

B. Specifications have been partially streamlined by intentionally omitting words and phrases, such as "the Contractor shall," "in conformity therewith," "shall be" following "as indicated," "a," "an," "the" and "all."
   1. Assume missing portions by inference.

C. Phrase "by Engineer" modifies words such as "accepted," "directed," "selected," "inspected," and "permitted," when they are unmodified.

D. Phrase "to Engineer" modifies words such as "submit," "report," and "satisfactory," when they are unmodified.

E. Colons (:) are used to introduce a list of particulars, an appositive, an amplification, or an illustrative quotation:
   1. When used as an appositive after designation of product, colons are used in place of words "shall be."

F. Word "provide" means to manufacture, fabricate, deliver, furnish, install, complete, assemble, erect in place, test, render ready for use or operation, including necessary related material, labor, appurtenances, services, and incidentals.

G. Words "Contractor shall" are implied when direction is stated in imperative mood.

H. Term "products" includes materials and equipment as specified in Section 01600 - Product Requirements.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01140

WORK RESTRICTIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for sequencing and scheduling the Work affected by existing site and facility, work restrictions, and coordination between construction operations and plant operations.

1.02 SUBMITTALS

A. Baseline Schedule with Method of Procedure (MOP) tasks.

B. MOP Form.

C. MOP Log.

D. Progress Schedule with MOP tasks.

1.03 GENERAL CONSTRAINTS ON SEQUENCE AND SCHEDULING OF WORK

A. The Ellis Creek Water Recycling Facility is the City of Petaluma's only means of treating domestic and industrial wastewater prior to discharging to the Petaluma River. Impairing the operational capabilities of this treatment plant will result in serious environmental damage and monetary fines.

B. Conduct Work in a manner that will not impair the operational capabilities of essential elements of the treatment process or reduce the capacity of the entire treatment plant below levels sufficient to treat the quality of raw wastewater to the water quality limitations specified in the discharge permit.

C. Conduct commissioning and process start-up activities as specified in Section 01756 - Commissioning in a manner that will not impair the operational capabilities of essential elements of the treatment process or reduce the capacity of the entire treatment plant below levels sufficient to treat the quality of raw wastewater to the water quality limitations specified in the discharge permit.

D. The status of the treatment plant shall be defined as "operational" when it is capable of treating the entire quantity of wastewater received to the water quality limits specified in the discharge permit.

E. Work sequence and constraints:
   1. Utilize description of critical events in work sequence in this Section as a guideline for scheduling and undertaking the Work.
   2. Work sequence and constraints presented do not include all items affecting completion of the Work, but are intended to describe critical events necessary to minimize disruption of the existing facilities and to ensure compliance with National Pollutant Discharge Elimination System permit requirements.

F. Instrumentation and controls process performance testing:
   1. After the Process Operational Period, test PCIS system as specified in Section 01756 - Commissioning.

1.04 SHUTDOWN AND CONSTRUCTION CONSTRAINTS

A. General shutdown constraints:
   1. Execute the Work while the existing facility is in operation.
   2. Some activities may be accomplished without a shutdown.
   3. Apply to activities of construction regardless of process or work area.
   4. Activities that disrupt plant or utilities operations must comply with these shutdown constraints.
   5. Organize work to be completed in a minimum number of shutdowns.
   6. Provide thorough advanced planning, including having required equipment, materials, and labor on hand at time of shutdown.
   7. Where required to minimize treatment process interruptions while complying with specified sequencing constraints, provide temporary pumping, power, lighting, controls, instrumentation, and safety devices.
   8. Final determination of the permitting of shutdowns will be the sole judgment of the Owner.
   9. Owner maintains the ability to abort on the day of the scheduled shutdown.

B. General maximum plant flow work limitations:
   1. Activities that disrupt plant operations are prohibited during the following flow conditions, unless otherwise approved in writing by the Engineer.
      a. Flow condition: flows greater than 16 mgd.

C. Unit process availability work limitations:
   1. Shutdowns and tie-ins or other activities that disrupt plant operations are prohibited unless the following unit process availability conditions exist and unless otherwise approved in writing by the Engineer.
   2. At a minimum, the following facilities must be in service in order to proceed with a scheduled shutdown:
      a. Headworks facility.
      b. The secondary treatment process including the oxidation ditches, secondary clarifiers, oxidation ponds, and associated piping, gates, valves, and appurtenances.
      c. Electrical and SCADA equipment.

D. Shutdown activities:
   1. Scheduling:
      a. Perform 8-hour maximum plant shutdowns during plant shift hours as directed by Owner.
      b. A minimum of 1 day of plant operation will be required between sequential 8-hour plant shutdowns; longer durations between shutdowns may be required and is at the discretion of the Owner.
      c. A 24-hour maximum plant shutdown may be allowed with approval by the Owner.
   2. Unplanned shutdowns due to emergencies are not defined in this Section.

E. Dewatering of existing process and disposal of residue:
   1. When the Owner has turned the process unit over to the Contractor for modification or temporary use, the Contractor is responsible for costs and procedures required to dewater and dispose of liquid, solids, etc., in the process unit:
      a. Drainage and disposal of process unit liquids, solids, etc. into another treatment process unit on the plant site may be allowed if approved in advance by the Engineer and Owner, and is conducted in accordance with Owner's requirements.
      b. Costs for dewatering, disposal of solids and residuals, and preparation of surfaces for the Work are Contractor's responsibility:
         1) Includes tipping fees for the removal and disposal of the grit/debris.
      c. Dewatering of grit/debris to meet landfill requirements is the responsibility of the Contractor.
      d. Contractor shall provide adequate time in schedules for draining and cleanup of basins and channels.

F. The Contractor shall be responsible for groundwater dewatering as needed for construction activities. Contractor shall dispose of construction and groundwater dewatering fluids using one of the following methods:
   1. Spray on construction site for dust control.
   2. Spread over other areas upon approval by the Owner.
   3. On-site disposal to ponds upon approval by Owner, using the storm water system.
   4. Off-site disposal in accordance with applicable permits and regulations.

G. Process area construction constraints:
   1. The following sequences and constraints shall be observed while working in and around each of the following process areas:
      a. Material hauling operations:
         1) Contractor shall comply with restrictions regarding Contractor's use of site and premises as specified in Section 01110 - Summary of Work.

1.05 METHOD OF PROCEDURE (MOP)

A. MOP Instructions: See Appendix A.

B. Prepare MOP for the following conditions:
   1. Shutdowns, diversions, and tie-ins to the existing facility.
   2. Process start-up activities.
   3. Power interruption and tie-ins.
   4. Switch over between temporary and permanent facilities, equipment, piping, and electrical and instrumentation systems.
   5. Process constraints requiring interruption of operating processes or utilities.

C. Other Work not specifically listed may require MOPs as determined necessary by the Contractor, Owner, or Engineer.

D. Submit Baseline Schedule, as specified in Section 01321 - Schedules and Reports, with proposed MOPs.

E. Submit MOP Log at construction progress meetings.

F. No consideration will be given to claims of additional time and cost associated to preparing MOPs required by the Owner and Engineer to complete this work in a manner that facilitates proper operation of the facility and compliance with effluent discharge criteria.

G. Where required to minimize treatment process interruptions while complying with specified sequencing constraints, provide temporary pumping, power, lighting, controls, instrumentation, and safety devices.

1.06 COMPLIANCE WITH NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT

A. The existing facility is operating under the terms of a National Pollutant Discharge Elimination System permit issued by the California Regional Water Quality Control Board, San Francisco Bay Region. This permit specifies the water quality limits that the plant must meet prior to discharge of effluent. A copy of the existing permit is on file for review at the City's Water Recycling Facility.

B. Perform work in a manner that will not prevent the existing facility from achieving the finished water quality requirements established by regulations.

C. Bear the cost of penalties imposed on the Owner for discharge violations caused by actions of the Contractor.

1.07 REQUIREMENTS FOR OPERATION OF PLANT AND MAINTAINING CONTINUOUS OPERATION OF EXISTING FACILITIES

A. Facilities or conditions required to keep the existing plant operational include, but are not limited to, the following:
   1. Electrical power including transformers, distribution wiring, and motor control centers.
   2. Piping and pumping for conveyance of wastewater, sludge, chemicals and utilities between treatment units.
   3. Chemical storage, metering, conveyance, and control facilities:
      a. Continuous addition of chemicals is required during plant operations.
   4. Plant water.
   5. Laboratory facilities.
   6. Office, toilets, and washrooms.
   7. Fencing and gates.
   8. Lighting.
   9. Heating, ventilation, and air conditioning.
   10. Instrumentation, meters, controls, and telemetry equipment.
   11. Safety equipment and features.
   12. Parking for City employees and vehicles required for operation and maintenance of the Ellis Creek Water Recycling Facility.
   13. Telephone system.
   14. Storm drainage.
   15. Natural gas service.

B. Conduct the Work and provide temporary facilities required to keep the existing plant continuously operational.

C. Do not remove or demolish existing facilities required to keep the existing plant operational at the capacities specified until the existing facilities are replaced by temporary, new, or upgraded facilities or equipment:
   1. Test replacement facilities to demonstrate operational success prior to removing or demolishing existing facilities.

D. This Work shall be bid, scheduled, and constructed in such a manner as to result in the least possible disruption to the operations and staff of the treatment facility. Disruptions or interference to one portion of the treatment process will also affect other processes since they are typically interrelated and dependent upon one another. Disruptions include, but are not limited to:
   1. Removing from service, restricting, or impeding the function of utility or potable water systems serving any portion of the plant facilities.
   2. Delaying or denying access to any plant structure or area needed by plant staff to complete their work assignments.

1.08 OPERATIONS AND MAINTENANCE ACCESS

A. Provide safe, continuous access to process control equipment for plant operations personnel.

B. Provide access on 1-hour advance notice to process control equipment for plant maintenance personnel and associated maintenance equipment.

C. For all operating equipment, reserve a minimum of 3-feet unencumbered workspace around equipment:
   1. Areas reserved for operations and maintenance access for all operating equipment shall be separated from CONTRACTOR'S working area with temporary orange plastic fencing or similar means.
   2. Storage of CONTRACTOR'S equipment or materials in access area is prohibited.

D. On-site parking is available for CONTRACTOR only within staging area designated in Bid Documents.

1.09 UTILITIES

A. Provide advance notice to and utilize services of Underground Services Alert (U.S.A.) for location and marking of underground utilities operated by utility agencies other than the Owner.

B. Maintain electrical, telephone, water, gas, sanitary facilities, and other utilities within existing facilities in service. Provide temporary utilities when necessary.

C. New yard utilities were designed using existing facility drawings:
   1. Field verification of utilities locations was not performed during design.
   2. Services crossed or located nearby by new yard utilities may require relocation and possible shutdowns.
   3. Pipe alignments as indicated on the Drawings.

1.10 WORK SEQUENCE

A. General:
   1. The Suggested Work Sequence and Constraints presented herein do not necessarily include all items affecting the completion of the Work but are intended to describe in general the critical events necessary to minimize disruptions of the existing facilities and to ensure compliance with the NPDES permit requirements. Utilize the description of critical events in the Work Sequence and Constraints in this Section as a guideline for scheduling and completing the Work. Additional Constraints may be imposed during the Work depending on Contractor's sequence of work.
   2. No more than one process, piping system, or electrical system may be removed from service at any one time, unless otherwise indicated by the OWNER.
   3. Any element not listed herein but requiring a shutdown shall have a maximum shutdown duration of 4 hours for planning purposes. Once these unforeseen shutdowns have been identified, confirm allowed shutdown durations with OWNER prior to starting the work.
   4. Unless noted otherwise or as determined by the ENGINEER, the term “Substantially Complete” referenced in this Section for any item shall be defined as when all structural, mechanical, HVAC, electrical, instrumentation, and other incidental Work necessary to render that item of Work complete and ready for operation by the OWNER at the OWNER’s discretion.

B. Project Elements and Associated Work Sequence:
   1. Tertiary System:
      a. Overall Constraints shall apply to the entire project. Specific constraint, as noted, shall apply to each process area.
      b. Tertiary system is the sole means of fire protection for the Ellis Creek WRF.
      c. Definitions:
         1) Recycled Water (RW) On-Season – May 1 through October 31.
         2) Recycled Water (RW) Off-Season – November 1 through April 30.
      d. Construction Period:
         1) All aspects of the Recycled Water Tertiary System shall be fully operational no later than July 31, 2024.
         2) The contractor shall substantially complete all aspects of the project within 365 calendar days from issuance of Notice To Proceed.
      e. Contractor shall coordinate outages with City for entire system and process areas listed below.
   2. Initial Staging Area and Employee Parking:
      a. During construction of parking facilities along entrance drive the Contractor may utilize the existing graveled area/roadway located between the entrance drive off Cypress Drive and Lakeville Road for staging and storage of equipment and materials.
      b. Employee Parking – During construction of parking facilities along Cypress Drive Contractor’s and Subcontractor’s employees shall not park in designated parking areas located at the site. The contractor’s employees shall park in the designated parking areas located approximately 1,200 linear feet south and west of the facility along the entrance drive. Only vehicles with clearly marked Company Logos shall be allowed to park in designated staging and storage areas.

3. Tertiary Pump Station:
    a. Suggested Work Sequence:
        1) Shutdown and isolation of the existing Tertiary Pump Station and Tertiary Feed Pumps shall be limited as follows:
            a) RW Off-Season – During RW Off-Season (November 1 through April 30) disruption of the Tertiary Pump Station operation shall be limited to two consecutive 24 hours within a 72-hour period.
            b) RW On-Season – During RW On-Season (May 1 through October 31) disruption of the Tertiary Pump Station operation shall be limited to 1 hour within a 24-hour period.
            c) Exceeding the allotted disruption period by more than 15 minutes will result in the Contractor paying a penalty of $2,000/day or fraction thereof for each violation during RW Off-Season and $10,000/day during the RW On-Season.
        2) Drain the existing 14-inch FI from the pump station to the Tertiary Filters.
        3) Perform demolition and structural improvements to prepare structure for installation of Tertiary Feed Pump Nos. 4 and 5.
        4) Install Tertiary Feed Pump Nos. 4 and 5, associated piping, valves, electrical conduit, and instrumentation.
        5) Install new VFDs at 20-MCC-A.
    b. Process, Power, and Control Connections and Shutdown Constraints:
        1) Perform 8-hour maximum shutdown for connection of new wiring to 20-MCC-A.
4. Existing Tertiary Continuous Backwash (CBW) Sand Filters:
    a. Suggested Work Sequence:
        1) Flocculation Tank Modifications - To complete work related to the sloping of the existing flocculation tank:
            a) Contractor will be allowed to take the existing filter out of service no more than 5 contiguous days to complete all aspects of work, including adequate product cure time as recommended by the manufacturer. After this period of time the system shall be fully operational.
            b) Flocculation tank work shall be completed in the RW Off-Season.
            c) Exceeding this allotted period by more than 4 hours will result in the Contractor paying a penalty of $2,000/day for each violation during RW Off-Season and $10,000/day during the RW On-Season.
        2) Perform demolition of guardrail and hypochlorite solution (HCS) piping at Tertiary Filter Nos. 1 through 5.
        3) Shutdown and isolate filter reject water (FRW) header for demolition of existing magmeter and associated piping.
        4) Install new FRW magmeters and associated piping and conduit, subject to the following constraints:
            a) If the Cloth Media Disk (CMD) Filters are not fully operational:
                (1) RW Off-Season – During RW Off-Season (November 1 through April 30) disruption of the Sand Filter Reject Water operation shall be limited to 24 hours within a 72-hour period.

(2) RW On-Season – During RW On-Season (May 1 through October 31) disruption of the Sand Filter Reject Water operation shall be limited to 1 hour within a 24-hour period.
(3) Exceeding this allotted period by more than 15 minutes will result in the Contractor paying a penalty of $2000/day for each violation during RW Off-Season and $10,000/day during the RW On-Season.

b) If CMD Filters are fully operational:
(1) Contractor must utilize CMD Filters during all aspects of CBW Sand FRW work.

5) Install new FEF yard piping connections for CBW FEF flow meter and combined FEF piping including two tees, bypass valve and two isolation valves and associated piping, subject to the following constraints:
a) RW Off-Season – During RW Off-Season (November 1 through April 30) disruption may be up to no more than 5 contiguous days to complete all aspects of work, if completed during the flocculation tank work, listed in 4,a,1 above. Same penalty for flocculation tank work shall apply to this work if scheduled during this outage.
b) RW Off-Season – During RW Off-Season (November 1 through April 30) disruption of the Sand Filter Reject Water operation shall be limited to 24 hours within a 72-hour period, if completed in other times than the flocculation tank work. Exceeding this allotted period by more than 15 minutes will result in the Contractor paying a penalty of $2000/day for each violation during RW Off-Season.

5. New Tertiary Cloth Media Disk (CMD) Filters:
a. Suggested Work Sequence:
1) FI inlet valve connection, including removal of the existing two blind flanges and installation of the two new filter inlet valves (12-inch BFV) shall be made during RW Off-Season (November 1 through April 30), so disruption of the CBW Filter operation shall be limited:
a) Alternative period 1: Disruption may be up to no more than 5 contiguous days to complete all aspects of work, if completed during the flocculation tank work, listed in 4,a,1 above. Same penalty for flocculation tank work shall apply to this work if scheduled during this outage.
b) Alternative period 2: Disruption shall be less than 24 hours within a 72-hour period. Exceeding this allotted period by more than 15 minutes will result in the Contractor paying a penalty of $2000/day for each violation during RW Off-Season.
2) Install new FTW yard piping connections for new CMD filter to existing FTW piping including removal of existing blind flange and installation of the buried isolation valves including associated piping, shall be made during RW Off-Season (November 1 through April 30), so disruption of the CBW Filter operation shall be limited:
a) Alternative period 1: Disruption may be up to no more than 5 contiguous days to complete all aspects of work, if completed during the flocculation tank work, listed in 4,a,1 above. Same

penalty for flocculation tank work shall apply to this work if scheduled during this outage.

b) Alternative period 2: Disruption shall be limited to 24 hours within a 72-hour period, if completed in other times than the flocculation tank work. Exceeding this allotted period by more than 15 minutes will result in the Contractor paying a penalty of $2000/day for each violation during RW Off-Season.

3) Install new FBW connection to the existing FRW line including installation of new isolation valve shall be limited:

a) Alternative period 1: Disruption may be up to no more than 5 contiguous days to complete all aspects of work, if completed during the flocculation tank work, listed in 4,a,1 above. Same penalty for flocculation tank work shall apply to this work if scheduled during this outage.

b) Alternative period 2: Disruption shall be limited to 24 hours within a 72-hour period, if completed in other times than the flocculation tank work. Exceeding this allotted period by more than 15 minutes will result in the Contractor paying a penalty of $2000/day for each violation during RW Off-Season.

4) Install new FEF piping connection and FEF flow meter for new CMD filter after the FEF piping connections and modification outlines in 5,a,5 above.

6. Installation of Pipe/Valve/Meters/Vault between Filters and UV Facility:
   a. RW Off-Season – During RW Off-Season (November 1 through April 30) disruption of effluent flow from Filters to UV system shall be limited to 24 hours within a 72-hour period.
   b. RW On-Season – During RW On-Season (May 1 through October 31) disruption of effluent flow from Filters to UV system shall be limited to 1 hour within a 24-hour period.
   c. In instances where these periods must be exceeded the Contractor shall supply a by-pass system between the Filter Effluent and UV Inlet systems. By-pass pumping capacities shall be 0.5 mgd in the RW Off-Season and 4 in the RW On-Season.
   d. If adequate by-pass pumping is not available, exceeding the allotted downtime period by more than 15 minutes will result in the Contractor paying a penalty of $2000/day for each violation during RW Off-Season and $10,000/day during the RW On-Season.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

APPENDIX A
"Method of Procedure" (MOP)
Instructions and Forms

Definition and Purpose

"Method of Procedure" (MOP) is a detailed document submitted by the Contractor to request process shutdown(s), utility tie-in(s), work in areas that may risk unanticipated outages, or flow diversions to accommodate site construction activities during a project. Such activities may include (but are not limited to) new tie-ins to utilities or structures, mechanical modifications to process piping or equipment, demolition, bulkhead installation, and cleaning processes.

The MOP provides a detailed plan to the Owner and Engineer that describes specific aspects of the work including purpose, time of execution, and anticipated impacts on treatment processes. The MOP also includes contingency measures and provisions for rapid closure in the event that shutdown or work progress difficulties are encountered. Information from relevant trades associated with the requested shutdown, diversion, or tie-in is also included.

The Owner should use the information within the MOP to define operational procedures and methods to safely and successfully assist the Contractor.

MOP Process Summary

WHO	STEP	TIMING
Contractor	1. Identify MOPs needed on MOP Log and Baseline Schedule.	7 days prior to Preconstruction Scheduling Meeting
Contractor, Owner, Engineer	2. Pre-MOP Meeting.	More than 28 days prior to work
Contractor	3. Submits MOP.	No later than 28 days prior to work
Owner	4. Reviews MOP.	
Owner	5. MOP finalized.	7 days prior to work
Contractor	6. Complete Readiness Checklist.	5 days prior to work
Contractor	7. Complete Safety Checklist.	Just prior to commencing work
Contractor	8. Complete Work.	
Contractor	9. Update MOP Log and Progress Schedules.	Monthly

MOP Process Detail

STEP 1. Identifies MOPs needed on MOP Log and Baseline Schedule.

Contractor submits a preliminary list of anticipated project MOPs on MOP Log. MOPs identified but not limited to those shutdowns, diversions, or tie-ins described in the Contract Documents. Incorporate MOPs as tasks in Baseline Schedule. Date scheduled MOPs to coincide with the appropriate construction activities.

STEP 2. Pre-MOP Meeting.

Contractor requests a Pre-MOP Meeting with the Owner and Engineer to discuss the nature of the shutdown, diversion, or tie-in, and to gather the information necessary to complete the MOP Form. The pre-MOP meeting may be waived by the Owner or Engineer if the work is deemed to be minor.

STEP 3. Submits MOP.

Contractor completes the MOP Form and submit 3 copies for approval to the Owner's Project Manager (OPM).

STEP 4. Reviews MOP.

OPM distributes MOP Form for review by the Owner's Construction Coordinator, O&M Representative, and Engineer's Project Representative. Review MOP Form for completeness, accuracy, compliance with both the construction schedule, constraints defined in contract documents, and to ensure that the requested work does not negatively impact plant operations or other concurrent project activities. Additional information may be requested to better understand the nature of and method for completing the Work.

STEP 5. MOP finalized.

Once the MOP is agreed to by all parties, the MOP will be finalized by signature. Copies are distributed to the Owner, Engineer, and Contractor.

STEP 6. Complete Readiness Checklist.

Contractor verifies everything is ready for the work.

STEP 7. Complete Safety Checklist.

Contractor ensures safety.

STEP 8. Complete work.

Contractor complete work.

STEP 9. Update MOP Log and Progress Schedules.

Contractor updates MOP Log weekly and distributes at the regularly scheduled construction progress meetings.

METHOD OF PROCEDURE (MOP) FORM

Owner: _____ **Date:** _____

Contractor: _____ **Carollo Project No.:** _____

Project Name: _____ **Submittal No.:** _____

Submittal Title: _____ **Spec/Dwg. Reference:** _____

MOP #	Task Title *(Provide <10 word title)*:	Submittal Date: *(No later than 28 days prior to work)*

SCHEDULE OF WORK ACTIVITY START: *(Date/Time)* END: (Date/Time)

REQUESTOR:

PRIMARY POINT OF CONTACT: PHONE/PAGER:

SECONDARY POINT OF CONTACT: PHONE/PAGER:

NOTIFY ☐ Control Room, Phone ☐ Security, Phone

BUILDING: LOCATION OF WORK FLOOR/LEVEL:

DESCRIPTION OF WORK: *(Provide sufficient details on process isolation, work sequencing, and safety (i.e., control of significant hazards unique to the work) to demonstrate an understanding of the work and how it will be completed within the constraints, and its impact on the processes and facility.)*

Task Summary: _____

Processes Affected: _____

Trades Affected: _____

WORK PLAN:

Work Sequencing: _____

Process Isolation: _____

Spill Prevention Plan: _____

Contingency Plans: _____

CRITICAL EQUIPMENT/TOOLS: *(pumps and discharge hoses with correct fittings, blind flanges and pipe plugs, no-hub fittings, properly sized electrical service components, generators, portable lighting, chlorine for potable water pipe breaks, etc.)*

☐	Acoustic Ceiling/or Walls Access	☐	Excavation Permit	☐	Lock Out/Tag Out
☐	Chemical Use Approval	☐	Fire Sprinkler Impairment	☐	Life Safety Systems
☐	Confined Space Permit	☐	Flammable Materials	☐	Roof Protocol
☐	Critical Lift Plan	☐	Flush / Discharge	☐	Work After Dark
☐	Energized Electrical Work	☐	High Pressure Test	☐	
☐	Elect. Panel Schedules	☐	Hot Work/Open Flame	☐	

EXISTING SERVICE(S) AT RISK:

☐	Breathing Air	☐	Elect Normal	☐	Process Access	☐	Telephones
☐	Chemical Distribution	☐	Fire Protection	☐	Safety Showers	☐	UPS
☐	City Water	☐	HVAC	☐	SCADA	☐	VAX/DATA
☐	Communication	☐	Inert Gas	☐	Security	☐	
☐	Domestic Drain	☐	Instrument - Air	☐	Solvent Drain	☐	
☐	Elect-Bus Duct	☐	Life Safety System	☐	Specialty Gases	☐	

☐	Elect Emergency	☐	Natural Gas	☐	Storm Drain	☐	

REVIEWER'S INSTRUCTIONS / COMMENTS:

☐ PREJOB BRIEFING MUST BE COMPLETED PRIOR TO COMMENCING WORK:

	Full Name (printed)	**Signature**	**Phone**	**Date**
Submitted By				
System Owner				
Reviewer (if needed)				
Reviewer (if needed)				
Reviewer (if needed)				
Reviewer (if needed)				

READINESS CHECKLIST
(5 days prior to work)

Checklist provided as a guide but is not all inclusive.

1. Confirm all parts and materials are on site: _____
2. Review work plan: _____
3. Review contingency plan: _____

SAFETY CHECKLIST
(Just prior to commencing work)

Checklist provided as a guide but is not all inclusive.

1. Location awareness:
   a. Emergency exits: _____
   b. Emergency shower and eyewash: _____
   c. Telephones and phone numbers: _____
   d. Shut-off valve: _____
   e. Electrical disconnects: _____
2. Inspect work area:
   a. Take time to survey the area you are working in. Ensure that what you want to do will work. Do you have enough clearance? Is your footing secure? Do you have adequate lighting and ventilation? Are surrounding utilities out of the way for you to perform your work?
3. SDS (Safety Data Sheets):
   a. Understand the chemicals and substances in the area you are working in by reading the SDS.
4. Lockout/Tagout Procedure:
   a. Lockout/tagout energy sources before beginning work.
   b. Make sure all valves associated with the work are locked out and tagged out on each side of the penetration.
   c. Make sure the lines are depressurized.
5. Overhead work:
   a. Use appropriate personal protective equipment; i.e., safety harness, lifeline, etc.
   b. Select appropriate tie-off points; i.e., structurally adequate, not a pipe or conduit, etc.
   c. Spotter assigned and in position.
   d. Pipe rack access; i.e., check design capacity, protective decking or scaffolding in place, exposed valves or electrical switches identified and protected.
6. Safety equipment:
   a. Shepherd's hook.
   b. ARC flash protection.
   c. Fire extinguisher.
   d. Other: _____.
7. Accidents:
   a. Should accidents occur, do not shut off and do not attempt to correct the situation, unless you are absolutely positive that your action will correct the problem and not adversely affect other people or equipment.
8. Review process start-up documents:
   a. In the event the system is shutdown, the Control Center should have a working knowledge of the process start-up procedures in order to deal effectively with unforeseen events.
9. Evacuation procedures:
   a. Do not obstruct evacuation routes.
   b. Take time to survey the area for evacuation routes.

Method of Procedure (MOP) Log
Sample

MOP Number	Task Title	Date Requested	Date Approved	Date Work Planned	Work Completed (yes/no)
001					
002					
003					

SECTION 01220

MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Procedures for measurement and payment of Work under this Contract for lump sum.

B. Process Area numbers are outlined in the Drawings, and on Drawing 00G003.

1.02 REFERENCES

A. Occupational Safety and Health Administration (OSHA).

1.03 LUMP SUM ITEMS

A. Item 1. A.: Mobilization.
   1. Measurement:
      a. Shall be no more than 3 percent of the total lump sum bid.
   2. Payment:
      a. Lump Sum, complete-in-place, paid based on Schedule of Values to be submitted to and reviewed

B. Item 1. B. 1.: Tertiary Pump Station (Area 6) improvements and modifications including installation of new tertiary pumps as specified in Section 11312G and as shown in the Drawings including all work associated with the Contract Documents:
   1. Measurement:
      a. Shall include full compensation for furnishing all tools, equipment, supplies, and manufactured articles, and for all labor, operations, and incidentals appurtenant to the items of work necessary to complete the Work as indicated in the Contract Documents.
   2. Payment:
      a. Lump Sum, complete-in-place, paid based on Schedule of Values to be submitted to and reviewed by Construction Manager in accordance with Schedule of Values.

C. Item 1. B. 2: New cloth media disk filters 5 and 6 (Area 6) construction and improvements including foundations, structure, mechanical equipment procurement and installation, and electrical and controls procurement and installation as specified in Section 11366B and as shown in the Drawings including all work associated with the Contract Documents:
   1. Measurement:
      a. Shall include full compensation for furnishing all tools, equipment, supplies, and manufactured articles, and for all labor, operations, and incidentals appurtenant to the items of work necessary to complete the Work as indicated in the Contract Documents.

2. Payment:
    a. Lump Sum, complete-in-place, paid based on Schedule of Values to be submitted to and reviewed by Construction Manager in accordance with Schedule of Values.

D. Item 1. B. 3: Existing continuous backwash filter 1 to 5 (Area 6) improvements and modifications including demolition, piping and structural modifications and as shown in the Drawings including all work associated with the Contract Documents:
    1. Measurement:
        a. Shall include full compensation for furnishing all tools, equipment, supplies, and manufactured articles, and for all labor, operations, and incidentals appurtenant to the items of work necessary to complete the Work as indicated in the Contract Documents.
    2. Payment:
        a. Lump Sum, complete-in-place, paid based on Schedule of Values to be submitted to and reviewed by Construction Manager in accordance with Schedule of Values.

E. Item 1. C: Existing Filter Support Building (Area 7) improvements and modifications including demolition, and HVAC modification and as shown in the Drawings including all work associated with the Contract Documents:
    1. Measurement:
        a. Shall include full compensation for furnishing all tools, equipment, supplies, and manufactured articles, and for all labor, operations, and incidentals appurtenant to the items of work necessary to complete the Work as indicated in the Contract Documents.
    2. Payment:
        a. Lump Sum, complete-in-place, paid based on Schedule of Values to be submitted to and reviewed by Construction Manager in accordance with Schedule of Values.

F. Item 1. D: New Storage Building construction including demolition, pre-engineered metal building construction, HVAC system installation, power distribution improvements and modifications of the existing maintenance building and as shown in the Drawings including all work associated with the Contract Documents:
    1. Measurement:
        a. Shall include full compensation for furnishing all tools, equipment, supplies, and manufactured articles, and for all labor, operations, and incidentals appurtenant to the items of work necessary to complete the Work as indicated in the Contract Documents.
    2. Payment:
        a. Lump Sum, complete-in-place, paid based on Schedule of Values to be submitted to and reviewed by Construction Manager in accordance with Schedule of Values.

G. Item 1. E: New Waste Oil Storage Canopy construction including pre-engineered metal building construction, as shown in the Drawings including all work associated with the Contract Documents:
   1. Measurement:
      a. Shall include full compensation for furnishing all tools, equipment, supplies, and manufactured articles, and for all labor, operations, and incidentals appurtenant to the items of work necessary to complete the Work as indicated in the Contract Documents.
   2. Payment:
      a. Lump Sum, complete-in-place, paid based on Schedule of Values to be submitted to and reviewed by Construction Manager in accordance with Schedule of Values.

H. Item 1. F. 1.: Electrical power distribution improvements including MCC modifications, new electrical equipment, cabling, conduit, and miscellaneous work associated with the Contract Documents:
   1. Measurement:
      a. Shall include full compensation for furnishing all tools, equipment, supplies, and manufactured articles, and for all labor, operations, and incidentals appurtenant to the items of work necessary to complete the Work as indicated in the Contract Documents.
   2. Payment:
      a. Lump Sum, complete-in-place, paid based on Schedule of Values to be submitted to and reviewed by Construction Manager in accordance with Schedule of Values.

I. Item 1. F. 2: General Instrumentation work not included in major work items as shown in the Drawings including all work associated with the Contract Documents and associated with the Contract Documents:
   1. Measurement:
      a. Shall include full compensation for furnishing all tools, equipment, supplies, and manufactured articles, and for all labor, operations, and incidentals appurtenant to the items of work necessary to complete the Work as indicated in the Contract Documents. This work includes all work required for the complete construction of the yard structures, including structural, mechanical, electrical, and instrumentation.
   2. Payment:
      a. Lump Sum, complete-in-place, paid based on Schedule of Values to be submitted to and reviewed by Construction Manager in accordance with Schedule of Values.

J. Item 1. G: Yard piping and paving and grading including new and existing filter piping modifications and improvements , and new drain swale, storm drain improvements and miscellaneous paving and paving repairs and as shown in the Drawings including all work associated with the Contract Documents and associated with the Contract Documents:
   1. Measurement:
      a. Shall include full compensation for furnishing all tools, equipment, supplies, and manufactured articles, and for all labor, operations, and incidentals appurtenant to the items of work necessary to complete the Work as indicated in the Contract Documents. This work includes all

work required for the complete construction of the yard structures, including structural, mechanical, electrical, and instrumentation.

2. Payment:
    a. Lump Sum, complete-in-place, paid based on Schedule of Values to be submitted to and reviewed.

K. Item 1. H: Testing, commissioning and assistance with regulatory testing as specified in the Contract Documents and associated with the Contract Documents:
    1. Measurement:
        a. Shall include full compensation for furnishing all tools, equipment, supplies, and manufactured articles, and for all labor, operations, and incidentals appurtenant to the items of work necessary to complete the Work as indicated in the Contract Documents. This work includes all work required for the complete construction of the yard structures, including structural, mechanical, electrical, and instrumentation.
    2. Payment:
        a. Lump Sum, complete-in-place, paid based on Schedule of Values to be submitted to and reviewed

L. Item 1. I: Demobilization:
    1. Measurement:
        a. Shall be no more than 2 percent of the total lump sum bid.
    2. Payment:
        a. Lump Sum, complete-in-place, paid based on Schedule of Values to be submitted to and reviewed.

M. Item 1. J: Temporary excavation support, per Section 02260.
    1. Measurement:
        a. Shall include full compensation for furnishing all tools, equipment, supplies, and manufactured articles, and for all labor, operations, and incidentals appurtenant to the items of work necessary to complete the Work as indicated in the Contract Documents. This work includes all work required for the complete construction of the yard structures, including structural, mechanical, electrical, and instrumentation.
    2. Payment:
        a. Lump Sum, complete-in-place, paid based on Schedule of Values to be submitted to and reviewed.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01292

SCHEDULE OF VALUES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for preparation, format, and submittal of Schedule of Values.

1.02 PREPARATION

A. Prepare Schedule of Values identifying costs of Major Items of Work and other costs shown in sample included at end of this Section.

B. Divide the work into following major items of work:
   1. Mobilization.
   2. Paving and Grading.
   3. Yard Piping and Yard Structures.
   4. Electrical ductbank and electrical site work.
   5. Sheeting, shoring, bracing, or equivalent methods.
   6. Tertiary Pump Station modifications.
   7. New tertiary cloth media disk filters Nos. 6 and 7.
   8. Modifications to Continuous Backwash filter Nos. 1 to 5.
   9. Filter Support Compressor room HVAC modifications.
   10. New Storage Building and Maintenance Building modifications.
   11. Demobilization.

C. Assign prices to Major Items of Work which aggregate the Contract Price. Base prices on costs associated with scheduled activities based on the Project Schedule for each Major Item of Work**.**

1.03 SUBMITTALS

A. Submit preliminary schedule of values.

B. Submit corrected schedule of values within 10 days upon receipt of reviewed Schedule of Values, but no later than 10 days prior to anticipated submittal of first Application for Payment.

C. Upon request, support prices with data which will substantiate their correctness.

D. If activities are added or removed from the Progress Schedule revise the Schedule of Values and resubmit.

1.04 SAMPLE SCHEDULE OF VALUES

A. Following is an acceptable form for Schedule of Values:

NO.	DESCRIPTION OF ITEM	LUMP SUM COST ($)
1	LUMP SUM BID ITEMS	
1.A	Mobilization.	
1.B.1	Tertiary pump station modifications.	
1.B.2	New tertiary filter construction.	
1.B.3	Existing filter modifications.	
1.C	Existing filter support building improvements.	
1.D	New storage building construction and existing maintenance building modifications.	
1.E	New waste oil storage canopy.	
1.F	General electrical work not included on major items of work.	
1.F.1	Miscellaneous yard electrical work not included in major work items.	
1.F.2	General instrumentation work not included on major items of work.	
1.G	Yard piping and paving and grading including new and existing filter piping modifications and improvements and drain age swale and storm drain improvements, and any paving and paving repairs.	
1.H	Testing, commissioning, and assistance with regulatory testing.	
1.L	Demobilization.	
1.M	Miscellaneous work items and other prices not included in previous items and necessary to complete the work.	
	TOTAL LUMP SUM BID	

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01312

PROJECT MEETINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for conducting conferences and meetings for the purposes of addressing issues related to the Work, reviewing and coordinating progress of the Work and other matters of common interest, and includes the following:
   1. Qualifications of Meeting Participants.
   2. Preconstruction Conference.
   3. Progress Meetings.
   4. Pre-Installation Meetings.
   5. Schedule Update Meetings.
   6. Quality Control Meetings.
   7. Pre-Shutdown Meetings.
   8. Pre-Process Start-up Meetings.
   9. Electrical and Instrumentation Coordination Meetings.
   10. Close-out meeting.
   11. Post Construction Meeting.

B. Related Sections:
   1. Section 01140 - Work Restrictions.
   2. Section 16050 - Common Work Results for Electrical.
   3. Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.02 QUALIFICATIONS OF MEETING PARTICIPANTS

A. Representatives of entities participating in meetings shall be qualified and authorized to act on behalf of entity each represents.

1.03 PRECONSTRUCTION CONFERENCE

A. Upon issuance of Notice to Proceed, or earlier when mutually agreeable, Engineer will arrange preconstruction conference in place convenient for most invitees.

B. Preconstruction Conference invitees: Contractor's project manager and superintendent, Owner, Engineer, representatives of utilities, major subcontractors and others involved in performance of the Work, and others necessary to agenda.

C. Engineer will preside at conference.

D. Purpose of conference: To establish working understanding between parties and to discuss Construction Schedule, shop drawing and other submittals, cost breakdown of major lump sum items, processing of submittals and applications for payment, and other subjects pertinent to execution of the Work.

E. Agenda will include:
   1. Adequacy of distribution of Contract Documents.
   2. Distribution and discussion of list of major subcontractors and suppliers.
   3. Proposed progress schedules and critical construction sequencing.
   4. Major equipment deliveries and priorities.
   5. Project coordination.
   6. Designation of responsible personnel.
   7. Procedures and processing of:
      a. Field decisions.
      b. Proposal requests.
      c. Submittals.
      d. Change Orders.
      e. Request for Information/Interpretations.
      f. Applications for Payment.
      g. Record Documents.
   8. Use of premises:
      a. Office, construction, and storage areas.
      b. Owner's requirements.
   9. Construction facilities, controls, and construction aids.
   10. Temporary utilities.
   11. Safety and first aid procedures.
   12. Security procedures.
   13. Housekeeping procedures.

F. Engineer will record minutes of meeting and distribute copies of minutes within 7 days of meeting to participants and interested parties.

1.04 PROGRESS MEETINGS

A. Engineer will schedule and administer meetings throughout progress of the Work at maximum weekly intervals.

B. Engineer will make arrangements for meetings, prepare agenda with copies for participants, and preside at meetings.

C. Attendance required: Owner, Engineer, Contractor, Contractor’s Project Manager, superintendent, quality control manager, project scheduler, major subcontractors and suppliers as appropriate to agenda topics for each meeting.

D. Additional invitees: Owner utility companies when the Work affects their interests, and others necessary to agenda.

E. Agenda:
   1. Review minutes of previous meeting/minutes.
   2. Safety and security.
   3. Construction schedule summary.
   4. Review of 6 weeks schedule.
   5. Review of off-site fabrication and delivery schedules.
   6. Review of submittals schedule and status of submittals.
   7. Request for information (RFIs) status.
   8. MOP’s/shutdown coordination.
   9. Change order management status.
   10. Maintenance of quality standards (QA/QC).

11. Field observations, problems, and conflicts.
12. Commissioning and process start-up.
13. Partnering recognition status (optional).
14. General Items.
15. Action items.
16. Next meeting.

F. Engineer will record minutes and distribute copies within 5 calendar days after meeting to participants, with copies to Contractor, Owner, and those affected by decisions made.

1.05 PRE-INSTALLATION MEETINGS

A. When required in individual specification sections or requested by Engineer, convene pre-installation meeting at Project site before commencing work of specific section.

B. Require attendance of parties directly affecting, or affected by, Work of specific section.

C. Notify Engineer no later than 7 calendar days in advance of meeting date.

D. Prepare agenda and preside at meeting:
1. Review conditions of installation, preparation and installation procedures.
2. Review coordination with related work.

E. Contractor will record minutes and distribute electronic copies within 7 calendar days after meeting to participants, with copies to Engineer, Owner, and those affected by decisions made.

1.06 SCHEDULE UPDATE MEETINGS

A. Engineer will schedule meetings throughout progress of the Work at maximum monthly intervals.

B. Engineer will make arrangements for meetings; Contractor will prepare agenda with copies for participants, and preside at meetings.

C. Attendance required: Owner, Engineer, Contractor, Contractor's Project Manager, General Superintendent, project scheduler, major subcontractors and suppliers as appropriate to agenda topics for each meetings.

D. Additional invitees: Owner utility companies when the Work affects their interests and others necessary to the agenda.

E. Agenda:
1. Review Monthly Schedule, (Actual Progress and Variance):
    a. "Activities Started/Completed" this period.
    b. "Activities Started/Completed" "Variance" Baseline vs. current.
    c. "Added/Deleted Activities".
    d. "Revised Activity Descriptions".
    e. Any significant Proposed Logic Changes.

2. Review milestone “Substantial Completion” Schedule:
   a. “Critical” Activities - “Critical Area, Float and Vital Statistics.”
3. Review “Cumulative and Monthly Costs” graph.
4. Review “Budgeted Cost” indicating the Current Project Budgeted Cost.

F. Contractor will record changes for update and distribute electronic copies within 7 calendar days after meeting to participants and interested parties.

1.07 QUALITY CONTROL MEETINGS

A. Contractor will schedule and administer meetings throughout progress of the Work at maximum weekly intervals.

B. Contractor will make arrangements for meetings, prepare agenda with copies for participants, and preside at meetings.

C. Attendance Required: Construction Manager and staff, Contractor’s Quality Control Manager and staff.

D. Agenda:
1. Review minutes of previous meetings.
2. Review of Work progress and schedule.
3. Review of out-of-compliance inspection or test results.
4. Field observations, problems, and decisions.
5. Review of offsite fabrication and delivery schedules.
6. Planned progress during succeeding work period.
7. Coordination of required inspections and tests.
8. Review 6-week schedule report with upcoming inspections and special tests.
9. Maintenance of quality and work standards.
10. Other business relating to Work.

E. Contractor will record minutes and distribute electronic copies within 5 calendar days after meeting to participants, and those affected by decisions made.

1.08 PRE-SHUTDOWN MEETINGS

A. Follow Owner’s standard Construction Method of Procedure (MOP). See Appendix A of Section 01140 - Work Restrictions for MOP format.

B. All short-term and longer-term shutdowns and other tie-ins that require an Owner approved MOP also require a pre-shutdown meeting at Project site prior to commencing shutdown for tie-in or modification of specific plant systems.

C. Require attendance of parties directly affecting, or affected by shutdown, including Engineer, specific work crews, Owner’s construction, operations, and maintenance staff.

D. Notify Engineer no later than 7 calendar days in advance of meeting date.

E. Prepare agenda and preside at meeting:
1. Review accepted MOP including conditions of shutdown, preparation, and installation procedures.
2. Review timelines and sequences.

3. Review responsibilities.
4. Review dry run plan and schedule, as necessary.
5. Review coordination with related work.

F. Contractor will record minutes and distribute copies within 5 calendar days after meeting and prior to scheduled shutdown to participants, with copies to Engineer, Owner, and those affected by decisions made.

1.09 PRE-PROCESS START-UP MEETINGS

A. All processes and equipment that requires testing and process start-up also requires a pre-startup meeting at Project site before commencing process start-up of specific plant systems.

B. Require attendance of parties directly affecting, or affected by process start-up and testing, including Engineer, specific work crews, Owner's construction operations, and maintenance staff.

C. Notify Engineer no later than 7 calendar days in advance of meeting date.

D. Prepare agenda and preside at meeting:
1. Review accepted MOP including conditions of process start-up and testing, preparation, and installation procedures.
2. Review timelines and sequences.
3. Review responsibilities.
4. Review dry run plan and schedule, as necessary.
5. Review coordination with related work.

E. Contractor will record minutes and distribute electronic copies within 5 calendar days after meeting and prior to scheduled process start-up to participants, with copies to Engineer, Owner, and those affected by decisions made.

F. Follow Owner's standard Construction Method of Procedure (MOP). See Appendix A of Section 01140 - Work Restrictions for MOP format.

1.10 ELECTRICAL AND INSTRUMENTATION COORDINATION MEETINGS

A. Electrical Meetings:
1. Pre-submittal review meeting as specified in Section 16050 - Common Work Results for Electrical.
2. Electrical System Study Meetings (3 separate meetings) as specified in Section 16305 - Electrical System Studies.
3. Other meetings as required and as otherwise specified.

B. Instrumentation and Control Meetings:
1. Pre-Submittal Conference as specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
2. System Configuration Meetings (3 separate meetings) as specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
3. Other meetings as required and as otherwise specified.

1.11 CLOSE-OUT MEETING

A. Engineer will schedule close-out meeting.

B. Engineer will make arrangements for meeting, prepare agenda with copies for participants, and preside at meeting.

C. Attendance required: Owner, Engineer, Contractor, Contractor's Project Manager, Superintendent.

D. Agenda:
   1. Review punch list completion.
   2. Transfer of record documents.
   3. Finalize payment.

E. Engineer will record minutes and within 5 calendar days after meeting distribute copies to participants.

1.12 POST CONSTRUCTION MEETING

A. Meet with and inspect the Work 11 months after date of Substantial Completion with Owner and Engineer.

B. Owner will arrange meeting at least 7 days before meeting.

C. Meet in Owner's office or other mutually agreed upon place.

D. Inspect the Work and draft list of items to be completed or corrected.

E. Review service and maintenance contracts, and take appropriate corrective action when necessary.

F. Complete or correct defective work and extend correction period accordingly.

G. Require attendance of Contractor, Project Manager, or Superintendent, appropriate manufacturers and installers of major units of constructions, and affected subcontractors.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01321

SCHEDULES AND REPORTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Schedules and reports.

1.02 SUBMITTAL REQUIREMENTS

A. Submit preliminary and baseline schedule.

B. Submit preliminary and baseline schedule of values.

C. Submit preliminary and baseline schedule of submittals.

D. Submit, on a monthly basis, updated schedules as specified.

E. Submit final schedule update as specified.

F. Submit revised schedules and time impact analyses as specified.

G. Submit schedules in the media and number of copies as follows:
   1. Provide each submittal in PDF format and in other formats specified in this Section.
   2. 3 sets of the CPM network and/or bar chart (as specified by the Owner) on D-size sheets:
      a. Color-coding to be specified by the Owner.
   3. 3 sets of tabular reports listing all activities sorted numerically identifying duration, early start, late start, early finish, late finish, total float, and all predecessor/successor information.
   4. 2 sets of CPM Schedule data electronic files in a native backed-up file (.xer).

1.03 SCHEDULER

A. Designate, in writing and within 5 calendar days after Notice of Award, the person responsible for preparation, maintenance, updating, and revision of all schedules.

B. Qualifications of scheduler:
   1. Authority to act on behalf of Contractor.
   2. A minimum of 5 years verifiable experience in preparation of construction schedules for projects of similar value, size, and complexity.
   3. Knowledge of critical path method (CPM) scheduling utilizing or SureTrak or Microsoft Project software.

C. Owner reserves the right to disapprove scheduler when submitted by Contractor if not qualified.

D. Owner reserves the right to remove scheduler from the project if found to be unqualified.

1.04 SCHEDULING FORMAT AND SOFTWARE

A. Schedule format: Utilize CPM format.

B. Prepare computerized schedule utilizing or SureTrak or Microsoft Project software, most current version:
   1. Provide 1 licensed copy of the scheduling software to the engineer, registered in the Engineer's name, for the duration of the project.
   2. The provided copy of the software shall be a standalone version for installation on a standalone computer.

C. Contractor and Engineer must agree on the format.

1.05 PRECONSTRUCTION SCHEDULING MEETING

A. Engineer will conduct Preconstruction Scheduling Meeting with Contractor's Project Manager, General Superintendent, and scheduler within 7 calendar days after Notice to Proceed:
   1. This meeting is separate from the Preconstruction Conference Meeting and is intended to exclusively cover schedule issues.

B. At the meeting, review scheduling requirements:
   1. These include schedule preparation, reporting requirements, labor and equipment loading, updates, revisions, and schedule delay analysis.
   2. Present schedule methodology, planned sequence of operations, cost and resource loading methodology, and proposed activity coding structure.
   3. Naming convention: Name schedule files with the year, month and day of the data date, revision identifier, and a description of the schedule:
      a. Example 1: 2014_07_30 rev 1 draft baseline schedule.xer.
      b. Example 2: 2014_09_30 rev 2 sep final update.xer.

C. Filing: Post submitted files to Owner's construction document control system.

1.06 REVIEW AND ACCEPTANCE OF SCHEDULES

A. Engineer will review Baseline Schedule, Schedule Updates, Schedule Revisions and Time Impact Analyses to ascertain compliance with specified project constraints, compliance with milestone dates, reasonableness of durations and sequence, accurate inter-relationships, and completeness.

B. Engineer and Owner will issue written comments following completion of review of Baseline Schedule within 21 calendar days after receipt.

C. Written comments on review of Schedule Updates and Schedule Revisions and Time Impact Analyses will be returned to Contractor within 14 calendar days after receipt by Engineer.

D. Revise and resubmit schedule in accordance with Engineer's comments within 7 calendar days after receipt of such comments or request joint meeting to resolve objections.

E. If Engineer requests a meeting, the Contractor and all major subcontractors must participate in the meeting with Engineer:
   1. Revise and resubmit schedule within 7 calendar days after meeting.

F. Use accepted schedule for planning, organizing, and directing the work and for reporting progress.

G. Engineer's submittal review response:
   1. When schedule reflects Owner's and Contractor's agreement of project approach and sequence, schedule will be accepted by Owner.
   2. Engineer's submittal review response for schedule submittal will be "Receipt Acknowledged - Filed for Record" including applicable comments.
   3. Acceptance of the schedules by the Owner is for general conformance with the Contract Documents and for Owner's planning information and does not relieve the Contractor of sole responsibility for planning, coordinating, and executing the Work within the contract completion dates. Omissions and errors in the accepted schedules shall not excuse performance less than that required by the Contract Documents. Acceptance by the Owner in no way constitutes an evaluation or validation of the Contractor's plan, sequence or means, methods, and techniques of construction.

1.07 SCHEDULE UPDATES

A. Any update:
   1. Prepare update using most recent accepted version of schedule including:
      a. Actual start dates of activities that have been started.
      b. Actual finish dates of activities that have been completed.
      c. Percentage of completion of activities that have been started but not finished.
      d. Actual dates on which milestones were achieved.
      e. Update activities by inputting percent complete figures with actual dates.
      f. Use retained logic in preparing Schedule Updates.
      g. When necessary, input remaining durations for activities whose finish dates cannot be calculated accurately with a percent complete figure only.
      h. Revisions to the schedule may be included that have been previously approved as specified in this Section under Revisions to Schedule.

B. Monthly updates:
   1. Submit written narrative report in conjunction with each Schedule Update including descriptions of the following:
      a. Activities added to or deleted from the schedule are to adhere to cost and other resource loading requirements:
         1) Identify added activities in manner distinctly different from original activity designations.
      b. Changes in sequence or estimated duration of activities.

c. Current or anticipated problems and delays affecting progress, impact of these problems and delays and measures taken to mitigate impact.
d. Assumptions made and activities affected by incorporating change order work into the schedule.

2. Submit updated schedule and materials specified under Submittal of Progress Schedules, 5 calendar days before the monthly schedule update meeting.
3. Since Monthly Schedule Update is the application for progress payment, submittal and acceptance of the monthly Schedule Update is a condition precedent to the making of any progress payments.

C. Weekly progress meeting:
1. Update the schedule prior to weekly progress meeting:
a. Identify overall progress of each Major Item of Work in the Summary Schedule.
b. If there are significant changes to the schedule, submit a written report at the weekly progress meeting.
2. Should monthly Schedule Update show project completion earlier than current Contract completion date, show early completion time as schedule activity, identified as “Project Float”.
3. Should monthly Schedule Update show project completion later than current Contract completion date, prepare and submit a Schedule Revision in accordance with the Revisions to Schedule.

1.08 REVISIONS TO SCHEDULE

A. Submit Revised Schedule within 5 days:
1. When delay in completion of any activity or group of activities indicates an overrun of the Contract Time or milestone dates by 20 working days or 5 percent of the remaining duration, whichever is less.
2. When delays in submittals, deliveries, or work stoppages are encountered making necessary the replanning or rescheduling of activities.
3. When the schedule does not represent the actual progress of activities.
4. When any change to the sequence of activities, the completion date for major portions of the work, or when changes occur which affect the critical path.
5. When Contract modification necessitates schedule revision, submit schedule analysis of change order work with cost proposal.

B. Create a separate submittal for Schedule Revisions:
1. Comply with schedule updates as specified in this Section.
2. Do not submit with Schedule Updates.

C. Schedule Revisions will not be reflected in the schedule until after the revision is accepted by the Owner:
1. This includes Schedule Revisions submitted for the purpose of mitigating a Contractor-caused project delay (Recovery Schedule).

1.09 ADJUSTMENT OF CONTRACT TIMES

A. Contract Time will be adjusted only for causes specified in Contract Documents:
1. Non-excusable delay:
a. Non-excusable delays include actions or inactions of the Contractor, or events for which the Contractor has assumed contractual responsibility (including actions or inactions of subcontractors, suppliers, or material

manufacturers at any tier) that would independently delay the completion of the Work beyond the current Contract completion date).
b. No time extensions will be granted for non-excusable delays.

2. Excusable delay:
   a. Events which are unforeseeable, outside the control of, and without the fault or negligence of either the Owner or the Contractor (or any party for whom either is responsible), which would independently delay the completion of the Work beyond the current Contract completion date.
   b. The Contractor is entitled to a time extension only.
   c. No other damages will be approved.
3. Compensable delay:
   a. Actions or inactions of the Owner, or events for which the Owner has assumed contractual responsibility, which would independently delay the completion of the Work beyond the current Contract completion date.
   b. The Contractor is entitled to a time extension and delay damages.
4. Concurrent delay:
   a. Concurrent delay is any combination of the above 3 types of delay occurring on the same calendar date.
   b. Exception to concurrent delay: Cases where the combination consists of 2 or more instances of the same type of delay occurring on the same calendar date. When one cause of delay is Owner-caused or caused by an event which is beyond the control and without the fault or negligence of either the Owner or the Contractor and the other Contractor-caused, the Contractor is entitled only to a time extension and no delay damages.

B. If the Contractor believes that the Owner has impacted its work, such that the project completion date will be delayed, the Contractor must submit proof demonstrating the delay to the critical path:
   1. This proof, in the form of a Time Impact Analysis, may entitle the Contractor to an adjustment of Contract Time.

C. Time Impact Analysis:
   1. Use the accepted schedule update that is current relative to the time frame of the delay event (change order, third party delay, or other Owner-caused delay). Represent the delay event in the schedule by:
      a. Inserting new activities associated with the delay event into the schedule.
      b. Revising activity logic.
      c. Revising activity durations.
   2. If the project schedule's critical path and completion date are impacted as a result of adding this delay event to the schedule, a time extension equal to the magnitude of the impact may be warranted.
   3. The Time Impact Analysis submittal must include the following information:
      a. A fragment of the portion of the schedule affected by the delay event.
      b. A narrative explanation of the delay issue and how it impacted the schedule.
      c. A schedule file used to perform the Time Impact Analysis.

D. When a delay to the project as a whole can be avoided by revising preferential sequencing or logic, and the Contractor chooses not to implement the revisions, the Contractor will be entitled to a time extension and no compensation for extended overhead.

E. Indicate clearly that the Contractor has used, in full, all project float available for the work involved in the request, including any float that may exist between the Contractor's planned completion date and the Contract completion date:
   1. Utilize the latest version of the Schedule Update accepted at the time of the alleged delay, and all other relevant information, to determine the adjustment of the Contract Time.

F. Adjustment of the Contract Times will be granted only when the Contract Float has been fully utilized and only when the revised date of completion of the Work has been pushed beyond the Contract completion date:
   1. Adjustment of the Contract Times will be made only for the number of days that the planned completion of the work has been extended.

G. Actual delays in activities which do not affect the critical path work or which do not move the Contractor's planned completion date beyond the Contract completion date will not be the basis for an adjustment to the Contract Time.

H. If completion of the project occurs within the specified Contract Time, the Contractor is not entitled to job-site or home office overhead beyond the Contractor's originally planned occupancy of the site.

I. Notify Engineer of a request for Contract Time adjustment:
   1. Submit request as specified in the Contract Documents.
   2. In cases where the Contractor does not submit a request for Contract Time adjustment for a specific change order, delay, or Contractor request within the specified period of time, then it is mutually agreed that the particular change order, delay, or Contractor request has no time impact on the Contract completion date and no time extension is required.

J. The Engineer will, within 30 calendar days after receipt of a Contract Time adjustment, request any supporting evidence, review the facts, and advise the Contractor in writing:
   1. Include the new Progress Schedule data, if accepted by the Owner, in the next monthly Schedule Update.
   2. When the Owner has not yet made a final determination as to the adjustment of the Contract Time, and the parties are unable to agree as to the amount of the adjustment to be reflected in the Progress Schedule, reflect that amount of time adjustment in the Progress Schedule as the Engineer may accept as appropriate for such interim purpose.
   3. It is understood and agreed that any such interim acceptance by the Engineer shall not be binding and shall be made only for the purpose of continuing to schedule the Work, until such time as a final determination as to any adjustment of the Contract Time acceptable to the Engineer has been made.
   4. Revise the Progress Schedule prepared thereafter in accordance with the final decision.

1.10 SCHEDULE PREPARATION

A. Preparation and submittal of Progress Schedule represents Contractor's intention to execute the Work within specified time and constraints:
   1. Failure to conform to requirement may result in termination for cause.

B. Contractor's bid covers all costs associated with the execution of the Work in accordance with the Progress Schedule.

C. During preparation of the preliminary Progress Schedule, Engineer will facilitate Contractor's efforts by being available to answer questions regarding sequencing issues, scheduling constraints, interface points, and dependency relationships.

D. Prepare schedule utilizing Precedence Diagramming Method (PDM).

E. Prepare schedule utilizing activity durations in terms of working days:
   1. Do not exceed 15 working day duration on activities except concrete curing, submittal review, and equipment fabrication and deliveries.
   2. Where duration of continuous work exceeds 15 working days, subdivide activities by location, stationing, or other sub-element of the Work.
   3. Coordinate holidays to be observed with the Owner and incorporate them into the schedule as non-working days.

F. Failure to include an activity required for execution of the Work does not excuse Contractor from completing the Work and portions thereof within specified times and at price specified in Contract:
   1. Contract requirements are not waived by failure of Contractor to include required schedule constraints, sequences, or milestones in schedule.
   2. Contract requirements are not waived by Owner’s acceptance of the schedule. In event of conflict between accepted schedule and Contract requirements, terms of Contract govern at all times, unless requirements are waived in writing by the Owner.

G. Reference schedule to working days with beginning of Contract Time as Day "1".

H. Baseline Schedule and Project Completion:
   1. Should Contractor submit a Baseline Schedule showing project completion more than 20 working days prior to Contract completion date, Owner may issue Change Order, at no cost to Owner, revising time of performance of Work and Contract completion date to match Contractor’s schedule completion date.
   2. Adjust accordingly any Contract milestone dates.

I. Imposed dates, hidden logic prohibited: Do not use imposed dates or hidden logic in preparation of schedule.

J. Interim milestone dates, operational constraints:
   1. In event there are interim milestone dates and/or operational constraints set forth in Contract, show them on schedule.
   2. Do not use Zero Total Float constraint or Mandatory Finish Date on such Contract requirements.

K. Contract float is for the mutual benefit of both Owner and Contractor:
   1. Changes to the project that can be accomplished within this available period of float may be made by Owner without extending the Contract Time, by utilizing float.
   2. Time extensions will not be granted nor delay damages owed until Work extends beyond currently accepted Contract completion date.

3. Likewise, Contractor may utilize float to offset delays other than delays caused by Owner.
4. Mutual use of float can continue until all available float shown by schedule has been utilized by either Owner or Contractor, or both. At that time, extensions of the Contract Time will be granted by Owner for valid Owner-caused or third party-caused delays which affect the planned completion date and which have been properly documented and demonstrated by Contractor.
5. Non-sequestering of float: Pursuant to float sharing requirements of Contract, schedule submittals can be rejected for, use of float suppression techniques such as preferential sequencing or logic, special lead or lag logic restraints, extended activity durations or imposed dates.

L. Commissioning schedule:
1. Commissioning activities and milestones shall be an integral part of the overall project schedule.
2. Commissioning activities and milestones shall be extracted from the main project schedule to provide a separate commissioning schedule that is submitted each time the project schedule is submitted.

M. Payments will not be made until updated Schedule of Values is accepted.

1.11 NETWORK DETAILS AND GRAPHICAL OUTPUT

A. Produce a clear, legible, and accurate calendar based, time scaled, and graphical network diagram:
1. Group activities related to the same physical areas of the Work. Produce the network diagram based upon the early start of all activities.

B. Include for each activity, the description, activity number, estimated duration in working days, total float, and all activity relationship lines.

C. Illustrate order and interdependence of activities and sequence in which Work is planned to be accomplished:
1. Incorporate the basic concept of the precedence diagram network method to show how the start of 1 activity is dependent upon the start or completion of preceding activities and its completion restricts the start of following activities.

D. Indicate the critical path for the project.

E. Delineate the specified contract duration and identify the planned completion of the Work as a milestone:
1. Show the time period between the planned and Contract completion dates, if any, as an activity identified as project float unless a Change Order is issued to officially change the Contract completion date.

F. Identify system shutdown dates, system tie-in dates, specified interim completion or milestone dates and contract completion date as milestones.

G. Include, in addition to construction activities:
   1. Submission dates and review periods for major equipment submittals, shoring submittals, and indicator pile program:
      a. Shoring reviews: Allow 4-week review period for each shoring submittal.
      b. Pile indicator program: Allow 3-week review period for analysis of program.
   2. Any activity by the Owner or the Engineer that may affect progress or required completion dates.
   3. Equipment and long-lead material deliveries over 8 weeks.
   4. Approvals required by regulatory agencies or other third parties.

H. Produce network diagram on 22-inch by 34-inch sheets with grid coordinate system on the border of all sheets utilizing alpha and numeric designations.

I. Identify the execution of the following:
   1. Mobilization.
   2. All required submittals and submittal review times showing 30 calendar day duration for such activities and equal amount of time for re-submittal reviews.
   3. Equipment and materials procurement/fabrication/delivery.
   4. Excavation.
   5. Grading, subbase, base, paving, and curb and gutters.
   6. Concrete, including installation of forms and reinforcement, placement of concrete, curing, stripping, finishing, and patching.
   7. Tests for leakage of concrete structures intended to hold water.
   8. Metal fastenings, framing, structures, and fabrications.
   9. Wood structures, finish carpentry, architectural woodwork, and plastic Finishes including coating and painting, flooring, ceiling, and wall covering.
   10. Process equipment, including identification of ordering lead-time, factory testing, and installation.
   11. Other electrical work including lighting, heating and cooling, and special systems, including identification of ordering lead-time.
   12. Instrumentation and controls, including identification of ordering lead-time.
   13. Preliminary testing of equipment, instrumentation, and controls.
   14. Commissioning Phase.
   15. Substantial completion.
   16. Punch list work.
   17. Demobilization.

1.12 WEATHER DAY ALLOWANCE

A. Definition:
   1. Weather conditions that prevent or inhibit the Contractor’s performance of the Work and affect the Critical Path indicated on the Schedule shall be referred to as a Weather Day.
   2. A Weather Day is defined as the Contractor being unable to perform at least 4 hours of work on the Critical Path.

B. Allowance:
   1. Include as a separate identifiable activity on the critical path, an activity labeled "Weather Days Allowance".

C. Actual weather day:
   1. Insert a weather delay activity in critical path to reflect actual weather day occurrences when weather days are experienced and accepted by Engineer.
   2. Reduce duration of Weather Days Allowance activity as weather delays are experienced and inserted into the Schedule. Remaining weather days in Weather Day Allowance at completion of project is considered float.
   3. The Contractor shall provide a written notice to the Engineer of the occurrence of a weather day within 2 days after the onset of such weather and shall describe in reasonable detail the type of weather encountered and the Work interfered with or interrupted:
      a. A schedule update will not suffice as a written notice.
      b. The Engineer will determine if the weather day constitutes a use of a portion of the Weather Day Allowance.
      c. After use of all the Weather Day Allowance, the Engineer will determine if the Contractor is entitled to an extension of the Contract Time due to weather conditions.
      d. Weather days are considered excusable delay as defined in this Section.

1.13 SCHEDULE OF SUBMITTALS

A. Schedule of Submittals shall include submittals required in the Contract Documents but not limited to test plans, training plans, test procedures, operation and maintenance manuals, shop drawings, samples, record documents, and specifically required certificates, warranties, and service agreements:
   1. Data for “Or Equals” or substitutions shall be submitted with the Schedule of Submittals.

B. Preliminary Schedule of Submittals:
   1. Due date: After Preliminary Schedule has been submitted and accepted by Owner.
   2. Format:
      a. Include submittals anticipated in the first 90 calendar days after award of contract using early start dates.
      b. Indicate week and month anticipated for submittal to Engineer.
      c. Indicate “Priority” submittals where review time can impact Contractor’s schedule:
         1) “Priority” indication will not alter review times specified in Section 01330 - Submittal Procedures.
         2) Engineer will endeavor to provide early review of “Priority” submittals where possible.
      d. List of “Or Equals” or substitutions.
   3. Submittal of Preliminary Schedule of Submittals shall be a condition precedent to Owner making progress payments during the first 90 calendar days after award of contract.

C. Final Schedule of Submittals:
   1. Due date: 30 days after Baseline Schedule has been submitted and accepted by Owner.
   2. Format:
      a. Include submittals using early start dates.
      b. Include all submittals, including those required in the Preliminary Schedule of Submittals.

c. Indicate week and month anticipated for submittal to Engineer.
d. Indicate “Priority” submittals where review time can impact Contractor’s schedule:
    1) “Priority” indication will not alter review times specified in Section 01330 - Submittal Procedures.
    2) Engineer will endeavor to provide early review of “Priority” submittals where possible.
e. Data for “Or Equals” or substitutions.

3. Submittal of Final Schedule of Submittals shall be a condition precedent to Owner making progress payments after the first 90 calendar days after Notice to Proceed.

D. Provide updated Schedule of Submittals with updated schedules if schedule revisions change listing and timing of submittals.

1.14 BASELINE SCHEDULE AND BASELINE SCHEDULE OF VALUES

A. Due date: No more than 45 calendar days after Notice to Proceed.

B. Format:
1. Schedule: Show sequence and interdependence of all activities required for complete performance of all Work, beginning with date of Notice to Proceed and concluding with date of final completion of Contract.
2. Schedule of Values: As specified in Section 01292 - Schedule of Values.

1.15 SUMMARY SCHEDULE

A. Due date: At weekly progress meetings and after each Schedule Update or Schedule Revision.

B. Format:
1. Consolidate groups of activities associated with Major Items of Work shown on Baseline Schedule.
2. intended to give an overall indication of the project schedule without a large amount of detail.

1.16 COST FLOW SUMMARY

A. Due date: After Baseline Schedule has been submitted and accepted by the Owner, submit on a monthly basis as specified in Contract Documents.

B. Format:
1. Tabular and graphic report showing anticipated earnings each month of the Contract period.
2. Base tabulation on the summation of the cost-loaded activities each month.
3. Show planned amounts.
4. Show actual earned amounts and anticipated remaining earnings.
5. Spreadsheet format of all schedule activities showing cost and percentage completion during the current month for which payment is sought.

1.17 PROGRESS SCHEDULE AND UPDATED SCHEDULE OF VALUES

A. Due date: Submit on a monthly basis as specified in Contract Documents.

B. Format: Schedule of Values: As specified in Section 01292 - Schedule of Values.

1.18 WEEKLY SCHEDULE

A. Due date: At every weekly progress meeting.

B. Format:
   1. Contractor and Engineer must agree on the format.
   2. 6-Week Schedule showing the activities completed during the previous week and the Contractor's schedule of activities for following 5 weeks.
   3. Use the logic and conform to the status of the current progress schedule when producing a Weekly Schedule in CPM schedule or a bar chart format:
      a. In the event that the Weekly Schedule no longer conforms to the current schedule, Contractor may be required to revise the schedule as specified in this Section.
   4. The activity designations used in the Weekly Schedule must be consistent with those used in the Baseline Schedule and the monthly Schedule Updates.

1.19 MANPOWER SCHEDULE

A. Due date: With progress payments after Baseline Schedule has been submitted and accepted by Owner.

B. Format:
   1. Schedule histogram depicting total craft manpower and craft manpower for Contractor's own labor forces and those of each subcontractor.
   2. Submit electronically in Excel format, with 1 paper copy.

C. Progress payments after the first 90 calendar days after Notice to Proceed will not be made until manpower schedule is provided.

1.20 COMMISSIONING SCHEDULE

A. Proposed Commissioning Schedule:
   1. Schedule requirements: As specified in Section 01756 - Commissioning.
   2. Submittal due date: Provide 60 days before start-up and testing.
   3. Engineer response due within 20 calendar days of receipt.
   4. Contractor responsible for updating schedule and resubmitting within 10 calendar days of receipt of Engineer and Owner comments.

B. Construction Schedule can include the Commissioning Schedule after Engineer acceptance of the Proposed Commissioning Schedule:
   1. Capable of extracting a stand-alone Commissioning Schedule.
   2. Capable of extracting a stand-alone Owner Training Schedule.

C. Monthly update requirements:
   1. Highlight percentages of completion, actual start and finish dates, and remaining durations, as applicable.

2. Include activities not previously included in the previously accepted detail work plan Commissioning Schedule.
3. Change Order required for any change to contractual dates.
4. Reviews of these submittals by Engineer will not be construed to constitute acceptance within the time frames, durations, or sequence of work for each added activity.

1.21 FINAL SCHEDULE

A. The final Schedule Update becomes the As-Built Schedule:
   1. The As-Built Schedule reflects the exact manner in which the project was constructed by reflecting actual start and completion dates for all activities accomplished on the project.
   2. Contractor's Project Manager and scheduler sign and certify the As-Built Schedule as being an accurate record of the way the project was actually constructed.

B. Retainage will not be released until final Schedule Update is provided.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01322

WEB BASED CONSTRUCTION DOCUMENT MANAGEMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for web-based construction document management.

1.02 REQUIREMENTS

A. Owner, Engineer, and Contractor shall utilize a software-based document management system (DMS) such as EADOC (EADOC is a registered trademark of EADOC LLC). For submission of all data and documents (unless specified otherwise in this Section) throughout the duration of the Contract:
   1. DMS is a web-based electronic media site hosted by a third-party provider.
   2. DMS is available to all Contractor's personnel, subcontractor personnel, suppliers, consultants, Owner, and Engineer at no cost.
   3. The joint use of this system is to facilitate electronic exchange of information, automation of key processes, and overall management of Contract Documentation.
   4. DMS shall be the primary means of project information submission and management.

1.03 USER ACCESS LIMITATIONS

A. Provide a list of Contractor's key DMS personnel for the Engineer's acceptance. The Engineer reserves the right to perform a security check on all potential users. The Contractor will be allowed to add additional personnel and subcontractors to DMS.

B. The Engineer will grant initial access to DMS by creating user profiles to accepted Contractor personnel. User profiles will define levels of access into the system; determine assigned function-based authorizations and user privileges. Subcontractors and suppliers will be given access to DMS by and through the Contractor. Contractor is responsible for adding and removing users from the system after the initial setup by the Engineer.

1.04 JOINT OWNERSHIP OF DATA

A. Data entered in a collaborative mode (entered with the intent to share as determined by permissions and workflows within the DMS system) by Engineer and Contractor will be jointly owned.

1.05 AUTOMATED SYSTEM NOTIFICATION AND AUDIT LOG TRACKING

A. Review comments made (or lack thereof) by Owner on Contractor submitted documentation shall not relieve Contractor from compliance with requirements of the Contract Documents. Contractor is responsible for managing, tracking, and documenting the Work to comply with the requirements of the Contract Documents. Owner's acceptance via automated system notifications or audit logs extends only to the face value of the submitted documentation and does not constitute validation of the Contractor's submitted information.

1.06 COMPUTER REQUIREMENTS

A. Contractor shall use computer hardware and software that meets the requirements of the DMS system as recommended by DMS provider to access and utilize DMS. As recommendations are modified by DMS, Contractor will upgrade their system(s) to meet or exceed the recommendations. Upgrading of Contractor's computer systems will not be justification for a cost or time modification to the Contract.

B. Contractor shall ensure that connectivity to the DMS system is accomplished through DSL, cable, T-1, or wireless communications systems. The minimum bandwidth requirement for using the system is 128 kb/s. It is recommended a faster connection be used when uploading pictures and files into the system.

C. DMS supports the current and prior two major versions of Chrome, Mozilla's Firefox, Microsoft's Internet Explorer, and Apple's Safari on a rolling basis:
   1. Each time a new version of one of these browsers is released, DMS will begin supporting the update and stop supporting the fourth-oldest version.

1.07 CONTRACTOR RESPONSIBILITY

A. Contractor shall be responsible for the validity of their information placed in DMS and for the abilities of their personnel.

B. Entry of information exchanged and transferred between the Contractor and its subcontractors and suppliers on DMS shall be the responsibility of the Contractor.

C. Accepted users shall be knowledgeable in the use of computers, including Internet Browsers, email programs, cad drawing applications, and Adobe Portable Document Format (PDF) document distribution program.

D. Contractor shall utilize the existing forms in DMS to the maximum extent possible. If a form does not exist in DMS the Contractor must include a form of their own or provided by Engineer as an attachment to a submittal.

E. Adobe PDF documents will be created through electronic conversion rather than optically scanned whenever possible. Contractor is responsible for the training of their personnel in the use of DMS (outside what is provided by Owner) and the other programs indicated above as needed.

1.08 TRAINING

A. The Owner has arranged and paid for web-based training on DMS for the Contractor.

B. Contractor shall arrange and pay for the facilities and hardware/software required to facilitate Contractor's training.

PART 2 PRODUCTS

2.01 DESCRIPTION

A. DMS project management application (no equal). Provided by third-party provider.

PART 3 EXECUTION

3.01 DMS UTILIZATION

A. DMS shall be utilized in connection with all document and information management required by these Contract Documents.

3.02 SUBMITTALS

A. Use DMS for submittals.

B. Content: As specified in Section 01330 - Submittal Procedures.

C. Format: As specified in Section 01330 - Submittal Procedures.

D. Submit Portable Document Format (PDF) documents to the DMS submittal work flow process and forms:
   1. Consolidate electronic format submittals with multiple pages into a single file.

E. Hardcopy submittals may be allowed, if approved by the Engineer on a case-by-case basis:
   1. Hardcopy requirements as specified in Section 01330 - Submittal Procedures.

F. Samples:
   1. Contractor shall enter submittal data information into DMS.
   2. Attach a copy of the submittal form(s) to the sample.

G. Record And Closeout Submittals:
   1. Operation and maintenance data as specified in Section 01782 - Operation and Maintenance Data.
   2. Extra materials, spare parts, etc.

3.03 REQUESTS FOR INFORMATION/INTERPRETATION (RFI)

A. Use DMS for RFIs as specified by Owner.

3.04 OFFICIAL CORRESPONDENCE

A. Use DMS for memos, notices, change proposals, or any official correspondence.

3.05 INSPECTION REQUESTS

A. Use DMS to request inspection for a portion of Work that is ready for inspection and prior to covering up the Work.

3.06 FINANCIAL SUBMITTALS

A. Use DMS for financial submittals as specified in Section 01330 - Submittal Procedures.

3.07 OTHER

A. Use DMS for daily reports, meeting agendas and minutes, and other construction documents.

END OF SECTION

SECTION 01329

SAFETY PLAN

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Development and maintenance of a Construction Safety Plan.

1.02 REFERENCES

A. California Labor Code, Section 6401.7.

B. National Fire Protection Association (NFPA):
   1. 70E - Standard for Electrical Safety in the Workplace.

C. Occupational Safety and Health Administration (OSHA).

1.03 CONSTRUCTION SAFETY PLAN

A. Detail the Methods and Procedures to comply with California Labor Code Section 6401.7 NFPA 70E, Federal, and Local Health and Safety Laws, Rules and Requirements for the duration of the Contract Times. Methods and procedures must also comply with the Owner's Safety Plan. Include the following:
   1. Identification of the Certified or Licensed Safety Consultant who will prepare, initiate, maintain and supervise safety programs, and procedures.
   2. Procedures for providing workers with an awareness of safety and health hazards expected to be encountered in the course of construction.
   3. Safety equipment appropriate to the safety and health hazards expected to be encountered during construction. Include warning devices, barricades, safety equipment in public right-of-way and protected areas, safety equipment used in multi-level structures, personal protective equipment (PPE) as required by NFPA 70E.
   4. Methods for minimizing employees' exposure to safety and health hazards expected during construction.
   5. Procedures for reporting safety or health hazards.
   6. Procedures to follow to correct a recognized safety and health hazard.
   7. Procedures for investigation of accidents, injuries, illnesses, and unusual events that have occurred at the construction site.
   8. Periodic and scheduled inspections of general work areas and specific workstations.
   9. Training for employees and workers at the jobsite.
   10. Methods of communication of safe working conditions, work practices and required personal protection equipment.
   11. Provision of a site specific emergency action and evaluation plan.
   12. Verify safety plan includes reference to and compliance with latest Owner safety policies.

B. Assume sole responsibility for every aspect of Health and Safety on the jobsite, including the health and safety of subcontractors, suppliers, and other persons on the jobsite:
   1. Forward available information and reports to the Safety Consultant who shall make the necessary recommendations concerning worker health and safety at the jobsite.
   2. Employ additional health and safety measures specified by the Safety Consultant, as necessary, for workers in accordance with OSHA guidelines.

C. Transmit to Owner and Engineer copies of reports and other documents related to accidents or injuries encountered during construction.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01330

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements and procedures for submittals.

1.02 REFERENCES

A. NSF International:
   1. NSF 61 - Drinking Water System Components - Health Effects.

1.03 DEFINITIONS

A. Certificates: Describe certificates that document affirmations by the Contractor or other entity that the work is in accordance with the Contract Documents.

B. Extra stock materials: Describe extra stock materials to be provided for the Owner's use in facility operation and maintenance.

C. Maintenance material submittals: Use this article to categorize maintenance materials submittals requiring no Engineer action other than confirmation of receipt under an explanatory heading.

D. Manufacturer's instructions: Instructions, stipulations, directions, and recommendations issued in printed form by the manufacturer of a product addressing handling, installation, erection, and application of the product; manufacturer's instructions are not prepared especially for the Work.

E. Product data: Product data usually consists of manufacturers' printed data sheets or catalog pages illustrating the products to be incorporated into the project.

F. Samples: Samples are full-size actual products intended to illustrate the products to be incorporated into the project. Sample submittals are often necessary for such characteristics as colors, textures, and other appearance issues.

G. Spare parts: Describe spare parts necessary for the Owner's use in facility operation and maintenance; identify the type and quantity here, but include the actual characteristics of the spare parts in Product as part of the specification of the product.

H. Shop drawings: Shop drawings are prepared specifically for the project to illustrate details, dimensions, and other data necessary for satisfactory fabrication or construction that are not shown in the contract documents. Shop drawings could include graphic line-type drawings, single-line diagrams, or schedules and lists of products and their application.

I. Submittals: Submittals are samples, product data, shop drawings, and others that demonstrate how Contractor intends to conform with the Contract Documents.

J. Tools: Tools are generally defined as items such as special wrenches, gauges, circuit setters, and other similar devices required for the proper operation or maintenance of a system that would not normally be in the Owner's tool kit.

1.04 GENERAL INSTRUCTIONS

A. Certification: Contractor is responsible to determine and verify all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and check and coordinate each item with other applicable approved shop drawings and all Contract requirements.

B. Provide submittals that are specified or reasonably required for construction, operation, and maintenance of the Work.

C. Where multiple submittals are required, provide a separate submittal for each specification section:
   1. In order to expedite construction, the Contractor may make more than 1 submittal per specification section, but a single submittal may not cover more than 1 specification section:
      a. The only exception to this requirement is when 1 specification section covers the requirements for a component of equipment specified in another section.
      b. For example, circuit breakers are a component of switchgear. The switchgear submittal must also contain data for the associated circuit breakers, even though they are covered in a different specification section.

D. Edit all submittals so that the submittal specifically applies to only the equipment furnished. Neatly cross out all extraneous text, options, models, etc. that do not apply to the equipment being furnished, so that the information remaining is only applicable to the equipment being furnished.

E. Prepare submittals in the English language. Do not include information in other languages.

F. Present measurements in customary American units (feet, inches, pounds, etc.).

G. Must be clear and legible, and of sufficient size for presentation of information.

H. Minimum page size will be 8 1/2 inches by 11 inches:
   1. Maximum page size will be 11 inches by 17 inches.

I. Show dimensions, construction details, wiring diagrams, controls, manufacturers, catalog numbers, and all other pertinent details.

J. Provide submittal information from only 1 manufacturer for a specified product. Submittals with multiple manufacturers for 1 product will be rejected without review.

K. Indicate project designated equipment tag numbers from P&IDs for submittal of devices, equipment, and assemblies.

1.05 SUBMITTAL ORGANIZATION

A. Fully indexed with bookmarks for every section.

B. Sequentially number pages within the tabbed sections:
   1. Submittals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.

C. Organize submittals in exactly the same order as the items are referenced, listed, and/or organized in the specification section.

D. For submittals that cover multiple devices used in different areas under the same specification section, the submittal for the individual devices must list the area where the device is used.

E. Attachments:
   1. Specification section: Include with each submittal a copy of the relevant specification section:
      a. Indicate in the left margin, next to each pertinent paragraph, either compliance with a check (√) or deviation with a consecutive number (1, 2, 3).
      b. Provide a list of all numbered deviations with a clear explanation and reason for the deviation.
   2. Drawings: Include with each submittal a copy of the relevant Drawing, including relevant addendum updates:
      a. Indicate either compliance with a check (√) or deviation with a consecutive number (1, 2, 3).
      b. Provide a list of all numbered deviations with a clear explanation and reason for the deviation.
      c. Provide field dimensions and relationship to adjacent or critical features of the Work or materials.

F. Contractor: Prepare submittal information in sufficient detail to show compliance with specified requirements:
   1. Determine and verify quantities, field dimensions, product dimensions, specified design and performance criteria, materials, catalog numbers, and similar data.
   2. Coordinate submittal with other submittals and with the requirements of the Contract Documents.
   3. Check, verify, and revise submittals as necessary to bring them into conformance with Contract Documents and actual field conditions.

1.06 SUBMITTAL METHOD AND FORMAT

A. As specified in Section 01322 - Web Based Construction Document Management.

B. Submittals in electronic media format:
   1. General: Provide all information in PC-compatible format using Windows® operating system as utilized by the Owner and Engineer.
   2. Text: Provide text documents and manufacturer's literature in Portable Document Format (PDF).
   3. Graphics: Provide graphic submittals (drawings, diagrams, figures, etc.) utilizing Portable Document Format (PDF).

1.07 SUBMITTAL PROCEDURE

A. Engineer: Review submittal and provide response:
   1. Review description:
      a. Engineer will be entitled to rely upon the accuracy or completeness of designs, calculations, or certifications made by licensed professionals accompanying a particular submittal whether or not a stamp or seal is required by Contract Documents or Laws and Regulations.
      b. Engineer's review of submittals shall not release Contractor from Contractor's responsibility for performance of requirements of Contract Documents. Neither shall Engineer's review release Contractor from fulfilling purpose of installation nor from Contractor's liability to replace defective work.
      c. Engineer's review of shop drawings, samples, or test procedures will be only for conformance with design concepts and for compliance with information given in Contract Documents.
      d. Engineer's review does not extend to:
         1) Accuracy of dimensions, quantities, or performance of equipment and systems designed by Contractor.
         2) Contractor's means, methods, techniques, sequences, or procedures except when specified, indicated on the Drawings, or required by Contract Documents.
         3) Safety precautions or programs related to safety which shall remain the sole responsibility of the Contractor.
      e. Engineer can Approve or Not Approve any exception at their sole discretion.
   2. Review timeframe:
      a. Except as may be provided in technical specifications, a submittal will be returned within 30 days.
      b. When a submittal cannot be returned within the specified period, Engineer will, within a reasonable time after receipt of the submittal, give notice of the date by which that submittal will be returned.
      c. Engineer’s acceptance of progress schedule containing submittal review times less than those specified or agreed to in writing by Engineer will not constitute Engineer’s acceptance of review times.
      d. Critical submittals:
         1) Contractor will notify Engineer in writing that timely review of a submittal is critical to the progress of Work.
   3. Schedule delays:
      a. No adjustment of Contract Times or Contract Price will be allowed due to Engineer’s review of submittals, unless all of the following criteria are met:
         1) Engineer has failed to review and return first submission within the agreed upon time frame.
         2) Contractor demonstrates that delay in progress of Work is directly attributable to Engineer’s failure to return submittal within time indicated and accepted by Engineer.
   4. Review response will be returned to Contractor with one of the following dispositions:
      a. Approved:
         1) No Exceptions:
            a) There are no notations or comments on the submittal and the Contractor may release the equipment for production.

2) Make Corrections Noted - See Comments:
   a) The Contractor may proceed with the work, however, all notations and comments must be incorporated into the final product.
   b) Resubmittal not required.
3) Make Corrections Noted - Confirm:
   a) The Contractor may proceed with the work, however, all notations and comments must be incorporated into the final product.
   b) Submit confirmation specifically addressing each notation or comment to the Engineer within 15 calendar days of the date of the Engineer's transmittal requiring the confirmation.

b. Not approved:
1) Correct and resubmit:
   a) Contractor may not proceed with the work described in the submittal.
   b) Contractor assumes responsibility for proceeding without approval.
   c) Resubmittal of complete submittal package is required within 30 calendar days of the date of the Engineer's submittal review response.
2) Rejected - See Remarks:
   a) Contractor may not proceed with the work described in the submittal.
   b) The submittal does not meet the intent of the Contract Documents. Resubmittal of complete submittal package is required with materials, equipment, methods, etc., that meet the requirements of the Contract Documents.

c. Receipt acknowledged - Filed for record:
1) This is used in acknowledging receipt of informational submittals that address means and methods of construction such as schedules and work plans, conformance test reports, health and safety plans, etc.

B. Contractor: Prepare resubmittal, if applicable:
1. Clearly identify each correction or change made.
2. Include a response in writing to each of the Engineer's comments or questions for submittal packages that are resubmitted in the order that the comments or questions were presented throughout the submittal and numbered consistent with the Engineer's numbering:
   a. Acceptable responses to Engineer's comments are listed below:
      1) "Incorporated" Engineer's comment or change is accepted and appropriate changes are made.
      2) "Response" Engineer's comment not incorporated. Explain why comment is not accepted or requested change is not made. Explain how requirement will be satisfied in lieu of comment or change requested by Engineer.
   b. Reviews and resubmittals:
      1) Contractor shall provide resubmittals which include responses to all submittal review comments separately and at a level of detail commensurate with each comment.

2) Contractor responses shall indicate how the Contractor resolved the issue pertaining to each review comment. Responses such as “acknowledged” or “noted” are not acceptable.
3) Resubmittals which do not comply with this requirement may be rejected and returned without review.
4) Contractor shall be allowed no extensions of any kind to any part of their contract due to the rejection of non-compliant submittals.
5) Submittal review comments not addressed by the Contractor in resubmittals shall continue to apply whether restated or not in subsequent reviews until adequately addressed by the Contractor to the satisfaction of the reviewing and approving authority.

c. Any resubmittal that does not contain responses to the Engineer’s previous comments shall be returned for Revision and Resubmittal. No further review by the Engineer will be performed until a response for previous comments has been received.

3. Resubmittal timeframe:
   a. Contractor shall provide resubmittal within 15 days.
   b. When a resubmittal cannot be returned within the specified period, Contractor shall notify Engineer in writing.
4. Review costs:
   a. Costs incurred by Owner as a result of additional reviews of a particular submittal after the second time it has been reviewed shall be borne by Contractor.
   b. Reimbursement to Owner will be made by deducting such costs from Contractor's subsequent progress payments.

1.08 SHOP DRAWINGS

A. Contractor to field verify elevation, coordinates, and pipe material for pipe tie-in to pipeline or structure prior to the preparation of shop drawings.

B. Details:
   1. Fabrication drawings: Drawn to scale and dimensioned.
   2. Front, side, and, rear elevations, and top and bottom views, showing all dimensions.
   3. Locations of conduit entrances and access plates.
   4. Component layout and identification.
   5. Weight.
   6. Finish.
   7. Temperature limitations, as applicable.
   8. Nameplate information.

C. Minor or incidental products and equipment schedules:
   1. Details:
      a. Shop Drawings of minor or incidental fabricated products will not be required, unless requested.
      b. Submit tabulated lists of minor or incidental products showing the names of the manufacturers and catalog numbers, with Product Data and Samples as required to determine acceptability.

1.09 PRODUCT DATA

A. Details:
   1. Supplier name and address.
   2. Subcontractor name and address.

B. Include:
   1. Catalog cuts.
   2. Bulletins.
   3. Brochures.
   4. Manufacturer's Certificate of Compliance: Signed by product manufacturer along with supporting reference data, affidavits, and tests, as appropriate.
   5. Manufacturer's printed recommendations for installation of equipment.
   6. Quality photocopies of applicable pages from manufacturer's documents.

C. Motor Data Sheet:
   1. Provide completed Motor Data Sheet as specified in Section 16222 - Low Voltage Motors Up to 500 Horsepower, for every motor furnished as part of the associated equipment submittal.

D. Test reports including the following information:
   1. Test description.
   2. List of equipment used.
   3. Name of the person conducting the test.
   4. Date and time the test was conducted.
   5. Ambient temperature and weather conditions.
   6. All raw data collected.
   7. Calculated results.
   8. Clear statement if the test passed or failed the requirements stated in Contract Documents.
   9. Signature of the person responsible for the test.

E. Certificates:
   1. As specified in technical sections.
   2. For products that will be in contact with potable water, submit evidence from a nationally recognized laboratory that the products comply with the requirements of the NSF 61 standard.

1.10 SAMPLES

A. Details:
   1. Submit labeled samples.
   2. Samples will not be returned.
   3. Provide samples from manufacturer's standard colors, materials, products, or equipment lines:
      a. Clearly label samples to indicate any that represent non-standard colors, materials, products, or equipment lines and that if selected, will require an increase in Contract Time or Contract Price.
   4. Provide number of sample submittals as below:
      a. Total: 3 minimum:
         1) Owner: 1.
         2) Engineer: 2.
         3) Contractor: None.

B. Field samples:
   1. As specified in technical sections.

1.11 DESIGN CALCULATIONS

A. Defined in technical sections:
   1. Calculations must bear the original seal and signature of a Professional Engineer licensed in the state where the project is located and who provided responsible charge for the design.

1.12 SCHEDULES

A. Progress schedules: As specified in Section 01324B:
   1. Each schedule submittal specified in these Contract Documents shall be submitted as a native backed-up file (.xer) of the scheduling program as specified in Section 01324B.
   2. The schedule and all required reports shall also be submitted as a PDF file.
   3. Schedule of values: As specified in Section 01292 - Schedule of Values.
   4. Schedule of submittals: As specified in Section 01324B.

B. Progress reports and quantity charts:
   1. As specified in Section 01324B.

1.13 REQUESTS FOR SUBSTITUTIONS (RFS)

A. As specified in Section 01600.

1.14 REQUESTS FOR INFORMATION (RFI)

A. As specified in Section 01260 - Contract Modification Procedures.

1.15 CONTRACTOR'S PROFESSIONAL ENGINEER (P.E.) CERTIFICATION FORM

A. Submit a completed Contractor's P.E. Certification Form, provided in this Section, to comply with technical sections requirement for a professional engineer's certification from an engineer licensed in the state the project is located.

1.16 CLOSEOUT SUBMITTALS

A. Provide closeout submittals as specified in Section 01770.

B. Operation and Maintenance Manuals: final documents shall be submitted as specified in Section 01782.

C. Extra materials, spare parts, etc.: Submittal forms shall indicate when actual materials are submitted.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

APPENDIX A

CONTRACTOR'S P.E. CERTIFICATION FORM

DOCUMENT 01330
CONTRACTOR'S P.E. CERTIFICATION FORM

Owner:	Click here to enter text.	**Date:**	MM/DD/YYYY.
Contractor:	Click here to enter text.	**Registration State:**	Click here to enter text.
Project Name:	Click here to enter text.	**Project No.:**	00000.00.
Responsibilities:	Click here to enter text.		
Spec Section:	Click here to enter text.		

Statement of Certification

The undersigned hereby certifies that he/she is a professional engineer registered in the State of and that he/she has been employed by

The undersigned further certifies that he/she has performed the said design in conformance with all applicable local, state, and federal codes, rules, and regulations; and, that his/her signature and P.E. stamp have been affixed to all calculation and drawings used in, and resulting from, the design.

The undersigned hereby agrees to make all original design drawings and calculations available to:

Click here to enter text.

(Name of Owner, or Owner's representative within 7 days of receiving a written request by the Owner.)

Prof. Engineer Signature: _____ **Date:** _____

Printed Name: _____ **Company Name:** _____

Contractor's Signature: _____ **Date:** _____

Printed Name: _____

APPENDIX B

CONTRACTOR SUBMITTAL TRANSMITTAL FORM

DOCUMENT 01330
CONTRACTOR SUBMITTAL TRANSMITTAL FORM

Owner:	Click here to enter text.	**Date:**	MM/DD/YYYY
Contractor:	Click here to enter text.	**Project No.:**	XXXXX.XX
Project Name:	Click here to enter text.	**Submittal Number:**	000
Submittal Title:	Click here to enter text.		
To:	Click here to enter text.		
From:	Click here to enter text.	Click here to enter text.	
	Click here to enter text.	Click here to enter text.	

Specification No. and Subject of Submittal / Equipment Supplier			
Spec ##:	Spec ##.	**Subject:**	Click here to enter text.
Authored By:	Click here to enter text.	**Date Submitted:**	XX/XX/XXXX

Submittal Certification		
Check Either (A) or (B):		
☐	(A)	We have verified that the equipment or material contained in this submittal meets all the requirements specified in the project manual or shown on the contract drawings with no exceptions.
☐	(B)	We have verified that the equipment or material contained in this submittal meets all the requirements specified in the project manual or shown on the contract drawings except for the deviations listed.
Certification Statement: By this submittal, I hereby represent that I have determined and verified all field measurements, field construction criteria, materials, dimensions, catalog numbers and similar data, and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements.		
General Contractor's Reviewer's Signature:		
Printed Name:		
In the event, Contractor believes the Submittal response does or will cause a change to the requirements of the Contract, Contractor shall immediately give written notice stating that Contractor considers the response to be a Change Order.		
Firm: Click here to enter text.	**Signature:**	**Date Returned:** XX/XX/XXXX

PM/CM Office Use	
Date Received GC to PM/CM:	
Date Received PM/CM to Reviewer:	
Date Received Reviewer to PM/CM:	
Date Sent PM/CM to GC:	

SECTION 01340

PHOTOGRAPHIC AND VIDEOGRAPHIC DOCUMENTATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes requirements for photographs and videos.

B. The purpose of the photographs and videos is to document the condition of the facilities prior to the Contractor beginning work at the Project site, the progress of the Work, and the Project site after Substantial Completion of the Work.

C. The scope of the photographic and videographic documentation shall be the sole responsibility of the Contractor, but shall be acceptable to the Engineer.

1.02 SUBMITTALS

A. Photographer qualifications.

B. Pre-construction photographs and videos: Submit prior to beginning work at the Project site or prior to the Preconstruction Conference specified in Section 01312 - Project Meetings, whichever occurs earlier.

C. Construction photographs and videos: Submit with each application for payment.

D. Post-construction photographs and videos: Submit with project closeout documents as specified in Section 01770 - Closeout Procedures.

1.03 PHOTOGRAPHER

A. Photographer qualified and equipped to photograph either interior or exterior exposures, with lenses ranging from wide angle to telephoto.

B. Submit example work of previous photographs and video recording meeting the requirements of this Section:
   1. Provide to Engineer no later than the pre-construction conference.
   2. Provide photographs used for site examination.
   3. Provide video of site examination.
   4. Provide samples that used same camera and lighting equipment proposed for the Work.
   5. Engineer will review work examples to determine if the quality of the images is acceptable.
   6. Contractor is responsible for modifications to equipment and/or inspection procedures to achieve report material of acceptable quality.
   7. Do not commence Work prior to approval of the material by the Engineer.
   8. Once accepted, the standard report material shall serve as a standard for the remaining work.

1.04 KEY PLAN

A. Submit key plan of Project site with notation of vantage points marked for location and direction of each photograph.

B. Include the same label information as the corresponding set of photographs.

1.05 PHOTOGRAPHS

A. Provide prints of each photograph for each area of Work.

B. Provide a digital copy of each photograph for each area of Work.
   1. Monthly: Indexed digital CD.
   2. Project record documents:
      a. Catalog and index prints in chronological sequence.
      b. Include typed table of contents.

1.06 PRE-CONSTRUCTION PHOTOGRAPHS AND VIDEOS

A. Provide photographs and video of the condition entire site including each area of Work prior to the start of Work.
   1. Areas to be photographed and videoed shall include the site of the Work and all existing facilities, either on or adjoining the Project site, including the interior of existing structures that could be damaged as a result of the Contractor's Work.
   2. Include general condition, structures, vegetation, staging, storing, working, parking areas and excavation areas.

1.07 CONSTRUCTION PHOTOGRAPHS AND VIDEOS

A. Provide photographs and videos of construction in each area of Work throughout progress of Work including a key plan designating where each photograph was taken.

B. Take site and interior photographs and videos from differing directions of building demolition, pre-excavation, footing excavation, soil testing, utility crossings, installation of bypass piping, excavation of access pits, installation of lining system in pipes, rehabilitation of manholes, building modifications, utilities, electrical and instrumentation modifications, and other applicable activities indicating relative progress of the work.

C. Take photos a maximum of 7 calendar days prior to submittal.

1.08 POST-CONSTRUCTION PHOTOGRAPHS AND VIDEOS

A. Provide photographs of the entire site including each area of Work at the completion of Work.
   1. Include general condition, structures, vegetation, staging, storing, working, parking areas and excavation areas.
   2. Take photos and video from same points in same direction as pre-construction examination.

B. Submittal of photos and videos is a condition of final payment.

PART 2 PRODUCTS

2.01 MEDIA

A. Digital media:
   1. 120 millimeters, 700-MB, 80-minute CD compatible with current Microsoft Windows.
   2. Provide photos as individual, indexed JPG files with the following characteristics:
      a. Compression shall be set to preserve quality over file size.
      b. Highest resolution JPG images shall be submitted. Resizing to a smaller size when high resolution JPGs are available shall not be permitted.
      c. JPG image resolution shall be 5 megapixels at 2,400 by 1,800 or higher.
      d. Images shall have rectangular clean images. Artistic borders, beveling, drop shadows, etc., are not permitted.
   3. Identification: On photograph, provide the following information:
      a. Name of project.
      b. Date stamp: Unless otherwise indicated, date and time stamp each photograph as it is being taken so stamp is integral to photograph.
      c. Description of vantage point, indicating location and direction by compass point.

B. Videos:
   1. DVD compatible, 120 millimeters, formatted for use with PC systems.
   2. Video quality shall be 720p HD or greater in MPG, AVCHD, AVI, or MP4 format.
   3. Digital color video format.
   4. Provide audio portion of the composite CD sufficiently free from electrical interference and background noise to provide complete intelligibility of oral report.
   5. Identification: On each copy provide a label with the following information:
      a. Name of project.
      b. Date video was recorded.
   6. Submit 4 copies of each video within 7 days of recording.

PART 3 EXECUTION

3.01 GENERAL

A. Videos:
   1. Display continuous running time.
   2. At start of each video recording, record weather conditions from local newspaper or television and the actual temperature reading at Project site.

END OF SECTION

SECTION 01350

SPECIAL PROCEDURES FOR LOCATING AND VERIFYING CONCEALED EXISTING UTILITIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Special procedures for locating and verifying concealed existing utilities.

1.02 CONCEALED EXISTING UTILITIES

A. Verify locations of utilities which may exist by consulting with the Owner, utility companies, and Underground Services Alert (USA) or other service available in area of Project:
   1. Abide by easement and right-of-way restrictions.

B. Perform exploratory vacuum excavation potholing, as necessary to more accurately identify location, depth, configuration, and utility service in congested utility areas prior to preparation of shop drawings and subsequent excavation:
   1. Potholing shall be backfilled immediately after purpose has been satisfied and the surface restored and maintained in a manner satisfactory to Engineer.
   2. Adjustments in construction methods shall be made to accommodate utility location information gained from potholing as necessary to protect existing utilities and maintain plant in operations.
   3. Note that installation of all underground yard piping and utilities in this project are considered to be installed in congested utility areas.
   4. Some variation from the conditions indicated on the Drawings is to be expected.

C. Notify the Owner, owners of facilities when the Work will be in progress.

D. Make arrangements for potential emergency repairs in accordance with requirements of owners of utility facilities, including individual or residential facilities.

E. Assume responsibility for repair of utilities and facilities damaged by performance of the Work.

F. Work required for raising, lowering, or relocating utilities not indicated will be performed by affected utility owners or as part of the Work at option of affected owners of utilities:
   1. When part of the Work, perform work in accordance with standards of affected utility owner, and adjustment to Contract Price and Contract Times will be made as stipulated in conditions of Contract.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01354

HAZARDOUS MATERIAL PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Procedures required when encountering hazardous materials at the Work site.

1.02 REFERENCES

A. California Code of Regulations (CCR):
   1. Title 8: Industrial Relations.
   2. Title 22: Social Security.

B. California Occupational Safety and Health Administration (Cal-OSHA).

C. Occupational Safety and Health Administration (OSHA).

D. United States Code of Federal Regulation (CFR):
   1. Title 29 - Labor:
      a. 1926.62 - Lead.
   2. Title 40 - Protection of Environment:
      a. 261 - Identification and Listing of Hazardous Waste.

1.03 SUBMITTALS

A. Submit laboratory reports, hazardous material removal plans, and certifications.

B. Submit the following work plan:
   1. Removal and Legal Disposal of Asbestos Cement Pipe Plan:
      a. Work plan shall include, but not be limited, to the following:
         1) Schedule of work.
         2) Security measures for work and disposal area.
         3) Staff training: Contractor shall provide at least one competent person who is capable of identifying asbestos hazards at the job site for the entire duration of the AC pipe removal and disposal operation.
         4) Trenching and removal of pipe procedure.

1.04 DEFINITIONS

A. Adequately Wet: Penetration of the pipe wall with liquid to prevent release of particulates.

B. Asbestos Cement Pipe: Also commonly referred to as AC Transite Pipe, AC pipe or ACP. Pipe that is generally composed of cement and asbestos fibers.

C. Competent Person: A trained worker who is capable of identifying existing and predictable asbestos hazards, perform exposure assessment and monitoring, is

qualified to train other workers, and has the authority to take immediate corrective action to eliminate a hazardous exposure.

D. Non-friable Asbestos - Containing Material (NACM): Material containing more than 1 percent asbestos, that when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure.

E. Regulated Asbestos - Containing Material (RACM): Category II non-friable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder in the course of work.

1.05 OPERATING DIGESTERS

A. Observe safety precautions in vicinity of operating digesters which contain digester gases, including methane, hydrogen sulfide, and carbon dioxide.

1.06 HAZARDOUS MATERIALS PROCEDURES

A. Hazardous materials are those defined by 40 CFR and State specific codes.

B. When hazardous materials have been found:
   1. Prepare and initiate implementation of plan of action.
   2. Notify immediately Owner, Engineer, and other affected persons.
   3. Notify such agencies as are required to be notified by Laws and Regulations with the times stipulated by such Laws and Regulations.
   4. Designate a Certified Industrial Hygienist to issue pertinent instructions and recommendations for protection of workers and other affected persons' health and safety.
   5. Identify and contact subcontractors and licensed personnel qualified to undertake storage, removal, transportation, disposal, and other remedial work required by, and in accordance with, laws and regulations.

C. Forward to Engineer, copies of reports, permits, receipts, and other documentation related to remedial work.

D. Assume responsibility for worker health and safety, including health and safety of subcontractors and their workers:
   1. Instruct workers on recognition and reporting of materials that may be hazardous.

E. File requests for adjustments to Contract Times and Contract Price due to the finding of Hazardous Materials in the Work site in accordance with Contract Documents:
   1. Minimize delays by continuing performance of the Work in areas not affected by hazardous materials operations.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01355A

STORMWATER POLLUTION PREVENTION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Requirements for the preparation and implementation of the Stormwater Pollution Prevention Plan (SWPPP) for the Contractor's construction activities. This document (and other identified in this Section will be used for the purpose of applying for and obtaining so the Owner can apply and pay for and receive a State of California General Construction Activity Stormwater Permit. This permit authorizes the discharge of stormwater associated with construction activities from the construction site.

1.02 REFERENCES

A. National Pollutant Discharge Elimination System (NPDES).

B. State of California, State Water Resources Control Board, Regional Water Quality Control Board (SWRCB).

C. United States Code of Federal Regulation (CFR):
   1. 40 - Protection of Environmental:
      a. 117 - Determination of reportable quantities for hazardous substance.
      b. 302 - Designation, reportable quantities, and notification.

1.03 SUBMITTALS

A. Construction General Permit:
   1. The Contractor shall prepare and submit all Permit Registration Documents (PRDs) to the Engineer for review, approval, and certification by the Legally Responsible Person (LRP) prior to start of work and mobilization:
      a. The LRP will electronically submit the PRDs to the Stormwater Multiple Application and Report Tracking System (SMARTS) to obtain approval of the Construction General Permit (CGP).
   2. The PRDs shall include but are not limited to the Notice of Intent (NOI), Risk Determination Worksheet, Site Maps, Stormwater Pollution Prevention Plan (SWPPP), Annual Fees and Owner Certification. It shall also include all other reports, calculations, studies, exhibits, and documentation required to obtain the CGP.
   3. Contractor shall provide a Qualified SWPPP Practitioner (QSP), who will be responsible for maintaining the existing CGP active throughout the duration of the project:
      a. Contractor shall be responsible for providing all reports required by the CGP (monitoring, inspection, Rain Event Action Plans, sampling, exceedance reports, annual reports, etc.) to the Engineer for review.
      b. Upon approval, the Contractor’s QSP shall upload the information to SMARTS.

c. Time-sensitive reports involving monitoring data shall be provided as soon as the information is made available.
d. All other reports shall be provided to the Engineer a minimum of 2 weeks prior to their deadline for submittal to the SWRCB through SMARTS.
e. All CGP documents shall be submitted to the Owner for reference, and a copy shall be located on site at all times.

B. Pollution Prevention Plan:
1. Prepare and submit a site-specific Stormwater Pollution Prevention Plan (SWPPP) in accordance with Section A of the General Construction Activity Stormwater Permit to the Owner for reference.
2. Prepare and submit a monitoring program and reporting plan in accordance with Section B of the General Construction Activity Stormwater Permit to the Owner for reference.
3. Submit to the Owner for reference a Stormwater Pollution Prevention Plan detailing the placement of physical Best Management Practices (BMPs) required for installation and the methods used to comply with those BMPs directed at operational procedures, Monitoring Program, and Reporting Plan.
4. The plan shall specifically address and detail changes from the alternatives called out in this Section. The Contractor's preferred techniques shall show how it will comply with the stated objectives of the program.
5. The SWPPP shall be prepared and amended by a Qualified SWPPP Developer (QSD), as defined by the CGP.

C. Contractor shall submit a copy of the BMP Handbook with each BMP to be utilized checkmarked to show compliance or marked to show deviation.

D. The entire plan shall be kept and maintained by the Contractor on the construction site during the duration of the project.

E. Contractor shall be responsible for taking the proper actions to prevent contaminants and sediments from entering the storm sewer drainage system should any unforeseen circumstance occur. The Contractor shall take immediate action if directed by the Engineer, or if the Contractor observes contaminants and/or sediments entering the storm drainage system, to prevent further stormwater from entering the system.

1.04 REGULATORY REQUIREMENTS

A. Contractor shall comply with the State Water Resources Control Board, Regional Water Quality Control Board, county, city, and other local agency requirements regarding stormwater discharges and management.

B. Contractor shall not begin any construction work until the Owner receives the State of California General Construction Activity Stormwater Permit. The Contractor shall allow the Owner 30 days to obtain this permit after receipt of the information listed in this Section.

C. Contractor shall comply with the following prohibitions and limitations, which are contained in the Stormwater Permit:
   1. Discharge prohibitions:
      a. Discharges of materials other than stormwater, which are not otherwise regulated by a NPDES permit, to a separate stormwater sewer system or water of the nation are prohibited.
      b. Stormwater discharges shall not cause or threaten to cause pollution, contamination (including sediment), or nuisance.
      c. Stormwater discharges regulated by this general permit shall not contain a hazardous substance equal to or in excess of a reportable quantity listed in 40 CFR 117 and 40 CFR 302.
   2. Receiving water limitations:
      a. Stormwater discharges to any surface or groundwater shall not adversely impact human health or the environment.
      b. Stormwater discharge shall not cause or contribute to a violation of any applicable water quality standards contained in the California Ocean Plan, Inland Surface Waters and Enclosed Bays and Estuaries Plan, or the applicable Regional Water Board's Basin Plan.

D. Requirements:
   1. In order to comply with the permit mandates the Sonoma County has developed a County-Wide Stormwater Pollution Prevention Program and summary of Best Management Practices (BMPs) that are suggested to be utilized by the Contractor. BMPs are measures or practices used to reduce the amount of pollution entering surface water. BMPs may take the form of a process, activity, or physical structure. Some BMPs are simple and can be put into place immediately, while others are more complicated and require extensive planning or space. They may be inexpensive or costly to implement. No additional compensation shall be made for implementation of BMPs.
   2. The Sonoma County-Wide Stormwater Pollution Prevention Program and Summary of BMPs are available for review at the Owner's Water Quality Control Plant.

1.05 STORMWATER POLLUTION PREVENTION PLAN IMPLEMENTATION

A. Contractor's QSP shall implement all activities required by the General Permit and as detailed in the Stormwater Pollution Prevention Plan, Monitoring Program, and Reporting Plan.

1.06 NON-STORMWATER MANAGEMENT

A. Stormwater Pollution Prevention Plan shall discuss any non-stormwater sources (i.e., landscaping irrigation, pipe flushing, street washing, and dewatering). In addition, the Plan shall include standard observation measures and best management practices, including best available technologies economically achievable and best conventional pollutant control technologies that are to be implemented in order to reduce the pollutant loading to the waters.

1.07 AMENDMENTS

A. Contractor's QSP shall amend the Stormwater Pollution Prevention Plan, Monitoring Program, and Reporting Plan whenever there is a change in construction or operations which may affect the discharge of pollutants to stormwater.

B. The Stormwater Pollution Prevention Plan shall also be amended if it is in violation of any conditions of the general permit or has not achieved the general objective of reducing pollutants in stormwater discharges.

C. All amendments shall be completed at no additional cost to the Owner.

1.08 ANNUAL SUMMARY

A. Contractor:
   1. Prepare an annual summary report (annual report) in accordance with all Regional Water Quality Control Board requirements.
   2. Utilize the annual report form available in the SMARTS and submit it to the Engineer a minimum of 2 weeks prior to the deadline for submittal.
   3. Upon approval of the report by the Engineer, the LRP will review and certify the report for final submittal via SMARTS.

1.09 NOTICE OF TERMINATION

A. Contractor shall provide all necessary information for the completion of a Notice of Termination (NOT) upon completion of all construction activities (refer to Section C of the General Construction Activity Stormwater Permit for general requirements). Upon review of the information submitted, the LRP will certify and submit the NOT via SMARTS.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Nonhazardous material/waste management:
   1. Designated area: The Contractor shall propose designated areas of the project site, for approval by the Engineer, suitable for material delivery, storage, and waste collection that, to the maximum extent practicable, are near construction entrances and away from catch basins, gutters, drainage courses, and creeks.
   2. Granular material:
      a. Contractor shall store granular material at least 50 feet away from catch basin and curb returns.
      b. Contractor shall not allow granular material to enter storm drains, creeks, or rivers.
      c. When rain is forecast within 24 hours or during wet weather, the Engineer may require the Contractor to cover granular material with a tarpaulin and to surround the material with sand bags:
         1) All stockpiles are required to be protected immediately if they are not scheduled to be used within 14 days.
   3. Dust control: The Contractor shall use reclaimed water to control dust on a daily basis or as directed by the Construction Manager.

4. Street sweeping and vacuuming:
    a. At the end of each working day or as directed by the Engineer, the Contractor shall clean and sweep roadways and on-site paved areas of all materials attributed to or involved in the work.
    b. Contractor shall not use water to flush down streets in place of street sweeping.
    c. Additionally, the Contractor shall not use kick brooms or sweeper attachments.

B. Spill prevention and control:
    1. Contractor shall keep a stockpile of spill cleanup materials, such as rags or absorbents, readily accessible on-site.
    2. Contractor shall immediately contain and prevent leaks and spills from entering storm drains, and properly clean up and dispose of the waste and cleanup materials:
        a. If the waste is hazardous, the Contractor shall dispose of hazardous waste only at authorized and permitted treatment, storage, and disposal facilities, and use only licensed hazardous waste haulers to remove the waste off-site, unless quantities to be transported are below applicable threshold limits for transportation specified in State and Federal regulations.
    3. Contractor shall not wash any spilled material into streets, gutters, storm drains, creeks, or rivers and shall not bury spilled hazardous materials.
    4. Contractor shall immediately report any hazardous materials spill to the Owner and Engineer for reporting to all applicable regulatory agencies.

C. Vehicle/equipment cleaning:
    1. Contractor shall not perform vehicle or equipment cleaning on-site or in the street using soaps, solvents, degreasers, steam cleaning equipment, or equivalent methods.
    2. Contractor shall perform vehicle or equipment cleaning, with water only, in a designated, bermed area that will not allow rinse water to run off-site or into streets, gutters, storm drains, creeks, or rivers.

D. Vehicle/equipment maintenance and fueling:
    1. Contractor shall perform maintenance and fueling of vehicles or equipment in designated, bermed area(s) or over a drip pan that will not allow run-on of stormwater or runoff of spills.
    2. Contractor shall use secondary containment, such as a drip pan, to catch leaks or spills any time that vehicle or equipment fluids are dispensed, changed, or poured.
    3. Contractor shall keep a stockpile of spill cleanup materials, such as rags or absorbents, readily accessible on-site.
    4. Contractor shall clean up leaks and spills of vehicle or equipment fluids immediately and dispose of the waste and cleanup materials as hazardous waste, as described in section "Spill prevention and control" above.
    5. Contractor shall not wash any spilled material into streets, gutters, storm drains, creeks, or rivers and shall not bury spilled hazardous materials.
    6. Contractor shall report any hazardous materials spill to the Owner and Engineer and all applicable regulatory agencies.

7. Contractor shall inspect vehicles and equipment arriving on-site for leaking fluids and shall promptly repair leaking vehicles and equipment. Drip pans shall be used to catch leaks until repairs are made.
8. Contractor shall recycle waste oil and antifreeze, to the maximum extent practicable.
9. The Contractor shall comply with Federal, State, and City requirements for aboveground storage tanks.

E. Contractor training and awareness:
1. Contractor's QSP shall train all employees/subcontractors on the stormwater pollution prevention requirements contained in these specifications.
2. Contractor's QSP shall inform subcontractors of the stormwater pollution prevention contract requirements and include appropriate subcontract provisions to ensure that these requirements are met.
3. Contractor shall post warning signs in areas treated with chemicals.
4. Contractor shall paint new, reset, or raised catch basins, constructed as part of the project, with a "No Dumping" stencil.

3.02 SPECIFIC REQUIREMENTS

A. Paving operations:
1. Project site management:
a. When rain is forecast within 24 hours or during wet weather, the Engineer may prevent the Contractor from paving.
b. Engineer may direct the Contractor to protect drainage courses by using control measures, such as earth dike, straw bale, and sand bag, to divert runoff or trap and filter sediment in addition to those already shown on the construction plan sheets.
c. Contractor shall place drip pans or absorbent material under paving equipment when not in use.
d. Contractor shall cover catch basins and manholes when paving or applying seal coat, tack coat, slurry seal, or fog seal.
e. If the paving operation includes an on-site mixing plant, the Contractor shall comply with applicable Federal, State, and local General Industrial Activities Stormwater Permit requirements.
2. Paving waste management:
a. Contractor shall not sweep or wash down excess sand (placed as part of a sand seal or to absorb excess oil) into gutters, storm drains, or creeks:
1) Instead, the Contractor shall both collect the sand and return it to the stockpile, or dispose of it in a trash container.
b. Contractor shall not use water to wash down fresh asphalt concrete pavement.

B. Concrete, grout, and mortar waste management:
1. Material management: Contractor shall store concrete, grout, and mortar away from drainage areas and ensure that these materials do not enter the storm drain system.
2. Concrete truck/equipment washout:
a. Contractor shall not washout concrete trucks or equipment into streets, gutters, storm drains, creeks, or rivers:
1) Washout areas should be located at least 50 feet from storm drains, open ditches, or water bodies.

b. Contractor shall perform washout of concrete trucks or equipment in a designated area:
    1) Washout site should be lined so there is no discharge into the underlying soil.

3. Exposed aggregate concrete wash water:
    a. Contractor shall avoid creating runoff from washing of exposed aggregate concrete. Contractor shall collect and return sweepings from exposed aggregate concrete to a stockpile or dispose of the waste in a trash container.

END OF SECTION

SECTION 01410

REGULATORY REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Regulatory authorities and codes.

1.02 AUTHORITIES HAVING JURISDICTION

A. Building Department: City of Petaluma.

B. Fire Department: City of Petaluma.

1.03 APPLICABLE CODES

A. California Code of Regulations (CCR), California Building Standards Code, CCR Title 24:
   1. Building code:
      a. California Building Code (CBC), Title 24, Part 2 – 2022.
   2. Electrical code:
      a. California Electrical Code (CEC), Title 24, Part 3 – 2022.
   3. Mechanical code:
      a. California Mechanical Code (CMC), Title 24, Part 4 – 2022.
   4. Plumbing code:
      a. California Plumbing Code (CPC), Title 24, Part 5 – 2022.
   5. Energy code:
      a. California Energy Code (CEC), Title 24, Part 6 – 2022.
   6. Historical building code:
      a. California Historical Building Code (CHBC), Title 24, Part 8 – 2022.
   7. Fire code:
      a. California Fire Code (CFC), Title 24, Part 9 – 2022.
   8. Existing building code:
      a. California Existing Building Code (CEBC), Title 24, Part 10 – 2022.
   9. Green building standards code:
      a. California Green Building Standards Code (CALGreen), Title 24, Part 11 – 2022.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01424

ABBREVIATIONS AND ACRONYMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Abbreviations and meanings.

1.02 INTERPRETATIONS

A. Interpret abbreviations by context in which abbreviations are used.

1.03 ABBREVIATIONS

A. Abbreviations used to identify reference standards:

AA	Aluminum Association
AABC	Associated Air Balance Council
AAMA	Architectural Aluminum Manufacturers Association
AAN	American Association of Nurserymen
AASHTO	American Association of State Highway and Transportation Officials
ABC	Associated Air Balance Council
AATCC	American Association of Textile Chemists and Colorists.
ABMA	American Bearing Manufacturers' Association (formerly AFBMA, Anti-Friction Bearing Manufacturers' Association)
ABPA	Acoustical and Board Products Association
ACGIH	American Conference of Government Industrial Hygienists
ACI	American Concrete Institute
ACIL	American Council of Independent Laboratories
ADC	Air Diffusion Council
ABMA	American Bearing Manufacturers' Association (formerly AFBMA, Anti-Friction Bearing Manufacturers' Association)
AGA	American Gas Association
AGC	Associated General Contractors
AGMA	American Gear Manufacturers' Association
AHRI	Air-Conditioning, Heating, and Refrigeration Institute
AI	Asphalt Institute
AIA	American Institute of Architects
AIMA	Acoustical and Insulating Materials Association
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMCA	Air Moving and Conditioning Association International, Inc.
AMG	Arizona Masonry Guild
ANSI	American National Standards Institute
APA	American Plywood Association
API	American Petroleum Institute
ASAHC	American Society of Architectural Hardware Consultants
ASCE	American Society of Civil Engineers

ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	ASTM International
AWI	Architectural Woodwork Institute
AWPA	American Wood Protection Association
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWSC	American Welding Society Code
AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturers Association
BIA	Brick Institute of America
BSI	Building Stone Institute
Caltrans	California Department of Transportation
Cal-OSHA	California Occupational Safety and Health Administration
CCR	California Code of Regulations
CFR	United States Code of Federal Regulations
CLFMI	Chain Link Fence Manufacturers Institute
CPSC	U.S. Consumer Product Safety Commission
CRA	California Redwood Association
CRI	Carpet and Rug Institute
CRSI	Concrete Reinforcing Steel Institute
CS	Commercial Standards
CSA	CSA International
CSI	Construction Specifications Institute
CTI	Ceramic Tile Institute
DHI	Door and Hardware Institute
EIFS	Exterior Insulation and Finish System
EJCDC	Engineers Joint Contract Documents Committee
EPA	United States Environment Protection Agency
FDA	Food and Drug Administration
FGMA	Flat Glass Marketing Association
FHWA	Federal Highway Administration
FIA	Factory Insurance Association
FM	FM (Factory Mutual) Global
FS	Federal Specifications
FTI	Facing Tile Institute
GA	Gypsum Association
HI	Hydraulic Institute
HMMA	Hollow Metal Manufacturers Association
IAPMO	International Association of Plumbing and Mechanical Officials
ICBO	International Conference of Building Officials
ICC	International Code Council
ICEA	Insulated Cable Engineer’s Association

ICRI	International Concrete Repair Institute
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISA	International Society of Automation
ISO	International Organization for Standardization
JIC	Joint Industrial Council
MAG	Maricopa Association of Governments
MIA	Marble Institute of America
ML/SFA	Metal Lath/Steel Framing Association
MS	Military Specifications
NAAMM	National Association of Architectural Metal Manufacturers
NACE	NACE International
NAPA	National Asphalt Pavement Association
NAVFAC	Department of the Navy Facilities Engineering Command
NBHA	National Builders Hardware Association
NCMA	National Concrete Masonry Association
NEBB	National Environmental Balancing Bureau
NEC	National Electrical Code
NECA	National Electrical Contractors Association
NETA	InterNational Electrical Testing Association
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NFPA	National Forest Products Association
NIOSH	National Institute for Occupational Safety and Health
NIST	National Institute of Standards and Technology
NMWIA	National Mineral Wool Insulation Association
NPCA	National Paint and Coatings Association
NRCA	National Roofing Contractors Association
NSF	NSF International
NTMA	National Terrazzo and Mosaic Association
NWMA	National Woodwork Manufacturer's Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Prestressed Concrete Institute
PDCA	Paint and Decorating Contractors of America
PDI	Plumbing and Drainage Institute
PEI	Porcelain Enamel Institute
PS	Product Standard
RCSC	Research Council on Structural Connections
RILEM	International Union of Testing and Research Laboratories for Materials and Structures
RTI	Resilient Tile Institute
SAE	SAE International
SCPA	Structural Clay Products Association
SDI	Steel Door Institute

SIGMA	Sealed Insulating Glass Manufacturers Association
SJI	Steel Joist Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SSPC	Society for Protective Coatings
TABB	Testing, Adjusting, and Balancing Bureau
TCA	Tile Council of America
UL	Underwriters Laboratories, Inc.
UNS	Unified Numbering System
USDA	United States Department of Agriculture
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
VA	Vermiculite Association
WCLA	West Coast Lumberman's Association
WCLIB	West Coast Lumber Inspection Bureau
WPA	Western Pine Association
WPOA	Western Plumbing Officials Association
WRC	Welding Research Council
WSCPA	Western States Clay Products Association
WWPA	Western Wood Products Association

B. Abbreviations used in Specifications and Drawings:

a	year or years (metric unit)
A	ampere or amperes
am	ante meridian (before noon)
ac	alternating current
ac-ft	acre-foot or acre-feet
atm	atmosphere
AWG	American Wire Gauge
bbl	barrel or barrels
bd	board
bhp	brake horsepower
BIL	basic impulse insulation level
bil gal	billion gallons
BOD	biochemical oxygen demand
Btu	British thermal unit or units
Btuh	British thermal units per hour
bu	bushel or bushels
BV	bed volume(s)
C	degrees Celsius
cal	calorie or calories
cap	capita
cd	candela or candelas
cfm	cubic feet per minute
Ci	curie or curies

CIPP	Cured-in-Place Pipe
cm	centimeter or centimeters
cmu	concrete masonry unit
CO	carbon monoxide
Co.	Company
CO_2	carbon dioxide
COD	chemical oxygen demand
Corp.	Corporation
counts/min	counts per minute
cu	cubic
cu cm	cubic centimeter or centimeters
cu ft	cubic foot or feet
cu ft/day	cubic feet per day
cu ft/hr	cubic feet per hour
cu ft/min	cubic feet per minute
cu ft/sec	cubic feet per second
cu in	cubic inch or inches
cu m	cubic meter or meters
cu yd	cubic yard or yards
d	day (metric units)
day	day (English units)
db	decibels
D/d	column diameter to particle diameter ratio
DB	dry bulb (temperature)
dc	direct current
diam	diameter
DO	dissolved oxygen
DS	dissolved solids
EBCT	empty bed contact time
EER	energy efficiency ratio
emf	electromotive force
fpm	feet per minute
F	degrees Fahrenheit
ft	feet or foot
fc	foot-candle or foot candles
ft/day	feet per day
ft/hr	feet per hour
ft/min	feet per minute
ft/sec	feet per second
g	gram or grams
G	gravitational force
gal	gallon or gallons
gal/day	gallons per day
gal/min	gallons per minutes
gal/sec	gallons per second
gfd	gallons per square foot per day
g/L	grams per liter
gpd	gallons per day

gpd/ac	gallons per day per acre
gpd/cap	gallons per day per capita
gpd/sq ft	gallons per day per square foot
gph	gallons per hour
gpm	gallons per minute
gpm/sq ft	gallons per minute per square foot
gps	gallons per second
g/cm^3	grams per cubic centimeter
h	hour or hours (metric units)
ha	hectare or hectares
hp	high point
hp	horsepower
hp-hr	horsepower-hour or horsepower-hours
hr	hour or hours (English units)
Hz	hertz
ID	inside diameter
ihp	indicated horsepower
Inc.	Incorporated
inch	inch
inches	inches
inches/sec	inches per second
I/O	input/output
J	joule or joules
JTU	Jackson turbidity unit or units
k	kips
K	kelvin
K	thermal conductivity
kA	kiloampere
kcal	kilocalorie or kilocalories
kcmil	thousand circular mils
kg	kilogram or kilograms
kip	kilopound or kilopounds
km	kilometer or kilometers
kN	kilonewton or kilonewtons
kPa	kilopascal or kilopascals
ksi	kips per square inch
kV	kilovolt or kilovolts
kVA	kilovolt-ampere or kilovolt-amperes
kW	kilowatt or kilowatts
kWh	kilowatt hour
L	liter or liters
lb/1000 cu ft	pounds per thousand cubic foot
lb/acre-ft	pounds per acre-foot
lb/ac	pounds per acre
lb/cu ft	pounds per cubic foot
lb/day/cu ft	pounds per day per cubic foot
lb/day/acre	pounds per day per acre

lb/sq ft	pounds per square foot
L/D Ratio	Ratio of filter height to filter media particle diameter
lin	linear, lineal
lin ft	linear foot or feet
lm	lumen or lumens
lmh	liters per square meter per hour
log	logarithm (common)
ln	logarithm (natural)
lx	lux
m	meter or meters
M	molar (concentration)
mA	milliampere or milliamperes
max	maximum
mCi	millicurie or millicuries
meq	milliequivalent
meq/mL	milliequivalents per milliliter
MFBM	thousand feet board measure
mfr	manufacturer
mg	milligram or milligrams
mgd/ac	million gallons per day per acre
mgd	million gallons per day
mg/L	milligrams per liter
mrem	millirem
□F	microfarad or microfarads
Mil	0.001 inch (used for coating thickness)
mile	mile
mil. gal	million gallons
miles	miles
min	minimum
min	minute or minutes
MLSS	mixed liquor suspended solids
MLVSS	mixed liquor volatile suspended solids
mm	millimeter or millimeters
mol wt	molecular weight
mol	mole
Mpa	megapascal or megapascals
mph	miles per hour
MPN	most probable number
MPT	National Pipe Thread, male fitting
mR	milliroentgen or milliroentgens
Mrad	megarad or megarads
mV	millivolt or millivolts
MW	megawatt or megawatts
□g/L	micrograms per liter
□m	micrometer or micrometers
µS/cm	microSeimens per centimeter
N	newton or newtons
N	normal (concentration)
ND	not detected
nm	nanometer

No.	number
Nos	numbers
NPT	National Pipe Thread
NRC	noise reduction coefficient
NTU or ntu	nephelometric turbidity unit
oc	on center
OD	outside diameter
ORP	oxidation-reduction potential
OT	ortho-tolidine
OTA	ortha-tolidine-arsenite
oz	ounce or ounces
oz/sq ft	ounces per square foot
Pa	pascal or pascals
pl	plate or property line
pm	post meridiem (afternoon)
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
pr	pair
psf/hr	pounds per square foot per hour
psf	pounds per square foot
psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gauge
PVC	polyvinyl chloride
qt	quart or quarts
R	radius
R	roentgen or roentgens
rad	radiation absorbed dose
RH	relative humidity
rpm	revolutions per minute
rps	revolutions per second
s	second (metric units)
S	Siemens (mho)
scfh	standard cubic feet per hour
scfm	standard cubic feet per minute
SDI	sludge density index or silt density index
sec	second (English units)
SI	International System of Units
sp	static pressure
sp gr	specific gravity
sp ht	specific heat
sq	square
cm^2 or sq cm	square centimeter or centimeters
sq ft	square feet or foot
sq inch	square inch
sq inches	square inches

km^2 or sq km	square kilometer or kilometers
m^2 or sq m	square meter or meters
mm^2 or sq mm	square millimeter or millimeters
sq yd	square yard or yards
SS	suspended solids
STC	Sound Transmission Class
SVI	sludge volume index
TDS	total dissolved solids
TEFC	totally enclosed, fan-cooled
TKN	total Kjeldahl nitrogen
TLM	median tolerance limit
TOC	total organic carbon
TOD	total oxygen demand
TOW	top of weir
TS	total solids
TSS	total suspended solids
TVS	total volatile solids
U	U Factor/U Value
U	Coefficient of Heat Transfer
U	heat transfer coefficient
UNS	Uniform Numbering System
US	United States
V	volt or volts
VA	volt-ampere or volt-amperes
W	watt or watts
WB	wet bulb
wg	water gauge
wk	week or weeks
WRT	water remediation technologies
wt	weight
yd	yard or yards
yr	year or years (English unit)

C. Abbreviations used on Drawings: As listed on Drawings or in Specifications.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01450

QUALITY CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Quality control and control of installation.
   2. Tolerances.
   3. References.
   4. Mock-up requirements.
   5. Authority and duties of Owner’s representative or inspector.
   6. Sampling and testing.
   7. Testing and inspection services.
   8. Contractor’s responsibilities.

1.02 QUALITY CONTROL AND CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.

B. Comply with manufacturers' instructions, including each step in sequence.

C. When manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Perform Work by persons qualified to produce required and specified quality.

F. Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

H. When specified, products will be tested and inspected either at point of origin or at Work site:
   1. Notify Engineer in writing well in advance of when products will be ready for testing and inspection at point of origin.
   2. Do not construe that satisfactory tests and inspections at point of origin is final acceptance of products. Satisfactory tests or inspections at point of origin do not preclude retesting or re-inspection at Work site.

I. Do not ship products which require testing and inspection at point of origin prior to testing and inspection.

1.03 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. When Manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

1.04 REFERENCES

A. ASTM International (ASTM):
   1. E329 - Standard for Agencies Engaged in Construction Inspection, Testing or Special Inspection.

1.05 MOCK-UP REQUIREMENTS

A. Tests will be performed under provisions identified in this Section and identified in respective product specification sections.

B. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals, and finishes.

C. Accepted mock-ups shall be comparison standard for remaining Work.

D. Where mock-up has been accepted by Engineer and is specified in product specification sections to be removed; remove mock-up and clear area when directed to do so by Engineer.

1.06 AUTHORITY AND DUTIES OF OWNER'S REPRESENTATIVE OR INSPECTOR

A. Owner’s Project Representative employed or retained by Owner is authorized to inspect the Work.

B. Inspections may extend to entire or part of the Work and to preparation, fabrication, and manufacture of products for the Work.

C. Deficiencies or defects in the Work which have been observed will be called to Contractor’s attention.

D. Inspector will not:
   1. Alter or waive provisions of Contract Documents.
   2. Inspect Contractor’s means, methods, techniques, sequences, or procedures for construction.
   3. Accept portions of the Work, issue instructions contrary to intent of Contract Documents, or act as foreman for Contractor. Supervise, control, or direct Contractor’s safety precautions or programs; or inspect for safety conditions on Work site, or of persons thereon, whether Contractor’s employees or others.

E. Inspector will:
   1. Conduct on-site observations of the Work in progress to assist Engineer in determining when the Work is, in general, proceeding in accordance with Contract Documents.
   2. Report to Engineer whenever Inspector believes that Work is faulty, defective, does not conform to Contract Documents, or has been damaged; or whenever there is defective material or equipment; or whenever Inspector believes the Work should be uncovered for observation or requires special procedures.

1.07 SAMPLING AND TESTING

A. General:
   1. Prior to delivery and incorporation in the Work, submit listing of sources of materials, when specified in sections where materials are specified.
   2. When specified in sections where products are specified:
      a. Submit sufficient quantities of representative samples of character and quality required of materials to be used in the Work for testing or examination.
      b. Test materials in accordance with standards of national technical organizations.

B. Sampling:
   1. Furnish specimens of materials when requested.
   2. Do not use materials which are required to be tested until testing indicates satisfactory compliance with specified requirements.
   3. Specimens of materials will be taken for testing whenever necessary to determine quality of material.
   4. Assist Engineer in preparation of test specimens at site of work, such as soil samples and concrete test cylinders.

1.08 TESTING AND INSPECTION SERVICES

A. Contractor will employ and pay for specified services of an independent firm to perform Contractor quality control testing as required in the technical specifications for various work and materials.

B. Owner will employ and pay for specified services of an “Owner’s independent testing firm” certified to perform testing and inspection as required in the technical specifications for various work and materials or stipulated in Section 01455 - Special Tests and Inspections to confirm Contractor’s compliance with Contract Documents.

C. The Owner’s independent testing firm will perform tests, inspections and other services specified in individual specification sections and as required by Owner and requested by the Engineer.

D. The qualifications of laboratory that will perform the testing, contracted by the Owner or by the Contractor, shall be as follows:
   1. Has authorization to operate in the state where the project is located.
   2. Meets “Recommended Requirements for Independent Laboratory Qualification,” published by American Council of Independent Laboratories.
   3. Meets requirements of ASTM E329.
   4. Laboratory Staff: Maintain full time specialist on staff to review services.

5. Testing Equipment: Calibrated at reasonable intervals with devices of accuracy traceable to National Bureau of Standards (NBS) or accepted values of natural physical constants.
6. Will submit copy of report of inspection of facilities made by Materials Reference Laboratory of NBS during most recent tour of inspection, with memorandum of remedies of deficiencies reported by inspection.

E. Testing, inspections and source quality control may occur on or off project site. Perform off-site testing inspections and source quality control as required by Engineer or Owner.

F. Contractor shall cooperate with Owner's independent testing firm, furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested:
1. Notify Engineer and Owner's independent testing firm 48 hours prior to expected time for operations requiring testing.
2. Make arrangements with Owner's independent testing firm and pay for additional samples and tests required for Contractor's use.

G. Limitations of authority of testing Laboratory: Owner's independent testing firm or Laboratory is not authorized to:
1. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
2. Agency or laboratory may not approve or accept any portion of the Work.
3. Agency or laboratory may not assume duties of Contractor.
4. Agency or laboratory has no authority to stop the Work.

H. Testing and employment of an Owner's independent testing firm or laboratory shall not relieve Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

I. Re-testing or re-inspection required because of non-conformance to specified requirements shall be performed by same Owner's independent testing firm on instructions by Engineer. Payment for re-testing or re-inspection will be charged to Contractor by deducting testing charges from Contract Sum/Price.

J. The Owner's independent testing firm responsibilities will include:
1. Test samples of mixes submitted by Contractor.
2. Provide qualified personnel at site. Cooperate with Engineer and Contractor in performance of services.
3. Perform specified sampling and testing of products in accordance with specified standards.
4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
5. Promptly notify Engineer and Contractor of observed irregularities or non-conformance of Work or products.
6. Perform additional tests required by Engineer.
7. Attend preconstruction meetings and progress meetings.

K. Owner's independent testing firm individual test reports: After each test, Owner's independent testing firm will promptly submit electronically and 3 hard copies of report to Engineer and to Contractor. Include the following:
1. Date issued.

2. Project title and number.
3. Name of inspector.
4. Date and time of sampling or inspection.
5. Identification of product and specifications section.
6. Location in Project.
7. Type of inspection or test.
8. Date of test.
9. Certified test results stamped and signed by a registered Engineer.
10. Summary of conformance with Contract Documents.
11. When requested by Engineer, the Owner's independent testing firm will provide interpretation of test results.

L. Owner's independent testing firm will provide monthly report of certification to identify all work performed for special inspections and other contract requirements on this project. The following certified monthly report at a minimum will include but not limited to:
1. Results of testing.
2. Testing logs.
3. Outstanding deficiencies.
4. Various statistical data.
5. Testing curves (up to 4 types) as required by the Engineer.

1.09 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with Owner's independent testing firm or laboratory personnel and provide access to construction and manufacturing operations.

B. Secure and deliver to Owner's independent testing firm or laboratory adequate quantities of representative samples of materials proposed to be used and which require testing.

C. Provide to Owner's independent testing firm or laboratory and Engineer preliminary mix design proposed to be used for concrete, and other materials mixes which require control by testing laboratory.

D. Furnish electronically and 5 hard copies of product test reports.

E. Furnish incidental labor and facilities:
1. To provide access to construction to be tested.
2. To obtain and handle samples at Work site or at source of product to be tested.
3. To facilitate inspections and tests.
4. For storage and curing of test samples.

F. Notify Owner's independent testing firm or laboratory 48 hours in advance of when observations, inspections and testing is needed for laboratory to schedule and perform in accordance with their notice of response time.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01455

SPECIAL TESTS AND INSPECTIONS

PART 1 GENERAL

1.01 SUMMARY

A. This Section describes the requirements for providing special tests and inspections.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C140 -Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
   2. C270 - Standard Specification for Mortar for Unit Masonry.
   3. C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
   4. C1019 - Standard Test Method for Sampling and Testing Grout.
   5. C1314 - Standard Test Method for Compressive Strength of Masonry Prisms.

B. California Building Code (CBC).

1.03 DESCRIPTION

A. This Section describes special tests and inspections of structural assemblies and components to be performed in compliance with CBC.

B. These special tests and inspections are in addition to the requirements specified in Section 01450 - Quality Control, and by the individual Sections.

C. The Owner or Owner Representative will employ 1 or more inspectors who will provide special inspections during construction.

1.04 INSPECTION

A. Duties of Special Inspector:
   1. General: Required duties of the Special Inspector are described in CBC.

1.05 TESTS

A. Selection of the material required to be tested shall be by the Owner's Testing Laboratory and not the Contractor.

1.06 SPECIAL TESTING AND INSPECTIONS

A. Testing laboratory: Special tests will be performed by the Owner's testing laboratory as specified in Section 01450 - Quality Control.

B. Owner reserves the right to positive material identification tests:
   1. Contractor must make materials available for testing.

C. The following types of work require special inspection as described in CBC, Refer to the following verification, testing and inspection schedules:
   1. Appendix A, Cast-In-Place Concrete Special Inspection Schedule.
   2. Appendix B, Essential Architectural, Mechanical and Electrical Inspection Schedule.
   3. Appendix C.
   4. Soils Verification and Inspection Schedule.
   5. Appendix D, Structural Steel Special Inspection Schedule.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 SCHEDULE

A. The Contractor shall allow time necessary for Special Inspections as listed above.

B. Sufficient notice shall be given so that the Special Inspections can be performed. This includes time for off-site Special Inspectors to plan the inspection and travel to site.

3.02 PROCEDURE

A. The Special Inspector will immediately notify the Engineer of any corrections required and follow notification with appropriate documentation.

B. The Contractor shall not proceed until the work is satisfactory to the Engineer.

END OF SECTION

APPENDIX A

CAST-IN-PLACE CONCRETE SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection	
		Continuous During Task Listed	Periodic During Task Listed
1. Inspection of reinforcing steel, including prestressing tendons, and placement.		-	X
2. Inspection of reinforcing steel welding.	IBC Table 1704.3, Item 5B	-	-
3. Inspect bolts to be installed in concrete prior to and during placement of concrete.		X	-
4. Verifying use of required design mix.		-	X
5. At the time fresh concrete is sampled to fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.		X	-
6. Inspection of concrete and shotcrete placement for proper application techniques.		X	-
7. Inspection for maintenance of specified curing temperature and techniques.		-	X

APPENDIX B

ESSENTIAL ARCHITECTURAL, MECHANICAL AND ELECTRICAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection	
		Continuous During Task Listed	Periodic During Task Listed
1. Anchorage of electrical equipment for emergency standby power.		-	X
2. Anchorage of other electrical or mechanical equipment over 1,000 lb. on floors or roofs.		-	X
3. Anchorage of ducts greater than 6 s.f. in cross-section.		-	X
4. Anchorage of pipelines greater than 8 inches in diameter.		-	X
5. Steel storage racks supporting pipelines.		-	X

APPENDIX C

SOILS VERIFICATION AND INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection	
		Continuous During Task Listed	Periodic During Task Listed
1. Verify materials below footings are adequate to achieve the design bearing capacity.		-	X
2. Verify excavations are extended to proper depth and have reached proper material.		-	X
3. Perform classification and testing of controlled fill materials.		-	X
4. Verify use of proper materials, densities, and lift thicknesses during placement and compaction of controlled fill.		X	-
5. Prior to placement of controlled fill, observe subgrade and verify that site has been prepared properly.		-	X

APPENDIX D

STRUCTURAL STEEL SPECIAL INSPECTION SCHEDULE

Verification and Inspection	Reference Standard	Frequency of Inspection	
		Continuous During Task Listed	Periodic During Task Listed
1. Material verification of high-strength bolts, nuts and washers:			
a. Identification markings to conform to ASTM standards specified in the approved construction documents.		-	X
b. Manufacturer's certificate of compliance required.		-	X
2. Inspection of high-strength bolting:			
a. Bearing-type connections.		-	X
b. Slip-critical connections.		X	X
3. Material verification of structural steel:			
a. Identification markings to conform to ASTM standards specified in the approved construction documents.		-	X
b. Manufacturers' certified mill test reports.		X	-
4. Material verification of weld filler materials:			
a. Identification markings to conform to AWS specification in the approved construction documents.		-	X
b. Manufacturer's certificate of compliance required.		-	X
5. Inspection of welding:			
a. Structural steel:		-	-
1) Complete and partial penetration groove welds.		X	-
2) Multi-pass fillet welds.		X	-
3) Single-pass fillet welds > 5/16".		X	-
4) Single-pass fillet welds < 5/16".		-	X
5) Floor and deck welds.		-	X
b. Reinforcing steel:		-	-
1) Verification of weldability of reinforcing steel other than ASTM A706.		-	X

Verification and Inspection	Reference Standard	Frequency of Inspection	
		Continuous During Task Listed	Periodic During Task Listed
2) Reinforcing steel-resisting flexural and axial forces in boundary elements of special reinforced concrete shear walls and shear reinforcement.		X	-
3) Shear reinforcement.		X	-
4) "Form Saver" (reinforcing couplers).		X	-
6. Inspection of steel frame joint details for compliance with approved construction documents:			X
a. Details such as bracing and stiffening.		X	-
b. Member locations.		X	-
c. Application of joint details at each connection.		X	
7. Seismic force resisting systems identified on structural plans.		X	-

SECTION 01500

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Furnishing, maintaining, and removing construction facilities and temporary controls, including temporary utilities, construction aids, barriers and enclosures, security, access roads, temporary controls, project sign, field offices and sheds, and removal after construction.

1.02 REFERENCE

A. American National Standards Institute (ANSI).

B. Occupational Safety and Health Administration (OSHA).

1.03 SUBMITTALS

A. General: For products specified to be furnished under this Section, submit product data as specified in Section 01330 - Submittal Procedures.

B. For temporary piping systems:
   1. Submit layout drawings showing proposed routing of piping, including proposed pipe support and pipe restraint locations.
   2. Submit product data for piping, fittings, appurtenances, restraints, supports, and all other components of the temporary piping system.
   3. Submit all information at least 28 days prior to when each temporary piping system is scheduled to be installed and allow 14 days for review and comment.

C. For temporary pumping systems:
   1. Submit pump data, performance curves, and other operating information as specified in Section 15050 - Common Work Results for Mechanical Equipment.
   2. Submit sketches showing layout of temporary pumping system, including pump quantity, configuration in wet well, and proposed piping layout specified in this Section.
   3. Submit piping headloss calculations based on proposed temporary piping system layout.

D. Submit all information at least 28 days prior to when the temporary pumping system is scheduled to be installed and allow 14 days for review and comment.

1.04 TEMPORARY UTILITIES

A. Temporary electrical power:
   1. Arrange with local utility to provide adequate temporary electrical service. Owner provides the power:
      a. Temporary electrical power is available at the following locations: MCC-9 and 20.
      b. The Contractor is responsible for providing all breakers, switches, transformers, and cables required to obtain temporary power from these location(s).
      c. The Owner will pay all charges for construction power obtained from these locations.
   2. Provide and maintain adequate jobsite power distribution facilities conforming to applicable Laws and Regulations.

B. Temporary electrical lighting:
   1. In work areas, provide temporary lighting sufficient to maintain lighting levels during working hours not less than lighting levels required by OSHA and state agency which administers OSHA regulations where Project is located.
   2. When available, permanent lighting facilities may be used in lieu of temporary facilities:
      a. Prior to Substantial Completion of the Work, replace bulbs, lamps, or tubes used by Contractor for lighting.

C. Temporary heating, cooling, and ventilating:
   1. Heat and ventilate work areas to protect the Work from damage by freezing, high temperatures, weather, and to provide safe environment for workers.
   2. Permanent heating system may be utilized when sufficiently completed to allow safe operation.

D. Temporary water:
   1. Pay for and construct facilities necessary to furnish potable water for human consumption and non-potable water for use during construction.
   2. Remove temporary piping and connections and restore affected portions of the facility to original condition before Substantial Completion.

E. Temporary sanitary facilities:
   1. Provide suitable and adequate sanitary facilities that are in compliance with applicable Laws and Regulations.
   2. Existing facility use is not allowed.
   3. At completion of the Work, remove sanitary facilities and leave site in neat and sanitary condition.

F. Temporary fire protection: Provide sufficient number of fire extinguishers of type and capacity required to protect the Work and ancillary facilities.

G. First aid: Post first aid facilities and information posters conforming to requirements of OSHA and other applicable Laws and Regulations in readily accessible locations.

H. Utilities in existing facilities: As specified in Section 01140 - Work Restrictions.

1.05 CONSTRUCTION AIDS

A. Provide railings, kick plates, enclosures, safety devices, and controls required by Laws and Regulations and as required for adequate protection of life and property.

B. Use construction hoists, elevators, scaffolds, stages, shoring, and similar temporary facilities of ample size and capacity to adequately support and move loads.

C. Design temporary supports with adequate safety factor to ensure adequate load bearing capability:
   1. When requested, submit design calculations by professional registered engineer prior to application of loads.
   2. Submitted design calculations are for information and record purposes only.

D. Accident prevention:
   1. Exercise precautions throughout construction for protection of persons and property.
   2. Observe safety provisions of applicable Laws and Regulations.
   3. Guard machinery and equipment, and eliminate other hazards.
   4. Make reports required by authorities having jurisdiction, and permit safety inspections of the Work.
   5. Before commencing construction work, take necessary action to comply with provisions for safety and accident prevention.

E. Barricades:
   1. Place barriers at ends of excavations and along excavations to warn pedestrian and vehicular traffic of excavations.
   2. Provide barriers with flashing lights after dark.
   3. Keep barriers in place until excavations are entirely backfilled and compacted.
   4. Barricade excavations to prevent persons from entering excavated areas in streets, roadways, parking lots, treatment plants, or other public or private areas.

F. Warning devices and barricades: Adequately identify and guard hazardous areas and conditions by visual warning devices and, where necessary, physical barriers:
   1. Devices shall conform to minimum requirements of OSHA and State agency which administers OSHA regulations where Project is located.

G. Hazards in public right-of-way:
   1. Comply with local jurisdiction standards and requirements for right-of-way barricades and other safety devices.
   2. Mark at reasonable intervals, trenches, and other continuous excavations in public right-of-way, running parallel to general flow of traffic, with traffic cones, barricades, or other suitable visual markers during daylight hours:
      a. During hours of darkness, provide markers with torches, flashers, or other adequate lights.
   3. At intersections or for pits and similar excavations, where traffic may reasonably be expected to approach head on, protect excavations by continuous barricades:
      a. During hours of darkness, provide warning lights at close intervals.

H. Hazards in protected areas: Mark or guard excavations in areas from which public is excluded, in manner appropriate for hazard.

I. Above grade protection: On multi-level structures, provide safety protection that meets requirements of OSHA and State agency which administers OSHA regulations where Project is located.

J. Protect existing structures, trees, shrubs, and other items to be preserved on Project site from injury, damage, or destruction by vehicles, equipment, worker or other agents with substantial barricades or other devices commensurate with hazards.

1.06 SECURITY

A. Make adequate provision for protection of the work area against fire, theft, and vandalism, and for protection of public against exposure to injury.

1.07 ACCESS ROADS

A. General:
   1. Build and maintain access roads to and on site of the Work to provide for delivery of material and for access to existing and operating plant facilities on site.
   2. Build and maintain dust free roads which are suitable for travel at 20 miles per hour.

B. Off-site access roads:
   1. Build and maintain graded earth roads.
   2. Build roads only in public right-of-way or easements obtained by Owner.
   3. Obtain rights-of-way or easements when electing to build along other alignment.

C. On-site access roads:
   1. Maintain access roads to storage areas and other areas to which frequent access is required.
   2. Maintain similar roads to existing facilities on site of the Work to provide access for maintenance and operation.
   3. Protect buried vulnerable utilities under temporary roads with steel plates, wood planking, or bridges.
   4. Maintain on-site access roads free of mud. Under no circumstances shall vehicles leaving the site track mud off the site onto the public right-of-way.

1.08 TEMPORARY CONTROLS

A. Dust control:
   1. Prevent dust nuisance caused by operations, unpaved roads, excavation, backfilling, demolition, or other activities.
   2. Control dust by sprinkling with water, use of dust palliatives, modification of operations, or other means acceptable to agencies having jurisdiction.

B. Noise control:
   1. Comply with noise and work hours regulations by local jurisdiction.
   2. In or near inhabited areas, particularly residential, perform operations in manner to minimize noise.
   3. In residential areas, take special measures to suppress noise during night hours.

C. Mud control:
   1. Prevent mud nuisance caused by construction operations, unpaved roads, excavation, backfilling, demolition, or other activities.

1.09 PROJECT SIGN

A. Provide and maintain Project identification sign consisting of painted 8-foot wide by 4-foot high exterior grade plywood and minimum 10-foot long, 4 by 4 lumber posts, set in ground at least 3 feet, with exhibit lettering by professional sign painter using no more than 5 sign colors:
   1. List at least the title of the Project, and names of the Owner, Engineer, and Contractor.
   2. Contractor's Engineer's names shall be identified in upper right hand corner underneath the bid number.

B. Provide project sign as directed by the Owner.

1.10 FIELD OFFICES AND SHEDS

A. Contractor's field office:
   1. Maintain on Project Site weather tight space in which to keep copies of Contract Documents, progress schedule, shop drawings, and other relevant documents.
   2. Provide field office with adequate space to examine documents, and provide lighting and telephone service in that space.

1.11 REMOVAL

A. Remove temporary buildings and furnishings before inspection for Substantial Completion or when directed.

B. Clean and repair damage caused by installation or use of temporary facilities.

C. Remove underground installations to minimum depth of 24 inches and grade to match surrounding conditions.

D. Restore existing facilities used during construction to specified or original condition.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01600

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Product requirements; product selection; product options and substitutions; quality assurance; shipping, delivery, handling, and storage; and instructions for spare parts, maintenance products, and special tools.

1.02 REFERENCES

A. American National Standards Institute (ANSI).

B. California Health and Safety Code.

C. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.
   2. 372 - Drinking Water System Components - Lead Content.

1.03 DEFINITIONS

A. Products: Inclusive of raw materials, finished goods, equipment, systems, and shop fabrications.

B. Special tools: Tools that have been specifically made for use on a product for assembly, disassembly, repair, or maintenance.

1.04 SUBMITTALS

A. As specified in Section 01330 - Submittal Procedures.

B. Calculations/certifications in accordance with NSF 61 and 372 for materials in contact with drinking water.

1.05 GENERAL REQUIREMENTS

A. Comply with Specifications and referenced standards as minimum requirements.

B. Provide products by same manufacturer when products are of similar nature, unless otherwise specified.

C. Provide like parts of duplicate units that are interchangeable.

D. Provide equipment that has not been in service prior to delivery, except as required by tests.

E. When necessary, modify manufacturer's standard product to conform to specified requirements or requirements indicated on the Drawings.

1.06 SUBSTITUTIONS

A. Formal substitution request procedure:
   1. Submit a written formal substitution request to Engineer for each proposed substitution within 30 days of effective date of Contract.
   2. Engineer will return initial opinion and request for additional information within 30 days.
   3. Engineer will notify Contractor in writing of decision to accept or reject the substitution request within 30 days of receiving required information.

B. Formal substitution request contents:
   1. Provide Substitution Request Form as specified in this Section.
   2. Manufacturer's literature including:
      a. Manufacturer's name and address.
      b. Product name.
      c. Product description.
      d. Reference standards.
      e. Certified performance and test data.
      f. Operation and maintenance data.
   3. Samples, if applicable.
   4. Shop drawings, if applicable.
   5. Reference projects where the product has been successfully used:
      a. Name and address of project.
      b. Year of installation.
      c. Year placed in operation.
      d. Name of product installed.
      e. Point of contact: Name and phone number.
   6. Itemized comparison of the proposed substitution with product specified including a list of significant variations:
      a. Design features.
      b. Design dimensions.
      c. Installation requirements.
      d. Operations and maintenance requirements.
   7. Define impacts:
      a. Impacts to construction schedule.
      b. Impacts to other contracts.
      c. Impacts to other work or products.
      d. Impact to Contract Sum:
         1) Do not include costs under separate contracts.
         2) Do not include Engineer's costs for redesign or revision of Contract Documents.
         3) Required license fees or royalties.
      e. Availability of maintenance services and sources of replacement materials.
   8. Contractor represents the following:
      a. Contractor shall pay associated costs for the Engineer to evaluate the substitution.
      b. Contractor bears the burden of proof of the equivalency of the proposed substitution.
      c. Proposed substitution does not change the design intent and will have equal performance to the specified product.
      d. Proposed substitution is equal or superior to the specified product.

e. Contractor will provide the warranties or bonds that would be provided on the specified product on the proposed substitution, unless Owner requires a Special Warranty.
f. Contractor will coordinate installation of accepted substitution into the Work and will be responsible for the costs to make changes as required to the Work.
g. Contractor waives rights to claim additional costs caused by proposed substitution which may subsequently become apparent.

C. Substitutions will not be considered for acceptance under the following conditions:
1. No formal substitution request is made.
2. The substitution is simply implied or indicated on shop drawings or product data submittals.
3. The formal substitution request is submitted by a subcontractor or supplier.

D. Substitution requests submitted after the deadline will not be considered unless the following evidence is submitted to the Engineer:
1. Proof that the specified product is unavailable for reasons beyond the control of the Contractor.
a. Reasons may include manufacturing discontinued, bankruptcy, labor strikes, or acts of God.
b. Contractor placed or attempted to place orders for the specified products within 10 days after the effective date of the Agreement.
c. The formal substitution request is submitted to Engineer within 10 days of the Contractor discovering the specified product cannot be obtained.

E. Engineer's decision on a substitution requests will be final and binding:
1. Approved substitutions will be incorporated into the Contract Documents with a Change Order.
2. Requests for time extensions and additional costs based on submission of, approval of, or rejection of substitutions will not be allowed.

PART 2 PRODUCTS

2.01 GENERAL

A. Material requirements:
1. Materials: Provide corrosion resistance suitable for project conditions as specified in Section 01610 - Project Design Criteria.
2. Dissimilar metals: Separate contacting surfaces with dielectric material.

B. Edge grinding:
1. Sharp projections of cut or sheared edges of ferrous metals which are not to be welded shall be ground to a radius required to ensure satisfactory paint adherence.

2.02 PRODUCTS IN CONTACT WITH DRINKING WATER

A. Materials in contact with drinking waters: In accordance with NSF 61 and NSF 372:
   1. Certification by an independent ANSI accredited third party, including, but not limited to, NSF International, as being lead free.

B. Materials in contact with drinking waters: In accordance with California Health and Safety Code, Section 116875.

2.03 PRODUCT SELECTION

A. When products are specified by standard or specification designations of technical societies, organizations, or associations only, provide products that meet or exceed reference standard and Specifications.

B. When products are specified with names of manufacturers but no model numbers or catalog designations, provide:
   1. Products by one of named manufacturers that meet or exceed Specifications.
   2. Engineer deemed "or equal" evidenced by an approved shop drawing or other written communication.

C. When products are specified with names of manufacturers and model numbers or catalog designations, provide:
   1. Products with model numbers or catalog designations by one of named manufacturers.
   2. Engineer deemed "or equal" evidenced by an approved shop drawing or other written communication.

D. When products are specified with names of manufacturers, but with brand or trade names, model numbers, or catalog designations by one manufacturer only, provide:
   1. Products specified by brand or trade name, model number, or catalog designation.
   2. Products by one of named manufacturers proven, in accordance with requirements for an "or equal", to meet or exceed quality, appearance and performance of specified brand or trade name, model number, or catalog designation.
   3. Engineer deemed "or equal" evidenced by an approved shop drawing or other written communication.

E. When Products are specified with only one manufacturer followed by "or Equal," provide:
   1. Products meeting or exceeding Specifications by specified manufacturer.
   2. Engineer deemed "or equal" evidenced by an approved shop drawing or other written communication.

2.04 SHIPMENT

A. Mandatory requirements prior to shipment of equipment:
   1. Engineer approved shop drawings.
   2. Engineer approved Manufacturer’s Certificate of Source Testing as specified in Section 01756 - Commissioning, when required by specifications.
   3. Draft operations and maintenance manuals, as specified in Section 01782 - Operation and Maintenance Data, when required by specifications.

B. Prepare products for shipment by:
   1. Tagging or marking products to agree with delivery schedule or shop drawings.
   2. Including complete packing lists and bills of material with each shipment.
   3. Packaging products to facilitate handling and protection against damage during transit, handling, and storage.
   4. Securely attach special instructions for proper field handling, storage, and installation to each piece of equipment before packaging and shipment.

C. Transport products by methods that avoid product damage.

D. Deliver products in undamaged condition in manufacturer's unopened containers or packaging.

2.05 SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS

A. Provide spare parts and maintenance products as required by Specifications.

B. Provide one set of special tools required to install or service the equipment.

C. Box, tag, and clearly mark items.

D. Contractor is responsible for spare parts, maintenance products, and special tools until acceptance by Owner.

E. Store spare parts, maintenance products, and special tools in enclosed, weather-proof, and lighted facility during the construction period:
   1. Protect parts subject to deterioration, such as ferrous metal items and electrical components with appropriate lubricants, desiccants, or hermetic sealing.

F. Provide spare parts and special tools inventory list, see Appendix A:
   1. Equipment tag number.
   2. Equipment manufacturer.
   3. Subassembly component, if appropriate.
   4. Quantity.
   5. Storage location.

G. Store large items individually:
   1. Weight: Greater than 50 pounds.
   2. Size: Greater than 24 inches wide by 18 inches high by 36 inches long.
   3. Clearly labeled:
      a. Equipment tag number.
      b. Equipment manufacturer.
      c. Subassembly component, if appropriate.

H. Store in spare parts box smaller items:
   1. Weight: Less than 50 pounds.
   2. Size: Less than 24 inches wide by 18 inches high by 36 inches long.
   3. Clearly labeled:
      a. Equipment tag number.
      b. Equipment manufacturer.
      c. Subassembly component, if appropriate.

I. Spare parts and special tools box:
   1. Wooden box:
      a. Size: 24 inches wide by 18 inches high by 36 inches long.
   2. Hinged wooden cover:
      a. Strap type hinges.
      b. Locking hasp.
      c. Spare parts inventory list taped to underside of cover.
   3. Coating: As specified in Section 09960 - High-Performance Coatings.
   4. Clearly labeled:
      a. The words “Spare Parts and/or Special Tools”.
      b. Equipment tag number.
      c. Equipment manufacturer.

PART 3 EXECUTION

3.01 DELIVERY AND HANDLING

A. Handle equipment in accordance with manufacturer's instructions.

B. Provide equipment and personnel to handle products by methods to prevent soiling or damage.

C. Upon delivery, promptly inspect shipments:
   1. Verify compliance with Contract Documents, correct quantities, and undamaged condition of products.
   2. Acceptance of shipment does not constitute final acceptance of equipment.

3.02 STORAGE AND PROTECTION

A. Immediately store and protect products and materials until installed in Work.

B. Store products with seals and legible labels intact.

C. Maintain products within temperature and humidity ranges required or recommended by manufacturer.

D. Protect painted surfaces against impact, abrasion, discoloration, and other damage:
   1. Repaint damaged painted surfaces.

E. Exterior storage of fabricated products:
   1. Place on aboveground supports that allow for drainage.
   2. Cover products subject to deterioration with impervious sheet covering.
   3. Provide ventilation to prevent condensation under covering.

F. Store moisture sensitive products in watertight enclosures.

G. Furnish covered, weather-protected storage structures providing a clean, dry, noncorrosive environment for mechanical equipment, valves, architectural items,

electrical and instrumentation equipment and special equipment to be incorporated into this project:

1. Storage of equipment shall be in strict accordance with the “instructions for storage” of each equipment supplier and manufacturer including connection of heaters, placing of storage lubricants in equipment, etc.
2. The Contractor shall furnish a copy of the manufacturer’s instructions for storage to the Engineer prior to storage of all equipment and materials.

H. Store loose granular materials on solid surfaces in well-drained area:
   1. Prevent materials mixing with foreign matter.
   2. Provide access for inspection.

I. Payment will not be made for equipment and materials improperly stored or stored without providing Engineer with the manufacturer's instructions for storage.

J. Provide an Equipment Log including, as a minimum, the equipment identification, date stored, date of inspection/maintenance, date removed from storage, copy of manufacturer’s recommended storage guidelines, description of inspection/maintenance activities performed, and signature of party performing inspection/maintenance.

3.03 PROTECTION AFTER INSTALLATION

A. Provide substantial coverings as necessary to protect installed products from damage from traffic and subsequent construction operations:
   1. Remove covering when no longer needed.
   2. Replace corroded, damaged, or deteriorated equipment and parts before acceptance of the project.

B. Update Equipment Log on a monthly basis with description of maintenance activities performed in accordance with the manufacturer’s recommendation and industry standards and signature of party performing maintenance.

3.04 QUALITY ASSURANCE

A. Employ entities that meet or exceed specified qualifications to execute the Work.

B. Verify project conditions are satisfactory before executing subsequent portions of the Work.

3.05 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.06 CLOSEOUT ACTIVITIES

A. Owner may request advanced delivery of spare parts, maintenance products, and special tools:
   1. Deduct the delivered items from the inventory list and provide transmittal documentation.

B. Immediately prior to the date of Substantial Completion, arrange to deliver spare parts, maintenance products, and special tools to Owner at a location on site chosen by the Owner:
   1. Provide itemized list of spare parts and special tools that matches the identification tag attached to each item.
   2. Owner and Engineer will review the inventory and the itemized list to confirm it is complete and in good condition prior to signing for acceptance.

3.07 ATTACHMENTS

A. Appendix A - Spare Parts, Maintenance Products, and Special Tools Inventory List.

B. Appendix B - Sample Substitution Request Form.

END OF SECTION

APPENDIX A

SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS INVENTORY LIST

SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS INVENTORY LIST

Owner: _____ **Date:** _____

Contractor: _____ **Project No.:** _____

Project Name: _____

Inventory List				
Spec Number: _____		Spec Title _____		
Equipment Tag No.: _____		Equipment Manufacturer: _____		
Quantity	**Subassembly Component**	**Description**	**Manufacturer's Part Number**	**Storage Location**

APPENDIX B

SUBSTITUTION REQUEST FORM

DOCUMENT 01600
SUBSTITUTION REQUEST FORM

Owner: _____ **Date:** _____

Contractor: _____ **Project No.:** _____

Project Name: _____

To: _____ **From:** _____

Re: _____

Contract For: _____

Engineering Project Number: _____ **Substitution Request Number:** _____

Specification Information
Title: _____
Number: _____ Page: _____ Article/Paragraph: _____
Description: _____

Proposed Substitution
Product: _____
Manufacturer: _____
Address: _____ Phone: _____
Trade Name: _____ Model No.: _____
Installer: _____
Address: _____ Phone: _____
History: New Product / 2-5 years old / 5-10 years old / More than 10 years old
Differences between proposed substitution and specified product:
Point-by-point comparative data and impacts attached – REQUIRED BY ENGINEER

Reason For Not Providing Specified Item

Reason: _____

Similar Installation: _____

Project: _____

Address: _____ Date Installed: _____

Owner: _____ Architect: _____

Proposed substitution affects other parts of Work:

____ No ____ Yes, Explain: _____

Benefit to Owner For Accepting Substitution

Savings: _____ ($) _____

Proposed substitution changes Contract Time:

____ No ____ Yes **(Add)** **(Deduct)** _____ days

Supporting Data Attached

___ Drawings ____ Product Data ____ Samples _____ Tests ____ Reports

___ Reference Projects Other: _____

Certifications

The undersigned certifies:

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

Certifications

- Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitted by: _____

Signed by: _____

Firm Name _____

Firm Address: _____

_____

_____

Phone: _____

Attachments: _____

Engineer's Review And Action

___ Substitution accepted - Make submittals in accordance with Specification Section 01330 - Submittal Procedures.

___ Substitution accepted as noted - Make submittals in accordance with Specification Section 01330 - Submittal Procedures.

___ Substitution rejected - Use specified materials.

___ Substitution Request received too late - Use specified materials.

Signed by: _____ Date: _____

Additional Comments

Additional Comments:

___ Contractor ___ Subcontractor ___ Supplier ___ Manufacturer ___ Engineer

Other: _____

Comments: _____

SECTION 01610

PROJECT DESIGN CRITERIA

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Project design criteria such as temperature and site elevation.

1.02 PROJECT DESIGN CRITERIA

A. All equipment and materials for the project are to be suitable for performance in domestic water treatment plant and under following conditions:
   1. Design temperatures are:
      a. Outdoor temperatures: 15 to 115 degrees Fahrenheit.
      b. Indoor temperatures for the following areas:
         1) Metal Storage Building: 55 to 95 degrees Fahrenheit.
         2) Filter Support Building Air Compressor rooms: 55 to 105 degrees Fahrenheit.
   2. Design groundwater elevation: +8.6 feet.
   3. Moisture conditions: Defined in individual equipment sections.
   4. Site elevation: Approximately 10 feet above mean sea level.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01612

SEISMIC DESIGN CRITERIA

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Seismic design criteria for the following:
   1. Anchorage of mechanical and electrical equipment.
   2. Seismic design and design of anchorage for small tanks fabricated off site and shipped to the Project site.
   3. Other structures or items as specified or indicated on the Drawings.

1.02 REFERENCES

A. American Society of Civil Engineers (ASCE):
   1. 7-16 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures.

1.03 SYSTEM DESCRIPTION

A. Design in accordance with the requirements of the building code as specified in Section 01410 - Regulatory Requirements.

B. Soil Site Class: D.

C. Design spectral acceleration at short period, S_{DS}: 1.186.

D. Design spectral acceleration at 1-seond, SD1: 0.767:
   1. A ground motion hazard analysis has not been performed as part of this Project. See ASCE 7-16 §11.4.8 for additional design requirements.

E. Design of non-structural components and their connections to structures:
   1. Component amplification factor, a_p: In accordance with ASCE 7, Tables 13.5-1 and 13.6-1.
   2. Component response modification factor, R_p: In accordance with ASCE 7, Tables 13.5-1 and 13.6-1.
   3. Component importance factor, I_p:

Table 1: Component Importance Factor, I_p

Component	Description	I_p
Electrical	Equipment and appurtenances provided and installed under Division 16.	1.5
Mechanical	Mechanical equipment and appurtenances provided and installed under other Divisions.	1.0

F. Seismic Design Category (SDC):
    1. Seismic Design Category (SDC) for certification of mechanical and electrical equipment as required by ASCE 7:
        a. Recycled Water Treatment Facility:
            1) All areas: Seismic Design Category D.

G. Design requirements: Anchorage of equipment to structures.
    1. Do not use friction to resist sliding due to seismic forces. Do not design or provide connections that use friction to resist seismic loads. Resist seismic forces through direct tension and/or shear on anchors and fasteners.
    2. Do not use more than 60 percent of the weight of the mechanical and electrical equipment for designing anchors for resisting overturning due to seismic forces.
    3. Do not use more than 60 percent of the weight of the tank for resisting overturning due to seismic forces.
    4. Anchoring and fastening to concrete and masonry:
        a. Use only cast-in anchors (anchor bolts or welded studs) for anchors at connections that resist seismic forces:
            1) Do not use concrete anchors, flush shells, sleeve anchors, screw anchors, powder actuated fasteners, or other types of post-installed mechanical anchors unless indicated on the Drawings or accepted in writing by the Engineer.

1.04 SUBMITTALS

A. Shop drawings and calculations: Complete shop drawings and seismic calculations for anchorage to structures.

B. Calculations shall be signed and sealed by a civil or structural engineer licensed in the state where the Project is located.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01614

WIND DESIGN CRITERIA

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Wind design criteria.

1.02 SYSTEM DESCRIPTION

A. Design requirements:
   1. Building code criteria: Design for wind in accordance with building code as specified in Section 01410 - Regulatory Requirements:
      a. Risk category: III.
      b. Wind speed, V_{ult}: 99 miles per hour.
      c. Wind speed, V_{asd}: 77 miles per hour.
      d. Exposure category**:** C**.**
      e. Topographic factor, K_{zt}: 1.0.
   2. Resist wind forces through direct bearing on anchors and fasteners. Do not design or provide connections that use friction to resist wind loads.
   3. Anchoring and fastening to concrete and masonry:
      a. Provide anchors specified in Section 03055 - Adhesive-Bonded Reinforcing Bars and All-Thread Rods and 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

1.03 SUBMITTALS

A. Shop drawings and calculations: Complete shop drawings and wind design calculations.

B. Calculations shall be signed and sealed by a civil or structural engineer licensed in the state where the Project is located.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01722

FIELD ENGINEERING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Field engineering to establish lines and grades for the Work.

1.02 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Qualifications of the professional land surveyor or registered civil engineer in California that will be performing the field engineering.

C. Pre-Excavation Report.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 SURVEY REFERENCE POINTS

A. Basic reference line, a beginning point on basic reference line, and a benchmark will be provided by Owner.

B. From these reference points, establish other control and reference points as required to properly lay out the Work.

C. Locate and protect control points prior to starting site work, and preserve permanent reference points during construction:
   1. Make no changes or relocations without prior written notice.
   2. Replace Project control point, when lost or destroyed, in accordance with original survey control.

D. Set monuments for principal control points and protect them from being disturbed and displaced:
   1. Re-establish disturbed monuments.
   2. When disturbed, postpone parts of the Work that are governed by disturbed monuments until such monuments are re-established.

3.02 PROJECT SITE SURVEY REQUIREMENTS

A. Establish minimum of 2 permanent benchmarks on site referenced to data established by survey control points.

B. Record permanent benchmark locations with horizontal and vertical data on Project Record Documents.

C. Perform verifications and checking in accordance with standard surveying practice.

D. Maintain complete, accurate log of control points and survey.

E. Affix civil engineer's or professional land surveyor's signature and registration number to Record Drawings to certify accuracy of information shown.

3.03 CONSTRUCTION STAKES, LINES, AND GRADES

A. Execute the Work in accordance with the lines and grades indicated.

B. Make distances and measurements on horizontal planes, except elevations and structural dimensions.

3.04 QUALITY CONTROL

A. Accuracy of stakes, alignments, and grades may be checked randomly by Engineer:
   1. Notice of when checking will be conducted will be given.
   2. When notice of checking is given, postpone parts of the Work affected by stakes, alignments, or grades to be checked until checked.
   3. Engineer's check does not substitute or complement required field quality control procedures.

3.05 RECORD DOCUMENTS

A. Prepare and submit Record Documents as specified in Section 01770 - Closeout Procedures.

B. Provide certified site survey in NGVD 29 datum scale including buildings, benchmarks, and appurtenances sealed and signed by professional land surveyor or registered civil engineer:
   1. File with permitting agency, as required.

END OF SECTION

SECTION 01738

SELECTIVE ALTERATIONS AND DEMOLITION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Cutting or modifying of existing and new work.
   2. Partial demolition of structures.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. A10.6 - Safety and Health Program Requirements for Demolition Operations.

B. International Concrete Repair Institute (ICRI):
   1. Guideline No. 310.2R - Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.
   2. Guideline No. 310.3R - Guide for the Preparation of Concrete Surfaces for Repair Using Hydrodemolition Methods.

1.03 DEFINITIONS

A. Chipping hammer: A hand-operated electrical or pneumatic demolition device for removal of hardened concrete or masonry materials having a weight of less than 15 pounds and an impact frequency of greater than 2,000 blows/minute.

B. Concrete breaker: A hand-operated electrical or pneumatic demolition device for removal of hardened concrete or masonry materials having a weight greater or impact frequency less than the limits defined for a chipping hammer.

C. Coring equipment: Non-impact rotary drill with diamond cutting edges.

D. Heavy abrasive blast: Cleaning procedure by which various abrasives materials, or steel shot, are forcibly propelled by high pressure against a surface to remove loose material and produce a concrete surface roughened to ICRI Surface Profile CSP-7, or higher, as specified in ICRI 301.3R.

1.04 DESCRIPTION OF WORK

A. The work includes partial demolition, cutting, and modifying of existing facilities, utilities, and/or structures.

B. These facilities may be occupied and/or operational. Satisfactory completion of the work will require that the Contractor plan activities carefully to work around unavoidable obstacles and to maintain overall stability of structures and structural elements. It will further require restoration of existing facilities, utilities, and structures that are to remain in place and that are damaged by demolition or removal operations.

1.05 SUBMITTALS

A. General:
   1. Submit specified in Section 01330 - Submittal Procedures.

B. Shop drawings: Include:
   1. The location of all embedded items shall be documented using diagrams and/or other media that clearly show dimensions and locations of existing structural elements, existing embedded items and any new embedded items and their relationship to each other.

C. Submittals for information only:
   1. Permits and notices authorizing demolition.
   2. Certificates of severance of utility services.
   3. Permit for transport and disposal of debris.
   4. Selective Demolition Plan.
   5. Pipe Abandonment Plan.

D. Quality assurance submittals:
   1. Qualifications of non-destructive testing agency/agencies.

E. Project record documents.

F. Drawings and/or other media documenting locations of service lines and capped utilities.

1.06 QUALITY ASSURANCE

A. Qualifications:
   1. Assign relocation, removal, cutting, coring and patching to trades and workers qualified to perform the Work in manner that causes the least damage and that provides means of returning surfaces to an appearance at least equal to that of the surrounding areas unaffected by the Work.
   2. Non-destructive testing agencies: Minimum of 5 years' experience performing non-destructive testing for location of steel reinforcement in existing concrete under conditions similar to that required for this Work.

1.07 SEQUENCING

A. Perform Work in sequences and within times specified in Section 01140 - Work Restrictions.

B. If the facility or utility to be modified cannot be removed from service, perform the Work while the facility is in operation using procedures and equipment that do not jeopardize operation or materially reduce the efficiency of that facility.

C. Coordinate the Work with operation of the facility:
   1. Do not begin alterations of designated portions of the Work until specific permission for activities in each area has been granted by Owner in writing.
   2. Complete Work as quickly and with as little delay as possible.

D. Operational functions of the facility that are required to be performed to facilitate the Work will be performed by facility personnel only.

E. Owner will cooperate in every way practicable to assist in expediting the Work.

F. When necessary for the proper operation or maintenance of portions of the facility, reschedule operations so the Work will not conflict with required operations or maintenance.

1.08 REGULATORY REQUIREMENTS

A. Dispose of debris in accordance with governing regulatory agencies.

B. Comply with applicable air pollution control regulations.

C. Obtain permits for building demolition, transportation of debris to disposal site and dust control.

1.09 PREPARATION

A. Non-destructive evaluation of existing concrete and masonry:
   1. Prior to cutting, drilling, coring, and/or any other procedure that penetrates existing concrete or masonry, retain and pay for the services of a qualified non-destructive testing agency to perform investigations to determine the location of existing steel reinforcement, plumbing, conduit, and/or other embedments in the concrete.
   2. Submit documentation of the investigations to the Engineer for review and approval as specified in Section 01330 - Submittal Procedures before any work involving penetration of existing concrete is initiated.

1.10 PROJECT CONDITIONS

A. Do not interfere with use of adjacent structures and elements of the facility not subject to the Work described in this Section. Maintain free and safe passage to and from such facilities.

B. Provide erect and maintain barricades, lighting, guardrails, and protective devices as required to protect building occupants, general public, workers, and adjoining property:
   1. Do not close or obstruct roadways without permits.
   2. Conduct operations with minimum interference to public or private roadways.

C. Prevent movement, settlement, or collapse of structures:
   1. Provide and place bracing or shoring.
   2. Cease operations and notify Engineer immediately when safety of structures appears to be endangered. Take precautions to properly support structure. Do not resume operations until safety is restored.
   3. Assume liability for movement, settlement, or collapse. Promptly repair damage.

D. Arrange and pay for capping and plugging utility services. Disconnect and stub off.
   1. Notify affected utility company in advance and obtain approval before starting demolition.
   2. Place markers to indicate location of disconnected services.

E. Unknown conditions:
   1. The drawings may not represent all conditions at the site and adjoining areas. Compare actual conditions with drawings before commencement of Work.
   2. Existing utilities and drainage systems below grade are located from existing documents and from surface facilities such as manholes, valve boxes, area drains, and other surface fixtures.
   3. If existing active services encountered are not indicated or otherwise made known to the Contractor and interfere with the permanent facilities under construction, notify the Engineer in writing, requesting instructions on their disposition. Take immediate steps to ensure that the service provided is not interrupted, and do not proceed with the Work until written instructions are received from the Engineer.

PART 2 PRODUCTS

2.01 SALVAGE MATERIALS

A. Salvage materials: Materials removed from existing facility.

B. Materials designated for salvage:
   1. All material as directed by the Owner.
   2. As indicated on the drawings

C. Handling and storage:
   1. Prevent damage to salvaged materials during removal, handling, and transportation of salvaged materials.
   2. Store salvaged materials at a locations designated by the Owner.

D. Pay costs associated with salvaging materials, including handling, transporting, and storage.

PART 3 EXECUTION

3.01 EXAMINATION

A. Prior to beginning selective demolition operations, perform a thorough inspection of the facility and site, and report to the Engineer defects and structural damage to or deterioration of existing construction to remain.

B. Examine areas affected by the Work and verify the following conditions prior to commencing demolition:
   1. Disconnection of utilities as required.
   2. That utilities serving occupied or active portions of surrounding facilities will not be disturbed, except as otherwise indicated.

C. If unsatisfactory conditions exist, notify the Engineer, and do not begin demolition operations until such conditions have been corrected.

3.02 PREPARATION

A. Selective Demolition Plan:
   1. Prepare and submit a comprehensive selective demolition plan for the Work including the following elements, at a minimum:
      a. Proposed sequence, methods, temporary support, and equipment for demolition, removal, and disposal of portions of structure(s).
      b. Provisions and procedures for salvage and delivery to Owner of salvaged items, if required.
   2. Submit plan a minimum 4 weeks before demolition is scheduled to begin.

B. Protection:
   1. Erect weatherproof closures to protect the interior of facilities and elements or equipment that are not designed for exposure to the weather. Provide temporary heat, cooling, and humidity control as necessary to prevent damage to existing and new construction. Maintain existing exiting paths and/or provide new paths in compliance with Building Code requirements.
   2. Erect and maintain dustproof partitions as required to prevent spread of dust, to other parts of building. Maintain negative pressure in the area where the Work is being performed to prevent the accidental spread of dust and to minimize the spread of fumes related to the Work.
   3. Upon completion of Work, remove weatherproof closures and dustproof partitions, and repair damaged surfaces to match adjacent surfaces.
   4. Provide and maintain protective devices to prevent injury from falling objects.
   5. Locate guardrails in stairwells and around open shafts to protect workers. Post clearly visible warning signs.
   6. Cause as little inconvenience to adjacent building areas as possible.
   7. Protect benchmarks**,** and existing construction to remain from damage or displacement.
   8. Carefully remove designated materials and equipment to be salvaged by Owner or reinstalled.
   9. Store and protect materials and equipment to be reinstalled.

C. Layout:
   1. The limits of selective demolition are indicated on the Drawings. Confine demolition operations within the limits indicated on the Drawings.
   2. Lay out demolition and removal work at the site and coordinate with related Work for which demolition and removal is required. Clearly mark the extent of structural elements to be removed on the actual surfaces that will be removed.
   3. Arrange for Engineer's inspection of the lay out extents.
   4. Do not begin demolition/removal operations until the lay out markings have been reviewed by the Engineer.

3.03 DEMOLITION

A. General:
   1. Perform demolition work in accordance with ANSI A10.6.
   2. Demolish designated portions of structures and appurtenances in orderly and careful manner in accordance with the Selective Demolition Plan.

3. Conduct demolition and removal work in a manner that will minimize dust and flying particles:
    a. Use water or dust palliative when necessary to prevent airborne dust.
    b. Provide and maintain hoses and connections to water main or hydrant.
4. Demolish concrete and masonry in small sections. Perform demolition with small tools as much as possible. Blasting with explosive charges is not permitted.
5. Sawcut concrete to establish the edges of demolition, wherever possible:
    a. Do not use a concrete breaker within 6 inches of reinforcing or structural metals that are designated to remain.
    b. At edges that are not sawcut, remove the final 6 inches of material with a chipping hammer as defined herein. At surfaces where material is removed with a chipping hammer, follow with a heavy abrasive blast to remove all loose material and microcracking.
    c. Alternate techniques to remove concrete may be used if acceptable to the Engineer; however, techniques other than those deemed by ICRI Guideline No. 310.2R to provide a low risk of introducing microcracking will require a subsequent procedure to remove loose material.
6. At locations indicated on the Drawings that the existing reinforcing is to be preserved, remove concrete using methods that do not damage the reinforcing. Use one of the following techniques:
    a. Hydrodemolition techniques as outlined in ICRI Guideline No. 310.3R.
    b. Chipping hammer, as defined herein, followed by heavy abrasive blast to remove all loose material and microcracking at remaining surfaces impacted by the chipping hammer.
    c. Alternate methods may be used, only if acceptable to the Engineer.
    d. For all methods, provide a small completed area for Engineer's review and acceptance. If the proposed method, in the opinion of the Engineer, damages the reinforcing, revise the removal method to remove the concrete with a less aggressive technique to protect the reinforcing.
7. Remove materials carefully, to the extent indicated and as required.
    a. Provide neat and orderly junctions between existing and new materials.
    b. Use methods that terminate surfaces in straight lines at natural points of division.
8. Do not remove anything beyond the limits of Work indicated without prior written authorization of the Engineer. If in doubt about whether to remove an item, obtain written authorization of the Engineer prior to proceeding.
9. Perform work so as to provide the least interference and most protection to existing facilities to remain.
10. Assume possession of demolished materials, unless otherwise indicated on the Drawings or specified.
    a. Remove demolished materials from site at least weekly and dispose of in accordance with Laws and Regulations.
    b. Do not burn materials on site.

B. Sizing of openings in existing concrete or masonry:
    1. Make openings large enough to permit final alignment of pipe and fittings without deflections, but without oversizing.

2. Allow adequate space for packing around pipes and conduit to ensure watertightness.
3. If the Engineer deems the opening to be insufficient in size to accomplish this criteria, remove additional material using the procedures outlined in this Section.

C. Cutting openings in existing concrete or masonry:
   1. Do not allow saw cuts to extend beyond limits of openings.
   2. Create openings by the following method or other means acceptable to the Engineer that prevents over-cutting of member at corners:
      a. Core-drill through slab or wall at corners, being careful not to damage materials beyond the area to be removed.
      b. Saw cut completely through the member, between the core holes at the corners.
      c. As an alternate to sawcutting through the member, score the edges of the opening with a saw to a 1-inch depth on both surfaces (when accessible):
         1) Remove concrete or masonry to within 6 inches of material to remain with a concrete breaker.
         2) Remove the remaining material with a chipping hammer.
      d. Remove the remaining material at the corners left by the core-drilling with a chipping hammer.
   3. Prevent debris from falling into adjacent tanks or channels in service or from damaging existing equipment and other facilities.

D. Immediately upon discovery, remove and dispose of contaminated, vermin-infested, or dangerous materials using safe means that will not endanger health of workers and public.

E. Backfill open pits and holes caused by demolition as specified in Section 02300 - Earthwork.

F. Remove demolished materials, tools, and equipment upon completion of demolition.

3.04 RESTORATION

A. General:
   1. Repair damage caused by demolition to a conditions equal to those that existing prior to beginning of demolition.
      a. Patch and replace portions of existing finished surfaces that are damaged, lifted, and discolored with matching material. Refinish patched portion surfaces in a manner which produces uniform color and texture to entire surface.
      b. When existing finish cannot be matched, refinish entire surface to nearest change of plane where angle of change exceeds 45 degrees.
   2. The cost of repairs shall be at the Contractor’s expense at no increase in the Contract Price.
   3. When new construction abuts or finishes flush with existing construction, make smooth transitions. Match finish of existing construction.
   4. Where partitions are removed, patch floors, walls, and ceilings with finish materials that match existing materials.

5. Where removal of partitions results in adjacent spaces becoming one, rework floors, walls, and ceilings to provide smooth planes without breaks, steps, or bulkheads.
6. Where changes of plane exceed 2 inches, request instructions for making transition.
7. Trim and refinish existing doors as necessary to clear new floors.
8. Match patched construction with adjacent construction in texture and appearance so that patch or transition is invisible at 5-foot distance.
9. When finished surfaces are cut so that smooth transition is impossible, terminate existing surface in neat manner along straight line at natural line of division and provide appropriate trim.

B. Restore existing concrete reinforcement as follows:
   1. Where existing reinforcement is to be incorporated into the new Work, protect, clean, and extend into new concrete.
   2. Where existing reinforcement is not to be retained, cut off as follows:
      a. Where new concrete joins existing concrete at the removal line, cut reinforcement flush with concrete surface at the removal line.
      b. Where concrete surface at the removal line will become the finished surface, cut reinforcement 2 inches below the surface, paint ends with epoxy, and patch holes with dry pack mortar.

C. Restore areas affected by removal of existing equipment, equipment pads and bases, piping, supports, electrical panels, electric devices, and conduits such that little or no evidence of the previous installation remains:
   1. Fill areas in existing floors, walls, and ceilings from removed piping, conduit, and fasteners with non-shrink grout and finish smooth.
   2. Remove concrete bases for equipment and supports by:
      a. Saw cutting clean, straight lines with a depth equal to the concrete cover over reinforcement minus 1/2-inch below finished surface:
         1) Do not cut existing reinforcement on floors.
      b. Chip concrete within scored lines and cut exposed reinforcing steel and anchor bolts.
      c. Patch with non-shrink grout to match adjacent grade and finish.
   3. Terminate abandoned piping and conduits with blind flanges, caps, or plugs.

3.05 FIELD QUALITY CONTROL

A. Do not proceed with demolition without Engineer's inspection of lay out.

B. Do not deviate from the submitted demolition plan without notifying the Engineer prior to Work.

END OF SECTION

SECTION 01756

COMMISSIONING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for each Commissioning phase of, the Project equipment/system and/or facility.

1.02 DEFINITIONS

A. Clean Water Facility Testing - Testing of complete facility utilizing clean water for purposes of confirming extended equipment/system operation prior to Process Start-up Phase.

B. Commissioning - The process of planning, testing, and process start-up of the installation for compliance with contract requirements and demonstrating, through documented verification, that the project has successfully met the Contractual requirements. It includes training the Owner's staff to operate the facility.

C. Commissioning Phases - The work activities of facility commissioning are grouped into the phases defined in the table below.

Commissioning		
Planning Phase	**Testing and Training Phase**	**Process Start-Up Phase**
Owner Training Plan and Schedule	Source Testing	Process Start-Up
Commissioning Schedule	Owner Training	Process Operational Period
Subsystem Testing Plan	Installation Testing	Instrumentation and Controls Fine-Tuning
Clean Water Facility Testing Plan	Functional Testing	
	Clean Water Facility Testing	
	Closeout Documentation	

D. Component - A basic building block of equipment, subsystems, and systems that requires installation or functional testing but does not have an electrical connection or internal electronics. (Examples: filter effluent piping and manual isolation valves).

E. Device - A basic building block of equipment, subsystems, and systems that requires installation or functional testing and does have an electrical connection or internal electronics. (Examples: filter level transmitter or water pump pressure transmitter).

F. Equipment - An assembly of component(s) and devices(s) that requires installation or functional testing. (Examples: Pump, motor, VFD, Filter, etc.).

G. Facility - A grouping of process areas, systems, subsystems, equipment, components, and devices (Examples: treatment plant, pump station, etc.).

H. Functional Testing - Testing performed on a completed subsystem to demonstrate that equipment/system meets manufacturers' calibration and adjustment requirements and other requirements as specified. Functional testing includes operating equipment/system manually in local, manually in remote (or remote manual), and automatically in remote (in remote auto).

I. Installation Testing - Testing to demonstrate that subsystem component (piping, power, networks, devices, etc.) is ready and meets the project requirements in advance of functional testing. Installation testing also includes manufacturers' certification of installation and other requirements as specified to prepare equipment/system for Functional Testing. Also referred to as Field Acceptance Testing.

J. Manufacturer's Certificate of Source Testing - When applicable, the form is used during Source Testing for the manufacturer to confirm that the applicable source tests have been performed and results conform to the Contract Documents. The form is provided at the end of this Section.

K. Manufacturer's Certificate of Installation and Functionality Compliance - The form is used during Installation Testing and Functional Testing. It is submitted at the end of Functional Testing to confirm that the equipment/system is installed in conformance with the Contract Documents and that it meets the Functional Testing requirements defined in the Contract Documents. The form is provided at the end of this Section.

L. Process Area - A grouping of systems, subsystems, equipment, components, and devices that divide a facility into functional areas. (Examples: Filter Process Area or Chemical Area).

M. Process Operational Period - A period of time after completion of the process start-up set aside for final Operational Testing to verify facility performance meets the Contract Document requirements. This period may specifically limit other construction activities.

N. Process Start-up Phase - Operating the facility to verify performance meets the Contract Document requirements.

O. Process Start-Up - Activities conducted after the testing and training phase that are necessary to place systems or process areas into operational service.

P. Product - A system, subsystem or component.

Q. Subsystem - A building block of systems made up from a grouping of components, devices, and equipment that perform a definable function. (Examples: Filter No. 1 Backwash Subsystem, Sedimentation Basin No. 1 Hoseless Sludge Removal Subsystem).

R. System - A grouping of subsystems, equipment, components, and devices that perform a definable function. (Examples: Filter No. 1, Sedimentation Basin).

1.03 COMMISSIONING COORDINATOR (CC)

A. Designate and provide a CC for this project.

B. Submit summary of the CC's qualifications within 30 days of NTP:
   1. Include description of previous experience as a CC on similar projects for the designated CC with a list of references including phone numbers for review and Owner approval.

C. CC responsibilities include the following:
   1. Lead efforts relating to Commissioning.
   2. Be thoroughly familiar with commissioning requirements in the Contract Documents.
   3. Be regularly engaged and experienced in all aspects of commissioning.
   4. Provide technical instruction for commissioning.
   5. Provide primary interface with Engineer and Owner for efforts relating to Commissioning of Project facilities.
   6. Coordinate training efforts.

1.04 SERVICES OF MANUFACTURER'S REPRESENTATIVES

A. Qualification of manufacturer's representative as specified in the Contract Documents technical sections include the following:
   1. Authorized representative of the manufacturer, factory trained and experienced in the technical applications, installation, operation, and maintenance of respective equipment/system with full authority by the equipment/system manufacturer to issue the certifications required of the manufacturer.
   2. Competent, experienced technical representative of equipment/system manufacturer for assembly, installation, testing guidance, and training.
   3. Additional qualifications may be specified in the individual sections.
   4. Submit qualifications of the manufacturer's representative no later than 30 days in advance of required observations.
   5. Representative subject to approval by Owner and Engineer.
   6. No substitute representatives will be allowed until written approval by Owner and Engineer has been obtained.

B. Completion of manufacturer on-site services: Engineer approval required.

C. Manufacturer is responsible for determining the time required to perform the specified services:
   1. Minimum times specified in the Contract Documents are estimates.

2. No additional costs associated with performing the required services will be approved.
3. Manufacturer required to schedule services in accordance with the Contractor's project schedule up to and including making multiple trips to project site when there are separate milestones associated with installation of each occurrence of manufacturer's equipment.

D. Manufacturer's on-site services as specified in the Contract Documents include the following:
1. Assistance during Commissioning Phase and Process Start-Up Phase.
2. Provide weekly copies of manufacturer's representatives' field notes and data to Engineer.
3. Other requirements as specified in the Contract Documents.

1.05 PLANNING PHASE

A. Overview of Planning Phase:
1. Define approach and timing for Commissioning.

B. Owner training plan and schedule:
1. Training outcomes:
a. Owner's operations, maintenance, and engineering staff have the information needed to safely operate, maintain, and repair the equipment/systems provided in the Contract Documents.
2. Training objectives:
a. To instruct personnel in the operation and maintenance of the equipment/system. Instruction shall include step-by-step troubleshooting procedures with all necessary test equipment/system.
b. To instruct personnel in the removal, inspection, and cleaning of equipment/system as needed.
c. Training tailored to the skills and job classifications of the staff attending the classes (e.g., plant superintendent, treatment plant operator, maintenance technician, electrician, etc.).
d. Provide supporting documentation, such as vendor operation and maintenance manuals.
3. Training schedule:
a. Schedule Owner's staff training within the constraints of their workloads. Those who will participate in this training have existing full-time work assignments, and training is an additional assigned work task, therefore, scheduling is imperative. Owner staff work schedules regularly shift, as treatment facilities are typically operated on an around-the-clock basis.
4. Training plan:
a. Coordinate and arrange for manufacturer's representatives to provide both classroom-based learning and field (hands-on) training, based on training module content and stated learning objectives.
b. Conduct classroom training at location designated by Owner.
c. Scope and sequence:
1) Plan and schedule training in the correct sequence to provide prerequisite knowledge and skills to trainees.
a) Describe recommended procedures to check/test equipment/system following a corrective maintenance repair.

5. Training scheduling coordination:
    a. CC is responsible for the following:
        1) Coordinate schedule for training periods with the Owner's personnel and manufacturer's representatives (instructors).
    b. Complete Owner training no sooner than 15 calendar days prior to start of process start-up of each system.
6. Meetings:
    a. CC is responsible for setting commissioning coordination meeting dates and times, as well as preparing the agendas and meeting minutes.
    b. CC shall meet with Engineer and Owner's designated training coordinator to develop list of personnel to be trained and to establish expected training outcomes and objectives at least 60 calendar days prior to commissioning of equipment/system.
    c. CC shall conduct commissioning progress meetings throughout construction, to plan, scope, coordinate, and schedule future activities, resolve problems, etc.
        1) Frequency: Monthly minimum. Increase frequency as needed based on complexity and quantity of commissioning activities.
7. Submittals:
    a. Submit Training Plan Schedule 90 calendar days before the first scheduled training session, including but not limited to lesson plans, participant materials, instructor's resumes, and training delivery schedules.
    b. Submit training documentation including the following:
        1) Training plan:
            a) Training modules.
            b) Scope and sequence statement.
            c) Contact information for manufacturer's instructors including name, phone, and e-mail address.
            d) Instructor qualifications.
        2) Training program schedule:
            a) Format: Bar chart:
                (1) Additionally include in the Project Progress Schedule.
            b) Contents:
                (1) Training modules and classes.
8. Training sessions:
    a. Provide training sessions for equipment/system as specified in the individual equipment/system section.

C. Commissioning Schedule:
1. Commissioning overview:
    a. Comply with Commissioning Roles and Responsibilities Matrix specified at the end of this Section.
2. Submittal due date:
    a. Submit Commissioning Schedule not less than 90 calendar days prior to planned initial commissioning of each subsystem or system.
3. Schedule requirements:
    a. Schedule durations and float for commissioning activities to ensure Work does not fall behind schedule due to complications or delays during commissioning.

b. Time-scaled network diagram detailing the work to take place in the period between 90 calendar days prior to planned initial commissioning of equipment and systems, and prior to the date of Substantial Completion, together with supporting narrative.
c. Provide detailed schedule of commissioning activities including durations and sequencing requirements.
    1) Identify the following activities:
        a) Testing and Training Phase:
            (1) Source Testing.
            (2) Owner Training.
            (3) Installation Testing.
            (4) Functional Testing.
            (5) Clean Water Facility Testing.
            (6) Closeout Documentation.
        b) Process Start-Up Phase:
            (1) Process Start-Up.
            (2) Process Operational Period.
            (3) Instrumentation and Controls Fine-Tuning**.**
d. Schedule manufacturer's services to avoid conflict with other on-site testing or other manufacturers' on-site services.
e. Verify that conditions necessary to allow successful testing have been met before scheduling services.

D. Subsystem testing plans:
    1. Provide separate testing plans for each individual subsystem and system that include the following:
        a. Approach to testing including procedures, schedule, and recirculation requirements.
        b. Test objective: Demonstrate subsystem meets the design requirements as specified in the technical sections.
        c. Test descriptions, forms, temporary systems (pumps, piping, etc.), shutdown requirements for existing systems, test forms, test logs, witness forms, and checklists to be used to control and document the required tests.
        d. Test forms: Include, but not limited to, the following information:
            1) Tag and name of equipment/system to be tested.
            2) Test date.
            3) Names of persons conducting the test.
            4) Names of persons witnessing the test, where applicable.
            5) Test data.
            6) Applicable project requirements.
            7) Check offs for each completed test or test step.
            8) Place for signature of person conducting tests and for the witnessing person, as applicable.
        e. Define start-up sequencing of unit processes:
            1) Include testing of alarms, interlocks, permissives, control circuits, capacities, speeds, flows, pressures, vibrations, sound levels, and other parameters.
            2) Provide detailed test procedures setting forth step-by-step descriptions of the procedures for systematic testing of equipment/system.

3) Demonstrate proper rotation, alignment, speed, flow, pressure, vibration, sound level, adjustments, and calibration:
a) Perform initial checks in the presence of and with the assistance of the manufacturer's representative.
4) Demonstrate proper operation of each control loop function including mechanical, electrical, alarms, local and remote controls, instrumentation, and other equipment/system functions:
a) Generate signals with test equipment/system to simulate operating conditions in each control mode.

2. Engineer approval of test plan is required prior to performing test.
   a. Revise and update test plans based on review comments, actual progress, or to accommodate changes in the sequence of activities.
   b. Submit test reports for each phase of testing for each equipment/system.
   c. Engineer approval of preceding test reports is required prior to start of next test.
   d. Tests will be rescheduled if test plan is not approved by the required deadline:
      1) Contractor is responsible for any resulting delay.
3. Contractor is responsible to reproduce and distribute final test procedures.
   a. Provide 3 copies for Engineer.
4. Tests may commence only after Engineer has received approved test plan copies.
5. Submittals:
   a. Submit test plans not less than 90 calendar days prior to planned installation testing of subsystem or system.
   b. Completed Manufacturer's Certificate of Installation and Functionality Compliance.
   c. Test procedures and forms: Provide signed-off copy of test forms and test reports upon completion of the test.
   d. Test reports:
      1) Submit preliminary copies within 1 day after testing completion.
      2) Submit final copies and report within 14 days after testing completion.

1.06 TESTING AND TRAINING PHASE

A. Overview of Testing and Training Phase:
   1. General:
      a. Include specified Source Testing, Owner Training, Installation Testing, Functional Testing, Clean Water Facility Testing, and Closeout Documentation required by this Section and the technical sections.
   2. Contractor responsibilities:
      a. Furnish labor, power, chemicals, tools, equipment, instruments, and services required for and incidental to completing commissioning activities in accordance with the approved Commissioning Plans.
      b. Prior to testing, verify equipment protective devices and safety devices have been installed, calibrated, and tested.

c. Acceptable tests: Demonstrate the equipment/system performance meets the requirements stated in the Contract Documents.
    1) When the equipment/system fails to meet the specified requirements, perform additional, more detailed, testing to determine the cause, correct, repair, or replace the causative components and repeat the testing that revealed the deficiency.

B. Source testing:
    1. Also referred to as factory testing or factory acceptance testing (FAT).
    2. Test components, devices, and equipment/system for proper performance at point of manufacture or assembly as specified in the technical sections.
    3. Notify the Engineer in writing when the equipment/system is ready for source inspection and testing.
    4. Source Test Plan:
        a. As specified in this Section and other technical sections.
        b. Source testing requirements as specified in technical sections:
            1) Non-witnessed: Provide Manufacturer's Certificate of Source Testing.
            2) Witnessed: 1 Owner's representative and 1 Engineer's representative present during testing, unless otherwise specified, and provide Manufacturer's Certificate of Source Testing.
        c. Prepared by Contractor as a result of discussions and planning emerging from regularly conducted commissioning meetings for source tests as specified in the Contract Documents.
        d. Provide the following items for each Source Test:
            1) Purpose and goals of the test.
            2) Identification of each item of equipment/system, including system designation, location, tag number, control loop identifier, etc.
            3) Description of the pass/fail criteria that will be used.
            4) Listing of pertinent reference documents (Contract Documents and industry standards or sections applicable to the testing).
            5) Complete description, including drawings or photographs, of test stands and/or test apparatus.
            6) Credentials of test personnel.
            7) Descriptions of test equipment to be used, product information, and all appropriate calibration records for the test equipment.
            8) Test set-up procedures.
            9) Detailed step-by-step test procedures:
                a) The level of detail shall be sufficient for any witness with a rudimentary technical aptitude to be able to follow the steps and develop confidence that the tests were being performed as planned.
                b) All steps are significant, and all steps shall be included in the procedures.
            10) Sample data logs and data recording forms.
            11) Sample computations or analyses with the results in the same format as the final report to demonstrate how data collected will be used to generate final results:
                a) Complete disclosure of the calculation methodologies.
                b) Include a sample for each type of computation required for the test and analysis of the results.
            12) Detailed outline of the Source Test report.
            13) Sample test reports.

e. Submit Source Test Plan and forms as specified in the technical sections:
    1) Submit a copy of the Source Test Plan at least 21 days before any scheduled test date.
    2) Engineer approval of Source Test Plan required prior to beginning source testing.
    3) Schedule the testing after approval of the test procedures submittal.
f. Indicate the desired dates for source inspection and testing.
    1) Notify the Engineer of the scheduled tests a minimum of 15 days before the date of the test.

5. Test results:
    a. Prepare and submit test results with collected data attached.
6. Contractor is responsible for costs associated with Owner's representatives and Engineer's representative witnessing Source Tests.
    a. Include costs for at least the following:
        1) Transportation:
            a) Travel 1 day on commercial airline to site including air flight costs and $1,600 allowance per person per day.
            b) Travel 1 day on commercial airline from site including air flight costs and $1,600 allowance per person per day.
            c) Rental car from hotel to and from the test site.
        2) Hotel costs at a facility with an American Automobile Association 4 star rating or equivalent for single occupancy room per person per day.
        3) Meal allowance of $60 per person per day.
        4) On-site time: 1 day at the site, unless specified otherwise, including $1,600 allowance per person per day.
    b. If Source Test is not ready when the witnesses arrive or if the Source Test fails, the witnesses will return home with Contractor responsible for costs associated with the trip including costs described above. Contractor is responsible for rescheduling the Source Test and witnesses' costs associated with the second trip including costs described above.
    c. Contractor is responsible for witnesses' costs associated with retests including costs described above.
7. Contractor is responsible for providing fuel, chemicals, and other consumables needed for Source Testing.

C. Owner training:
1. Training instruction format:
    a. The training for operations and maintenance personnel shall be provided as one entity.
    b. Instructors shall apply adult education best practices, emphasizing learner participation and activity.
    c. Training delivery may include problem solving, question/answer, hands-on instruction, practice, evaluation/feedback tools, and lecture.
    d. Visual aids and hands-on practice sessions must support training objectives.
    e. Lecturing should be less than 30 percent of class time.
    f. Conduct hands-on instruction according to the following descriptions:
        1) Present hands-on demonstrations of at least the following tasks:
            a) Proper start-up, shutdown, and normal and alternative operating strategies.

b) Common corrective maintenance repairs for each group.
c) Describe recommended procedures to check/test equipment/system following a corrective maintenance repair.

2) Use tools and equipment provided by manufacturer to conduct the demonstrations.
a) Submit requests for supplemental assistance and facilities with the Contractor's proposed lesson plans.

3) Contractor remains responsible for equipment disassembly or assembly during hands-on training situations involving equipment disassembly or assembly by Owner's personnel.
a) Provide written certification of proper equipment/system operation to Engineer after completion of hands-on training.

2. Class agenda:
   a. Include the following information in the agenda:
      1) Instructor name.
      2) Listing of subjects to be discussed.
      3) Time estimated for each subject.
      4) Allocation of time for Owner staff to ask questions and discuss the subject matter.
      5) List of documentation to be used or provided to support training.
   b. Owner may request that particular subjects be emphasized and the agenda be adjusted to accommodate these requests.
   c. Distribute copies of the agenda to each student at the beginning of each training class.
3. Number of students:
   a. Estimated maximum class size: 10 persons.
      1) Owner will determine the actual number of students.
      2) Engineer will provide an estimated headcount 1 week prior to the class, so that the instructor can provide the correct number of training aids for students.
4. Instructor qualifications:
   a. Provide instructors completely knowledgeable in the equipment/system for which they are training.
   b. Provide instructors experienced in conducting classes.
   c. Provide instructor's technical preparation and instructional technology skills and experience.
   d. Sales representatives are not qualified instructors unless they possess the detailed operating and maintenance knowledge required for proper class instruction.
   e. If, in the opinion of the Owner, an appropriately knowledgeable person did not provide the scheduled training, such training shall be rescheduled and repeated with a suitable instructor.
5. Classroom documentation:
   a. Trainees will keep training materials and documentation after the session.
   b. Operations and maintenance manuals, as specified in technical sections:
      1) Provide a minimum of 2 copies of final Engineer-approved operations and maintenance manuals as specified in Section 01782 - Operation and Maintenance Data for use during the classroom instruction.
      2) Owner reserves the right to delay training for a particular equipment item if the operations and maintenance manuals for that equipment

are incomplete, inaccurate, or otherwise unsuitable for use by the Owner's staff.
3) No contract extensions or extra costs will be allowed for training delays due to operations and maintenance manual submittal delays.

c. Provide supplemental documentation handouts to support instruction.
d. Digitally record audio and video of each training session:
1) Include classroom and field instruction with question and answering periods.
2) Engineer approval required for producer of video materials from one of the following options:
a) Qualified, professional video production company.
b) Contractor demonstrates satisfactory skill.
3) Record in digital format and recording shall become property of the Owner:
a) Provide audio quality that is not degraded during the recording of the field sessions due to background noise, space, distance or other factors.
4) Video files shall be file format and delivery medium as directed and approved by Owner.
5) Provide 2 complete sets of video materials fully indexed and cataloged with printed labels stating session content and dates recorded.
6) The Contractor shall provide a written release from all claims to the recorded training material produced, if required.
e. Training modules:
1) Provide a training module for each equipment category.
2) Divide each training module's instructional content into discrete lesson plans.
f. Lesson plans:
1) Provide performance-based learning objectives.
2) State learning objectives in terms of what the trainees will be able to do at the end of the lesson.
3) Define student conditions of performance and criteria for evaluating instructional success.
4) Instruction lesson plan outlines for each trade:
a) Provide specific components and procedures.
5) Minimum requirements:
a) Hands-on demonstrations planned for the instructions.
b) Cross-reference training aids.
c) Planned training strategies such as whiteboard work, instructor questions, and discussion points or other planned classroom or field strategies.
d) Attach handouts cross-referenced by section or topic in the lesson plan.
e) Indicate duration of outlined training segments.
6) Provide maintenance instruction lesson plans including mechanical, HVAC, instrumentation, and electrical aspects:
a) Equipment operation:
(1) Describe equipment's operating (process) function and system theory.
(2) Describe equipment's fundamental operating principles and dynamics.

(3) Identify equipment's mechanical, electrical, and electronic components and features.
(4) Identify support equipment associated with the operation of subject equipment.
(5) Detail the relationship of each piece of equipment or component to the subsystems, systems, and process.
(6) Cite hazards associated with the operations, exposure to chemicals associated with the component, or the waste stream handled by the component.
(7) Specify appropriate safety precautions, equipment, and procedures to eliminate, reduce, or overcome hazards.

b) Detailed component description:
(1) Define Preventative Maintenance (PM) inspection procedures required on equipment in operation, spot potential trouble symptoms (anticipate breakdowns), and forecast maintenance requirements (predictive maintenance):
(a) Review preventive maintenance frequency and task analysis table.
(2) Identify each component function and describe in detail.
(3) Where applicable, group relative components into subsystems.
(4) Identify and describe in detail equipment safety features, permissive and controls interlocks.

7) Provide the following information in equipment troubleshooting lesson plans:
a) Define recommended systematic troubleshooting procedures as they relate to specific craft problems.
b) Provide component specific troubleshooting checklists as they relate to specific craft problems.

8) Provide the following information in equipment Corrective Maintenance (CM) troubleshooting lesson:
a) Describe recommended equipment preparation requirements as they relate to specific craft problems.
b) Identify and describe the use of any special tools required for maintenance of the equipment as they relate to specific craft problems.
c) Describe component removal/installation and disassembly/assembly procedures for specific craft repairs.
d) Perform at least 2 hands-on demonstrations of common corrective maintenance repairs.
(1) Additional demonstrations may be required by the Owner.
e) Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.

6. Class logistics:
a. Delivery time minimum: 2 hours.
b. Delivery time maximum: 4 hours.
1) Longer time requires Engineer approval.
c. Class agenda:
1) Refreshment break: One 10-minute break.

2) Meal break: One 45-minute break, unless otherwise specified.
3) Schedule refreshment breaks and meal breaks to meet the class needs and Owner work rules.

d. Schedule specific sessions:
1) Minimum of 30 days in advance to allow Owner staffing arrangements to take place.
2) At the times requested by the Owner, within the period 7 a.m. to 7 p.m. Monday through Friday.
a) Times scheduled will be at Owner's discretion.
3) Owner approval and confirmation required for session schedules.
4) Provide minimum of 2 sessions for each class unless otherwise noted:
a) The purpose of having multiple sessions on each class is to accommodate the attendance of as many Owner personnel working different shifts as possible.

7. Distribute Training Evaluation Form following each training session.
a. Training Evaluation Form is included in this Section.
b. Return completed Training Evaluation Forms to Owner's designated training coordinator immediately after session is completed.
c. Revise training sessions judged "Unsatisfactory" by a majority of attendees:
1) Conduct training sessions again until a satisfactory rating is achieved at no additional cost to Owner.

8. Submittals:
a. Prior to the training session:
1) Instructor qualifications: Due 30 calendar days prior to initial training session.
2) Training course materials: Due 14 calendar days prior to initial training session.
a) Training agenda, lesson plan, presentation, and handouts.
b) Other audio-visual aids utilized during each training course.
c) Format: 2 electronic copies and 3 hard copies organized in notebooks.

b. Post training session:
1) Training course materials: Due 14 calendar days after class completion:
a) Video recordings.
b) Class attendance sheet.
c) Training agenda, final lesson plan, presentation, and handouts.
d) Other audio-visual aids utilized during each training course.
e) Provide materials for all sessions of the class in a single transmittal.
f) Format: 2 electronic copies and 3 hard copies organized in notebooks.

D. Installation Testing:
1. Perform subsystem testing according to approved Subsystem Testing Plans.
2. Initiate the Manufacturer's Certificate of Installation and Functionality Compliance for all equipment:
a. Manufacturer's Certificate of Installation and Functionality Compliance form is included in this Section.

b. Manufacturer’s Certificate of Installation and Functionality Compliance certifies the equipment meets the following requirements:
    1) Has been properly installed, adjusted, aligned, and lubricated.
    2) Is free of any stresses imposed by connecting piping or anchor bolts.
    3) Is able to be operated as necessary for Functional Testing.
c. Form shall be submitted after completion of Functional Testing, as specified in this Section.

3. Coordinate Installation Testing with restrictions and requirements as specified in Section 01140 - Work Restrictions.
4. Perform coating holiday testing as specified in Section 09960 - High-Performance Coatings.
5. Perform pressure and leakage testing as specified in individual component Sections and Section 15956 - Piping Systems Testing.
6. Perform mechanical equipment Installation Testing: As specified below and in individual equipment sections, such as Section 15050 - Common Work Results for Mechanical Equipment, 15954 - Testing, Adjusting, and Balancing for HVAC, and 15958 - Mechanical Equipment Testing:
    a. Remove rust preventatives and oils applied to protect equipment during construction.
    b. Flush lubrication systems and dispose of flushing oils:
        1) Recharge lubrication system with lubricant recommended by manufacturer.
    c. Flush fuel system and provide fuel for testing and start-up.
    d. Install and adjust packing, mechanical seals, O-rings, and other seals. Replace defective seals.
    e. Remove temporary supports, bracing, or other foreign objects installed to prevent damage during shipment, storage, and erection.
    f. Check rotating machinery for correct direction of rotation and for freedom of moving parts before connecting driver.
    g. Perform cold alignment and hot alignment to manufacturer's tolerances.
    h. Adjust V-belt tension and variable pitch sheaves.
    i. Inspect hand and motorized valves for proper adjustment:
        1) Tighten packing glands to ensure no leakage, but permit valve stems to rotate without galling.
        2) Verify valve seats are positioned for proper flow direction.
    j. Tighten leaking flanges or replace flange gasket:
        1) Inspect screwed joints for leakage.
    k. Install gratings, safety chains, handrails, shaft guards, and sidewalks prior to operational testing.
7. Electrical devices and subsystems Installation Testing: As specified below, in Section 16950 - Field Electrical Acceptance Tests, and the technical sections:
    a. Perform insulation resistance tests on all wiring except wiring and control wiring inside electrical panels.
    b. Perform grounding resistance tests on grounding systems.
    c. Test and set relays and circuit breaker trip units for proper operation:
        1) Settings as documented in approved electrical studies performed as specified in Section 16305 - Electrical System Studies.
    d. Perform direct-current high-potential tests on all cables that will operate at more than 2,000 volts.

e. Motors:
1) Windings energized to 1,000 volts DC for 1 minute:
a) Motor resistance measured at the end of the test and recorded.
2) Check motors for actual full-load amperage draw and proper rotation.

8. Instrumentation devices and subsystems Installation Testing: As specified below, in Section 17950 - Testing, Calibration, and Commissioning, and technical sections.
9. Heating, ventilating, and air conditioning systems Installation Testing: As specified below, in Section 15954 - Testing, Adjusting, and Balancing for HVAC, and technical sections:
a. Perform testing of heating, ventilating, and air conditioning equipment, balancing of distribution systems, and adjusting of ductwork accessories.
b. Test hydronic systems, if required by technical sections.

E. Functional Testing:
1. Perform subsystem testing according to approved Subsystem Testing Plan.
2. Notify the Engineer 5 days prior to when the Work is ready for Functional Testing:
a. Perform testing in the presence of the Engineer.
3. Determine Functional Testing durations with Owner's input:
a. Durations will vary depending on the availability of water for testing.
b. Target minimum Functional Test duration: 8 hours:
1) Identify equipment/system that cannot be tested for a minimum of 8 hours as specified in technical sections.
4. Perform Functional Testing as specified in technical sections:
a. Perform Functional Testing in addition to the other tests specified in the technical sections.
b. Perform Functional Testing to demonstrate that the component equipment functions as an entire system in accordance with the design requirements.
c. Perform Functional Testing to demonstrate that the unit process has operated in a manner necessary to demonstrate equipment/system functions manually in local, manually in remote (or remote manual), and automatically in remote (in remote auto).
d. Perform testing with Contractor-provided water.
e. Repair or replace parts that operate improperly and retest.
f. Submit testing results as specified in the technical sections to the Owner and Engineer for approval of Functional Testing results.
5. Provide completed Manufacturer's Certificate of Installation and Functionality Compliance forms for all equipment:
a. Manufacturer's Certificate of Installation and Functionality Compliance form is included in this Section.
b. Manufacturer's Certificate of Installation and Functionality Compliance certifies the equipment/system meets the following requirements:
1) Is suitable for satisfactory full-time operation under full-load conditions.
2) Operates within the allowable limits for vibration and noise.
3) Electrical and instrumentation requirements:
a) Electrical equipment, instrumentation, and control panels are properly installed, calibrated, and functioning.

b) Electrical Installation Testing is complete, and test results have been approved by the Engineer:
   (1) Noted deficiencies have been corrected.
   (2) Relays, circuit breakers, and other protective devices are set.
c) Control logic for start-up, shutdown, sequencing, interlocks, control, and emergency shutdown has been tested and is properly functioning.
d) Motor control is calibrated and tested.

F. Clean Water Facility Testing:
1. Utilize plant water.
2. Do not begin Clean Water Facility Testing until Engineer has approved submittals for Functional Testing requirements.
3. Test entire facility with recirculating water supply at the design flow for the largest single process or system train to ensure proper complete facility (equipment/system) hydraulic performance.
4. Perform testing in the presence of the Engineer unless such presence is expressly waived in writing.
5. The purpose of Clean Water Facility Testing is to confirm extended equipment/system operation prior to process start-up:
   a. Testing shall occur for a minimum of 7 days with all systems operational to the extent possible.

G. Closeout documentation:
1. Submittals:
   a. Provide records generated during Commissioning Phase of Project:
      1) Required documents include but are not limited to:
         a) Training documentation.
         b) Manufacturer’s Certificate of Source Testing.
         c) Manufacturer’s Certificate of Installation and Functionality Compliance.
         d) Daily logs of equipment/system testing identifying tests conducted and outcome.
         e) Test forms and documentation.
         f) Functional Testing results.
         g) Logs of time spent by manufacturer's representatives performing services on the job site.
         h) Equipment lubrication records.
         i) Electrical phase, voltage, and amperage measurements.
         j) Insulation resistance measurements.
         k) Bearing temperature measurements.
      2) Data sheets of control loop testing including testing and calibration of instrumentation devices and setpoints. Format: 2 electronic copies and 3 hard copies organized in notebooks.
      3) Due date: Within 14 calendar days of Substantial Completion.

1.07 PROCESS START-UP PHASE

A. Overview of Process Start-Up Phase:
1. Operating the facility to verify performance meets the Contract Document requirements.

B. Process Start-Up:
   1. Perform process start-up in the presence of the Engineer.
   2. Pre-start-up activities:
      a. Commissioning Documentation and Data Review.
      b. Start-Up Go/No-Go Decision Criteria.
      c. Building and Fire Inspection Compliance Check.
      d. Process Start-Up Sequence Review:
         1) Submit a Process Start-Up plan for review by Engineer not less than 90 calendar days prior to planned commencement of process start-up activities.
         2) Include the following:
            a) Pre-start-up activities.
            b) Process Start-Up.
            c) Process Operational Period.
      e. Description of Temporary Testing Arrangement, if applicable.
      f. Final Process Start-Up Forms and Documentations.
      g. Final Operational Testing Plan.
   3. Control loop tuning:
      a. Perform control loop tuning during system testing with water to the extent possible.
   4. Process area start-ups:
      a. Process start-up individual process areas comprised of multiple interdependent systems where possible and beneficial to reduce complexity and risk of complete facility testing.
      b. Process area test flows may be limited by upstream and downstream process constraints (i.e., tank and basin volumes) and/or localized recirculation capabilities.
   5. Facility-wide process start-up:
      a. Upon approved completion of pre-start-up activities, perform entire facility process start-up:
         1) Complete control loop tuning during this phase of process start-up.
         2) Continue process start-up operations until facility meets or exceeds the Contract requirements.
      b. Process control systems testing:
         1) Test complete system instrumentation, controls and PLC, HMI, and LOI programming for the facility.
      c. HVAC systems start-up and testing:
         1) Test complete HVAC system for the facility.
      d. Ancillary systems start-up and testing:
         1) Test complete security system, phone system, fire alarm system, etc. for the facility.
      e. Remaining equipment/system tests:
         1) Conduct remaining specified equipment/system performance tests that could not be performed during the Testing and Training Phase due to inter-system and/or treatment process dependencies.

C. Process Operational Period:
    1. Prior to beginning the Process Operational Period:
        a. Conformance with treatment standards is required prior to Operational Testing, if applicable:
            1) Biological processes require time to build up the necessary population of organisms to meet treatment standards, as specified in Section 01140 - Work Restrictions.
        b. Correct any outstanding punch list items prior to the Operational Testing.
    2. Duration: 7 calendar days.
    3. Engineer will be present for process operational period unless such presence is expressly waived in writing.
    4. Prove facility conformance with Contract Document requirements.
    5. Contractor to provide:
        a. Specified start-up materials and operating supplies.
        b. Necessary craft of labor assistance, in the event of an emergency equipment failure requiring immediate attention (emergency is defined as a failure of function which precludes the further operation of a critical segment of or the whole of the Work) with a response time of not more than 4 hours from the time of notification.
        c. Manufacturer's authorized representative to supervise placing equipment/systems in operation and provide guidance during Operational Testing per applicable section.
        d. Necessary manufacturer's representatives and operating supplies for retesting systems that fail to pass the initial Operational Testing due to deficiencies in products of workmanship at no additional cost to the Owner.
        e. List of 24-hour "on-call" representative supervisory persons who will monitor the Operational Testing and serve as liaison for the Engineer and Owner.
    6. Owner will provide:
        a. Operations personnel for duration of test.
    7. Prior to date of Substantial Completion of Installation, the Contractor's CC shall oversee Process Operational Period.
        a. Owner staff will operate the completed Project construction.
        b. Entire system shall continuously meet performance requirements and shall operate without fault, failure, or defect for a continuous period.
        c. Individual equipment/system failures that are corrected within 24 hours and do not prevent the entire project from continuously satisfying the established operational requirements shall not require the consecutive day test to be restarted unless the failure recurs.
        d. Restart the consecutive test period for any of the following conditions:
            1) Any failure of the complete Project construction to meet operational requirements.
            2) When malfunctions or deficiencies cause shutdown or partial operation of the facility, or results in failure of the complete Project construction to meet operational requirements.

3) Any individual equipment/system failure that meets any of the following conditions:
   a) Requires more than 24 hours to correct, unless otherwise specified in Section 17950 - Testing, Calibration, and Commissioning.
   b) Recurs within the 24-hour correction period requiring further correction.
4) Immediately correct defects in material, workmanship, or equipment/system which became evident during Operational Testing.

1.08 INSTRUMENTATION AND CONTROLS FINE-TUNING:

A. After the Process Operational Period, test PCIS system for additional 60 days as specified in Section 17950 - Testing, Calibration, and Commissioning to identify issues and make corrections, as needed.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

MANUFACTURER'S CERTIFICATE OF SOURCE TESTING

OWNER _____ EQPT/SYSTEM _____
PROJECT NAME _____ EQPT TAG NO. _____
PROJECT NO. _____ EQPT SERIAL NO. _____
SPECIFICATION NO. _____
SPECIFICATION TITLE _____

Comments: _____

_____

_____

_____

_____

I hereby certify Source Testing has been performed on the above-referenced equipment/system as defined in the Contract Documents, and results conform to the Contract Document requirements. Testing data is attached.

Date of Execution: _____, 20____

Manufacturer: _____

Manufacturer's Authorized Representative Name *(print)*: _____

_____
(Authorized Signature)

If applicable, Witness Name *(print)*: _____

_____
(Witness Signature)

MANUFACTURER'S CERTIFICATE OF
INSTALLATION AND FUNCTIONALITY COMPLIANCE

OWNER _____ EQPT/SYSTEM _____
PROJECT NAME _____ EQPT TAG NO. _____
PROJECT NO. _____ EQPT SERIAL NO. _____
SPECIFICATION NO. _____
SPECIFICATION TITLE _____

I hereby certify that the above-referenced equipment/system has been: (Check Applicable)

- ☐ Installed in accordance with manufacturer's recommendations.
- ☐ Inspected, checked, and adjusted.
- ☐ Serviced with proper initial lubricants.
- ☐ Electrical/instrumentation and mechanical connections meet quality and safety standards.
- ☐ All applicable safety equipment has been properly installed.
- ☐ Functionally tested.
- ☐ System has been performance tested, and meets or exceeds specified performance requirements.

NOTES:
Attach test results with collected data and test report.

Attach written certification report prepared by and signed by the electrical and/or instrumentation subcontractor.

Comments: _____

_____

I, the undersigned manufacturer's representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate this equipment/system, and (iii) authorized to make recommendations required to ensure that the equipment/system furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20 ____

Manufacturer: _____

Manufacturer's Authorized Representative Name *(print)*: _____

By Manufacturer's Authorized Representative: _____
(Authorized Signature)

COMMISSIONING

TRAINING EVALUATION FORM

EQUIPMENT/SYSTEM ITEM: _____

VENDOR/MANUFACTURER: _____

DATE: _____ NAME OF REPRESENTATIVE: _____

1.	Was representative prepared?	Acceptable	Unacceptable	or	N/A
2.	Was an overview description presented?	Acceptable	Unacceptable	or	N/A
3.	Were specific details presented for system components?	Acceptable	Unacceptable	or	N/A
4.	Were alarm and shutdown conditions clearly presented?	Acceptable	Unacceptable	or	N/A
5.	Were step-by-step procedures for starting, stopping, and troubleshooting presented?	Acceptable	Unacceptable	or	N/A
6.	Were routine/preventative maintenance items clearly identified?	Acceptable	Unacceptable	or	N/A
7.	Was the lubrication schedule (if any) discussed?	Acceptable	Unacceptable	or	N/A
8.	Was the representative able to answer all questions?	Acceptable	Unacceptable	or	N/A
9.	Did the representative agree to research and answer unanswered questions?	Acceptable	Unacceptable	or	N/A
10.	Comments: _____				
11.	Overall Rating:	Satisfactory	Unsatisfactory		

Note:

Sessions judged “Unsatisfactory” by a majority of attendees shall be revised and conducted again until a satisfactory rating is achieved.

COMMISSIONING ROLES AND RESPONSIBILITIES MATRIX

NO.	TASK	OWNER	CONTRACTOR	ENGINEER
Testing and Training Phase				
Source Testing				
1	Source Testing	Witness	Lead	Witness, Review
Installation Testing				
2	Electrical Conductor Testing	No Action	Lead	Witness
3	Electrical Field Acceptance Tests	No Action	Lead	Witness
4	Instrument Field Calibration	No Action	Lead	Witness
5	Network Installation Testing	Witness	Lead	Witness
6	Loop Testing	Witness	Lead	Witness
7	Pressure Testing	No Action	Lead	Witness
8	Leak Testing	No Action	Lead	Witness
9	Holiday Testing	No Action	Lead	Witness
10	HVAC Testing	No Action	Lead	Witness
11	Motor Electrical Testing	No Action	Lead	Witness
Functional Testing				
12	Network Operational Testing	Witness	Lead	Review
13	Preliminary Run Testing Local/Manual Control	Witness	Lead	Review
14	PCIS Functional Demonstration Testing - Local/Auto Control Testing - Remote/Manual Contact Testing - Alarm Testing - Control Loop Testing	No Action	Lead	Review
15	Subsystem Start-Up and Testing	Witness	Lead	Review
16	Equipment/System Start-Up and Testing	Witness	Lead	Review
17	HVAC Start-Up and Testing	Witness	Lead	Review
18	Corrosion Control Start-Up and Testing	Witness	Lead	Review
19	Wide Area Network Communications Testing	Support	Lead	Witness
20	Manufacturer's Certificate of Installation and Functionality Compliance	No Action	Lead	Witness, Review
Clean Water Facility Testing				
21	Test Water Management Plan Finalization	Support	Lead	Review
22	Clean Water Facility Testing	Witness	Lead	Witness, Review
Process Start-Up Phase				
Process Start-Up				
23	Commissioning Documentation and Data Review	Review	Support	Lead
24	Start-Up Go/No-Go Decision Criteria	Lead	Support	Review
25	Building and Fire Inspection Compliance Check	No Action	Lead	Witness

NO.	TASK	OWNER	CONTRACTOR	ENGINEER
26	HVAC Functionality Check	No Action	Lead	Witness
27	Start-Up Sequence Review	Support	Lead	Review
28	Temporary Testing Arrangement Finalization	Support	Lead	Support
29	Start-Up Forms Finalization	Support	Lead	Support
30	Operation Testing Plan Finalization	Review	Support	Lead
31	Test Water Management Plan Finalization	Support	Lead	Review
32	System Testing	Support	Lead	Witness
33	Control Loop Tuning	Support	Lead	Witness
34	Process Area Start-Ups	Support	Lead	Witness
35	Facility-Wide Start-Up	Support	Lead	Witness
36	Process Control Systems Testing	Support	Lead	Witness
37	HVAC Final Testing, Adjust, and Balancing	Witness	Lead	Witness, Review
Process Operational Period				
38	Operational Testing	Support	Lead	Witness, Review
39	Final Testing Reports	Support	Lead	Review
40	Water Quality Testing and Documentation	Support	Lead	Review
Instrumentation and Controls Reliability Phase				
Instrumentation and Controls Reliability Period				
41	As specified in Section 17950 - Testing, Calibration, and Commissioning			

Legend:
Lead: Primarily responsible for organization, coordination, and execution of task work product or result.
Support: Assist the lead with organization, coordination, and execution of task work product or result.
Witness: Observe and document completion of task work product or result.
Review: As necessary to accept task work product result.
No Action: Limited or no involvement.

SECTION 01759

WATER LEAKAGE TEST FOR CONCRETE STRUCTURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Hydrostatic leakage test for concrete water-holding structures.

1.02 REFERENCES

A. Abbreviations and acronyms.

B. Definitions:
   1. Damp spots: Surfaces where visible moisture can be picked up by a dry hand.
   2. Containment structure, lined: Liquid-containing structure with barrier coating or membrane applied to the inside surfaces to prevent leaking of contents to the outside.
   3. Containment structure, unlined: Liquid containing structure where only the concrete structure itself is used to prevent leaking of contents to the outside.

C. Reference standards.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination.

B. Pre-installation meetings.

C. Sequencing.

D. Scheduling.

1.04 SUBMITTALS

A. Product data.

B. Shop drawings:
   1. Description and details of each evaporation/precipitation-measuring device anticipated for use during the test.

C. Samples.

D. Certificates.

E. Delegated design submittals.

F. Tests and evaluation reports:
   1. Results of water leakage test for each structure and for each portion of a structure designated for testing.

G. Manufacturer instructions.

H. Source quality control submittals.

I. Field/site quality control submittals.

J. Manufacturer reports.

K. Sustainable design submittals.

L. Special procedure submittals:
   1. Testing plan for each structure, or portion thereof, required to be tested:
      a. Describe methods of obtaining water for testing and of releasing water for disposal, including provisions for dechlorination if required.
      b. Include plans showing locations where measurements will be made and locations of evaporation/precipitation-measuring device.
      c. Indicate plans for filling and draining structure(s).
      d. Include schedule showing duration of test for each structure or cell to be tested, date and time for start of each test, dates and times of observations and measurements during the test, dates and times for closeout of testing procedures, and date for submittal of final results.
   2. Proposed procedures and products for repair of leaks.

M. Qualifications statements.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 GENERAL

A. Test structures and portions of structures listed in the following paragraphs for water leakage:
   1. Unless otherwise specified, the Contractor shall:
      a. Obtain all required permits for discharging testing water.
      b. Provide dechlorination of such water if required by the permits.
      c. Prepare and fill the structures.
      d. Provide access and equipment required for testing and for recording test results.
      e. Take measurements and make observations required for testing.
   2. At all times during testing, the Engineer shall have access to observe measurements by others or to make independent measurements.

B. Test the following concrete structures for water leakage:
   1. Filter Nos. 6 and 7.

C. Required preparation for testing is designated in this Section. Waiver of, or failure to complete preparations shall not change the testing criteria or approval criteria for the areas tested.

D. Retest structures and portions of structures until the evaluation criteria are satisfied.

3.02 TEST WATER SOURCE AND DISPOSAL

A. Water used for the first filling of the tank will be furnished by Owner from plant water system.

B. After leakage testing is complete, Contractor shall dispose of water by draining to the storm drain

3.03 PREPARATION

A. For each structure to be tested, prepare and submit a plan showing schedule and sequence of activities, method of filling, and methods of disposing of test water.

B. Sequencing requirements:
   1. Complete construction of concrete structure and cure concrete to obtain minimum specified 28-day compressive strength as specified in Section 03300 - Cast-in-Place Concrete:
      a. Do not begin tests until all portions of structure are complete and have reached their minimum specified 28-day compressive strength.
      b. Do not begin tests until at least 14 days have passed since completion of the last concrete placement.
   2. Complete tests before:
      a. Covering any surface of the structure with materials that might mask the location of leaks or obscure damp concrete surfaces. Such coverings include, but are not limited to basin bottom grout, masonry veneer, stucco, plaster, and other coatings.
      b. Installation of equipment, unless otherwise approved by the Engineer.
      c. Backfilling structures to elevations above the limits indicated in the following paragraphs.
   3. Liners and coatings:
      a. Install liners that are mechanically locked to the concrete surface during placement of plastic concrete and before leakage testing:
         1) Examine liners for pinholes, tears, and partially fused splices, complete all required liner integrity testing, and make required repairs before commencing leakage testing.
      b. Unless otherwise specified, do not install surface-applied protective or decorative coatings and linings until leakage tests have been completed.

C. Weather requirements:
   1. Tests on structures with tops open to the atmosphere shall not be scheduled for periods when the 10-day weather forecast indicates a substantial change in weather patterns.
   2. Measurements of water surface levels in the structure shall not be scheduled for periods when the weather forecast indicates a difference of more than

35 degrees Fahrenheit between the ambient temperature readings at the times of initial and final measurements.

3. Tests shall not be scheduled for periods when the 10-day weather forecast indicates that the water surface may freeze before the test is complete.

D. Clean interior of structure:
   1. Remove dirt, contaminants, and construction debris.
   2. Flush floors and sumps to provide clean surfaces.
   3. Remove standing water that would interfere with examination of surfaces, cracks, or joints.

E. Observe the structure, or portions of the structure being tested, for potential leak locations:
   1. Give particular attention to cracks, open joints, voids, and honeycombed and repaired surfaces.
   2. Visually observe openings, fitting, and pipe penetrations in the structure at both faces, if possible.
   3. Repair potential leak locations in accordance with these Specifications and as approved by the Engineer.
   4. Backfill excavations to the top of the structure foundation. Do not place backfill against water-bearing walls or over footings unless approved in advance by the Engineer:
      a. If requesting backfilling of walls before testing, include a description of methods that will be used to detect leakage in the backfilled areas.
      b. Engineer's approval of backfilling before testing shall not relieve Contractor of the responsibility to conduct leakage tests, to satisfy the leakage acceptance criteria for the structure, or to repair leaking portions of the structure, including those portions below or behind the backfill.
   5. See Drawings and Section 02300 - Earthwork for requirements to provide wall stability before backfilling.

F. Inlets to/outlets from the structure:
   1. Make inlets to and outlets from the structure watertight:
      a. Include valves; stop, sluice, and slide gates; and temporary bulkheads as required.
      b. Inlets and outlets not required to be operable may be temporarily sealed before testing of the compartments to which they open.
      c. Secure inlets used to fill the structure for testing to ensure that no water is entering or leaving the structure once it has been filled to the test level.
   2. Adjustments to measured leakage at inlets and outlets based on manufacturer's or Contractor's estimates will not be allowed:
      a. Adjustments to measured leakage may be permitted by the Engineer, and, at his/her discretion, only when the Contractor makes specific measurements of leakage at each individual inlet and outlet using methods approved by the Engineer.

3.04 HYDROSTATIC LEAKAGE TEST FOR OPEN OR COVERED CONTAINMENT STRUCTURES ("HST-100")

A. Isolate sections of water-holding structures that can be isolated in actual operation. Fill and test sections for leakage separately:
   1. Fill structures and sections of structures scheduled for testing to the normal operating water level indicated on the Hydraulic Profile indicated on the Drawings.

B. Initial rate for filling of structures shall not exceed 4 feet per hour.

C. HST-100 testing includes 2 parts, "Qualitative Testing," and "Quantitative Testing," as described in the following paragraphs:
   1. HST-100, Part 1 - Qualitative Testing:
      a. During the first 24 hours after structures are filled, examine exposed concrete surfaces for damp spots or flowing water:
         1) Make observations in early morning, at midday, and in late afternoon.
         2) Continue observations through the duration of the Quantitative Testing period.
         3) Pay particular attention to conditions at joints, honeycombed areas, cracks, and repaired portions of the structure.
      b. Evaluation criteria:
         1) The structure shall be considered to have failed these Qualitative Testing requirements if any of the following conditions are observed:
            a) Water droplets or moist areas on an outside surface that could only have originated inside the structure.
            b) Water is flowing or seeping from joints, cracks, or surfaces:
               (1) Exception: Dampness or wetness on top of a footing, in the absence of flowing water, shall not be considered as failure to meet this criterion.
            c) Moisture can be transferred to a dry hand from the outside surfaces of the filled area.
      c. Repairs and retesting:
         1) Where damp spots or flowing water as described in the preceding paragraphs are observed, mark locations, provide repairs, and retest the structure as specified in subsequent paragraphs.
   2. HST-100 - Part 2: Quantitative Testing:
      a. If approved by the Engineer, Quantitative Testing may begin before repairs are made to areas failing Part 1 of this test; however:
         1) Adjustments to volume loss calculations of Quantitative Testing based on observed leakage will not be permitted.
         2) All defects identified for repair during Qualitative Testing shall be repaired to the satisfaction of the Engineer before approval of the structure.
      b. Report the results of Quantitative Testing on "Leakage Test Report" included as Figure A at the end of this Section, or similar form prepared by the Contractor and containing at least the information included in Figure A.
      c. Unlined concrete structures:
         1) Fill to the designated water surface elevation. Maintain that level for at least 72 hours before recording initial water levels for leakage test.

2) Duration of test:
    a) Filter Structure: 72 hours.

d. Measurements: Water level:
    1) Record water levels at 24-hour intervals for the full duration of the test period.
    2) Measure water levels at not less than 2 locations on opposite ends of the structure, and preferably at 4 locations spaced equally around the structure. Mark locations on the structure and take measurements at the same locations throughout the duration of the test.
    3) Measure, to an accuracy of 1/16 inch, the vertical distance to the water surface from a fixed point on the structure above.

e. Measurements: Temperatures:
    1) As part of the first and last sets of level measurements, record water temperature at a depth of 18 inches below the water surface. Measure temperature at the same locations where level measurements are taken.
    2) Record ambient temperature at the time of each water level measurement.

f. Measurements: Evaporation and precipitation:
    1) Measure evaporation and precipitation by floating pans inside the structures during testing:
        a) For uncovered structures, measure both evaporation and precipitation.
        b) For covered structures that are well ventilated, measure evaporation.
    2) Measure using specially constructed clear containers:
        a) Provide clear plastic, calibrated, open-top containers not less than 18 inches in diameter and 18-inches deep.
        b) Partially fill containers with water and float inside the structure. Make provisions to hold containers in place at each measurement location, but away from structure walls and items passing overhead, such as beams or pipes.
        c) Measure initial depth of water in each device. Measure changes in water level in each device at the same time measurements of the water level inside the structure are taken.

g. Restart of test:
    1) The Engineer may order a restart of the test when, in the Engineer's opinion, measurements have become unreliable due to unusual precipitation or other factors.
    2) If measurements or observed leakage during the testing period indicate that the allowable leakage requirements will be exceeded, the test may be terminated before completion of the full test period. Take appropriate actions to correct problems before restarting the test.

h. Calculations of leakage test results:
    1) For each section of the structure tested, use water surface level records to calculate average loss of volume per 24-hour interval:
        a) For each 24-hour interval during the test, calculate the average of all measured drops in water level around the structure.
        b) Use the average drop thus determined to calculate an average loss of volume for each 24-hour interval.

2) Adjustments to leakage calculations:
   a) For uncovered basins, calculations shall be corrected for precipitation added to the structure.
   b) Calculations may be corrected for evaporation and water temperature.

i. Evaluation criteria:
   1) Unless otherwise specified, the average loss of volume during any 24-hour interval shall not exceed the limits shown in Table A.

Table - Loss of Volume Criteria for Leakage Tests	
Structure Type	**Maximum Loss of Water Volume**
• Structure fully lined prior to leakage test. • Secondary containment areas.	No measurable loss over 72-hour test period.
• Structure with monolithically placed membrane floor slab.	0.0125 percent of volume per 24-hour period.
• Concrete paved canals, drying beds, lagoons, and similar structures.	0.100 percent of volume per 24-hour period.
• Other containment structures.	0.050 percent of volume per 24-hour period.

j. Repairs and retesting:
   1) Structures and portions of structures that have satisfied the qualitative requirements of HST-100, but have failed to satisfy the quantitative requirements of HST-100 may be immediately retested for volume loss:
      a) If the structure fails the second test for volume loss, the structure shall be drained, and the Contractor shall observe the interior for probable areas of leakage.
      b) The structure shall not be retested until repairs to the probable areas of leakage are complete.

3.05 REPAIRS FOR RETESTING

A. Locations showing damp spots or flowing water:
   1. Mark locations of visible leaks and damp spots.
   2. Drain structures for repair.
   3. Repair defects causing damp spots and flowing water using methods specified in Section 03300 - Cast-in-Place Concrete and approved by the Engineer:
      a. Repair both interior and exterior surfaces and make structures watertight.
      b. Submit proposed repair products and procedures for Engineer's review.
      c. Refill structures for retesting.
   4. Repeat filling, observations, and repairs until no leaks or damp spots appear.

B. Structures for which loss of water volume loss exceeds the limits specified after adjustments for evaporation, and precipitation:
   1. Determine cause of volume loss.
   2. Drain structures of water.

3. Repair defects causing loss of water volume using methods specified in Section 03300 - Cast-in-Place Concrete and approved by the Engineer:
   a. Submit proposed repair products and procedures for Engineer's review.
4. Refill water-holding structures.
5. Repeat testing and repairs until volume loss does not exceed specified limits.

END OF SECTION

FIGURE A

WATER TIGHTNESS TEST REPORT

PROJECT:		SUBMITTED BY:	
STRUCTURE:		WITNESSED BY:	
AREA:		TEST DATES:	
TEST DURATION:		TEST DURATION:	

Surface area of structure tested:		(square feet)
Volume of structure tested:		(cubic feet)
Volume of structure tested:		(gallons)
Measured loss through gates, etc.:		(gallons / day)
Allowable loss of water volume:		(per day)
Allowable loss of water volume:		(% in 24 hours)
Allowable measured loss over test duration (inches):		
Measured loss of water:		(gallons / day - From E below)
Measured loss of water volume (%):		(in 24 hours - From E below)

Water Temperature: Start of test: °F End of test: °F

			Water Surface Elevation (top of structure to top of water)				
			Location #1	Location #2	Location #3	Location #4	Initials**
Day	Date	Time	(inches)	(inches)	(inches)	(inches)	
1							
2							
3							
4							
5							
Changes in Level:							

A. Average change in level (feet): _____ (Average of total charges for all locations)

B. Correction for precipitation: _____ (Measured from pan)

C. Correction for evaporation: _____ (Measured from pan)

D. Corrected change in level (CL): _____

E. Total days tested: _____

F. Average measured % water loss in 24 hours: _____ = $\frac{\text{(CL) x (surface area) x 100}}{\text{(initial water volume) x (number of test days)}}$

Notes and field observations**

** Place date and initials at the beginning of each entry

SECTION 01770

CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Contract closeout requirements including:
   1. Final cleaning.
   2. Waste disposal.
   3. Touch-up and repair.
   4. Disinfection of systems.
   5. Preparation and submittal of closeout documents.
   6. Certificate of Substantial Completion.

1.02 REFERENCES

A. American Water Works Association (AWWA).

1.03 FINAL CLEANING

A. Perform final cleaning prior to inspections for Substantial Completion.

B. Employ skilled workers who are experienced in cleaning operations.

C. Use cleaning materials which are recommended by manufacturers of surfaces to be cleaned.

D. Prevent scratching, discoloring, and otherwise damaging surfaces being cleaned.

E. Clean roofs, gutters, downspouts, and drainage systems.

F. Broom clean exterior paved surfaces and rake clean other surfaces of site work:
   1. Police yards and grounds to keep clean.

G. Remove dust, cobwebs, and traces of insects and dirt.

H. Clean grease, mastic, adhesives, dust, dirt, stains, fingerprints, paint, blemishes, sealants, plaster, concrete, and other foreign materials from sight-exposed surfaces, and fixtures and equipment.

I. Remove non-permanent protection and labels.

J. Polish waxed woodwork and finish hardware.

K. Wash tile.

L. Wax and buff hard floors, as applicable.

M. Wash and polish glass, inside and outside.

N. Wash and shine mirrors.

O. Polish glossy surfaces to clear shine.

P. Vacuum carpeted and soft surfaces.

Q. Clean permanent filters and replace disposable filters when heating, ventilation, and air conditioning units were operated during construction.

R. Clean ducts, blowers, and coils when units were operated without filters during construction.

S. Clean light fixtures and replace burned-out or dim lamps.

T. Probes, elements, sample lines, transmitters, tubing, and enclosures have been cleaned and are in like-new condition.

1.04 WASTE DISPOSAL

A. Arrange for and dispose of surplus materials, waste products, and debris off-site:
   1. Prior to making disposal on private property, obtain written permission from Owner of such property.

B. Do not create unsightly or unsanitary nuisances during disposal operations.

C. Maintain disposal site in safe condition and good appearance.

D. Complete leveling and cleanup prior to Final Completion of the Work.

1.05 TOUCH-UP AND REPAIR

A. Touch-up or repair finished surfaces on structures, equipment, fixtures, and installations that have been damaged prior to inspection for Substantial Completion.

B. Refinish or replace entire surfaces which cannot be touched-up or repaired satisfactorily.

1.06 CLOSEOUT DOCUMENTS

A. Submit following Closeout Submittals before Substantial Completion:
   1. Punch list of items to be completed or corrected with the request for issuance of Substantial Completion.
   2. Evidence of Compliance with Requirements of Governing Authorities.
   3. Project Record Documents.
   4. Approved Operation and Maintenance Manuals.
   5. Approved Warranties and Bonds.
   6. Keys and Keying Schedule.
   7. Completed contract requirements for commissioning and process start-up.

B. Submit following Closeout Submittals before final completion of the Work and at least 7 days prior to submitting Application for Final Payment:
   1. Punch list of items have been completed and Engineer and Owner are satisfied that all deficiencies are corrected.

2. Evidence of Payment and Release of Liens or Stop Payment Notices as outlined in Conditions of the Contract.
3. Release of claims as outlined in Conditions of the Contract.
4. Submit certification of insurance for products and completed operations, as specified in the General Conditions.
5. Final statement of accounting.

1.07 PROJECT RECORD DOCUMENTS

A. Maintain at Project site, available to Owner and Engineer, 1 copy of the Contract Documents, shop drawings, and other submittals in good order:
   1. Mark and record field changes and detailed information contained in submittals and change orders.
   2. Record actual depths, horizontal and vertical location of underground pipes, duct banks, and other buried utilities. Reference dimensions to permanent surface features.
   3. Identify specific details of pipe connections, location of existing buried features located during excavation, and the final locations of piping, equipment, electrical conduits, manholes, and pull boxes.
   4. Identify location of spare conduits including beginning, ending, and routing through pull boxes and manholes. Record spare conductors, including number and size, within spare conduits and filled conduits.
   5. Provide schedules, lists, layout drawings, and wiring diagrams.
   6. Make annotations in either electronic format or hard copy format with erasable colored pencil conforming to the following color code:

Additions:	Red
Deletions:	Green
Comments:	Blue
Dimensions:	Graphite

B. Maintain documents separate from those used for construction:
   1. Label documents "RECORD DOCUMENTS."

C. Keep documents current:
   1. Record required information at the time the material and equipment is installed and before permanently concealing.
   2. Engineer will review Record Documents weekly to ascertain that changes have been recorded.

D. Affix civil engineer's or professional land surveyor's signature and registration number to Record Drawings to certify accuracy of information shown.

E. Deliver Record Documents with transmittal letter containing date, Project title, Contractor's name and address, list of documents, and signature of Contractor.

F. Record Documents will be reviewed monthly to determine the percent complete for the monthly pay application.

G. Updated Record Documents are a condition for Engineer's recommendation for progress payment.

H. Final Schedule Submittal as specified in Section 01321.

1.08 MAINTENANCE SERVICE

A. Maintenance service as specified in technical specifications.

1.09 SUBSTANTIAL COMPLETION

A. Obtain Certificate of Substantial Completion.

1.10 FINAL COMPLETION

A. When Contractor considers the Work is complete, submit written certification that:
   1. Work has been completed in accordance with the Contract Document:
   2. Punch list items have been completed or corrected.
   3. Work is ready for final inspection.

B. Engineer will make an inspection to verify the status of completion with reasonable promptness.

C. Should the Engineer consider that the Work is incomplete or defective:
   1. Engineer will promptly notify the Contractor in writing, listing the incomplete or defective work.
   2. Contractor shall take immediate steps to remedy the stated deficiencies, and send a second written certification to the Engineer that the Work is complete.
   3. Engineer shall re-inspect the Work.

1.11 FINAL ADJUSTMENT OF ACCOUNTS

A. Submit a final statement of accounting to the Engineer at least 7 days prior to final Application for Payment.

B. Statement shall reflect all adjustments to the Contract amount:
   1. The original Contract amount.
   2. Additions and deductions resulting from:
      a. Change Orders.
      b. Units installed and unit prices.
      c. Set-offs for uncorrected or incomplete Work.
      d. Set-offs for liquidated damages.
      e. Set-offs for reinspection payments.
      f. Extended engineering and/or inspection services and inspection overtime.
      g. Excessive shop drawings review cost by the Engineer.
      h. Other adjustments.
   3. Total Contract amount, as adjusted.
   4. Previous payments.
   5. Remaining payment due.

C. Engineer will prepare a final Change Order reflecting approved adjustments to the Contract amount which were not previously made by Change Orders.

1.12 FINAL APPLICATION FOR PAYMENT

A. Contractor shall submit the final Application for Payment reflecting the agreed upon information provided in the final statement of accounting.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01782

OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Preparation and submittal of Operation and Maintenance (O&M) Manuals.

1.02 GENERAL

A. Submit O&M Manuals as specified in technical sections.

B. Make approved manuals available at project site for use by construction personnel and Owner.

1.03 SUBMITTALS

A. Draft O&M Manuals:
   1. Submit prior to shipment of equipment or system to site.
   2. Shipment will be considered incomplete without the draft O&M Manuals.
   3. Quantity:
      a. Hard copy: 2 sets.
      b. Electronic: 2 CD-ROM or DVD.

B. Final O&M Manuals:
   1. Make additions and revisions in accordance with Owner's and Engineer's review comments on draft manuals.
   2. Submit approved O&M Manuals at least 30 days prior to Functional Testing and at least 60 days prior to Owner Training.
   3. Quantity:
      a. Hard copy: 2 sets.
      b. Electronic: 2 CD-ROM or DVD.

1.04 PREPARATION

A. General requirements:
   1. Provide dimensions in English units.
   2. Assemble material, where possible, in the same order within each volume.
   3. Reduce drawings and diagrams to 8 1/2 by 11-inch size, if possible unless otherwise specified.
   4. Complete forms on computer, handwriting not acceptable.
   5. Delete items or options not provided in the supplied equipment or system.
   6. Provide package control system annotated ladder logic for PLC, if applicable.

B. Hard copy requirements:
   1. Binders: 3-ring with rigid covers:
      a. Break into separate binders as needed to accommodate large size.
   2. Utilize numbered tab sheets to organize information.

3. Provide original and clear text on reproducible non-colored paper, 8 1/2 by 11-inch size, 24 pound paper.
4. Drawings larger than 8 1/2 by 11 inch:
    a. Fold drawings separately and place in envelope bound into the manual.
    b. Label each drawing envelope on the outside regarding contents.

C. Electronic requirements:
1. File format:
    a. Entire manual in PDF format.
        1) Include text and drawing information.
        2) Provide a single PDF file even if the hard copy version is broken into separate binders due to being large.
        3) Create PDF from the native format of the document (Microsoft Word, graphics programs, drawing programs, etc.):
            a) If material is not available in native format and only available in paper format, remove smudges, fingerprints, and other extraneous marks before scanning to PDF format.
            b) Hard copy record drawing requirements:
                (1) Provide a single multipage PDF file of each set of the scanned drawings.
                (2) Page 1 shall be the cover of the drawing set.
            c) At file opening, display the entire cover:
                (1) Scan drawings at 200 to 300 dots per inch (DPI), black and white, Group IV Compression, unless otherwise specified.
                (2) Scan drawings with photos in the background at 400 dots per inch (DPI), black and white, Group IV Compression.
        4) Pagination and appearance to match hard copy.
        5) Searchable.
        6) Scanned images are not acceptable.
        7) Bookmarks:
            a) Bookmarks shall match the table of contents.
            b) Bookmark each section (tab) and heading.
            c) Drawings: Bookmark at a minimum, each discipline, area designation, or appropriate division.
            d) At file opening, display all levels of bookmarks as expanded.
        8) Thumbnails optimized for fast web viewing.
    b. Drawing requirements:
        1) Provide additional copy of drawings in most current version of AutoCAD format.
        2) Drawings shall have a white background.
        3) Drawing shapes shall not degrade when closely zoomed.
        4) Screening effects intended to de-emphasize detail in a drawing must be preserved.
        5) Delete items or options not provided in the supplied equipment or system.
2. Media:
    a. CD-ROM or DVD-ROM compatible with Microsoft Windows.
    b. Flash drive.
    c. Secure Electronic File Transfer (SEFT).
3. Label media with the following information:
    a. O&M Manual.
    b. Equipment name.

c. Specification Section Number.
d. Equipment tag number.
e. Owner's name.
f. Project number and name.
g. Date.

4. If multiple submittals are made together, each submittal must have its own subdirectory that is named and numbered based on the submittal number.

1.05 CONTENTS

A. Label the spines:
1. Equipment name.
2. Tag number.
3. Project name.
4. Owner name.

B. Cover page:
1. O&M Manual.
2. Equipment name.
3. Specification Section Number.
4. Equipment tag number.
5. Owner's name.
6. Project number and name.
7. Date.

C. Table of Contents: General description of information provided within each tab section.

D. Equipment Summary Form: Completed form as specified in Appendix A of this Section.

E. Equipment Maintenance Summary Form: Completed form as specified in Appendix B of this Section.

F. Electric Motor Technical Data Form: Completed form as specified in Appendix C of this Section.

G. Description of equipment function, normal operating characteristics, and limiting conditions.

H. Manufacturer's product data sheets:
1. Where printed material covers more than 1 specific model, indicate the model number, calibrated range, and other special features.

I. Assembly, installation, alignment, adjustment, and checking instructions.

J. Storage instructions: Control diagrams:
1. Internal and connection wiring, including logic diagrams, wiring diagrams for control panels, ladder logic for computer based systems, and connections between existing systems and new additions, and adjustments such as calibrations and set points for relays, and control or alarm contact settings.
2. Complete set of 11-inch by 17-inch drawings of the control system.
3. Complete set of control schematics.

K. Programming: Copies of Contractor furnished programming.

L. Start-up procedures: Recommendations for installation, adjustment, calibration, and troubleshooting.

M. Operating procedures:
   1. Step-by-step instructions including but not limited to the following:
      a. Safety precautions.
      b. Guidelines.
      c. Manual keyboard entries.
      d. Entry codes.
      e. System responses.
      f. Other information as needed for safe system operation and maintenance.
   2. Modes:
      a. Startup.
      b. Routine and normal operation.
      c. Regulation and control.
      d. Shutdown under specified modes of operation.
      e. Emergency operating shutdown.

N. Preventative maintenance procedures:
   1. Recommended steps and schedules for maintaining equipment.
   2. Troubleshooting.

O. Lubrication information: Required lubricants and lubrication schedules.

P. Overhaul instructions: Directions for disassembly, inspection, repair and reassembly of the equipment; safety precautions; and recommended tolerances, critical bolt torques, and special tools that are required.

Q. Parts list:
   1. Complete parts list for equipment including but not limited to the following information:
   2. Catalog data: Generic title and identification number of each component part of equipment.
   3. Include bearing manufacturer, model and ball or roller pass frequencies for every bearing.
   4. Availability.
   5. Service locations.

R. Spare parts list: Recommended number of parts to be stored at the site and special storage precautions.

S. Engineering data:
   1. Drawings: Complete set of 11-inch by 17-inch equipment drawings.
   2. Exploded view or plan and section views with detailed callouts.
   3. Outline, cross-section, and assembly drawings.
   4. System drawings: Provide interconnection and wiring diagrams, plan views, panel layouts, bill of materials, etc.
   5. Packaged equipment system drawings: Provide instrumentation loop drawing, control schematic diagrams, interconnection and wiring diagrams, plan views, panel layouts, bill of materials, etc.

6. System drawings and data sheets: Include drawings and data furnished by the Engineer and the Supplier; provide "as installed" version.
7. Provide electrical and instrumentation schematic record drawings.

T. Test data and performance curves, when applicable.

U. Manufacturer's technical reference manuals.

V. Source (factory) Test results: Provide copies of Source Tests reports as specified in technical sections.

W. Functional Test results: After Functional Tests are completed, insert Functional Test reports as specified in technical sections.

1.06 ARCHIVAL DOCUMENTATION

A. Typically does not require updating to remain valid and should be stored in a format that preserves the document and limits one's ability to make changes.

B. Types of archival documents include the following:
1. Record drawings.
2. Reports.
3. Specifications.
4. Shop drawings.
5. Vendor Equipment O&M Manuals.
6. Photos.
7. Demonstration and training videos.
8. Other.

1.07 LIVING DOCUMENTATION

A. Requires periodic updates to remain valid and should be stored in formats that are easy to update.

B. Types of living documents include the following:
1. Facility O&M Manuals.
2. Standard Operating Procedures.
3. Other.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

APPENDIX A
EQUIPMENT SUMMARY FORM

1. EQUIPMENT ITEM _____

2. MANUFACTURER _____

3. EQUIPMENT IDENTIFICATION NUMBER(S) _____
(maps equipment number)

4. LOCATION OF EQUIPMENT _____

5. WEIGHT OF INDIVIDUAL COMPONENTS (OVER 100 POUNDS) _____

_____

_____

_____

NAMEPLATE DATA -

Horsepower _____
Amperage _____
Voltage _____
Service Factor (S.F.) _____
Speed _____
ENC Type _____
Capacity _____
Other _____

7. MANUFACTURER'S LOCAL REPRESENTATIVE

Name _____

Address _____

Telephone Number _____

8. MAINTENANCE REQUIREMENTS _____

_____

_____

9. LUBRICANT LIST _____

_____

10. SPARE PARTS (recommendations) _____

_____

11. COMMENTS _____

APPENDIX B
EQUIPMENT MAINTENANCE SUMMARY

1. Equipment Item: _____
2. Manufacturer: _____
3. Serial No. (if applicable): _____
4. Manufacturer's Order No. (if applicable): _____
5. Nameplate Data (horsepower, voltage, speed, etc.): _____

   _____
6. Manufacturer's Local Representative:

   Name: _____

   Address: _____

   Telephone: _____
7. Maintenance Requirements:

Maintenance Operation	Frequency	Lubricant (if applicable)	Comments
(List each operation required. Refer to specific information in Manufacturer's Manual, if applicable)	(List required frequency of each maintenance operation)	(Refer by symbol to lubricant list as required)	

8. Lubricant List:

Reference Symbol	Conoco Phillips	Exxon/Mobil	BP/Amoco	Other (List)
(Symbols used in Item 7 above)	(List equivalent lubricants, as distributed by each manufacturer for the specific use recommended)			

9. Spare Parts: (Include recommendation on what spare parts should be kept on the job):

_____

_____

APPENDIX C
ELECTRIC MOTOR TECHNICAL DATA

Technical Data for Each Motor:

Application: _____

Manufacturer: _____

Frame No.: _____ Type: _____

Code Letter: _____ Design Letter: _____

Rating:

Horsepower: _____Voltage: _____ Phase: _____

Cycles: _____Full Load rpm: _____
(wound rotor secondary)

Volts: _____ Amperes: _____

Full Load Current: _____ amperes

Locked Rotor Current: _____ amperes

Locked Rotor or Starting Torque (percent of full load): _____ percent

Full Load Torque: _____ ft-lb

Breakdown Torque: _____ percent

Efficiency:		Power Factor:	
Full Load:	_____ percent	Full Load	_____ percent
3/4 Load:	_____ percent	3/4 Load:	_____ percent
1/2 Load:	_____ percent	1/2 Load:	_____ percent

Insulation:

Type: _____

Class: _____

Temperature Rise: _____ Above Ambient: _____

Enclosure: _____

Net Weight: _____ lbs

Wk^2: _____ lbs/sq ft

Type of Bearings: _____

Service Factor: _____

Noise Level in Decibels: _____

Heaters: _____ kW, _____ Phase, _____ volts

Altitude: _____

SECTION 02050

SOILS AND AGGREGATES FOR EARTHWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Material requirements for soils and aggregates.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C117 - Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
   2. C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   3. C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   4. C535 - Standard Test Method for Resistance to Degradation of Larger-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   5. D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
   6. D2844 - Standard Test Method for Resistance R-Value and Expansion Pressure of Compacted Soils.
   7. D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   8. D4829 - Standard Test Method for Expansion Index of Soils.
   9. D5821 - Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.

B. California State Transportation Agency, Department of Transportation (CALTRANS):
   1. Standard Specifications.
   2. California Test Methods (CTM):
      a. California Test 205 - Method of Test for Determining Crushed Particles.
      b. California Test 211 - Method of Test for Abrasion of Coarse Aggregate by Use of the Los Angeles Abrasion Testing Machine.
      c. California Test 217 - Method of Test for Sand Equivalent.
      d. California Test 229 - Method of Test for Durability Index.
      e. California Test 301 - Method of Test for Determining the Resistance "R" Value of Treated and Untreated Bases, Subbases, and Basement Soils by the Stabilometer.

1.03 SUBMITTALS

A. Product data:
   1. Material source.
   2. Gradation.
   3. Testing data.

B. Quality control for aggregate base course:
   1. Test reports: Reports for tests required by Sections of Standard Specifications.
   2. Certificates of Compliance: Certificates as required by Sections of Standard Specifications.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Storage and protection: Protect from segregation and excessive moisture during delivery, storage, and handling.

B. Comply with Standard Specifications storage requirements, if applicable.

PART 2 PRODUCTS

2.01 MATERIALS - GENERAL

A. Provide material having maximum particle size not exceeding 4 inches and that is free of trash, lumber, debris, leaves, grass, roots, stumps, and other organic matter.

B. Materials derived from processing demolished or removed asphalt concrete are not acceptable.

C. Comply with soil and aggregate material requirements in the Standard Specifications, unless specified otherwise.

2.02 NATIVE MATERIAL

A. Native soil:
   1. Sound, earthen material.
   2. Expansion index less than 35 when tested in accordance with ASTM D4829.
   3. Conforms to size and grade within the following limits when tested in accordance with ASTM C117 and ASTM C136:

Sieve Sizes (Square Openings)	Percent by Weight Passing Sieve
1-inch	100
Number 200	30 maximum

2.03 AGGREGATE BASE COURSE

A. Material requirements:
   1. Class 2, 3/4-inch maximum aggregate size, free from organic matter and other deleterious substances, and of such nature that aggregate can be compacted readily under watering and rolling to form a firm, stable base.
   2. Aggregate base course for structures:
      a. Consist of crushed or fragmented particles.
      b. Coarse aggregate material retained in Number 4 sieve shall consist of material of which at least 25 percent by weight shall be crushed particles when tested in accordance with California Test 205.
   3. Aggregate shall not be treated with lime, cement, or other chemical material.

4. Durability index: Not less than 35 when tested in accordance with California Test 229.
5. Aggregate grading and sand equivalent tests shall be performed to represent not more than 500 cubic yards or 1 day's production of material, whichever is smaller.
6. Sand equivalent: Not less than 25 when tested in accordance with California Test 217.
7. Resistance (R-value): Not less than 78 when tested in accordance with California Test 301.
8. Conforms to size and grade within the following limits when tested in accordance with ASTM C117 and ASTM C136:

Sieve Sizes (Square Openings)	Percent by Weight Passing Sieve
1 inch	100
3/4 inch	90 - 100
Number 4	35 - 60
Number 30	10 - 30
Number 200	2 - 9

2.04 GRAVEL

A. Material requirements:
1. Consists of hard, durable particles of stone or gravel; or crushed to the specified sizes and gradations; and free from organic matter, lumps or balls of clay, and other deleterious matter.
2. Crush or waste coarse material and add or waste fine material in order to meet the specified gradations.
3. Fraction of material passing Number 40 sieve: Material having plasticity index not greater than 5 when tested in accordance with ASTM D4318.
4. Durability: Percentage of wear not greater than 40 percent when tested in accordance with California Test 211.
5. Conform to sizes and grade within the following limits when tested in accordance with ASTM C117 and C136:

Sieve Size (Square Openings)	Percent by Weight Passing Sieve		
	Type A	Type B	Type C
2 inch	100	--	--
1-1/2 inch	95 - 100	100	--
3/4 inch	35 - 60	55 - 85	100
3/8 inch	15 - 40	35 - 65	50 - 100
Number 4	0 - 25	20 - 35	30 - 45
Number 30	--	5 - 15	10 - 20
Number 200	0 - 5	2 - 9	2 - 9

2.05 DRAIN ROCK

A. Material requirements:
   1. Durability index: Percentage of wear not greater than 40 when tested in accordance with California Test 229.
   2. Consists of hard, durable particles of stone or gravel; screened or crushed to specified size and gradation; and free from organic matter, lumps or balls of clay, or other deleterious matter.
   3. Crush or waste coarse material and waste fine material as required to meet gradation requirements.
   4. Conforms to size and grade within the following limits when tested in accordance with ASTM C117 and C136:

Sieve Size (Square Openings)	Percent By Weight Passing Sieve
2 inch	100
1-1/2 inch	95 - 100
3/4 inch	50 - 100
3/8 inch	15 - 55
Number 200	0 - 2

2.06 SAND

A. Clean, coarse, natural sand.

B. Non-plastic when tested in accordance with ASTM D4318.

C. Conforms to size and grade within the following limits when tested in accordance with ASTM C117 and C136:

Sieve Size (Square Openings)	Percent by Weight Passing Sieve
1/2 inch	100
Number 200	0 - 20

2.07 STABILIZATION MATERIAL

A. Durability percentage of wear not greater than 40 percent when tested in accordance with California Test 211.

B. Consists of clean, hard, durable particles of crushed rock or gravel; screened or crushed to the specified sizes and gradations; and free of any detrimental quantity of soft, friable, thin, elongated, or laminated pieces, disintegrated material, organic matter, oil, alkali, or other deleterious substance.

C. Shall be free of slaking or decomposition under the action of alternate wetting and drying.

D. The portion of material retained on the 3/8-inch sieve shall contain at least 50 percent of particles having 3 or more fractured faces. Not over 5 percent shall be pieces that show no such faces resulting from crushing. Of that portion which passes the 3/8-inch sieve but is retained on the Number 4 sieve, not more than 10 percent shall be pieces that show no faces resulting from crushing.

E. Conforms to size and grade when tested in accordance with ASTM C117 and ASTM C136.

Sieve Size (Square Openings)	**Percent by Weight Passing Sieve**
1 inch	100
3/4 inch	90 - 100
Number 4	0 - 10
Number 200	0 - 2

2.08 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 02084

PRECAST DRAINAGE STRUCTURES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Onsite utility structures:
      a. Precast drainage inlets.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

B. ASTM International (ASTM):
   1. C361 - Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
   2. C478 - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections.
   3. C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   4. C858 - Standard Specification for Underground Precast Concrete Utility Structures.

1.03 SUBMITTALS

A. Shop Drawings: Submit for precast utility structures.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Precast drainage inlets:
   1. Construct precast concrete drainage inlets in accordance with the size, shape, form, details, and at locations indicated on the Drawings and specified.
   2. Base design and manufacture to A-16 (HS 20-44) loading in accordance with ASTM C857.
   3. In accordance with ASTM C858.

B. Precast concrete utility trench:
   1. Manufacturers: One of the following, or equal:
      a. Trenwa, Inc. Road Crossing Trench with Removable Concrete Lid (BHC3024-120).
   2. Contractor to coordinate trench manufacture details as needed to accommodate curb and gutter crossings, as indicated on the Drawings.

3. Construct precast concrete utility trench in accordance with design, size, shape, form, details, and at locations indicated on the Drawings and as specified.
4. Provide precast sections meeting strength requirements in accordance with ASTM C478.
5. Base design and manufacture on A-16 (AASHTO HS 20-44) loading in accordance with ASTM C857.
6. Sections of the trench designated for road crossing use shall be designed to carry AASHTO HS20 loading, 32,000 pound axle loading and shall be furnished in standard 10-foot lengths (except where special length requirements are necessary to fulfill the overall trench length requirement).
7. Lids for the road crossing trench shall be made of steel reinforced concrete designed to carry AASHTO HS20 loading, 32,000 pound axle loading.
8. Utility trench shall be water resistant and free from infiltration or exfiltration.
9. Interior dimensions of utility trench shall be as indicated on the Drawings.
10. Seal joints with precast concrete joint sealant.
11. Piping penetrations:
    a. Manufacturers: The following or equal:
        1) Kor-N-Seal, rubber gasket boots with steel clamps.
12. Piping connections to the utility trench shall be as indicated on the Drawings.
13. End plates: Positively connected to the trench to minimize liquid seepage in or out of the trench.
14. Cast weld plates into trench wall for Contractor-installed pipe supports at the following locations:
    a. Vertical wall placement at 6 inches and 12 inches from the base of the utility trench.
    b. Linear maximum spacing of weld plates at the vertical wall locations: 5 feet.
15. Provide welded tie plates that positively connect the trench sections to minimize shifting and differential settlement.
16. Provide galvanized steel impact channels at the utility trench to concrete lid connections.

2.02 DESIGN AND PERFORMANCE CRITERIA

A. Performance requirements:
    1. Appurtenances shall be watertight and free from infiltration or exfiltration.

2.03 ACCESSORIES

A. Standpipes for irrigation or drainage pipes:
    1. Covers: As indicated on the Drawings.

B. Precast drainage inlets:
    1. Covers: As indicated on the Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Standpipes for irrigation or drainage pipes:
   1. Excavation and backfill: As specified in Section 02318 - Trenching.

B. Precast drainage inlets:
   1. Excavation and backfill: As specified in Section 02318 - Trenching.

END OF SECTION

SECTION 02085

PRECAST CONCRETE VAULTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Precast concrete vaults.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO).
   1. LRFD Bridge Design Specifications.

B. American Concrete Institute (ACI):
   1. 318 - Building Code Requirements for Structural Concrete and Commentary.

C. ASTM International (ASTM):
   1. C150 - Standard Specification for Portland Cement.
   2. C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   3. C858 - Standard Specification for Underground Precast Concrete Utility Structures.

D. Occupational Safety and Health Administration (OSHA).

1.03 SUBMITTALS

A. General:
   1. Furnish submittals as specified in Section 01330 - Submittal Procedures.

B. Shop drawings:
   1. Show dimensions, locations, lifting inserts, reinforcement, and joints.
   2. Structural design calculations for vaults, signed by a licensed registered Civil or Structural Engineer licensed in the State where project is located.

C. Manufacturer’s Certification for Vaults: Written certification that the vault complies with the requirements of this Section.

1.04 QUALITY ASSURANCE

A. Inspection:
   1. After installation, the Contractor shall demonstrate that vaults have been properly installed, level, with tight joints, at the correct elevations and orientations, and that the backfilling has been carried out in accordance with the Contract Documents.

PART 2 PRODUCTS

2.01 VAULTS

A. Manufacturers: One of the following or equal:
   1. Utility Vault Co.
   2. Oldcastle Precast.

B. Provide precast vaults for the size indicated on the Drawings.

C. The minimum structural member thickness for vaults shall be 5 inches:
   1. Cement shall be Type V portland cement in accordance with ASTM C150.
   2. The minimum 28-day concrete compressive strength shall be 4,000 pounds per square inch.
   3. All reinforcing steel shall be embedded in the concrete with a minimum clear cover as recommended by ACI 318.

D. Design requirements: Loads on structures:
   1. In accordance with ASTM C857, except as modified in this Section.
   2. Loads at the ground surface:
      a. ”Roadway”: Load from heavy, frequently repeated vehicle traffic:
         1) ASTM C857, Table 1, Designation A-16 (AASHTO HS20-44).
   3. Loads against walls. Include effects of groundwater and seismic accelerations on earth pressures:
      a. Equivalent lateral pressure:
         1) Triangular distribution: 70 pounds per square foot per foot of depth (triangular distribution).
         2) Rectangular distribution backfill-induced live load surcharge: 240 pounds per square foot.
      b. Surface surcharge load: In accordance with ASTM C857 A-16 wheel load if such surcharge exceeds backfill loads described in the preceding paragraph.
      c. Groundwater effects: Include groundwater effects on lateral earth pressure loads using design groundwater elevation of 5 foot below grade:
         1) Use equivalent lateral pressure of 90 pounds per square foot per foot of depth (triangular distribution) for soil below the design groundwater elevation.
      d. Seismic acceleration effects:
         1) As specified in Section 01612 - Seismic Design Criteria.
         2) On opposite sides of the structure, uniform equivalent lateral leave in pressure type distribution, with a pressure of 37.5 in pounds per square foot where it is the depth of structure.
         3) Adding lateral force for soil accelerating toward structure:
            a) Direct uniform pressure distribution toward the wall, effectively increasing the static lateral soil pressure.
         4) Reducing lateral force for soil accelerating away from structure:
            a) Direct inverted pressure distribution away from the wall, effectively reducing the static lateral soil pressure.

4. Groundwater and flood loads, and buoyancy effects:
    a. As specified in Geotechnical Report for design groundwater and design flood elevations.
    b. Lateral pressure effects: Determine based on groundwater and flood elevations specified.
    c. Buoyancy: For groundwater and flood conditions, provide factor of safety against flotation of at least 1.20:
        1) If the weight of soil overlying footing projections on the structure is considered to resist flotation, use a buoyant unit weight of soil equal to not more than 40 pounds per cubic foot.
        2) Concrete fill may be provided in the bottom section of precast portland cement concrete structures to add weight. Submit proposed details.
5. Soil bearing pressure at base:
    a. Maximum 1,500 pounds per square foot total pressure on prepared subgrade soils.
6. Lifting and handling loads:
    a. Make provision in the design for the effects of loads or stresses that may be imposed on structures during fabrication, transportation, or erection.
7. Load combinations:
    a. Design structures to sustain the specified loads individually or in combination.

E. Design requirements: Structural analysis, design and detailing:
1. Analyze and design structures including the effects of 2-way action (“plate action”) and of load transfer around current and future openings.
2. Where structures include panels designed for future removal (“knockout panels”), design structures for loads and stresses with any combination of any or all such panels in place or removed.
3. Design structures in accordance with the requirements of ACI 318 and this Section.
4. Provide reinforcement at all areas subject to tensile stress when loaded with the specified loads and combinations thereof.
5. Provide temperature and shrinkage reinforcement to equal or exceed ACI 318 requirements in all concrete sections.
6. Provide minimum clear concrete cover over reinforcement at both interior and exterior faces of all members in accordance with the following:
    a. Vaults: 2 inches.
7. Reinforcement details:
    a. Walls: For structures with wall thickness of 8 inches or less, locate a single mat of reinforcement at the center of the wall.
    b. Slabs: For structures with slab thickness of 7 inches or less, locate a single mat of reinforcement at the center of the slab.
    c. Structures with wall or slab thicknesses exceeding these limits shall have a reinforcement at each face of the member.
8. Joints:
    a. Provide structures with watertight joints between sections, and detailed to minimize water infiltration at duct bank and conduit penetrations.
    b. Provide structures with non-skid, shiplap, or tongue and groove joints between sections.

F. Design requirements: Materials:
   1. Portland cement concrete vaults:
      a. In accordance with ASTM C858, except as modified in this Section.
      b. Proportion concrete mixes to resist damage from freezing and thawing in a moist environment, and for exposure to deicing chemicals. In accordance with ACI 318 requirements for minimum specified compressive strength and air entrainment.
   2. Seal joints watertight with precast concrete joint sealant as specified in Section 07900 - Joint Sealants.

G. Where joints are designed in pre-cast concrete vaults, such joints shall be interlocking to secure proper alignment between members and prevent migration of soil through the joint. Structural sections at joints shall be sized sufficiently to reinforce the section against localized distress during transportation and handling and against excess contact bearing pressures through the joint.

H. Vault shall be solid walled construction:
   1. Where penetrations of the pre-cast concrete vault are required for piping, conduit, or ducts, such penetrations shall be accommodated through pre-cast openings or core-drilled sections.
   2. Openings for penetrations shall be smooth and free of surface irregularities and without exposed steel reinforcing.
   3. Vaults need not be designed to resist thrust from piping passing through the vault.
   4. Coordinate pipe penetration locations with piping arrangement as indicated on the Drawings.

I. Slope bottom of vault to Drainage Sump as indicated on the Drawings.

J. Drainage Sump: Dimensions as indicated on the Drawings:
   1. Drainage Sump shall consist of an open knockout in the bottom of the vault. Provide additional reinforcing as required to accommodate knockout.
   2. Provide FRP grating with rebate as indicated on the Drawings:
      a. Grating shall be designed for 300 pounds per square foot load with L/200 maximum deflection.
      b. Provide removable grating sections to facilitate grating removal without disconnecting Automatic Sump Drain Ejector Assembly indicated on the Drawings.

K. Ladders:
   1. General:
      a. Type:
         1) Safety type conforming to local, State, and OSHA standards as minimum.
         2) Furnish guards for ladder wells.
      b. Size: 18 inches wide between side rails of length, size, shape, detail, and location indicated on the Drawings.

2. Aluminum ladders:
    a. Materials: 6063-T5 aluminum alloy.
    b. Rungs:
        1) 1-inch minimum solid square bar with 1/8-inch grooves in top and deeply serrated on all sides.
        2) Capable of withstanding 1,000 pound load without failure.
    c. Side rails: Minimum 4-inch by 1/2-inch flat bars.
    d. Fabrication:
        1) Welded construction, of size, shape, location, and details indicated on the Drawings.

2.02 ACCESS HATCH

A. Where openings for access to the vault are required, the full clear space opening indicated shall be provided, without obstructions from brackets or supports. For large openings where brackets or supports are designed to protrude into the opening for support of required covers, such brackets or supports shall be designed to be easily removed and replaced with a minimum of effort and without cutting or welding.

B. Access hatch as specified in Section 08320 - Floor Access Doors for access floor requirements.

2.03 COATINGS

A. Coat interior and exterior of valve vault in accordance with Section 09960 - High-Performance Coatings or as indicated on the Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Pre-cast concrete sections shall be transported and handled with care in accordance with the manufacturer’s written recommendations:
    1. Where lifting devices are provided in pre-cast sections, such lifting devices shall be used as intended.
    2. Where no lifting devices are provided, the Contractor shall follow the manufacturer’s recommendations for lifting procedures to provide proper support during lifting.

B. Buried pre-cast concrete vaults shall be assembled and placed in excavations on properly compacted soil foundations as indicated. Pre-cast concrete vaults shall be set to grade and oriented to provide the required dimensions and clearances from pipes and other structures.

C. Apply coatings in accordance with manufacturer's instructions.

D. Ladders:
    1. Secure to supporting surface with bent plate clips providing minimum 8 inches between supporting surface and center of rungs.
    2. Anchorage by manufacturer.

3. Where exit from ladder is forward over top rung, extend side rails 3 feet 3 inches minimum above landing, and return the rails with a radius bend to the landing.
4. Where exit from ladder is to side, extend ladder 5 feet 6 inches minimum above landing and rigidly secure at top.
5. Erect rail straight, level, plumb, and true to position indicated on the Drawings. Correct deviations from true line or grade which are visible to the eye.

END OF SECTION

SECTION 02200

SITE CLEARING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Clearing, grubbing, and stripping project site.

1.02 DEFINITIONS

A. Clearing: Consists of removal of natural obstructions and existing foundations, buildings, fences, lumber, walls, stumps, brush, weeds, rubbish, trees, boulders, utility lines, and any other items which interferes with construction operations or are designated for removal.

B. Grubbing: Consists of the removal and disposal of wood or root matter below the ground surface remaining after clearing and includes stumps, trunks, roots, or root systems greater than 1 inch in diameter or thickness to a depth of 6 inches below the ground surface.

C. Stripping: Includes the removal and disposal of all organic sod, topsoil, grass and grass roots, and other objectionable material remaining after clearing and grubbing from the areas designated to be stripped. The depth of stripping is estimated to be 6 inches, but the required depth of stripping will be determined by the Engineer.

1.03 QUALITY ASSURANCE

A. Regulatory requirements: Verify and comply with applicable regulations regarding those governing noise, dust, nuisance, drainage and runoff, fire protection, and disposal.

B. Pre-construction conference: Meet with Engineer to discuss order and method of work.

1.04 PROJECT CONDITIONS

A. Environmental requirements:
   1. For suspected hazardous materials found: As specified in Section 01354 - Hazardous Material Procedures.

1.05 SEQUENCING AND SCHEDULING

A. Clearing and grubbing: Perform clearing and grubbing in advance of grading operations.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine site and verify existing conditions for beginning work.

3.02 PREPARATION

A. Protect existing improvements from damage by site preparation work.

3.03 INSTALLATION

A. Clearing:
   1. Clear areas where construction is to be performed and other areas as indicated on the Drawings, or specified in this Section, of fences, lumber, walls, stumps, brush, roots, weeds, trees, shrubs, rubbish, and other objectionable material of any kind which, if left in place, would interfere with proper performance or completion of the work, would impair its subsequent use, or form obstructions.
   2. Do not incorporate organic material from clearing and grubbing operations in fills and backfills.

B. Grubbing:
   1. From excavated areas: Grub stumps, roots, and other obstructions 3 inches or over in diameter to depth of not less than 18 inches below finish grade.
   2. In embankment areas or other areas to be cleared outside construction area: Do not leave stumps, roots, and other obstructions higher than the following requirements:

Height of Embankment Over Stump	Depth of Clearing and Grubbing
0 feet to 2 feet	Grub stumps or roots 3 inches or over in diameter to 18 inches below original grade. Cut others flush with ground.
2 feet to 3 feet	Grub stumps 1 foot and over in diameter to 18 inches below original grade. Cut others flush with ground.
Over 3 feet	Leave no stumps higher than stump top diameter, and in no case more than 18 inches.

   3. Backfill and compact cavities left below subgrade elevation by removal of stumps or roots to density of adjacent undisturbed soil.

C. Stripping:
   1. Remove soil material containing sod, grass, or other vegetation to depth of 6 inches from areas to receive fill or pavement and from area within 5 feet outside foundation walls.
   2. Deposit stripped material in accordance with following requirements:
      a. At locations acceptable to Engineer.
      b. Use accepted material in top 6 inches of areas to be used for future planting.
   3. Replace topsoil where indicated on the Drawings.

D. Material reuse and recycling:
   1. 100 percent of trees, stumps, rocks and associated vegetation and soils resulting primarily from land clearing shall be reused or recycled. For a phased project, such material may be stockpiled on site until project completion.
   2. Contractor shall provide Engineer with list of local markets and salvage sites for reuse of clearing debris.

END OF SECTION

SECTION 02260

EXCAVATION SUPPORT AND PROTECTION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for designing, providing, maintaining, and removing excavation support and protection.

1.02 REFERENCES

A. American Society of Civil Engineers (ASCE):
   1. Guidelines of Engineering Practice for Braced and Tied-Back Excavations.

B. California Code of Regulations (CCR):
   1. Title 8 - Industrial Relations:
      a. Division 1. Department of Industrial Relations.
         1) Chapter 4. Division of Industrial Safety.
            a) Subchapter 4. Construction Safety Orders.
               (1) Article 6. Excavations.

C. Department of the Navy Naval Facilities Engineering Command (NAVFAC):
   1. Design Manual 7.2 - Foundations and Earth Structures.
   2. Design Manual 7.3 - Soil Dynamics and Special Design Aspects.

D. State of California Department of Transportation (Caltrans):
   1. Caltrans California Trenching and Shoring Manual.

E. United States Steel Corporation (USS):
   1. Steel Sheet Piling Design Manual.

1.03 DEFINITIONS

A. General Engineering Design Practice: General engineering design practice in area of the Project, performed in accordance with recent engineering literature on subject of shoring and stability of excavations.

B. Shoring: A temporary structural system designed to support vertical faces, or nearly vertical faces, of soil or rock for purposes of excavation. Shoring includes, internally braced sheet piling, slurry walls, and other similar shoring systems. Sloping of the soil is not shoring.

C. Support levels: Level of tiebacks, wales, rackers, bottom of excavation, and other types of support.

1.04 SYSTEM DESCRIPTION

A. Where general engineering design practice is specified, provide drawings and calculations that are performed and signed by civil or structural engineer registered in State where Project is located:
   1. Clearly disclose assumptions made, criteria followed, and stress values used for materials being used in design calculations.
   2. Submit list of references acceptable to Engineer that substantiating appropriateness of design assumptions, criteria, and stress values.

B. Design requirements:
   1. General:
      a. For trench excavations 5 feet or more in depth and for trenches less than 5 feet in depth when there is potential for cave-in:
         1) Perform design pursuant to general engineering design practice.
      b. In accordance with requirements in CCR, Title 8, Chapter 4, Subchapter 4, Article 6 for trench excavations 5 feet or more in depth and for trenches less than 5 feet in depth when there is potential for cave-in:
         1) Where such designs vary from excavation support standards set forth in CCR, Title 8, Chapter 4, Subchapter 4, Article 6, submit design calculations pursuant to general engineering design practice.
         2) Provide means for safe and stable excavations that are not less effective than required in CCR, Title 8, Chapter 4, Subchapter 4, Article 6.
         3) The preceding requirements do not apply to trench excavation support conforming to standards set forth CCR, Title 8, Chapter 4, Subchapter 4, Article 6.
      c. When electing to design with material stresses for temporary construction higher than allowable stresses prescribed in building code as specified in Section 01410 - Regulatory Requirements, increase in such stresses shall not exceed 10 percent of value of prescribed stresses.
      d. Minimum safety factor used for design shall not be less than 1.5.
      e. The calculated minimum depth of penetration of shoring below bottom of excavation shall be increased not less than 30 percent if full value of allowable passive pressure is used in design.
      f. Maximum height of cantilever shoring above bottom of excavation shall not exceed 15 feet. Use braced shoring when height of shoring above bottom of excavation exceeds 15 feet.
      g. The location of point of fixity for shoring shall not be less than half calculated minimum embedment depth below bottom of excavation.
      h. Generally acceptable references for design of shoring and excavations are as follows:
         1) ASCE Guidelines of Engineering Practice for Braced and Tied-Back Excavations.
         2) Caltrans California Trenching and Shoring Manual.
         3) NAVFAC Design Manual 7.2.
         4) NAVFAC Design Manual 7.3.
         5) USS Steel Sheet Piling Design Manual.

C. Performance requirements:
   1. General:
      a. Support faces of excavations and protect structures and improvements in vicinity of excavations from damage and loss of function due to settlement or movement of soils, alterations in ground water level caused by such excavations, and related operations.
      b. Specified provisions:
         1) Complement, but do not substitute or diminish, obligations of Contractor for furnishing of safe place of work pursuant to provisions of the Occupational Safety and Health Act of 1970 and its subsequent amendments and regulations and for protection of Work, structures, and other improvements.
         2) Represent minimum requirement for:
            a) Number and types of means needed to maintain soil stability.
            b) Strength of such required means.
            c) Methods and frequency of maintenance and observation of means used for maintaining soil stability.
   2. Provide safe and stable excavations by means of sheeting, shoring, bracing, sloping, and other means and procedures, such as draining and recharging groundwater and routing and disposing of surface runoff, required to maintain stability of soils and rock.
   3. Provide support for trench excavations for protection of workers from hazard of caving ground.
   4. Provide shoring:
      a. Where, as result of excavation work and analysis performed pursuant to general engineering design practice, as defined in this Section:
         1) Excavated face or surrounding soil mass may be subject to slides, caving, or other types of failures.
         2) Stability and integrity of structures and other improvements may be compromised by settlement or movement of soils, or changes in soil load on structures and other improvements.
      b. For trenches 5 feet and deeper.
      c. For trenches less than 5 feet in depth, when there is potential for cave-in.
      d. Where indicated on the Drawings.
   5. For safe and stable excavations, use appropriate design, construction, and maintenance procedures to minimize settlement of supported ground and to prevent damage to structures and other improvements, including:
      a. Using stiff shoring systems.
      b. Following appropriate construction sequence.
      c. Using shoring system that is tight enough to prevent soil loss through the shoring.
      d. Using shoring system that extends far enough below bottom of excavation to prevent piping, heave, or flow of soil under shoring.
      e. Design for safety factor of not less than 1.50.
      f. Providing surface runoff routing and discharge away from excavations.
      g. Where dewatering inside shoring is necessary, recharge groundwater outside shoring as necessary to prevent settlement in area surrounding shored excavation.
      h. Where sheet piling is used, use interlocking type sheets:
         1) Sheet piles shall be continuous and driven in interlock.
         2) If bottom of the excavation is located below the water table, use “ball and socket” or "thumb and finger" type interlock.

i. Not applying shoring loads to existing structures and other improvements.
j. Not changing existing soil loading on existing structures and other improvements.
k. Provide welded steel packing between soil retaining members such as sheet piles and wales and similar members when gap exceeds 1/2 inch before wales are loaded.

1.05 SUBMITTALS

A. Shop drawings and calculations:
1. Calculations for different load, support, and other conditions that occur during the sequence of installation of shoring, construction of facilities protected by shoring, and sequence of removal of shoring.
2. Sketches showing the condition at various stages of installation and removal of shoring.
3. Show on plan shoring, structures, pipelines, and other improvements located near shoring.
4. When utilities penetrate shoring, show location of penetrations on elevation of all sides of shoring.
5. Show details for ground support and sealing around utility penetrations.
6. Indicate method used for installing driven shoring.

B. Control points and schedule of measurements:
1. Submit location and details of control points and method and schedule of measurements.
2. Survey data.

C. Detailed sequence of installation and removal of shoring:
1. Consider effects of ground settlement in sequence of installation and removal of shoring.
2. Provide sketches showing conditions at various stages in sequence of installation and removal of shoring.

D. Submit submittals for excavation support and protection as complete package and include all items required in this Section:
1. Incomplete submittals will not be reviewed and will be returned for resubmittal as complete package.

E. Submit dewatering submittals with submittals for excavation support and protection.

1.06 SEQUENCING

A. Do not begin construction of any shoring or excavation operations until:
1. Submittals for shoring and dewatering have been accepted.
2. Control points as specified in this Section and on existing structures and other improvements as indicated on the Drawings have been established and surveyed to document initial elevations and locations.
3. Materials necessary for installation are on site.

B. Submit submittals minimum of 60 days prior to scheduled date to begin excavation work.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 CONSTRUCTION

A. Installation of shoring:
   1. Install means for providing safe and stable excavations as indicated in submittals.

B. Removal of shoring:
   1. Except for slurry walls, and similar shoring systems, remove shoring by completion of Work.
   2. Select shoring system and method of removal, which will minimize soil that sticks to shoring from creating voids and causing settlement.
   3. To prevent settlement caused by pulling shoring, fill voids with pressure injected grout:
      a. Inject grout starting at bottom of void and progressively fill void to grade.
      b. Minimize length of shoring removed ahead of grouting operation and limit time void is left ungrouted to prevent void from closing up before being grouted.
   4. Pressure preservative treated wood lagging may be left in place if acceptable to Engineer.

C. Control points:
   1. Establish control points on shoring and on structures and other improvements in vicinity of excavation for measurement of horizontal and vertical movement:
      a. Set control points on shoring support system:
         1) Set points at distances not exceeding 25 feet at each support level.
   2. Promptly upon completion of construction of control points survey control points. Submit copy of field notes with measurement.
   3. Perform horizontal and vertical survey and measurement of control points at least once every week:
      a. Field notes shall show current measurement and change in measurement from first measurement taken.
   4. Set control points on corners of existing structures and on curbs, manholes, and other improvements at the locations indicated on the Drawings.
   5. Provide plumb bobs with horizontal targets indicating original position of plumb bobs in relation to shoring at control points.

D. Maintenance:
   1. Where loss of soil occurs, plug gap in shoring and replace lost soil with fill material acceptable to Engineer.
   2. Where measurements and observations indicate possibility of failure or excessive movement of excavation support, determined in accordance with general engineering design practice, take appropriate action immediately.

END OF SECTION

SECTION 02300

EARTHWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Loosening, excavating, filling, grading, borrow, hauling, preparing subgrade, compacting in final location, wetting and drying, and operations pertaining to site grading for buildings, basins, reservoirs, boxes, roads, and other facilities:
   2. Backfilling and compacting under and around structures.
   3. Backfilling and compacting above buried structures.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

B. ASTM International (ASTM):
   1. D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone Method.
   2. D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3).
   3. D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.03 DEFINITIONS

A. Backfill adjacent to structure: Backfill within volume bounded by the exterior surfaces of structure, the surface of undisturbed soil in the excavation around structure, and finish grade around structure.

B. Embankments: Dikes, levees, berms, and similar facilities.

C. Excavation: Consists of loosening, removing, loading, transporting, depositing, and compacting in final location, wet and dry materials, necessary to be removed for purposes of construction of structures, ditches, grading, roads, and such other purposes as are indicated on the Drawings.

1.04 SYSTEM DESCRIPTION

A. Performance requirements:
   1. Where mud or other soft or unstable material is encountered, remove such material and refill space with stabilization material. Wrap stabilization material with stabilization fabric.

2. Obtain acceptable import material from other sources if surplus obtained within Project site does not conform to specified requirements or are not sufficient in quantity.
3. No extra compensation will be made for hauling of fill materials nor for water required for compaction.

1.05 SUBMITTALS

A. Copy of Property Owner's Agreement allowing placement of surplus soil material on their property.

B. Excavation plan.

C. Testing lab: Submit Contractor's proposed testing laboratory capabilities and equipment.

D. Test reports:
1. Submit certified test reports of all tests specified to be performed by the Contractor.
2. Sign and seal test reports by a registered Civil Engineer who practices geotechnical engineering registered in (the state where the project is located).

1.06 QUALITY ASSURANCE

A. Initial compaction demonstration:
1. Adequacy of compaction equipment and procedures: Demonstrate adequacy of compaction equipment and procedures before exceeding any of following amounts of earthwork quantities:
   a. 50 cubic yards of backfill adjacent to structures.
   b. 100 cubic yards of embankment work.
   c. 100 cubic yards of fill.
   d. 50 cubic yards of roadway base material.
   e. 100 cubic yards of road fill.
2. Compaction sequence requirements: Until specified degree of compaction on previously specified amounts of earthwork is achieved, do not perform additional earthwork of the same kind.
3. After satisfactory conclusion of initial compaction demonstration and at any time during construction, provide confirmation tests as specified under "FIELD QUALITY CONTROL."

B. Contractor shall perform all work related to this Section in accordance with the approved Stormwater Pollution Prevention Plan (SWPPP).

1.07 SEQUENCING AND SCHEDULING

A. Schedule earthwork operations to meet requirements specified in this Section for excavation and uses of excavated material.

B. If necessary, stockpile excavated material in order to use it at specified locations.

C. Excavation, backfilling, and filling: Perform excavation, backfilling, and filling during construction in manner and sequence that provides drainage at all times.

PART 2 PRODUCTS

2.01 MATERIALS

A. Water for compacting: Use water from source acceptable to Engineer.

B. Soil and rock materials:
   1. General:
      a. Provide aggregate base course, Class 2 permeable, controlled low-strength material, drain rock, gravel, native material, sand, and stabilization material where specified or indicated on the Drawings.
      b. If suitable surplus materials are available, obtain native material and select material from cut sections or excavations
   2. Aggregate base course materials: As specified in Section 02050.
   3. Drain rock: As specified in Section.
   4. Gravel: As specified in Section 02050.
   5. Native material: As specified in Section 02050.
   6. Sand: As specified in Section 02050.
   7. Stabilization material: As specified in Section 02050.

C. Controlled low-strength material: As specified in Section 02312 - Controlled Low Strength Materials (CLSM).

D. Geotextile fabrics:
   1. Filter fabric: As specified in Section 02620 - Filter Fabric.
   2. Stabilization fabric: As specified in Section 02621 - Stabilization Fabric.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
   1. Character and quantity of material:
      a. Verify character and quantity of rock, gravel, sand, silt, water, and other inorganic or organic materials to be encountered in work to be performed.
      b. Determine gradation, shrinkage, and swelling of soil, and suitability of material for use intended in work to be performed.
      c. Determine quantity of material, and cost thereof, required for construction of backfills, cuts, embankments, excavations, fills, and roadway fills, whether from onsite excavations. Include in cost of work to be performed.
      d. Include wasting of excess material, if required, in cost of work to be performed.

3.02 PREPARATION

A. Backfills:
   1. After clearing and excavation are completed, scarify entire areas that underlie backfills or structures to a depth of 6 inches and until surface is free of ruts, hummocks, and other features that would prevent uniform compaction by equipment to be used.
   2. Recompact scarified areas to density specified before placing backfill material or concrete.

3. Do not place backfill against walls until:
    a. Walls have been cast full height of structure and concrete has reached the specified strength.
    b. Connecting slabs and beams have been cast, and concrete has reached the specified strength.
4. Prior to backfilling:
    a. Remove all forms.
    b. Clean all trash and debris from the excavation site.
5. After inspection of foundation, walls, and pipes, place backfill symmetrically around structures to prevent eccentric loading of structures.

B. Embankments:
1. After clearing is completed, scarify entire areas that underlie embankments to a depth of 6 inches and until surface is free of ruts, hummocks, and other features that would prevent uniform compaction by equipment to be used.
2. Recompact scarified areas to density specified for embankments before placing of embankment material.

C. Fills:
1. After clearing is completed, scarify entire areas that underlie fill sections or structures to a depth of 6 inches and until surface is free of ruts, hummocks, and other features that would prevent uniform compaction by equipment to be used.
2. Recompact scarified areas to density specified for compacted fills before placing of fill material or concrete.

D. Roadway fills:
1. After clearing is completed, scarify entire areas that underlie roadway fills to a depth of 6 inches and until surface is free of ruts, hummocks, and other features that would prevent uniform compaction by equipment to be used.
2. Recompact scarified areas to density specified for roadway fills before placing of roadway fill material.

3.03 INSTALLATION

A. General:
1. Dispose of excavated materials that are not required or are unsuitable for fill and backfill in lawful manner.
2. Dispose of surplus material on private property only when written permission agreement is furnished by owner of property. Submit copies of such agreements.
3. Rocks, broken concrete, or other solid materials larger than 4 inches in greatest dimension: Remove from project site at no additional cost to the Owner.
4. Stabilization of subgrade: Provide materials used, or perform work required, to stabilize subgrade so it can withstand loads that may be placed upon it by Contractor's equipment.

B. Borrow area: There is no borrow area on Project site.
1. Where material is required, import material from source located off Project site selected by the Contractor and subject to acceptance by the Engineer.
2. There will be no additional cost to the Owner for use of imported material.

C. Compaction:
   1. Provide specified compaction for backfills, cuts, embankments, fills, roadway fills, and other earthwork.
   2. Perform confirmation tests to verify and confirm that work has complied, and is complying at all times, with compaction requirements specified in this Section for initial compaction demonstration and field quality control testing.
   3. In-place density of compacted backfills, cuts, embankments, fills, and roadway fills determined in accordance with ASTM D1556, or with ASTM D6938.
   4. Maximum density, laboratory compaction: Soil maximum density and optimum water content when tested in accordance with ASTM D1557.
   5. To prevent damage to structures due to backfilling operations, place backfill with equipment that does not exceed AASHTO Standard Specifications for Highway Bridges, H-20 vehicle loading, within a distance from the face of the structure of not less than 1/2 the depth of backfill. The depth of backfill is the distance between the level being compacted and the bottom of the excavation. Outside this distance, heavier compaction equipment may be used.
   6. Compact to percentage of maximum density as follows:
      a. Backfill adjacent to structures: 95 percent.
      b. Backfilling voids: 95 percent.
      c. Other areas: 85 percent.
      d. Under present and future structures: 95 percent.
      e. Under roadways, parking and storage areas, curbs, and sidewalks: 95 percent.
      f. Upper 6 inches of cuts: 95 percent.
      g. Fills: 95 percent.

D. Excavation:
   1. Blasting: Not permitted.
   2. Excavations for trenching: As specified in Section 02318 - Trenching.
   3. Excavations for structures:
      a. Provide excavations conforming to dimensions and elevations indicated on the Drawings for each structure.
      b. After clearing is complete, excavate for the structure, down to the elevation indicated on the Drawings. Unless directed by Engineer, do not carry excavations below elevation indicated on the Drawings.
      c. Where soil is encountered having unsuitable bearing value, Engineer may direct in writing that excavation be carried to elevations below those indicated on the Drawings.
      d. Where excavations are made below elevations indicated on the Drawings, adjust elevations of excavations in accordance with the following requirements:
         1) Under slabs: Restore to proper elevation in accordance with procedure specified for backfill in this Section.
         2) Under footings: Restore to the proper elevation using one of the following:
            a) Aggregate base course.

e. Excavation width:
    1) Extend excavations at least 2 feet clear from walls and foundations of structures to allow for placing and removal of forms, installation of services, and inspection.
    2) Do not undercut slopes.
f. Difficulty of excavation: No extra compensation will be made for removal of rock or any other material due to difficulty of excavation.

4. Excavation of ditches and gutters:
    a. Cut ditches and gutters accurately to cross sections and grades indicated on the Drawings.
    b. Take care not to excavate ditches and gutters below grades indicated on the Drawings.
    c. Backfill excessive ditch and gutter excavations to grade with suitable material acceptable to the Engineer.
    d. Do not deposit any material within 3 feet of edge of ditch unless otherwise indicated on the Drawings.
5. Necessary over excavation:
    a. Where it becomes necessary to excavate beyond normal lines of excavation in order to remove boulders or other interfering objects, backfill voids remaining after removal as specified in backfilling of voids below, or as acceptable to the Engineer.
    b. Backfill voids with material acceptable to the Engineer:
        1) With acceptance of the Engineer, backfill with one of the following:
            a) Aggregate base course.
            b) Controlled low-strength material.

E. Materials for backfills, embankments, fills, and roadway fills:
1. General:
    a. Obtain import material from other sources if surplus materials from cuts and excavations obtained from within Project site or borrow areas do not conform to specified requirements or are not sufficient in quantity for construction of Project.
2. Backfills:
    a. Backfill adjacent to structures, slabs, or walls: Native material or imported material meeting the requirements of native material, unless otherwise specified or indicated on the Drawings.
    b. Backfill material under concrete structures: Aggregate base course material, except in areas where controlled low-strength material or concrete encasement are indicated on the Drawings.
    c. Extend backfill in any area under concrete structures from undisturbed soil or rock to the bottom aggregate base course material layer.
3. Embankments:
    a. Native material or imported material meeting the requirements of native material, unless otherwise specified or indicated on the Drawings.
4. Fills:
    a. Native material or imported material meeting the requirements of native material, unless otherwise specified or indicated on the Drawings.
    b. Extend fill in any area under concrete structures from undisturbed soil or rock to the bottom aggregate base course material layer.
5. Roadway fills: One of the following, unless otherwise specified or indicated on the Drawings:
    a. Aggregate base course material.

F. Placement:
1. General:
a. Lines and grades:
1) Construct backfills, embankments, fills, and road fills, at locations and to lines and grades indicated on the Drawings.
2) Overbuild all permanent fill slopes by at least 1 foot and then cut to final grade to provide adequate compaction of the remaining fill.
2. Backfills:
a. Place loose material in successive layers that do not exceed 8 inches in depth after compaction.
b. Bring each layer to a moisture content between optimum moisture content and 3 percent above optimum moisture content before compacting.
c. Defective compacted backfills: Remove and recompact.
3. Fills:
a. Place loose material in successive layers that do not exceed 8 inches in depth after compaction.
b. Bring each layer to a moisture content between optimum moisture content and 3 percent above optimum moisture content before compacting.
c. Defective compacted fills: Remove and recompact.
4. Embankments:
a. Place loose material in successive layers that do not exceed 8 inches in depth after compaction.
b. Bring each layer to a moisture content between optimum moisture content and 3 percent above optimum moisture content before compacting.
c. Defective compacted embankments: Remove and recompact.
5. Roadway fills:
a. Place loose material in successive layers that do not exceed 8 inches in depth after compaction.
b. Bring each layer to a moisture content between optimum moisture content and 3 percent above optimum moisture content before compacting.
c. Defective compacted roadway fills: Remove and recompact.

3.04 FIELD QUALITY CONTROL

A. Confirmation tests:
1. Contractor's responsibilities:
a. Adequacy of compaction equipment and procedures:
1) Demonstrate adequacy of compaction equipment and procedures.
2) At each test location include tests for each type or class of backfill from bedding to finish grade.
b. Compaction sequence requirements:
1) Do not perform additional earthwork of the same kind until specified degree of compaction has been demonstrated.
c. Cost of confirmation tests: Paid for by the Contractor.
d. Qualifications of Contractor's testing laboratory: Acceptable to Engineer.
e. Copies of confirmation test reports: Submit promptly to the Engineer.
2. Frequency of confirmation testing:
a. Perform testing not less than the following:
1) In-place density:
a) Backfill: 1 every 50 cubic yards.
b) Cuts: 1 every 200 cubic yards.
c) Embankments: 1 every 200 cubic yards.

d) Fills: 1 every 50 cubic yards.
e) Roadway fills: 1 every 50 cubic yards.

2) Maximum dry density versus moisture:
a) Backfill: Each change in material type.
b) Cuts: Each change in material type.
c) Embankments: Each change in material type.
d) Fills: Each change in material type.
e) Roadway fills: Each change in material type.

b. Cost of confirmation tests:
1) Paid for by the Contractor.

c. Qualifications of Contractor's testing laboratory:
1) Perform confirmation testing by soils testing laboratory acceptable to the Engineer. Copies of confirmation test reports: Submit promptly to the Engineer.

B. Tolerances:
1. Finish grading of backfills, cuts, embankments, fills, and roadway fills:
a. Perform fine grading under concrete structures such that finish surfaces are never above the grade or cross section indicated on the Drawings and are never more than 0.10 feet below.
b. Provide finish surface for areas outside of structures that are within 0.10 feet of grade or cross section indicated on the Drawings.
2. Unlined channels and basins:
a. In both cut and fill, and levee and access road side slopes in cut: Vertical tolerance of none above and 3 inches below grade indicated on the Drawings on bottom and side slopes.
b. On top surface of levee and access road in both cut and fill, and levee and access road side slopes in fill: Vertical tolerance of none below and 3 inches above grade indicated on the Drawings.
3. Areas which are not under structures, concrete, asphalt, roads, pavements, sidewalks, dikes, and similar facilities:
a. Provide finish graded surfaces of either undisturbed soil, or cohesive material not less than 6 inches deep.
b. Intent of proceeding is to avoid sandy or gravelly areas.
4. Finish grading of surfaces:
a. Reasonably smooth, compacted, and free from irregular surface changes.
b. Provide degree of finish that is ordinarily obtainable from blade grader operations, except as otherwise specified.
c. Uniformly grade areas that are not under concrete.
d. Finish ditches and gutters so that they drain readily.

C. Compliance tests:
1. Frequency of testing: Periodic compliance tests will be made by the Engineer to verify that compaction is meeting requirements previously specified.

3.05 ADJUSTING

A. Finish grades of excavations, backfills, and fills:
1. Repair and reestablish grades to required elevations and slopes due to any settlement or erosion that may occur from action of the elements or any other cause prior to final acceptance.

3.06 PROTECTION

A. Finish grades of backfills, cuts, excavations, and fills:
   1. Protect newly graded areas from erosion and deterioration by action of the elements.

B. Ditches and gutters:
   1. Maintain ditches and gutters free from detrimental quantities of debris that might inhibit drainage until final acceptance.

END OF SECTION

SECTION 02312

CONTROLLED LOW STRENGTH MATERIAL (CLSM)

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Controlled low strength material (CLSM), also known as "flowable fill."

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 229R - Report on Controlled Low-Strength Materials.
   2. 301 - Specifications for Structural Concrete.

B. ASTM International (ASTM):
   1. C33 - Standard Specification for Concrete Aggregates.
   2. C94 - Standard Specification for Ready Mix Concrete.
   3. C143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
   4. C150 - Standard Specification for Portland Cement.
   5. C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
   6. C494 - Standard Specification for Chemical Admixtures for Concrete.
   7. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   8. D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3(600 kN-m/m^3)).
   9. D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3(2,700 kN-m/m^3)).
   10. D4832 - Standard Test Method of Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
   11. D5971 - Standard Practice for Sampling Freshly Mixed Controlled Low Strength Material.
   12. D6023 - Standard Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material.

1.03 SYSTEM DESCRIPTION

A. Mixture of portland cement, water, pozzolan, fine aggregate and admixtures, proportioned in accordance with the recommendations of ACI 229 to produce a homogeneous mixture that is flowable, that will readily work into corners and angles; that will not segregate in the plastic state; and that is self-compacting at the time of placement without the use of mechanical vibration.

B. Performance requirements:
   1. Air content, total calculated in accordance with ASTM D6023: Not less than 8.0 percent, nor greater than 12.0 percent.
   2. Compressive strength, measured in accordance with ASTM D4832 at 28 days: Not less than 50 pounds per square inch, nor greater than 150 pounds per square inch.

3. Wet density: Not greater than 132 pounds per cubic foot.
4. Slump, measured in accordance with ASTM C143 at the point of placement: Greater than 9 inches and that allows CLSM to flow freely and to be self-compacting during placement.

1.04 SUBMITTALS

A. Product data: Submit data completely describing materials in the mix and demonstrating compliance with the requirements of this Section:
   1. Cement: Mill tests. Indicate alkali content representative of each shipment.
   2. Fly ash: Identify source and type of fly ash.
   3. Water: Identify source and quality if not from a municipal treatment source.
   4. Admixtures: Manufacturer's product data indicating suitability for use in CLSM mixes and recommended dosage rates.
   5. Aggregate:
      a. Submit source, type, and sieve analyses. Include testing to demonstrate that materials in accordance with ASTM C33 requirements.
      b. Resubmit at any time there is a significant change in grading of materials.

B. Mix design:
   1. Submit full details, including mix design calculations for mix proposed for use.
   2. Trial batch test data:
      a. Submit data for each test cylinder.
      b. Submit data that identifies mix and slump for each test cylinder.

1.05 DELIVERY, STORAGE AND HANDLING

A. Store or stockpile cement, fly ash, and aggregate in accordance with ACI 301.

B. Store admixtures in accordance with the manufacturer's recommendations.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cement:
   1. Portland cement in accordance with ASTM C150, Type II.
   2. Having total alkali content not more than 0.60 percent.

B. Fly ash: Class C or Class F fly ash in accordance with ASTM C618.

C. Water:
   1. Potable water: Clean and free from oil and deleterious amounts of alkali, acid, organic matter, or other substances.

D. Admixtures: Products of a single manufacturer, specifically manufactured or recommended by that manufacturer for use in CLSM.
   1. Air entraining admixture: In accordance with ASTM C260.
   2. Water reducing admixture: In accordance with ASTM C494, Type A.

E. Aggregate:
   1. Non-expansive, non-reactive, inert natural sand in accordance with ASTM C33 for fine aggregate.

2.02 MIXES

A. See System Description for performance requirements of the plastic and hardened mix.

2.03 SOURCE QUALITY CONTROL

A. Trial batch:
   1. After mix design has been accepted by Engineer, have trial batch of the accepted mix design prepared by testing laboratory acceptable to Engineer.
   2. Prepare trial batches using the specific cement, fly ash, admixtures, aggregates, and water proposed for the Work.
   3. Prepare trial batch with quantity sufficient to determine slump, workability, and consistency; and to provide test cylinders as indicated in this Section.

B. Trial batch testing:
   1. Determine slump in accordance with ASTM C143, with the following modifications:
      a. Do not rod the concrete material.
      b. Place material in slump cone in one semi-continuous filling operation, slightly overfill, tap lightly, strike off, and then measure and record slump.
   2. Prepare and test trial batch specimens in accordance with ASTM D4832, with the following modifications:
      a. Provide cylindrical test specimens, each 6-inches in diameter by 12-inch high.
      b. Provide a minimum of 8 cylinders for testing of each trial batch.
      c. Fill the molds to overflowing and tap sides lightly to settle the mix.
      d. Do not rod the mix for consolidation in the cylinder.
      e. Strike off the excess material.
   3. Place test cylinders in a moist curing room. Exercise caution in moving and transporting the cylinders since they are fragile and will withstand only minimal bumping, banging, or jolting without damage.
   4. Do not remove the test cylinder from mold until that cylinder is to be capped and tested:
      a. Perform the capping carefully to prevent premature fractures.
      b. Do not perform initial compression test until the cylinders reach a minimum age of 3 days.
   5. Provide compressive strength tests:
      a. Test 4 test cylinders at 7 days after casting, and another 4 cylinders at 28 days after casting.
      b. The compression strength of the 4 test cylinders tested at 28 days shall be equal to or greater than the minimum required compression strength, but shall not exceed maximum compression strength.

C. If the trial batch tests do not meet the Specifications for strength or density, revise and re-submit the mix design, prepare additional trial batch(es), and complete

additional trial batch tests. Repeat until an acceptable trial batch is that conforms to the Specifications is produced.

1. All the trial batches and acceptability of materials shall be paid by the Contractor.
2. After acceptance, do not change the mix design without submitting a new mix design, trail batches, and test information.

PART 3 EXECUTION

3.01 PREPARATION

A. Do not place CLSM until preparation and condition of surfaces receiving the fill have been observed and accepted by the Engineer.

B. Remove debris foreign matter, and standing or running water from excavations and areas receiving CLSM before placement.

3.02 INSTALLATION

A. Pipes and trenches.
   1. Install cellular concrete as indicated on the Drawings and specified.
   2. Where CLSM is placed around and over pipes, secure pipes in place, or place CLSM in lifts to prevent pipe flotation.
   3. Where CLSM is placed in long, open trenches, confine material using bulkheads of sandbags, earth dams, or stiffer concrete at open ends of placement.
   4. Place CLSM at specified access points in the abandoned in-place pipe.

B. Soil preparation:
   1. Prior to placement of CLSM, prepare underlying soils as follows:
      a. Scarify surface to a depth of 8 inches.
      b. Adjust moisture content to or slightly above the optimum in accordance with ASTM D1557.
      c. Re-compact scarified surface to a minimum of 95 percent relative density in accordance with ASTM D1557.

3.03 MEASURING, BATCHING, MIXING AND TRANSPORTING

A. Measure, batch, mix and transport CLSM in accordance with the requirements of ASTM C94 and this Section.

B. Mix until there is uniform distribution of materials.

C. Discharge mixer completely prior to recharging.

D. After trial batch testing and mix acceptance, maintain slump during construction within plus or minus 1 inch of the design slump.

3.04 PLACING

A. Place controlled low strength material by method that preserves the quality of the material in terms of compressive strength and density.

B. Maintain fluid properties of the mix during placement:
   1. At point of placement, provide material that flows easily around, beneath, or through walls, pipes, conduits, or other structures.
   2. Do not place CLSM that has partially hardened or that has been contaminated by foreign materials.
   3. Handle and place CLSM using methods that minimize segregation of the mix.
   4. Deposit mix as near its final position as possible to avoid segregation due to rehandling or flowing.
   5. Contain and confine mix while it is fluid. Design containment structures and bracing at walls and forms to withstand lateral pressures of wet mix.

C. Lifts:
   1. Limit lift heights of CLSM placed against structures and other facilities that could be damaged due to the pressure from the CLSM, to the lesser of 3 feet or the lift height indicated on the Drawings.
   2. Do not place another lift of CLSM until the last lift of CLSM has set and gained sufficient strength to prevent additional lateral load against the forms or structure due to the weight of the next lift of CLSM.

D. Water conditions:
   1. Do not place CLSM in standing or flowing water.
   2. Do not permit water to flow over the surface of freshly placed or un-hardened CLSM.
   3. Do not submerge CLSM in water within 24 hours after placement.

E. Manage CLSM bleed water:
   1. Grade top surface of CLSM to drain away from the fill.
   2. Provide side containment that permits bleed water to drain to a contained management area away from the fill.

3.05 CURING AND PROTECTION

A. Curing:
   1. Prior to and during curing, install barriers to prevent equipment or personnel from falling into or becoming entrapped in CLSM.

B. Protect CLSM from:
   1. Damage from the elements.
   2. Damage of any nature during surrounding construction operations.

3.06 FIELD QUALITY CONTROL

A. Provide quality control over the Work of this Section as specified in Section 01450 - Quality Control and as specified in this Section.

B. General:
   1. Engineer inspection and acceptance required prior to placement.
   2. Make provisions for and furnish all material for the test specimens, and provide manual assistance to assist the Owner’s Testing Laboratory in preparing said specimens.

3.07 FIELD QUALITY ASSURANCE

A. Provide quality control over the work of this Section as specified in Section 01450 - Quality Control.

B. Field inspections:
   1. Engineer shall provide on-site inspection for the Work of this Section.
   2. Advise Engineer of readiness to proceed at least 24 hours prior to each placement of CLSM.
   3. Required inspections:
      a. Engineer will observe the prepared areas. Do not place CLSM until Engineer has observed and accepted preparations.
   4. Record of inspections.

C. Special tests and inspections:
   1. As specified in Section 01455 - Special Tests and Inspections.

D. Field sampling and testing:
   1. During construction, Owner shall provide sampling and testing to determine whether the CLSM, as produced and placed, complies with the requirements specified:
      a. Make provisions for and furnish material for test specimens. Cooperate by allowing free access for Owner’s independent testing firm to sample and test materials. Provide assistance in obtaining and preparing said specimens.
   2. Sample CLSM for testing in accordance with ASTM D5971.
   3. Required tests:
      a. Air content: Prepare sample and test in accordance with ASTM D6023.
      b. Compressive strength: Prepare and test cylinder specimens in accordance with ASTM D4832:
         1) Prepare 6-inch diameter by 12-inch high specimens for testing.
            a) Provide one set of specimens for each 150 cubic yards of CLSM placed, but not less than 1 set for each half day's placement.
            b) Prepare and test not less than 3 cylinders for each set.
            c) Place CLSM in the molds in accordance with ASTM D4832. Do not rod or otherwise consolidate the material in the mold.
            d) In accordance with ASTM D4832 recommendations for displacing bleed water at the top of the molds and refilling the molds before covering with a lid. Do not use air-tight lids.
         2) Place the cylinders in a safe location away from construction activities:
            a) Protect cylinders from bumping and impact.
            b) Maintain temperature surrounding cylinders between 60 and 80 degrees Fahrenheit until delivery to the laboratory for testing.
            c) After the first day, surround molds with a high humidity environment by covering with wet burlap, or equivalent highly absorptive material. Maintain saturation of the cover. Do not sprinkle water directly on the cylinders.

3) After 4 days, place the cylinders in a protective container for transport to the laboratory for testing:
    a) Exercise caution in moving and transporting the cylinders since they are fragile and will withstand only minimal bumping, banging, or jolting without damage.
    b) Transport container may be a box with a Styrofoam or similar lining that will limit jarring and bumping of the cylinders.
4) Upon receipt at the testing laboratory, place test cylinders in a moist curing room until dates for testing.
5) Do not remove test cylinders from molds until the day that cylinders is to be capped and tested.
6) Cap and test for compressive strength in accordance with ASTM D4832:
    a) Do not perform initial compression test until the cylinders reach an age of at least 4 days.
    b) Test 1 cylinder at 7 days and 2 at 28 days.
7) Compressive strength of the cylinders tested at 28 days shall be equal to or greater than the minimum required compression strength, but shall not exceed maximum compression strength specified.

3.08 NON-CONFORMING WORK

A. When testing or observation indicates CLSM with properties outside the specified and accepted range, Engineer will issue instructions regarding disposition of nonconforming materials.

B. Engineer may:
    1. Reject CLSM represented by those test specimens and require its removal and replacement.
    2. Require modification of the mix design to provide CLSM with the properties specified.

C. Make such modifications at no additional expense to the Owner and with no adjustment to the schedule.

END OF SECTION

SECTION 02318

TRENCHING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Trench excavation and trench backfill for pipelines, manholes, vaults, and appurtenances.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand Cone Method.
   2. D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3).
   3. D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.03 SUBMITTALS

A. As specified in Section 01330 - Submittal Procedures.

B. Product data on soils and aggregates:
   1. Material source.
   2. Gradation.
   3. Test data to demonstrate compliance with requirements as specified in this Section.

C. Samples:
   1. Provide 50-pound sample of materials when requested by the Engineer.

D. Confirmation testing:
   1. Certification of Contractor's testing laboratory.
   2. Record copy report for tests performed by Contractor's testing laboratory.

1.04 DEFINITIONS

A. Backfill: Material placed in trench above the pipe embedment zone.

B. Bedding: Material placed under, around, and over pipes or ducts in trenches.

C. Fine grading: bedding material placed directly below pipes or ducts to provide support at the bottom of the trench and to bring those elements to required grades and elevations.

D. Pipe foundation: Stabilization material placed at the bottom of trench to provide support when the trench bottom is not firm, dry or uniform.

E. Pipe embedment zone: Includes bedding, fine grading, and haunch zone.

F. Haunch zone: Material placed below and beside the pipe up to the pipe springline.

G. Pipe springline: A horizontal reference line located at mid-height, or halfway point, of a circular conduit, pipe, or tunnel. It is the maximum horizontal dimension or diameter of a circular conduit, pipe, or tunnel.

H. Rigid pipe: Includes reinforced non-cylinder concrete, reinforced concrete cylinder, prestressed concrete cylinder, vitrified clay, polymer concrete, cast iron, asbestos cement and cast-in-place pipes.

I. Flexible pipe: Includes steel, ductile iron, thermoplastics such as polyvinyl chloride (PVC) and high-density polyethylene (HDPE), thermosetting plastics such as fiberglass-reinforced polymer (FRP), bar-wrapped concrete cylinder pipe, and corrugated steel pipes.

J. Haunch zone: Material placed below and beside the pipe up to the pipe springline.

K. Lift: A layer of soil or aggregate material, measured before compaction.

L. Maximum density, laboratory compaction: Soil maximum density and optimum water content when tested in accordance with ASTM D1557.

M. Maximum density, field compaction: Soil density and water content when tested in accordance with ASTM D6938.

N. Pavement section: Includes pavement plus underlying courses such as base course and subgrade.

O. Pipe embedment zone: Includes bedding, fine grading, and haunch zone.

P. Pipe foundation: Material placed at the bottom of trench to provide support.

Q. Pipe springline: A horizontal reference line located at mid-height, or halfway point, of a circular conduit, pipe, or tunnel. It is the maximum horizontal dimension or diameter of a circular conduit, pipe, or tunnel.

PART 2 PRODUCTS

2.01 MATERIALS

A. As specified in Section 02050 - Soils and Aggregates for Earthwork.

B. Class C concrete: As specified in Section 03300 - Cast-in-Place Concrete.

PART 3 EXECUTION

3.01 PREPARATION

A. Stabilize excavations as specified in Section 02260 - Excavation Support and Protection.

3.02 TRENCH EXCAVATION

A. Excavate bottom of trench to depth indicated on the Drawings.

B. Areas of new fill or embankment:
   1. Prior to laying pipes or electrical service, place fill and compact as specified to not less than 2 feet above top of pipe, conduit, or duct bank.
   2. Excavate through fill for pipe trench.

C. Trench widths as specified in the following table:

Buried Pipe Or Accessory	Minimum Trench Width	Maximum Trench Width
Nominal Pipe Diameter: 4 inch to 24 inch	OD + 18 inches	OD + 24 inches
Nominal Pipe Diameter: Greater than 24 inch	OD + 24 inches	OD + 36 inches
Manholes, vaults, valves, or other accessories	12 inches between outer surface and trench side or shoring	Not applicable

D. Potable water pipe and appurtenances:
   1. Lay in trenches separate from those used for sewers and recycled water.
   2. Unless otherwise specified or indicated on the Drawings, lay in trenches having cover of not less than 3 feet below surface of ground located at distance of not less than 10 feet clear horizontally from any parallel sewer and 1 foot clear vertically above any parallel sewer.

E. At road crossings or existing driveways:
   1. Provide notification, vehicular access, and traffic control as required by permits and special conditions.
   2. Provide temporary asphalt or plating for traffic or access at the end of each work day unless approved in writing by Engineer.
   3. If unexpected utility conflicts or changed site conditions require trenchless technologies or temporary bridges, immediately notify the Engineer in writing. Approval is required before proceeding with construction.
   4. When trench width at top of pipe is increased beyond width specified in this Section because of soil conditions, safety requirements, or other reasons, Engineer approval for remedy is required without additional cost to Owner.
      a. Remedy may include upgrade laying conditions or install stronger pipe designed in accordance with Specifications.

3.03 TRENCH BACKFILL - GENERAL

A. Trench area terminology and locations as indicated on the Drawings.

B. Place material, except CLSM and concrete, in maximum 6 inch lifts, measured before compaction.

C. Backfilling of manhole excavation: Conform to backfilling requirements for trenches as specified in this Section.

3.04 PIPE FOUNDATION

A. Provide trench bottom with firm, dry, uniform bearing surface at the grade indicated on the Drawings.

B. Excess excavation below elevation indicated on the Drawings will require installation of pipe foundation material to bring the trench bottom back to the elevation indicated on the Drawings at no additional cost to Owner:
   1. Materials and placement:
      a. Stabilization material:
         1) Wrap stabilization material as specified in Section 02621 - Stabilization Fabric.

C. If bottom of trench excavation consists of soil:
   1. Scarify bottom of trench to a depth of 6 inches below the grade indicated on the Drawings.
   2. Materials and placement:
      a. Recompact scarified material to 95 percent of maximum density.

D. If bottom of trench excavation consists of rock or any material that, by reason of its hardness, cannot be excavated to provide uniform bearing surface:
   1. Remove such rock or other material to a depth of not less than 4 inches below pipe embedment zone.
   2. Materials:
      a. Class C concrete.

E. If bottom of trench excavation consists of mud or other soft unstable material:
   1. Remove such unacceptable material to a depth of not less than 18 inches below pipe embedment zone.
   2. Material and placement:
      a. Stabilization material:
         1) Wrap stabilization material as specified in Section 02621 - Stabilization Fabric.

3.05 PIPE EMBEDMENT ZONE

A. Pipe displacement:
   1. Take necessary precautions in placement and compaction of bedding material to prevent displacement of piping.
   2. In event there is movement or floating of the piping, re-excavate, re-lay, and backfill the pipe.

B. Fine grading:
   1. Place 6-inches of approved haunch zone bedding material from the trench bottom to the bottom of the pipe or duct to provide support at the bottom of the trench and to bring those elements to required line and grade.

C. Depressions for joints or couplings:
   1. Excavate holes in the fine grading material at the bottom of the trench.
   2. Provide holes of sufficient width to provide ample room for grouting, banding, or welding as necessary for making joints and to ensure that pipe rests upon prepared trench bottom and not supported by any portion of the joint.

D. Rigid pipe:
   1. Pipe embedment zone: Below pipe springline:
      a. Materials and placement:
         1) Aggregate base course compacted to 95 percent maximum dry density.
   2. Pipe embedment zone: Above pipe springline:
      a. Compacted to a depth above pipe: 12-inch minimum.
      b. Materials and placement:
         1) Aggregate base course compacted to 95 percent maximum dry density.

E. Flexible pipe:
   1. Pipe embedment zone:
      a. Compacted to a depth above pipe: 12-inch minimum.
      b. Materials and placement:
         1) Aggregate base course compacted to 95 percent maximum dry density.
         2) Sand.

3.06 BACKFILL

A. Trenches:
   1. Materials and placement:
      a. Native soil - select compacted to 95 percent maximum dry density.
      b. Imported fill compacted to 95 percent maximum dry density.
      c. Aggregate base course compacted to 95 percent maximum dry density.
      d. CLSM:
         1) Density.

B. Trenches below or within 10 feet of the outside perimeter of structures:
   1. Backfill to underside of aggregate base course below structure or structural fill below structure, as specified in Section 02300 - Earthwork.
   2. Materials and placement:
      a. Aggregate base course compacted to 95 percent of maximum density.
      b. CLSM.

C. Trenches in roadways and paved areas:
   1. Backfill trench to underside of pavement.
   2. Materials and placement:
      a. Aggregate base course compacted to 95 percent of maximum density.

D. Trenches in areas outside the improved section of roadways or in open country:
   1. Backfill to finished grade.
   2. Materials and placement:
      a. Native soil, native soil - select, imported material, or aggregate base course compacted to 90 percent of maximum density.

E. Trenches under existing intersecting pipes, duct banks, or conduits larger than 3 inches in diameter:
   1. Backfill from above top of new pipe embedment zone to springline of intersecting pipe or conduit:
      a. Extend backfill at least 2 feet on either side of intersecting pipe or conduit to ensure backfill material remains in place while other backfill is being placed.
      b. Materials and placement:
         1) CLSM, unless otherwise indicated on the Drawings.
   2. Backfill remainder of trench:
      a. Materials and placement:
         1) CLSM.
         2) Class C concrete.

3.07 EXCESS MATERIAL

A. Remove excess excavated material from the Project site as specified in Section 02300 - Earthwork.

3.08 FIELD QUALITY CONTROL

A. Provide field quality control for the Work as specified in Section 01450 - Quality Control.

B. Confirmation tests: As specified in Section 02300 - Earthwork.
   1. Minimum frequency of confirmation testing:
      a. At each test location include tests for each type or class of backfill from bedding to finished grade.
      b. For trenches: 1 location every 200 linear feet.
      c. Crossing paved roads: 1 location at each crossing.
      d. Under pavement cuts or within 2 feet of pavement edges: 1 location every 400 linear feet.

C. Compliance tests:
   1. Make periodic compliance tests to verify that compaction is meeting requirements as specified in this Section.
   2. Perform remedial work if compaction test fails to meet specified requirements using one of the following methods:
      a. Remove and replace backfill at the proper density.
      b. Other means acceptable to the Engineer.
   3. Retesting:
      a. Costs of retesting: Contractor is responsible for the costs of retesting required to confirm and verify that remedial work has brought compaction within specified requirements.
      b. Contractor's confirmation tests during performance of remedial work:
         1) Performance: Perform tests in manner acceptable to the Engineer.
         2) Frequency: Double amount specified for initial confirmation tests.

D. Piping system testing:
   1. As specified in Section 15958- Piping Systems Testing.

END OF SECTION

SECTION 02581

PRECAST ELECTRICAL HANDHOLES AND ELECTRICAL MANHOLES

PART 1 GENERAL

1.01 SUMMARY

A. Design, fabricate, and install precast electrical handholes and precast electrical manholes of the size and type indicated on the Drawings and specified:
   1. Construction of cast-in-place concrete electrical structures, including handholes and manholes, are specified in other sections.

B. Section includes:
   1. Precast polymer concrete handholes and accessories.
   2. Precast portland cement concrete handholes, manholes and accessories.

C. Alternates:
   1. Contractor may propose to construct cast-in-place structures in lieu of the precast structures specified:
      a. Obtain Engineer's acceptance of this alternative before submitting, providing, or installing.
      b. Submit full information on design and detailing of proposed alternatives including design details and drawings of the same types required by this Section for precast structures.

1.02 REFERENCES

A. American Association of State Highway Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

B. American Concrete Institute (ACI):
   1. 318 - Building Code Requirements for Structural Concrete and Commentary.

C. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   3. C858 - Standard Specification for Underground Precast Concrete Utility Structures.
   4. C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures.
   5. C1028 - Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method.
   6. C1037 - Standard Practice for Inspection of Underground Precast Concrete Utility Structures.

D. National Fire Protection Association (NFPA):
   1. National Electrical Code (NEC).

E. National Precast Concrete Association (NPCA).

F. Society of Cable Telecommunications Engineers (SCTE):
   1. 77 - Specification for Underground Enclosure Integrity.

G. Underwriters Laboratories (UL).

1.03 DEFINITIONS

A. Handhole: An enclosure for use in underground systems that has been sized and detailed to allow personnel to reach into, but not enter, the enclosure to install, operate, or maintain equipment or wiring or both. (Reference: NEC, Article 100):
   1. As used in this Section, “handhole” will refer to a precast electrical handhole.

B. Manhole: An enclosure for use in underground systems that has been sized and detailed to allow personnel to enter the enclosure to install, operate, or maintain equipment or wiring or both:
   1. As used in this Section, “manhole” will refer to a precast electrical manhole.

C. Polymer concrete: A composite material consisting of an organic polymer binder mixed with embedded aggregate particles. Also known as “resin concrete:”
   1. Abbreviated “PC” as in “PC HANDHOLE.”

D. Portland cement concrete: A composite material consisting of a portland cement binder, water, admixtures, and a combination of fine and coarse mineral aggregates:
   1. Abbreviated “PCC” as in “PCC HANDHOLE” or “PCC MANHOLE.”

E. Precast concrete: A concrete fabrication designed by a qualified engineer and subsequently fabricated at a qualified fabrication site, which is usually located some distance from the site where the fabrication will be installed.

1.04 SYSTEM DESCRIPTION

A. General requirements for handholes and manholes:
   1. As specified in Section 16050 - Common Work Results for Electrical for general requirements for electrical work.
   2. Provide structures of the sizes and shapes indicated on the Drawings, with layouts, dimensions, and details as indicated on the Drawings and as specified.
   3. Conform to the requirements of:
      a. NEC.
      b. Project regulatory requirements as specified in Section 01410 - Regulatory Requirements.

B. Polymer concrete handholes:
   1. Load resistance of boxes and covers:
      a. Conform to all provisions of SCTE 77 for Tier 5, 8, 15, or 22 applications as specified in this Section:
         1) Where multiple “Tiers” are specified, handholes shall adequately support compatible covers while providing the highest Tier rating specified.

2) Load rating of cover for an assembly shall not exceed the load capability of the box below.
3) Coefficient of friction between cover and box: Not less than 0.50 when measured in accordance with ASTM C1028.

2. Testing and certification:
   a. Each handhole to be installed shall have a report certifying that the design and construction of the unit has successfully passed all tests for materials and product performance required by SCTE 77:
      1) Testing and report shall be by a qualified testing agency, independent of the manufacturer. Test report shall bear the seal of a licensed professional engineer.
      2) Provide evidence of UL listing as required by NEC for products to be provided.

C. Portland cement concrete handholes and manholes:
   1. Load resistance of boxes and covers.
   2. Design requirements: Loads on structures:
      a. In accordance with ASTM C857, except as modified in this Section.
      b. Loads at the ground surface:
         1) See “Electrical Handhole and Manhole Schedule” indicated on the Drawings for minimum surface loading requirements at each structure. Loads are designated as “sidewalk,” or ”roadway”.
         2) The vehicle and pedestrian loadings in the following paragraphs need not be additive; however, structures designated for “roadway” loading shall also support “sidewalk” loads.
         3) “Sidewalk”: Load from regular pedestrian traffic with considerations for occasional non-deliberate vehicular traffic:
            a) Designation "A-0.3" in ASTM C857 Table 1 (300-psf uniform load).
         4) ”Roadway”: Load from heavy, frequently repeated vehicle traffic:
            a) Designation "A-16" in ASTM C857 Table 1 (AASHTO HS20-44).
      c. Lateral earth pressure loads:
         1) Determine in accordance with the following requirements. Include effects of groundwater and seismic accelerations on lateral earth pressures:
            a) Equivalent lateral pressure: 65 pounds per square foot per foot of depth (triangular distribution).
            b) Surface surcharge load:
               (1) Backfill-induced live load surcharge of 125 pounds per square foot (rectangular distribution).
               (2) In accordance with ASTM C857 Vehicle Load Designation "A-16" for "Roadway" or "A-0.3" for "Sidewalk" where such surcharge exceeds backfill loads described in the preceding paragraph.
            c) Groundwater effects:
               (1) Include effects from groundwater and soils saturated by flooding using design elevations specified in Section 01610 - Project Design Criteria.
               (2) Use equivalent lateral pressure of 95 pounds per square foot per foot of depth (triangular distribution) for soil below the design groundwater elevation.

d) Seismic acceleration effects:
(1) As specified in Section 01610 - Project Design Criteria and Section 01612 - Seismic Design Criteria.
(2) On opposite sides of the structure that are perpendicular to the direction of acceleration, include equivalent lateral pressure (inverted fluid pressure distribution), beginning with a pressure of 0 at the base of the structure, and increasing at a rate of 30 pounds per square foot per foot of rise toward the ground surface.
(3) Apply seismic effects as additive force on side where the soil mass is being accelerated toward the structure, and as subtractive force on the opposite side where the soil mass is being accelerated away from the structure.

d. Groundwater and flood loads - buoyancy effects:
1) As specified in Section 01610 - Project Design Criteria for design groundwater and design flood elevations. Groundwater: Design for site groundwater elevation taken at the level of finished grade around the structure.
2) Buoyancy: For groundwater and flood conditions, provide factor of safety against flotation of at least 1.20:
a) If the weight of soil overlying footing projections on the structure is considered to resist flotation, use a buoyant unit weight of soil equal to not more than 30 pounds per cubic foot.
b) Concrete fill may be provided in the bottom section of precast portland cement concrete structures to add weight. Submit proposed details.

e. Soil-bearing pressure at base:
1) Maximum 1,000 pounds per square foot total pressure on prepared subgrade soils or pressure not greater than the weight of the vertical column of soil removed (assuming a soil unit weight of 125 pounds per cubic foot).

f. Lifting and handling loads:
1) Make provision in the design for the effects of loads or stresses that may be imposed on structures during fabrication, transportation, or erection.

g. Load combinations:
1) Design structures to sustain the specified loads individually or in combination.

3. Design requirements: Structural analysis, design, and detailing:
a. General:
1) Analyze and design structures including the effects of 2-way action (“plate action”) and of load transfer around current and future openings.
2) Where structures include panels designed for future removal (“knockout panels”), design structures for loads and stresses with any combination of any or all such panels in place or removed.

b. Precast polymer concrete handholes:
1) Design to resist loads with cover in place or removed.
2) Detail cover support and top edges to maintain cover in place over walls and to prevent soil from sloughing into the handhole when cover is removed.

c. Precast portland cement concrete handholes and manholes:
    1) Design structures in accordance with the requirements of ACI 318 and this Section.
    2) Provide reinforcement at all areas subject to tensile stress when loaded with the specified loads and combinations thereof.
    3) Provide temperature and shrinkage reinforcement to equal or exceed ACI 318 requirements in all concrete sections.
    4) Provide minimum clear concrete cover over reinforcement at both interior and exterior faces of all members in accordance with the following:
        a) Handholes: 1.25 inches.
        b) Manholes: 2 inches.
    5) Reinforcement details:
        a) Walls: For structures with wall thickness of 8 inches or less, locate a single mat of reinforcement at the center of the wall.
        b) Slabs: For structures with slab thickness of 7 inches or less, locate a single mat of reinforcement at the center of the slab.
        c) Structures with wall or slab thicknesses exceeding these limits shall have a reinforcement at each face of the member.
    6) Joints:
        a) Provide structures with watertight joints between sections, and detailed to minimize water infiltration at duct bank and conduit penetrations.
        b) Provide structures with non-skid, shiplap or tongue and groove joints between sections.

1.05 SUBMITTALS

A. Product data: Manufacturer's catalog data, details, and warranties for the following items.
    1. Polymer concrete handholes:
        a. Materials of construction, and resistance of those materials to water absorption, flammability, sunlight/ultraviolet exposure, and chemicals likely to be found in the area of use.
        b. Available colors.
        c. Details for covers, cover support, and cover attachment to the underlying box.
    2. Portland cement concrete handholes and manholes:
        a. Materials of construction.
        b. Joint details and joint-sealing materials.
        c. Data for hatches or covers and rings.
        d. Preformed channels and accessories for cable racking.
        e. Drain and sump details, including removable covers.
        f. Pulling iron details.

B. Shop drawings:
    1. Polymer concrete handholes:
        a. Manufacturer's catalog cuts showing dimensions and details of construction.

2. Portland cement concrete handholes and manholes:
    a. Shop drawings for each structure shall bear the seal and signature of a professional engineer licensed in the state where the structures will be installed.
    b. Dimensioned and “to-scale” plans, sections, and details for each structure including:
        1) Layout plan for that structure.
        2) Sizes, locations, and vertical positions of duct bank windows and knockout panels.
        3) Locations and details for access openings, pulling irons, embedded cable supports and racks, and sumps.
        4) Details of structural reinforcement showing bar size and spacing; true position of reinforcement in structural members with clear concrete cover at both inside and outside faces; location, bar size, and spacing of added reinforcement around openings; and other details relevant to design and fabrication of the structure.
        5) Details of joints between adjacent precast sections, including provisions for overlap and for placement of sealants.

C. Design data:
    1. Polymer concrete handholes:
    2. Portland cement concrete handholes and manholes:
        a. Structural calculations:
            1) Submit complete structural calculations for each structure.
            2) Provide calculations bearing the seal and signature of a professional engineer licensed in the state where the structures will be installed.
        b. Manufacturer’s statement of materials used for fabrication and construction, in accordance with ASTM C858, for record. Include the following:
            1) Concrete mix design: For each concrete mix design to be used for the structures, include data describing:
                a) Source and type of cement.
                b) Sources, grading, and specific gravities of aggregates.
                c) Aggregate reactivity data.
                d) Concrete mix proportions and design strength.
                e) Type, name, and dosage of all admixtures included in the concrete mix.
            2) Reinforcing steel: Mill certificates.

D. Test reports:
    1. Polymer concrete handholes:
        a. Independent laboratory test reports bearing the seal of a licensed professional engineer and demonstrating compliance with the requirements of SCTE 77 for the loading conditions specified.
    2. Portland cement concrete handholes and manholes:
        a. Fabricator’s tests for compressive strength of concrete used in structures, made in accordance with recommendations of ASTM C858.

E. Certificates:
    1. Polymer concrete handholes:
        a. Manufacturer’s certification that polymer concrete handholes are in accordance with the requirements of SCTE 77.

2. Portland cement concrete handholes and manholes:
    a. Manufacturer's current plant certification under NPCA for the structures to be supplied:
        1) Certification shall be current and in-effect at the time structures are manufactured.
    b. Manufacturer's certification that handholes and manholes are in accordance with the requirements of ASTM C858.

F. Manufacturer's instructions:
1. Instructions for handling and setting structures in place.

G. Manufacturer's field reports:
1. Portland cement concrete handholes and manholes:
    a. Manufacturer's inspection reports in accordance with ASTM C1037.

H. Closeout documents:
1. Project record documents:
    a. Portland cement concrete handholes and manholes:
        1) Final, revised plans and details of as-constructed precast handholes and manholes if requested for record by the Engineer.
2. Warranties:
    a. Manufacturer's standard warranty for:
        1) Polymer concrete handholes.
        2) Portland concrete handholes and manholes and accessories.

1.06 QUALITY ASSURANCE

A. Qualifications:
1. Designer:
    a. Portland cement concrete handholes and manholes:
        1) Professional engineer qualified in the design of concrete structures and holding a current license in the state where the structures will be installed.
2. Manufacturer:
    a. Polymer concrete handholes:
        1) Demonstrating at least 5 years of experience in the design and production of products of the type required for this Work.
        2) Holding product testing records demonstrating load resistance of products to be installed.
    b. Portland cement concrete handholes and manholes:
        1) Holding current NPCA plant certification for the products produced.
        2) Demonstrating at least 5 years of experience in the design, production, and installation of products of the type required for this Work.
        3) Capable of providing structural designs prepared by a professional engineer licensed in the state where the structures will be installed.
        4) Providing inspection during fabrication and handling in accordance with the requirements of ASTM C1037.
3. Installer:
    a. Capable of providing equipment of adequate capacity and mobility to handle and set units with proper bearing on the subgrade and without damage to the unit.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Packing, shipping, handling, and unloading:
   1. Package and brace structures to avoid damage during shipping and handling.
   2. Furnish crane or forklift for unloading and setting of portland cement concrete handholes and manholes.

B. Acceptance at site:
   1. Structures delivered to the site with cracks, damage, and damaged or missing accessories shall be removed from the site and replaced at no additional cost to the Owner.

C. Storage and protection:
   1. Store handholes and manholes and their appurtenances in areas protected from damage due to weather and site operations.

1.08 PROJECT CONDITIONS

A. Environmental requirements: As specified in Section 01610 - Project Design Criteria.

1.09 SEQUENCING

A. Coordinate installation of precast electrical handholes and manholes with duct banks specified in Section 16133 - Duct Banks.

1.10 WARRANTY

A. Provide manufacturer’s standard warranty for precast handhole and manhole structures and accessories.

1.11 SYSTEM START-UP

A. As specified in Section 16050 - Common Work Results for Electrical.

PART 2 PRODUCTS

2.01 EXISTING PRODUCTS - NOT USED

2.02 MATERIALS

A. Cast-in-place concrete for fill at base sections of portland cement concrete manholes with deep sumps or ballast to resist buoyancy shall be “Class A” concrete as specified in Section 03300 - Cast-in-Place Concrete.

2.03 MANUFACTURED UNITS - POLYMER CONCRETE HANDHOLES

A. General:
   1. Enclosures, boxes, and cover shall conform to all test provisions of SCTE 77.

B. Manufacturers: One of the following or equal:
   1. Quazite Division of Hubble, Incorp.
   2. Carson Ind., LLC.

C. Materials:
   1. Polymer concrete with optional fiberglass reinforcement.
      a. Handholes constructed of plastic or fiberglass will not be permitted.

D. Components:
   1. Cover:
      a. Provide gasketed cover with lifting slot and stainless steel hex head bolts for attachment to box.
      b. Fasten cover to box using stainless steel hex head bolts.
      c. Skid-resistant surface: Coefficient of friction for walking surface on top of cover shall be at least 0.50 when measured in accordance with ASTM C1028.
      d. Custom logo not required.
   2. Box:
      a. Open-bottom base unless otherwise indicated on the Drawings:
         1) Stackable sections with interlocking joints to maintain horizontal and vertical alignment.
      b. Provide knockouts, terminators, pulling eyes, and inserts as required for a complete installation.
   3. Fabrication:
      a. All components in assembly (boxes and cover) shall be manufactured using matched surface tooling for consistency of production.

E. Load rating:
   1. Provide “TIER” rating based on Schedule of Electrical Handholes and Electrical Manholes indicated on the Drawings, and the following loading requirements:

Surface Loading Rating	Requirements
“Sidewalk”	“TIER 15” - “Medium Duty” For driveway, parking, and ramp areas where vehicle wheel loads will not exceed 2,000 pounds on a single wheel.
“Roadway”	Not allowed. - “Heavy Duty” For highway traffic or AASHTO wheel loads of at least 16,000 pounds.

   2. Provide covers with “TIER” rating embossed or cast into the top surface.
   3. Design load rating of cover for an assembly may not exceed the design load rating of the box below.

F. Accessories:
   1. Provide 2 non-corroding steel lifting hooks for removing covers.

2.04 MANUFACTURED UNITS - PORTLAND CEMENT CONCRETE HANDHOLES AND MANHOLES

A. General:
   1. Provide portland cement concrete handholes and manholes configured and designed as indicated on the Drawings and specified.
   2. In accordance with ASTM C858 unless otherwise noted.

B. Manufacturers: One of the following, or equal:
   1. Oldcastle Precast.
   2. Jensen Precast.

C. Components:
   1. Floor:
      a. Construct floors as a monolith.
      b. Where sump or low-point drain is included, slope floor to that point.
   2. Roof, walls, and base:
      a. Designed and rated to support vehicle and pedestrian loads at the spans indicated.
      b. See the Electrical Handhole and Manhole Schedule indicated on the Drawings for required load rating by structure location.
   3. Access covers:
      a. Handholes: Aluminum plate hinged floor access door (hatch) as specified in Section 08320 - Floor Access Doors.
         1) Load rating:
            a) “Heavy Duty” for covers at locations designated for “Roadway” loads.
            b) “Medium Duty” or stronger for covers at locations designated for “Sidewalk” loads.
         2) Minimum access door size not less than 36 inches square, unless otherwise indicated on the Drawings.
         3) Provide bearing surface with pre-installed continuous elastomeric gasket to minimize water infiltration at lid.
         4) Provide skid-resistant lid with cast-in or machined-in grid pattern and the word “ELECTRICAL” in block letters at least 1.5 inches high.
      b. Manholes: Cast iron frame and cover:
         1) Manhole rings and covers: As specified in Section 05500 - Metal Fabrications.

D. Accessories:
   1. Provide accessories as indicated on the Drawings and specified.
   2. Materials at duct bank penetrations:
      a. Joint filler as specified in Section 03150 - Concrete Accessories.
      b. Backer rod and sealant as specified in Section 07900 - Joint Sealants.
   3. Pulling irons:
      a. Provide non-corroding cable pulling irons located for use with each current duct bank location and additional irons for use with duct banks that may be installed through future knockout panels.
      b. Pulling irons may not be located on the floor.
      c. Where pulling irons are installed on the wall, any pockets surrounding the irons shall have bottom surfaces sloped to drain.
      d. Secure pulling eyes to structure reinforcement.

4. Cable racks and racking hardware:
    a. Materials: Stainless steel as specified in Section 16070 - Hangers and Supports.
    b. Embedded slots: Maximum depth of 1.5 inches.
5. Sumps and drains:
    a. Fiberglass or HDPE fabrications including removable lids to prevent tripping hazards.
6. Exterior dampproofing:
    a. As specified in Section 07110 - Dampproofing.
    b. Field applied to all wall and roof surfaces exposed to soil.

E. Fabrication:
1. Embeds:
    a. Install embedded items with provisions for drainage to remove dripping or standing water, and to minimize corrosion.
        1) Pulling irons may not be placed on the floor or in pockets that will collect water.
        2) Detail bottom of cable rack channels to provide a downward sloping “sill” at the bottom of each vertical channel, so that the channel slot drains toward the floor.
    b. Concrete cover:
        1) Provide minimum 0.75-inch clear concrete cover between embeds and surrounding reinforcement.
        2) Provide minimum 1.25-inch clear concrete cover between embed and exterior face of wall.

F. Tests and inspections:
1. Test and inspect structures in accordance with ASTM C858 and ASTM C1037.

PART 3 EXECUTION

3.01 GENERAL

A. Furnish and install precast electrical handholes and manholes as indicated on the Drawings and specified.

B. Install additional handholes and manholes required so installation procedures will conform to cable manufacturer’s pulling tension requirements.
1. Include proposed locations and details of such additional handholes and manholes with the submittals under this Section.

3.02 EXAMINATION (NOT USED)

3.03 PREPARATION

A. Design:
1. Prepare detailed and scalable layouts for each manhole structure showing locations of conduit or duct bank penetrations, clearances, locations, and sizes of access openings and major accessories.

B. Protection:
   1. Where handhole and manhole structures are installed adjacent to existing site structures or utilities, provide excavation support or other protection as required to maintain those facilities in service and to prevent damage to both existing and new facilities.

C. Site preparation:
   1. Excavate and prepare exposed subgrade as indicated on the Drawings and as specified.
   2. Install and compact foundation layer as indicated on the Drawings and specified.
   3. Level foundation materials so that structures will be set plumb, and duct banks will be at proper grade and alignment:
      a. Install with uniform bearing on foundation materials.
      b. Wedging or blocking of base sections for leveling over the foundation materials will not be permitted.

3.04 INSTALLATION

A. General:
   1. Protect handholes and manholes from displacement, flooding, or flotation.

B. Polymer concrete handholes:
   1. Install structures in accordance with the manufacturer's recommendations.
   2. Clean joints between adjacent sections for tight fit.
   3. Set covers at elevations indicated on the Drawings:
      a. Securely attach cover to below-grade box.
   4. Backfill polymer concrete handholes as indicated on the Drawings and as specified.

C. Portland cement concrete handholes and manholes:
   1. Install structures in accordance with ASTM C891 and the provisions of this Section:
      a. In the event of conflicts, the more restrictive provisions shall apply.
   2. Clean and prime joints between adjacent precast sections:
      a. Install sealing compound between sections and provide watertight joints.
   3. Set covers and hatches at elevations indicated on the Drawings:
      a. Securely attach frames to top of precast structures and grade adjustment rings.
   4. Penetrations:
      a. Holes for duct banks and other penetrations may not be cut into precast handholes and manholes unless they are located at designated locations shown on the shop drawings or at knockout panels cast into the structure during manufacturing.
      b. Carefully remove concrete from knockout panel areas with saws:
         1) Ensure that break-back does not extend beyond the designated limits of the knockout panel.
      c. Coat any reinforcement cut or exposed during removal of knockout panel sections with minimum 2 coats of high solids epoxy as specified in Section 09960 - High-Performance Coatings:
         1) Apply epoxy coating applied over and at least 1-inch past the perimeter of the reinforcement.

5. Install duct banks and conduit penetrations in accordance with the penetration details indicated on the Drawings:
    a. Place all joint fillers, caulks, and sealants before coating exterior concrete surface with bituminous dampproofing.
6. Fill holes that were provided for handling or other temporary purposes with non-shrink cement grout using procedures as specified in Section 03300 - Cast-in-Place Concrete unless otherwise detailed by the manufacturer.
7. After structures are set and before backfilling, coat exterior below-grade surfaces (around the sidewalls, over the top slab, and around any vertical risers to grade) with 2 heavy coats of bituminous dampproofing as specified in Section 07110 – Dampproofing:
    a. Apply dampproofing in accordance with the coating manufacturer's instructions and at a rate of 40 to 60 square feet per gallon per coat.
    b. Mask over at least 1 inch back from joint caulks or sealants, and prevent dampproofing from coming in contact with those materials.
8. Backfill handholes and manholes as indicated on the Drawings and as specified.

D. Site tolerances:
1. Set electrical handholes and manholes plumb and true at locations indicated on the Drawings.
2. Tolerances on placing:
    a. Horizontal location: Plus or minus 1 inch.
    b. Vertical elevation: Plus or minus 1/2 inch.
    c. Plumb: Plus or minus 1/8 inch over 10 feet.

3.05 REPAIR/RESTORATION

A. Repair cracks or blemishes in concrete by methods acceptable to the Engineer. Submit proposed repairs for acceptance before commencing work.

3.06 FIELD QUALITY CONTROL

3.07 ADJUSTING

A. After final grading is complete, adjust access covers to grade.

3.08 CLEANING

A. Before installation of cables in any duct banks and handholes or manholes, remove all concrete spoil, forms, debris, silt, dust, and other foreign material.

3.09 SCHEDULES

A. See Drawings for Electrical Handhole and Electrical Manhole Schedule.

END OF SECTION

SECTION 02620

FILTER FABRIC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Nonwoven filter fabric.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
   2. D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   3. D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
   4. D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   5. D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.
   6. D5261 - Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
   7. D6241 - Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.

1.03 DEFINITIONS

A. Filter fabric: Nonwoven geotextile fabric manufactured from polypropylene fibers.

1.04 SUBMITTALS

A. Product data.

B. Samples.

C. Quality control submittals:
   1. Certificates of Compliance.
   2. Manufacturer's Instructions.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Storage and protection:
   1. Furnish filter fabric in protective covers capable of protecting the fabric from ultraviolet rays, abrasion, and water.

1.06 PROJECT CONDITIONS

A. Take field measurements to determine the lengths and dimensions of the surfaces to receive the fabric.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Propex, Geotex 401.
   2. Ten Cate Geosynthetics, Mirafi 140N.

2.02 MATERIAL REQUIREMENTS

A. Physical properties: Meet the following minimum requirements:

Property(1)	Test Method	Unit	Requirements(1)
Minimum Weight	ASTM D5261	oz	4.0
Grab Tensile Strength	ASTM D4632	lbs	100
Grab Elongation	ASTM D4632	%	50
Trapezoid Tear Strength	ASTM D4533	lbs	50
CBR Puncture Resistance	ASTM D6241	lbs	300
UV Resistance (strength retained at 500 hrs)	ASTM D4355	%	70
Apparent Opening Size (AOS)	ASTM D4751	US sieve	70
Permittivity	ASTM D4491	sec^{-1}	1.7
Flow Rate	ASTM D4491	gpm/ft^2	130
(1) Minimum average roll values.			

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Verify that conditions are satisfactory for the installation of filter fabric.

3.02 PREPARATION

A. Surface preparation:
   1. During grading operations, take care not to disturb the subgrade.
   2. This may require use of lightweight dozers for low strength soils such as saturated, cohesionless, or low cohesion soils.

B. Prior to placement of fabric: Prepare surface to smooth condition free of debris, depressions, or obstructions that may damage the fabric.

3.03 INSTALLATION

A. Follow manufacturer's installation instructions and as complimented in this Section.

B. Place the filter fabric smoothly without folds or wrinkles.

C. Use special care when placing the filter in contact with the soil so that no void spaces occur between the filter and the prepared surface.

D. Overlap the parallel rolls and ends of rolls a minimum of 24 inches and not less than manufacturer's instructions.

E. Do not drag filter fabric across subgrade.

F. Make overlaps at ends of rolls in the direction of the aggregate placement with the previous roll on top.

G. Use lightweight dozers if necessary. Do not allow equipment directly on filter fabric.

3.04 FIELD QUALITY CONTROL

A. Inspection:
   1. Before covering, the condition of the fabric will be observed by the Engineer to determine that no holes or rips exist in the fabric.
   2. Repair all holes and rips by placing a new layer of fabric extending beyond the defect in all directions a distance equal to the minimum overlap required for adjacent rolls.

END OF SECTION

SECTION 02621

STABILIZATION FABRIC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Woven stabilization fabric used for subgrade enhancement.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
   2. D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   3. D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
   4. D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   5. D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.
   6. D6241 - Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.

1.03 DEFINITIONS

A. Stabilization fabric: Woven geotextile fabric manufactured from polypropylene yarns.

1.04 SUBMITTALS

A. Product data.

B. Samples.

C. Quality control submittals:
   1. Certificates of Compliance.
   2. Manufacturer's Installation Instructions.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Storage and protection:
   1. Furnish stabilization fabric in protective covers capable of protecting the fabric from ultraviolet rays, abrasion, and water.

1.06 PROJECT CONDITIONS

A. Field measurements:
   1. Take field measurements to determine the exact lengths and dimensions of the surfaces to receive the fabric.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Propex, Geotex 315ST.
   2. Ten Cate Geosynthetics, Mirafi 600X.

2.02 MATERIAL REQUIREMENTS

A. Physical properties: Meet the following minimum requirements:

Property[(1)]	Test Method	Unit	Requirements[(1)]
Grab Tensile Strength	ASTM D4632	lbs	315
Grab Elongation	ASTM D4632	%	15
Trapezoid Tear Strength	ASTM D4533	lbs	120
CBR Puncture Resistance	ASTM D6241	lbs	900
UV Resistance (strength retained at 500 hrs)	ASTM D4355	%	70
Apparent Opening Size (AOS)	ASTM D4751	US sieve	40
Permittivity	ASTM D4491	sec^{-1}	0.05
Flow Rate	ASTM D4491	gpm/ft^2	4
(1) Minimum average roll values.			

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Verify that conditions are satisfactory for the installation of stabilization fabric.

3.02 PREPARATION

A. Surface preparation: During grading operations, take care not to disturb the subgrade. This may require use of lightweight dozers for low strength soils such as saturated, cohesionless, or low cohesion soils.

B. Prior to placement of fabric: Prepare surface to smooth condition free of debris, depressions, or obstructions that may damage the fabric.

3.03 INSTALLATION

A. Follow manufacturer's installation instructions and as complimented in this Section.

B. Place the stabilization fabric smoothly without folds or wrinkles.

C. Use special care when placing the stabilization fabric in contact with the soil so that no void spaces occur between the stabilization fabric and the prepared surface.

D. Overlap the parallel rolls and ends of rolls a minimum of 24 inches and not less than recommended by manufacturer.

E. Do not drag stabilization fabric across subgrade.

F. Make overlaps at ends of rolls in the direction of the aggregate placement with the previous roll on top.

G. Use lightweight dozers, if necessary. Do not allow equipment directly on stabilization fabric.

3.04 FIELD QUALITY CONTROL

A. Inspection: Before covering, the condition of the fabric will be observed by the Engineer to determine that no holes or rips exist in the fabric. Repair all holes or rips by placing a new layer of fabric extending beyond the defect in all directions, a distance equal to the minimum overlap required for adjacent rolls.

END OF SECTION

SECTION 02742A

ASPHALTIC CONCRETE PAVING (CA)

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Asphalt pavement on prepared subgrade or aggregate base course to lines, grades, and compacted thickness as indicated on the Drawings.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft. lbf/f_4^3) (2,700 kN-m/m^3).
   2. D1561 - Standard Practice for Preparation of Bituminous Mixture Test Specimens by Means of California Kneading Compactor.

B. Caltrans Standard Test Methods:
   1. Calif Test 202 - Sieve Analysis of Fine and Coarse Aggregates.
   2. Calif Test 304 - Preparation of Bituminous Mixtures for Testing.
   3. Calif Test 362 - Determining Asphalt Content in Bituminous Mixtures by Vacuum Extraction.
   4. Calif Test 375 - Determining the In-Place Density and Relative Compaction of AC Pavement.
   5. Calif Test 379 - Determining Asphalt Content in Bituminous Mixtures (Troxler Nuclear Gauge Model 3241).

C. State of California Department of Transportation Standard Specifications, latest edition (Caltrans Standard Specifications):
   1. Section 37 - Bituminous Seals.
   2. Section 39 - Hot Mix Asphalt.
   3. Section 88 - Geosynthetics.
   4. Section 92 - Asphalts.
   5. Section 93 - Liquid Asphalts.

1.03 SYSTEM DESCRIPTION

A. This Work shall consist of furnishing and mixing aggregate and asphalt binder at a central mixing plant, spreading and compaction of the mixture as specified and as indicated on the Drawings.

B. In general, asphalt concrete and asphalt concrete base shall conform to Section 39 “Hot Mix Asphalt,” and all applicable referenced sections of the Caltrans Standard Specifications:
   1. Where conflicts exist, this specification shall govern.

1.04 DEFINITIONS

A. “Asphalt Concrete” as used by Caltrans shall be considered the “Surface Course,” or the final lift of the pavement section.

B. “Asphalt Concrete Base” as used by Caltrans shall be the remaining portion of the asphalt pavement section excluding the final lift.

C. “Asphalt Pavement” shall be the total pavement section of asphalt including Asphalt Concrete and Asphalt Concrete Base.

1.05 SUBMITTALS

A. Mix design.

B. Shop drawings.

C. Product data:
   1. Asphalt.
   2. Asphalt aggregate.
   3. Pavement reinforcing fabric.

D. Quality control submittals:
   1. Test results.
   2. Certificate of Compliance.
   3. Certificate of Competence.

E. Equipment list.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Asphalt pavement delivery:
   1. Transport the mixture from the mixing plant to the point of use in vehicles having tight bodies previously cleaned of all foreign materials.
   2. Treat bodies as necessary to prevent material from sticking to the bodies.
   3. Cover each load with canvas or other suitable material of sufficient size and thickness to protect the asphalt mixture from the weather.

1.07 PROJECT CONDITIONS

A. Environmental requirements:
   1. Asphalt concrete:
      a. Place asphalt concrete only when surface is dry, and when atmospheric temperature in the shade is 40 degrees Fahrenheit and rising, or above 50 degrees Fahrenheit if falling.
      b. Do not place asphalt concrete when weather is foggy or rainy, when base on which material is to be placed is in wet or frozen conditions, or when, in the opinion of the Engineer, weather conditions will prevent proper handling, finishing, or compaction of the mixtures.

2. Prime coat:
    a. Do not apply prime coat when atmospheric temperature is below 60 degrees Fahrenheit.
    b. Apply prime coat only when base course is dry or contains moisture not in excess of that which will permit uniform distribution and desired penetration.

PART 2 PRODUCTS

2.01 ASPHALT PAVEMENT MATERIALS

A. Asphalts:
    1. Asphalt binder: Steam-refined paving asphalt, PG 64-10, conforming to Section 92-1.02C “Grades” of the Caltrans Standard Specifications.
    2. Prime coat and tack coat: Grade SC-70, conforming to Section 93 of the Caltrans Standard Specifications.

B. Asphalt aggregate:
    1. Aggregate for asphalt concrete shall conform to Section 39-1.02E of the Caltrans Standard Specifications for Type B grading, 1/2-inch maximum, medium.
    2. Aggregate for asphalt concrete base shall conform to Section 39-1.02E of the Caltrans Standard Specifications for Type B grading.

C. Asphalt pavement shall be produced in a batch mixing plant, a continuous pugmill mixing plant, or dryer-drum mixing plant:
    1. Proportioning shall conform to Section 39-3.03 of the Caltrans Standard Specifications.
    2. Mixing shall conform to Section 39-3.04 of the Caltrans Standard Specifications.

2.02 AGGREGATE BASE COURSE

A. Aggregate base course: As specified in Section 02050 - Soils and Aggregates for Earthwork.

B. Aggregate base course shall be placed at the following locations:
    1. At all locations indicated on the Drawings.
    2. All asphalt pavement.

C. Compacted thickness of aggregate base course shall be as indicated on the Drawings**.**

2.03 EQUIPMENT

A. Spreading and compacting equipment:
    1. Spreading equipment shall conform to Section 39-1.10 and all applicable referenced sections of the Caltrans Standard Specifications:
        a. Only in areas inaccessible to the machine, by approval of the Engineer, will hand spreading be permitted.
    2. Compaction equipment shall conform to Section 39-1.10 and all applicable referenced sections of the Caltrans Standard Specifications.

2.04 SOURCE QUALITY CONTROL

A. The Engineer will perform sampling and tests of materials in accordance with California Test Method Number 304 and California Test Method Number 362 or 379, as applicable. Samples will be taken from materials as delivered to the site.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Verify surfaces and site conditions are ready to receive work. If unsatisfactory conditions exist, do not commence installation until such conditions have been corrected. Beginning application means acceptance of existing conditions.

3.02 PREPARATION

A. Protection:
   1. Protect concrete pavements and walks, curbs and bases, and other improvements adjacent to the operations with suitable materials.
   2. Building and other surfaces shall be covered with paper or other protection, when required.
   3. Contractor shall be responsible for any damage caused by Contractor's employees. All damage caused by the Contractor's operations shall be repaired to the satisfaction of the Engineer at no additional cost to Owner.

B. Subgrade preparation:
   1. Immediately prior to applying tack coat, or immediately prior to placing the asphalt pavement when tack coat is not required, the subgrade to receive asphalt pavement shall conform to the compaction requirement and elevation tolerances specified for the material involved and shall be cleaned to remove any loose or extraneous material.
   2. If the asphalt pavement is to be placed on an existing base or pavement that was not constructed as part of the contract, the Contractor shall clean the surface by sweeping, flushing, or other means to remove all loose particles of paving, all dirt, and all other extraneous material immediately before applying the tack coat.

3.03 TACK COAT

A. Tack coat:
   1. A tack coat of asphaltic emulsion shall be applied to all vertical surfaces of existing pavement, curbs, gutters, and construction joints in the surfacing against which additional material is to be placed, or as otherwise specified in this Section.
   2. Tack coat shall be applied in one application at a rate of 0.1 gallons per square yard of surface covered.

3.04 ASPHALT PAVEMENT

A. Placing materials in a windrow, then picking it up and placing it in the asphalt paver with loading equipment, will be permitted provided that:
   1. The asphalt paver is of such design that the material will fall into a hopper that has a movable bottom conveyor to feed and screed.
   2. The loader is constructed and operated so that substantially all of the material deposited into windrows is picked up and deposited into the paving machine.
   3. The windrow is deposited only so far in advance of the paver to provide for continuous operation of the paver and not so far as to allow the temperature of the asphalt pavement in the windrow to fall below 260 degrees Fahrenheit.

B. Unless lower temperatures are directed by the Engineer, asphalt concrete shall be spread, and the first coverage of initial or breakdown compaction shall be performed when the temperature of the mixture is not less than 250 degrees Fahrenheit, and all breakdown compaction shall be completed before the temperature of the mixture drops below 205 degrees Fahrenheit.

C. Asphalt pavement shall be spread and compacted in the number of layers and of the thicknesses indicated in the following table:
   1. A thickness tolerance of within 0.1 inches is allowed for asphalt concrete.
   2. A total thickness tolerance of within 0.2 inches is allowed for asphalt concrete base.

Total Thickness Indicated on Drawings(1)	Number of Lifts	Top Layer Thickness (inches)		Next Lower Layer Thickness (inches)		All Other Lower Layer Thicknesses (inches)	
		Min.	Max.	Min.	Max.	Min.	Max.
3 inches(2)	2	1-1/4	1-1/2	1-1/4	1-1/2	-----	-----
3-1/4 - 4-3/4 inches	2	1-3/4	2-1/”	1-3/4	3	-----	-----

Notes:
(1) When pavement-reinforcing fabric is shown to be placed between layers of asphalt pavement, the thickness of asphalt pavement above the pavement-reinforcing fabric shall be considered to be the “Total Thickness Indicated on the Drawings” for the purpose of spreading and compacting the asphalt pavement above the pavement-reinforcing fabric.
(2) If approved by the Engineer, one lift of 3 inches may be placed.

D. A layer shall not be placed over another layer which exceeds 3 inches in compacted thickness until the temperature of the layer which exceeds 3 inches in compacted thickness is less than 160 degrees Fahrenheit at mid depth:
   1. If the temperature of any layer drops below 140 degrees Fahrenheit, or if directed by the Engineer, apply tack coat before placing next layer.

E. Unless otherwise indicated on the Drawings, asphalt mixtures shall not be handled, spread, or windrowed in a manner that will stain the finished surface of any pavement or other improvements.

F. The completed mixture shall be deposited on the prepared subgrade at a uniform quantity per linear foot, as necessary to provide the required compacted thickness without resorting to spotting, picking up, or otherwise shifting the mixture.

G. Spreading:
   1. All layers of asphalt pavement shall be spread with an asphalt paver and shall conform to Section 39-1.11 and all applicable referenced sections of the Caltrans Standard Specifications.
   2. At locations where the asphalt pavement is to be placed over areas inaccessible to spreading and rolling equipment, all layers of asphalt pavement shall be distributed directly out of the back of the dump truck and spread by hand:
      a. Asphalt pavement spread by hand shall be compacted thoroughly to the required lines, grades, and cross-sections by means of pneumatic tampers, or by other methods that will produce the same degree of compaction as pneumatic tampers.

H. Compaction:
   1. Compaction of asphalt pavement shall conform to Sections 39-1.11, 39-3.03, 39-3.04, and all applicable referenced sections of the Caltrans Standard Specifications.
   2. Minimum required density for each layer of asphalt pavement shall be 95 percent of that obtained in the laboratory in accordance with ASTM Test Method D1561.

I. Segregation shall be avoided, and the surfacing shall be free of pockets of coarse or fine material. Asphalt pavement containing hardened lumps shall not be used:
   1. In areas inaccessible to paving and compacting equipment where spreading is done by hand, minimize the amount of segregation.

J. Location of longitudinal joints in the top layer will be determined by the Engineer and shall not adversely affect the quality of the finished product.

K. At all locations, or as directed by the Engineer, the asphalt concrete shall be square and at least 1-inch thick when conforming to existing surfacing. Tapering or feathering is not allowed.

3.05 FIELD QUALITY CONTROL

A. Contractor shall control the quality of Work and shall provide adequate testing to ensure compliance with these Specifications:
   1. The type and size of the samples shall be suitable to determine conformance with stability, density, thickness, and other specified requirements. Use an approved power saw or core drill for cutting samples. Furnish all tools, labor, and materials for cutting samples, testing, and replacing the pavement where samples were removed. Take a minimum of 1 sample for every 4,000 square feet of asphalt pavement placed.

B. All asphalt pavement shall match the grades indicated on the Drawings and shall be completely free from unintended hollows and high spots:
   1. After completion of paving work, all paving shall be flooded with water. Any ponding that results in standing water greater than 3/4 inch in depth shall be ringed with chalk. Such hollows shall be corrected by removing and replacing

the asphalt concrete. The asphalt concrete patch shall be square and at least 1-inch thick when conforming to existing surfacing. Tapering or feathering is not allowed.

C. Contractor shall perform in-place density and compaction tests of the completed pavement in accordance with California Test Method Number 375, to determine compliance with the specified requirements. Submit test results to Engineer for approval.

D. Cracks, settling of surface, improper drainage, improper compaction, and sloppy connection to previously laid surfaces will be construed as improper workmanship and will not be accepted.

3.06 MAINTENANCE OF PAVEMENT

A. Upon completion of final rolling, traffic shall not be permitted on the finished pavement for at least 6 hours, or until the asphalt pavement has cooled sufficiently to withstand traffic without being deformed.

3.07 WORKMANSHIP AND WARRANTY

A. Contractor shall provide written warranty against defects in materials or workmanship for a period of not less than 1 year upon completion of Work.

END OF SECTION

SECTION 02772

CONCRETE CURBS, GUTTERS, AND SIDEWALKS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Concrete curbs, gutters, sidewalks, driveways, access ramps, and alley intersections.

1.02 SYSTEM DESCRIPTION

A. Performance requirements: Construct various types of concrete curb, gutter, sidewalk, driveways and alley intersections to dimensions and details indicated on the Drawings.

1.03 SUBMITTALS

A. Product data: Submit data completely describing products.

B. Samples: Submit samples when requested.

PART 2 PRODUCTS

2.01 MATERIALS

A. Concrete: Class A, as specified in Section 03300 - Cast-In-Place Concrete.

B. Curb finishing mortar: 1 part portland cement to 2 parts sand.

C. Form release material: Light oil or other releasing agent of type which does not discolor concrete or interfere with the application of finishing mortar to curb tops and faces.

D. Joint materials:
   1. Expansion: As specified in Section 03150 - Concrete Accessories.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:
   1. Verify field conditions, including subgrade condition and interferences, before beginning construction.

3.02 PREPARATION

A. Surface preparation:
   1. Subgrade:
      a. Construct and compact true to grades and lines indicated on the Drawings and requirements as specified Section 02050 - Soils and Aggregates for Earthwork.
      b. Remove soft or unsuitable material to depth of not less than 6 inches below subgrade elevation and replace with satisfactory material.
   2. Forms and subgrade: Water immediately in advance of placing concrete.

3.03 INSTALLATION

A. Special techniques:
   1. Contractor's option:
      a. Construct concrete curbs and gutters by conventional use of forms, or by means of curb and gutter machine when acceptable to the Engineer.
      b. When use of machines designed specifically for work of this Section are accepted by the Engineer, results must be equal to or better than those produced by use of forms.
      c. Applicable requirements of construction that apply to use of forms also apply to use of machines.
      d. Discontinue use of machines when results are not satisfactory to the Engineer.

B. Forms:
   1. Carefully set to line and grade and securely stake in position forms conforming to dimensions of items to be constructed.
   2. Thoroughly clean prior to each use and coat with form releasing material.

C. Expansion and weakened-plane joints:
   1. Expansion joints:
      a. Construct vertically, and at right angles to centerline of street and match joints in adjacent pavement or sidewalks.
      b. Constructed at radius points, driveways, alley entrances, and at adjoining structures.
      c. Fill joints with expansion joint filler material.
   2. Weakened-plane joints:
      a. Construct as indicated on the Drawings.
      b. Match joint locations and details in adjacent curbs, gutters, and sidewalks.

D. Concrete:
   1. Placing:
      a. Thoroughly spade concrete away from forms so that no rock pockets exist next to forms and so that no coarse aggregate will show when forms are removed.
   2. Compacting:
      a. Compact by mechanical vibrators accepted by the Engineer.
      b. Continue tamping or vibrating until mortar flushes to surface and coarse aggregate is below concrete surface.

3. Form removal:
    a. Front form faces: Do not remove before concrete has taken initial set and has sufficient strength to carry its own weight.
    b. Gutter and rear forms: Do not remove until concrete has hardened sufficiently to prevent damage to edges. Take special care to prevent damage.
4. Finishing and curing: Comply with requirements as specified in Section 03366 - Tooled Concrete Finishing except as modified here:
    a. As soon as curb face forms are stripped, apply finishing mortar to the top and face of curb and trowel to a smooth, even finish. Finish with fine haired broom in direction of work.
    b. Where curb is installed without integral gutter, extend finish 2 inches below grade.
    c. Edge concrete at expansion joints to 1/4 inch radius.
    d. Flow lines of gutters shall be troweled smooth 4 inches out from curb face for integral curb and gutter and 4 inches on both sides of flowline for gutters without curbs.
    e. Sidewalks and ramps: Broom finish.

E. Backfilling:
1. Unless otherwise specified, backfill behind curbs, gutters, or sidewalks with soil native to area and to lines and grades indicated on the Drawings.

3.04 FIELD QUALITY CONTROL

A. Tests:
1. Curbs and gutters:
    a. Test face, top, back, and flow line with 10 foot straightedge or curve template longitudinally along surface.
    b. Correct deviations in excess of 1/4 inch.
2. Gutters:
    a. Frequency of testing: When required by the Engineer, where gutters have slope of 0.8 foot per 100 feet or less, or where unusual or special conditions cast doubt on capability of gutters to drain.
    b. Test method: Establish flow in length of gutter to be tested by supplying water from hydrant, tank truck, or other source.
    c. Required results:
        1) 1 hour after supply of water is shut off, inspect gutter for evidence of ponding or improper shape.
        2) In event water is found ponded in gutter to depth greater than 1/2 inch, or on adjacent asphalt pavement, correct defect or defects in manner acceptable to the Engineer without additional cost to the Contract.

3.05 ADJUSTING

A. Repair portions of concrete damaged while stripping forms or, when damage is severe, replace such work at no additional cost to the Contract. Evidence of repairs shall not be noticeable in the finished product.

B. Remove and replace sections of work deficient in depth or not conforming to requirements indicated on the Drawings and specified in the Specifications at no additional cost to the Contract. Removal and replacement shall be the complete section between 2 joints.

END OF SECTION

SECTION 02952

PAVEMENT RESTORATION AND REHABILITATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Resurfacing roads and paved surfaces in which surface is removed or damaged by installation of new work.

1.02 SYSTEM DESCRIPTION

A. Performance requirements:
   1. Limiting dimensions:
      a. Determine the exact lengths and dimensions of such roads, pavements, parking areas, and walks that will require removal and replacement for new work.
      b. Join existing surfaces to terminals of new surfacing in smooth juncture.

1.03 SUBMITTALS

A. Mix designs:
   1. Prior to placement of asphalt concrete, submit full details, including design and calculations for the asphalt concrete mix proposed.
   2. Submit gradation of aggregate base.
   3. Submit proposed mix design of portland cement concrete.

PART 2 PRODUCTS

2.01 MATERIALS

A. Aggregate base course: As specified in Section 02050 - Soil and for Earthwork.

B. Asphalt pavement: As specified in Section 02742A - Asphaltic Concrete Paving.

C. Portland cement concrete replacement material: Class A concrete as specified in Section 03300 - Cast-in-Place Concrete.

2.02 EQUIPMENT

A. Roads, pavements, parking areas, and walks:
   1. Equipment requirements: Good condition, capable of performing work intended in satisfactory manner.

2.03 ACCESSORIES

A. Material for painting asphalt concrete pavement: Tack coat as specified in Section 02742A - Asphaltic Concrete Paving.

PART 3 EXECUTION

3.01 INSTALLATION

A. Aggregate surface removal replacement:
   1. When trench cut is in aggregate surfaced areas, replace aggregate base course material with material matching existing material compacted to 95 percent of its maximum density.

B. Pavement removal and temporary asphalt replacement:
   1. Install temporary asphalt pavement or first course of permanent pavement replacement immediately following backfilling and compaction of trenches that have been cut through existing pavement.
   2. Except as otherwise provided, maintain this temporary pavement in safe and reasonably smooth condition until required permanent pavement is installed.
   3. Remove and dispose of temporary paving from project site.
   4. Where longitudinal trench is partly in pavement, replace pavement to original pavement edge, on a straight line, parallel to centerline of roadway.
   5. Where no part of longitudinal trench is in pavement, surfacing replacement shall only be required where existing surfacing materials have been removed.

C. Asphalt pavement replacement:
   1. Replace asphalt pavement to same thickness as adjacent pavement and match as nearly as possible adjacent pavement in texture, unless otherwise indicated on the Drawings.
   2. Cut existing asphalt pavements to be removed for trenches or other underground construction by wheel cutter, clay spade, or other device capable of making neat, reasonably straight and smooth cut without damaging adjacent pavement. Cutting device operation shall be subject to acceptance of Engineer.
   3. Cut and trim existing pavement after placement of required aggregate base course and just prior to placement of asphalt concrete for pavement replacement, and paint trimmed edges with material for painting asphalt concrete pavement immediately prior to constructing new abutting asphalt pavements. No extra payment will be made for these items, and all costs incurred in performing this work shall be incidental to pipe laying or pavement replacement.
   4. Conform replacement of asphalt pavement to contour of original pavement.

D. Portland cement concrete pavement replacement:
   1. Where trenches lie within portland cement concrete section of streets, alleys, sidewalks, and similar concrete construction, saw cut such concrete (to a depth of not less than 1-1/2 inches) to neat, vertical, true lines in such manner adjoining surfaces are not damaged.
   2. Place portland cement concrete replacement material to dimension as indicated on the Drawings.
   3. Provide expansion joints that match existing.
   4. Before placing replacement concrete, thoroughly clean edges of existing pavement and wash with neat cement and water.
   5. Surface finish: Wood float finish.

E. Curb, gutter, and sidewalk replacement:
   1. Where any concrete curb, gutter, or sidewalk has been removed or displaced, replace to nearest construction joints with new Class A curb, gutter, or sidewalk to same dimensions and finish as original construction that was removed:
      a. Provide expansion joints of same spacing and thickness as original construction.

F. Asphalt pavements:
   1. Trim existing asphalt pavements which are to be matched by pavement widening or pavement extension to neat true line with straight vertical edges free from irregularities with saw specifically designed for this purpose. Minimum allowable depth of cut shall be 1-1/2 inches.
   2. Cut and trim existing pavement after placement of required aggregate base course and just prior to placement of asphalt concrete for pavement widening or extension, and paint trimmed edges with material for painting asphalt concrete pavement immediately prior to constructing new abutting asphalt concrete pavements.
   3. No extra payment will be made for these items and all costs incurred in performing this work shall be incidental to widening or pavement extension.

3.02 FIELD QUALITY CONTROL

A. Tests:
   1. Asphalt concrete as specified in Section 02742A - Asphaltic Concrete Paving.
   2. Concrete as specified in Section 03300 - Cast-in-Place Concrete.

B. Inspection:
   1. Asphalt concrete:
      a. Lay 10-foot straightedge parallel to centerline of trench when the trenches run parallel to street, and across pavement replacement when trench crosses street at angle.
      b. Remove and correct any deviation in cut pavement replacement greater than 1/4 inch in 10 feet.
   2. Portland cement concrete replacement pavement:
      a. Lay 10-foot straightedge either across pavement replacement or longitudinal with centerline of gutter or ditch.
      b. Remove and correct any deviation in cut pavement replacement greater than 1/4 inch in 10 feet.

END OF SECTION

SECTION 03055

ADHESIVE-BONDED REINFORCING BARS AND ALL THREAD RODS IN CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Bonding reinforcing bars and all thread rods in concrete using adhesives.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 355.4 - Qualification of Post-Installed Adhesive Anchors in Concrete and Commentary.

B. American National Standards Institute (ANSI):
   1. Standard B212.15 - Carbide Tipped Masonry Drills and Blanks for Carbide Tipped Masonry Drills.

C. ASTM international (ASTM):
   1. C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

D. Concrete Reinforcing Steel Institute (CRSI).

E. ICC Evaluation Service, Inc. (ICC-ES):
   1. AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.

F. Society for Protective Coatings (SSPC):
   1. SP-1 - Solvent Cleaning.

1.03 DEFINITIONS

A. Evaluation Service Report (ESR): Report prepared by ICC-ES, or other testing agency acceptable to Engineer and to the Building Official, that documents testing and review of a product to confirm that it complies with the requirements of designated ICC-ES Acceptance Criteria, and to document its acceptance for use under the Building Code specified in Section 01410 - Regulatory Requirements.

1.04 SUBMITTALS

A. Product data: Technical data for adhesives, including:
   1. Manufacturer's printed installation instructions (MPII).
   2. Independent laboratory test results indicating allowable loads in tension and shear for concrete of the types included in this Work, with load modification factors for temperature, spacing, edge distance, and other installation variables.
   3. Handling and storage instructions.

B. Quality control submittals:
   1. Special inspection: Detailed step-by-step instructions for the special inspection procedures required by the building code specified in Section 01410 - Regulatory Requirements.
   2. For each adhesive to be used, Evaluation Report confirming that the product complies with the requirements of AC308 for both un-cracked and cracked concrete and for use in Seismic Design Categories A through F.
   3. Installer qualifications:
      a. Submit evidence of successful completion of adhesive manufacturer's installation training program.
      b. Submit evidence of current certification for installation of inclined and overhead anchors under sustained tension loading.

C. Inspection and testing reports:
   1. Inspections: Field quality control: Reports of inspections and tests:
      a. Inspections: Field quality assurance: Reports of special inspections and tests.

1.05 QUALITY ASSURANCE

A. Qualifications:
   1. Installation requirements:
      a. Have available at the site, and install anchors in accordance with, the adhesive manufacturer's printed installation instructions.
   2. Installer qualifications:
      a. Demonstrating successful completion of adhesive manufacturer's on-site training program for installation of adhesive-bonded anchors.
      b. Holding current certification for installation of adhesive-bonded anchors by a qualified organization acceptable to the Engineer and to the Building Official:
         1) Organizations/certification programs deemed to be qualified are:
            a) ACI-CRSI Adhesive Anchor Installer Certification Program.
            b) Adhesive anchor manufacturer's certification program, subject to acceptance by the Engineer and the Building Official.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store and protect products as follows, unless more restrictive requirements are recommended by the manufacturer:
   1. Store adhesives and adhesive components on pallets or shelving in a covered-storage area protected from weather.
   2. Control temperature to maintain storage within manufacturer's recommended temperature range.
      a. If products have been stored at temperatures outside manufacturer's recommended range, test by methods acceptable to the Engineer to confirm acceptability before installing in the Work.
   3. Dispose of products that have passed their expiration date.

1.07 PROJECT CONDITIONS

A. As specified in Section 01612 - Seismic Design Criteria.

B. Seismic Design Category (SDC) for structures is indicated on the Drawings.

PART 2 PRODUCTS

2.01 GENERAL

A. Like items of materials: Use end products of one manufacturer in order to achieve structural compatibility and singular responsibility.

B. Adhesives shall have a current Evaluation Report documenting testing and compliance with the requirements or ACI 355.4 and of ICC-ES AC308 for use with un-cracked concrete and with cracked concrete in the Seismic Design Category specified.

C. Bond reinforcing bars and all thread rods in concrete using epoxy adhesive unless other adhesives specified are specifically indicated on the Drawings or approved in writing by the Engineer.

2.02 EPOXY ADHESIVE

A. Materials:
   1. Meeting the physical requirements of ASTM C881, Type IV, Grade 3, Class B or C depending on site conditions.
   2. 2-component, 100 percent solids, insensitive to moisture.
   3. Cure temperature, pot life, and workability: Compatible with intended use and environmental conditions.

B. Packaging:
   1. Disposable, self-contained cartridge system furnished in side-by-side cartridges designed to fit into a manually or pneumatically operated caulking gun, and with resin and hardener components isolated until mixing through manufacturer's static mixing nozzle:
      a. Nozzle designed to dispense components in the proper ratio and to thoroughly blend the components for injection from the nozzle directly into prepared hole.
      b. Provide nozzle extensions as required to allow full-depth insertion and filing from the bottom of the hole.
   2. Container markings: Include manufacturer's name, product name, batch number, mix ratio by volume, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

C. Manufacturers: One of the following or equal:
   1. Hilti, Inc., HIT-RE 500 V3.
   2. Simpson Strong-Tie Co., Inc., SET-3G.

2.03 ALL THREAD RODS

A. Materials: As specified in Section 05120 - Structural Steel for rods, nuts and washers.

2.04 REINFORCING BARS

A. As specified in Section 03200 - Concrete Reinforcing.

PART 3 EXECUTION

3.01 GENERAL

A. Execution of this work is restricted to installers who have personally completed the adhesive manufacturer's on-site training for the products to be installed, and who are personally certified through a qualified certification program described under Quality Assurance and accepted by the Engineer and the Building Official:
   1. Do not install holes or adhesive until training is complete.

B. Perform work in strict compliance with the accepted MPII and the following instructions. Where the accepted MPII and the instructions conflict, the MPII shall prevail.

C. Install reinforcing bars and all thread rods to embedment depth, and at spacing and locations indicated on the Drawings:
   1. If embedment depth is not indicated, contact Engineer for requirements.
   2. Do not install adhesive-bonded all thread rods or reinforcing bars in upwardly inclined or overhead applications unless accepted in advance by Engineer.

3.02 PREPARATION

A. Do not begin installation of adhesive bonded anchors until:
   1. Concrete has achieved an age of at least 21 days after placement.
   2. On-site training in installation of adhesive bonded anchors by manufacturer's technical representative is complete. Do not drill holes in concrete or install adhesive and embeds in holes.

B. Review manufacturer's printed installation instructions (MPII) and "conditions of use" stipulated in the Evaluation Report before beginning work:
   1. Bring to the attention of the adhesive manufacturer's technical representative any discrepancies between these documents, and resolve before proceeding with installation.

C. Install adhesive bonded anchors in full compliance with manufacturer's printed installation instructions using personnel who have successfully completed manufacturer's on-site training for products to be used and who hold certifications specified in this Section.

D. Confirm that adhesive and substrate receiving adhesive are within manufacturer's recommended range for temperature and moisture conditions, and will remain so during the curing time for the product.

3.03 HOLE SIZING AND INSTALLATION

A. Drilling holes:
   1. Determine location of reinforcing bars or other obstructions with a nondestructive indicator device, and mark locations with construction crayon on the surface of the concrete.
   2. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without prior acceptance by Engineer.

B. Hole drilling equipment:
    1. Electric or pneumatic rotary impact type with medium or light impact:
        a. Installation of anchors in cored holes is not permitted.
        b. Set drill to "rotation only" mode, or to "rotation plus hammer" mode in accordance with the manufacturer's installation instructions and the requirements of the Evaluation Report.
        c. Where edge distances are less than 2 inches and "rotation plus hammer" mode is permitted, use lighter impact equipment to prevent micro-cracking and concrete spalling during the drilling process.
    2. Drill bits: Carbide-tipped in accordance with ANSI B212-15 unless otherwise recommended by the manufacturer or required as a "condition of use" in the Evaluation Report:
        a. Hollow drill bits with flushing air systems are preferred. Air supplied to hollow drill bits shall be free of oil, water, or other contaminants that will reduce bond.

C. Hole diameter: As recommended in the manufacturer's installation instructions and the Evaluation Report.

D. Hole depth: As recommended in the manufacturer's installation instructions to provide minimum effective embedment indicated on the Drawings.

E. Obstructions in drill path:
    1. If an existing reinforcing bar or other obstruction is hit while drilling a hole, unless otherwise accepted by Engineer, stop drilling. Prepare and fill the hole with dry-pack mortar. Relocate the hole to miss the obstruction and drill another hole to the required depth:
        a. Obtain Engineer's acceptance of distance between abandoned and relocated holes before proceeding with the relocation.
        b. Allow dry-pack mortar to cure to a strength equal to that of the surrounding concrete before resuming drilling in the area.
        c. Epoxy grout may be substituted for dry-pack mortar when accepted by Engineer.
    2. Avoid drilling an excessive number of holes in an area of a structural member, which would excessively weaken the member and endanger the stability of the structure.
    3. When existing reinforcing steel is encountered during drilling and when specifically accepted by Engineer, enlarge the hole by 1/8 inch, core through the existing reinforcing steel at the larger diameter, and resume drilling at original hole diameter using pneumatic rotary impact drill.
    4. Bent bar reinforcing bars: Where edge distances are critical, and interference with existing reinforcing steel is likely, if acceptable to Engineer, drill hole at 10 degree (or less) angle from axis of reinforcing bar or all thread rod being installed.

F. Cleaning holes:
    1. Insert air nozzle to bottom of hole and blow out loose dust:
        a. Use compressed air that is free of oil, water, or other contaminants that will reduce bond.
        b. Provide minimum air pressure of 90 pounds per square inch for not less than 4 seconds.

2. Using a stiff bristle brush with diameter that provides contact around the full perimeter of the hole, vigorously brush hole to dislodge compacted drilling dust:
    a. Insert brush to the bottom of the hole and withdraw using a simultaneous twisting motion.
    b. Repeat at least 4 times.
3. Repeat the preceding steps as required to remove drilling dust or other material that will reduce bond, and in the number of cycles required by the MPII and the Evaluation Report.
4. Leave prepared holes clean and dry.
5. Protect prepared and cleaned holes from contamination and moisture until adhesive is installed.
6. Re-clean and dry previously prepared holes if, in the opinion of the Engineer, the hole has become contaminated after initial cleaning.

3.04 INSTALLATION OF ADHESIVE AND INSERTS

A. Clean and prepare inserts reinforcing bars and all thread rods:
    1. Prepare embedded length of reinforcing bars and all thread rods by cleaning to bare metal. Inserts shall be free of oil, grease, paint, dirt, mill scale, rust, or other coatings that will reduce bond.
    2. Solvent clean prepared reinforcing bars and all thread rods over the embedment length in accordance with SSPC SP-1. Provide an oil and grease free surface for bonding of adhesive to steel.

B. Fill holes with adhesive:
    1. Starting at the bottom of the hole, fill hole with adhesive inserting the reinforcing bar or all thread rod.
    2. Fill hole as nozzle is withdrawn without creating air voids.
    3. Unless otherwise indicated on the Drawings, fill hole with sufficient adhesive so that excess adhesive is extruded out of the hole when the reinforcing bar or all thread rod is inserted.
    4. Where necessary, seal hole at surface of concrete to prevent loss of adhesive during curing.

C. Installing reinforcing bars and all thread rods:
    1. Unless otherwise indicated on the Drawings, install bars and rods perpendicular to the concrete surface.
    2. Insert reinforcing bars and all thread rods into adhesive in accordance with manufacturer's recommended procedures.
    3. Confirm that insert has reached the designated embedment in the concrete, and that adhesive completely surrounds the embedded portion.
    4. Securely brace bars and all thread rods in place to prevent displacement while the adhesive cures. Bars and rods displaced during curing will be considered damaged and replacement will be required.
    5. Clean excess adhesive from the mouth of the hole.

D. Curing and loading:
   1. Provide and maintain curing conditions recommended by the adhesive manufacturer for the period required to fully cure the adhesive at the temperature of the concrete.
   2. Do not disturb or load bonded embeds until manufacturer's recommended cure time, based on temperature of the concrete, has elapsed.

3.05 POST-INSTALLATION ACTIVITIES

A. Do not bend bars or all-thread rods after bonding to the concrete, unless accepted in advance by the Engineer.

B. Attachments to all thread rods:
   1. After assemblies to be connected are placed, install nuts and washers for threaded rods as indicated on the Drawings.
   2. Draw nuts down tight, using practices specified for "snug tight" installation of bolts in steel to steel connections.

3.06 FIELD QUALITY CONTROL

A. Provide field quality control over the Work of this Section as specified in Section 01450 - Quality Control.

B. Do not allow work described in this Section to be performed by individuals who do not hold the specified certifications and who have not completed the specified job site training.

C. Manufacturer's services:
   1. Before beginning installation, furnish adhesive manufacturer's technical representative to conduct on-site training in proper storage and handling of adhesive, drilling and cleaning of holes, and preparation and installation of reinforcing bars and all thread rods:
      a. Provide notice of scheduled training to Engineer and to Special Inspector(s) not less than 10 working days before training occurs. Engineer and Special Inspector may attend training sessions.
   2. Submit record, signed by the manufacturer's technical representative, listing Contractor's personnel who completed the training. Only qualified personnel who have completed manufacturer's on-site training shall perform installations.

D. Field inspections and testing:
   1. Hole drilling and preparation.
   2. Results: Submit records of inspections and testing to Engineer by electronic copies within 24 hours after completion.

3.07 FIELD QUALITY ASSURANCE

A. Provide field quality assurance over the Work of this Section as specified in Section 01450 - Quality Control.

B. Special inspections, special tests, and structural observation:
   1. Provide as specified in Section 01455 - Special Tests and Inspections.

2. Frequency of inspections:
    a. Unless otherwise indicated on the Drawings or in this Section, provide periodic special inspection as required by the Evaluation Report for the product installed.
    b. Provide continuous inspection for the initial installation of each type and size of adhesive bonded reinforcing bar and all thread rod. Subsequent installations of the same anchor may be installed with periodic inspection as defined in subsequent paragraphs.
    c. Provide continuous inspection of all drilling, cleaning and bonding activities for bars and rods installed in horizontal an upwardly inclined positions.
3. Preparation:
    a. Review Drawings and Specifications for the Work to be observed.
    b. Review adhesive manufacturer's MPII and recommended installation procedures.
    c. Review Evaluation Report "Conditions of Use" and "Special Inspection" requirements.
4. Inspection: Periodic:
    a. Initial inspection. Provide an initial inspection for each combination of concrete and reinforcing bar strength or concrete strength and all thread rod material being installed. During initial inspection, observe the following for compliance with the installation requirements:
        1) Concrete: Class (minimum specified compressive strength) and thickness.
        2) Environment: Temperature conditions at work area, and moisture conditions of concrete and drilled hole.
        3) Holes: Locations, spacing, and edge distances; verification of drill bit compliance with requirements; cleaning equipment and procedures; cleanliness of hole. Before adhesive is placed, confirm that depth and preparation of holes conforms to the requirements of the Contract Documents, the MPII, and the "conditions of use" listed in the Evaluation Report.
        4) Adhesive: Product manufacturer and name; lot number and expiration date; temperature of product at installation; installation procedure. Note initial set times observed during installation.
        5) Reinforcing bars and all thread rods: Material diameter and length; steel grade and/or strength; cleaning and preparation; cleanliness at insertion; minimum effective embedment provided.
    b. Subsequent inspections: Subsequent installations of the same reinforcing bars or all thread rods may be performed without the presence of the special inspector, provided that:
        1) There is no change in personnel performing the installation, the general strength and characteristics of the concrete receiving the inserts, or the reinforcing bars and all thread rods being used.
        2) For ongoing installations, the special inspector visits the site at least once per day during each day of installation to observe the work for compliance with material requirements and installation procedures.
5. Inspection: Continuous:
    a. Make observations as described under "Inspection - Periodic, Initial Inspection" during all drilling, cleaning, and bonding activities for all bars and rods installed.

6. Records of inspections:
    a. Provide a written record of each inspection using forms acceptable to the Engineer and to the Building Official.
    b. Submit electronic copies of inspection reports to Engineer within 24 hours after completion of inspection.

END OF SECTION

SECTION 03071

EPOXIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Epoxy.
   2. Epoxy gel.
   3. Epoxy bonding agent.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C881 - Standard Specification for Epoxy-Resin-Base Systems for Concrete.
   2. C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
   3. D638 - Standard Test Method for Tensile Properties of Plastics.
   4. D695 - Standard Test Method for Compressive Properties of Rigid Plastics.

1.03 SYSTEM DESCRIPTION

A. Performance requirements:
   1. Provide epoxy materials that are new.
   2. Store and use products within limitations set forth by manufacturer.
   3. Perform and conduct work of this Section in neat orderly manner.

1.04 SUBMITTALS

A. General: Submit as specified in Section 01330 - Submittal Procedures.

B. Product Data: Submit manufacturer's data completely describing epoxy materials:
   1. Submit evidence of conformance to ASTM C881. Include manufacturer’s designations of Type Grade, Class, and Color.
   2. Submit documentation that materials meet or exceed the specified strength and performance characteristics. Indicate test methods and test results.

C. Quality control submittals:
   1. Manufacturer's installation instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
   1. Moisture tolerant, water-insensitive, two-component epoxy resin adhesive material containing 100 percent solids, and meeting or exceeding the

performance properties specified when tested in accordance with the standards specified.

B. Epoxy: Low viscosity product in accordance with ASTM C881; Types I, II and IV; Grade 1; Class C.
   1. Manufacturers: One of the following or equal:
      a. BASF, MasterInject 1500.
      b. Dayton Superior, Sure Inject J56.
      c. Sika Corporation, Sikadur 35 Hi-Mod LV.
      d. Approved equal.
   2. Required properties:

Table 1 - Material Properties - Epoxy		
Property	**Test Method**	**Required Results ("neat")**
Tensile Strength (7-day)	ASTM D638	7,100 pounds per square inch, minimum.
Compressive Strength (7-day)	ASTM D695	11,000 pounds per square inch, minimum.
Bond Strength (2-day)	ASTM C882	1,500 pounds per square inch, minimum. Concrete failure before failure of epoxy.
Viscosity (mixed)		250-550 centipoise
Notes: Testing results are for materials installed and cured at a temperature between 72 and 78 degrees Fahrenheit for 7 days, unless otherwise noted.		

C. Epoxy gel: Non-sagging product in accordance with ASTM C881, Types I and IV, Grade 3, Class C:
   1. Manufacturers: One of the following or equal:
      a. BASF, MasterEmaco ADH 327.
      b. Dayton Superior, Sure Anchor J50.
      c. Sika Corp., Sikadur 31, Hi-Mod Gel.
      d. Approved Equal.
   2. Required properties:

Table 2 - Material Properties - Epoxy Gel		
Property	**Test Method**	**Required Results ("neat")**
Tensile Strength (7-day)	ASTM D638	2,000 pounds per square inch, minimum.
Compressive Yield Strength (7-day)	ASTM D695	8,000 pounds per square inch, minimum.
Bond Strength (14-day)	ASTM C882	1,500 pounds per square inch, minimum.
Notes: Testing results are for materials installed and cured at a temperature between 72 and 78 degrees Fahrenheit for 7 days, unless otherwise noted.		

D. Epoxy bonding agent: Non-sagging product in accordance with ASTM C881, Type II, Grade 2, Class C:
   1. Manufacturers: One of the following or equal:
      a. BASF, MasterEmaco ADH 326.
      b. Dayton Superior, Sure Bond J58.
      c. Sika Chemical Corp., Sikadur 32 Hi-Mod LPL.
      d. Approved equal.

E. Required properties:

Table 3 - Material Properties - Epoxy Bonding Agent		
Property	**Test Method**	**Required Results**
Tensile Strength (7-day)	ASTM D638	3,300 pounds per square inch, minimum.
Compressive Yield Strength (7-day)	ASTM D695	8,300 pounds per square inch, minimum.
Bond Strength (14-days)	ASTM C882	1,800 pounds per square inch, minimum. Concrete failure before failure of epoxy bonding agent.
Pot Life	-	Minimum 75 minutes at 73 degrees Fahrenheit.
Notes: Testing results are for materials installed and cured at a temperature between 72 and 78 degrees Fahrenheit for 7 days, unless otherwise noted.		

   1. If increased contact time is required for concrete placement, epoxy resin/portland cement bonding agent as specified in Section 03072 - Epoxy Resin/Portland Cement Bonding Agent may be used instead of epoxy bonding agent.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install and cure epoxy materials in accordance with manufacturer's installation instructions.

B. Epoxy:
   1. Apply in accordance with manufacturer's installation instructions.

C. Epoxy gel:
   1. Apply in accordance with manufacturer's installation instructions.
   2. Use for vertical or overhead work, or where high viscosity epoxy is required.
   3. Epoxy gel used for vertical or overhead work may be used for horizontal work.

D. Epoxy bonding agent:
   1. Apply in accordance with manufacturer's installation instructions.
   2. Bonding agent will not be required for filling form tie holes or for normal finishing and patching of similar sized small defects.

END OF SECTION

SECTION 03072

EPOXY RESIN/PORTLAND CEMENT BONDING AGENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Epoxy resin/portland cement bonding agent.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. Cube Specimens).
   2. C348 - Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.
   3. C496 - Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
   4. C882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.

B. Federal Highway Administration (FHWA):
   1. FHWA-RD-86-193 - Highway Concrete Pavement Technology Development and Testing Volume V: Field Evaluation of SHRP C9206 Test Sites (Bridge Deck Overlays).

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Sika Corp., Sika Armatec 110.

B. Substitutions: The use of other than the specified product will be considered, providing the Contractor requests its use in writing to the Engineer. This request shall be accompanied by:
   1. A certificate of compliance from an approved independent testing laboratory that the proposed substitute product meets or exceeds specified performance criteria, tested in accordance with the specified test standards.
   2. Documented proof that the proposed substitute product has a 1-year proven record of performance of bonding portland cement mortar/concrete to hardened portland cement mortar/concrete, confirmed by actual field tests and 5 successful installations that the Engineer can investigate.

2.02 MATERIALS

A. Epoxy resin/portland cement adhesive:
   1. Component "A" shall be an epoxy resin/water emulsion containing suitable viscosity control agents. It shall not contain butyl glycidyl ether.
   2. Component "B" shall be primarily a water solution of a polyamine.

3. Component "C" shall be a blend of selected portland cements and sands.
4. The material shall not contain asbestos.

2.03 PERFORMANCE CRITERIA

A. Properties of the mixed epoxy resin/portland cement adhesive:
   1. Pot life: 75 to 105 minutes.
   2. Contact time: 24 hours.
   3. Color: Dark gray.

B. Properties of the cured epoxy resin/portland cement adhesive:
   1. Compressive strength in accordance with ASTM C109:
      a. 3 day: 4,500 pounds per square-inch minimum.
      b. 7 days: 6,500 pounds per square-inch minimum.
      c. 28 days: 8,500 pounds per square-inch minimum.
   2. Splitting tensile strength in accordance with ASTM C496:
      a. 28 days: 600 pounds per square-inch minimum.
   3. Flexural strength:
      a. 1,100 pounds per square-inch minimum in accordance with ASTM C348.
   4. Bond strength in accordance with ASTM C882 modified at 14 days:
      a. 0 hours open time: 2,800 pounds per square-inch minimum.
      b. 24 hours open time: 2,600 pounds per square-inch minimum.
   5. The epoxy resin/portland cement adhesive shall not produce a vapor barrier.
   6. Material must be proven to prevent corrosion of reinforcing steel when tested under the procedures as set forth by the FHWA Program Report Number FHWA-RD-86-193. Proof shall be in the form of an independent testing laboratory corrosion report showing prevention of corrosion of the reinforcing steel.

PART 3 EXECUTION

3.01 INSTALLATION

A. Mixing the epoxy resin: Shake contents of Component "A" and Component "B." Empty all of both components into a clean, dry mixing pail. Mix thoroughly for 30 seconds with a jiffy paddle on a low-speed with 400 to 600 revolutions per minute drill. Slowly add the entire contents of Component "C" while continuing to mix for a minimum of 3 minutes and until uniform with no lumps. Mix only the quantity that can be applied within its pot life.

B. Placement procedure:
   1. Apply to prepared surface with stiff-bristle brush, broom, or "hopper-type" spray equipment:
      a. For hand applications: Place fresh plastic concrete/mortar while the bonding bridge adhesive is wet or dry, up to 24 hours.
      b. For machine applications: Allow the bonding bridge adhesive to dry for 12 hours minimum.

C. Adhere to all limitations and cautions for the epoxy resin/portland cement adhesive in the manufacturer's current printed literature.

3.02 CLEANING

A. Leave finished work and work area in a neat, clean condition without evidence of spillovers onto adjacent areas.

END OF SECTION

SECTION 03102

CONCRETE FORMWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Concrete formwork.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 117 - Specifications for Tolerances for Concrete Construction and Materials and Commentary.

B. Underwriters Laboratories (UL).

1.03 DEFINITIONS

A. Green concrete: Concrete with less than 100 percent of the minimum specified compressive strength (f'_c).

1.04 SYSTEM DESCRIPTION

A. Design requirements:
   1. Design of concrete forms, falsework, and shoring in accordance with local, state, and federal regulations.
   2. Design forms and ties to withstand concrete pressures without bulging, spreading, or lifting of forms.

B. Performance requirements:
   1. Construct forms so that finished concrete conforms to shapes, lines, grades, and dimensions indicated on the Drawings.
   2. It is intended that surface of concrete after stripping presents smooth, hard, and dense finish that requires minimum amount of finishing.
   3. Provide sufficient number of forms so that the work may be performed rapidly and present uniform appearance in form patterns and finish.
   4. Use forms that are clean and free from dirt, concrete, and other debris.
      a. Coat with form release agent if required, prior to use or reuse.

1.05 SUBMITTALS

A. Information on proposed forming system:
   1. Submit in such detail as the Engineer may require to assure themselves that intent of the Specifications can be complied with by use of proposed system.
   2. Alternate combinations of plywood thickness and stud spacing may be submitted.

B. Form release agent.

1.06 QUALITY ASSURANCE

A. Qualifications of formwork manufacturers: Use only forming systems by manufacturers having a minimum of 5 years of experience, except as otherwise specified, or accepted in writing by the Engineer.

B. Regulatory requirements: Install work of this Section in accordance with local, state, and federal regulations.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Forms: Built-up plywood:
   1. Built-up plywood forms may be substituted for prefabricated forming system subject to following minimum requirements:
      a. Size and material:
         1) Use full size 4-foot by 8-foot plywood sheets, except where smaller pieces are able to cover entire area.
         2) Sheet construction: 5-ply plywood sheets, 3/4-inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.
      b. Wales: Minimum 2-inch by 4-inch lumber.
      c. Studding and wales: Contain no loose knots and be free of warps, cups, and bows.

B. Forms: Steel or steel framed:
   1. Steel forms:
      a. Rigidly constructed and capable of being braced for minimum deflection of finish surface.
      b. Capable of providing finish surfaces that are flat without bows, cups, or dents.
   2. Steel framed plywood forms:
      a. Provide forms that are rigidly constructed and capable of being braced.
      b. Plywood paneling: 5-ply, 5/8-inch nominal or 3/4-inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.

C. Form release agent:
   1. Effective, non-staining, bond-breaking coating compatible with form surfaces and concrete mixes used.

D. Form ties:
   1. General:
      a. Provide form ties for forming system selected that are manufactured by recognized manufacturer of concrete forming equipment.
      b. Do not use wire ties or wood spreaders of any form.
      c. Provide ties of type that accurately tie, lock, and spread forms.

d. Provide form ties of such design that when forms are removed, they locate no metal or other material within 1-1/2 inches of the surface of the concrete.
e. Do not allow holes in forms for ties to allow leakage during placement of concrete.

2. Cone-snap ties:
   a. Cone-snap ties shall form a cone shaped depression in the concrete with minimum diameter of 1 inch at the surface of the concrete and minimum depth of 1-1/2 inches.
   b. Provide neoprene waterseal washer that is located near the center of the concrete.
3. Taper ties:
   a. Neoprene plugs for taper tie holes: Size so that after they are driven, plugs are located in center third of wall thickness.

E. Incidentals:
1. External angles:
   a. Where not otherwise indicated on the Drawings, provide with 3/4-inch bevel, formed by utilizing true dimensioned wood or solid plastic chamfer strip on walkways, slabs, walls, beams, columns, and openings.
   b. Provide 1/4-inch bevel formed by utilizing true dimensioned wood or solid plastic chamfer strip on walkways, walls, and slabs at expansion and construction joints.
2. Keyways: Steel, plastic, or lumber treated with form release agent.

PART 3 EXECUTION

3.01 EXAMINATION

A. Site verification of conditions:
1. Do not place concrete until forms have been checked for alignment, level, and strength, and mechanical and electrical inserts or other embedded items for correct location.

3.02 INSTALLATION

A. Forms: Built-up plywood:
1. Studding:
   a. Spaced at 16 inches or 24 inches on center.
   b. Closer spacing may be required depending upon strength requirements of the forms, in order to prevent any bulging surfaces on faces of finished concrete work.
   c. Install studs perpendicular to grain of exterior plys of plywood sheets.
2. Wales: Form wales of double lumber material with minimum size as specified in this Section.
3. Number of form reuses: Depends upon durability of surface coating or overlay used, and ability to maintain forms in condition such that they are capable of producing flat, smooth, hard, dense finish on concrete when stripped.

B. Forms: Steel or steel framed:
1. Steel forms:
   a. Adequately brace forms for minimum deflection of finish surface.

2. Steel framed plywood forms:
    a. Rigidly construct and brace with joints fitting closely and smoothly.
    b. Number of form reuses: Depends upon durability of surface coating or overlay used.
3. Built-up plywood forms: As specified in this Section may be used in conjunction with steel forms or steel framed plywood forms for special forming conditions such as corbels and forming around items which will project through forms.

C. Form bracing and alignment:
1. Line and grade: Limit deviations to tolerances which will permit proper installation of structural embedded items or mechanical and electrical equipment and piping.
2. Formwork:
    a. Securely brace, support, tie down, or otherwise hold in place to prevent movement.
    b. Make adequate provisions for uplift pressure, lateral pressure on forms, and deflection of forms.
3. When second lift is placed on hardened concrete: Take special precautions in form work at top of old lift and bottom of new lift to prevent:
    a. Spreading and vertical or horizontal displacement of forms.
    b. Grout "bleeding" on finish concrete surfaces.
4. Pipe stubs, anchor bolts, and other embedded items: Set in forms where required.
5. Cracks, openings, or offsets at joints in formwork: Close those that are 1/16-inch or larger by tightening forms or by filling with acceptable crack filler.

D. Forms: Incidentals:
1. Keyways: Construct as indicated on the Drawings.
2. Reentrant angles: May be left square.
3. Level strips: Install at top of wall concrete placements to maintain true line at horizontal construction joints.
4. Inserts:
    a. Encase pipes, anchor bolts, steps, reglets, castings, and other inserts, as indicated on the Drawings or as required, in concrete.
5. Pipe and conduit penetrations:
    a. Install pipe and conduit in structures as indicated on the Drawings, and seal with materials as specified in Section 7900 - Joint Sealants.

E. Form release agent:
1. Apply in accordance with manufacturer’s instructions.

F. Form ties:
1. Cone-snap ties: Tie forms together at not more than 2-foot centers vertically and horizontally.

3.03 FORM REMOVAL

A. Keep forms in place for at least the periods indicated in the following paragraphs.
   1. Vertical forms:
      a. Keep vertical forms in place for a minimum of 24 hours after concrete is placed.
      b. If, after 24 hours, concrete has sufficient strength and hardness to resist surface or other damage, forms may be removed.
   2. Other forms and shoring: Keep in place:
      a. Sides of footings: 24 hours minimum.
      b. Vertical sides of beams, girders, and similar members: 48 hours minimum.
      c. Bottom of slabs, beams, and girders: Until concrete strength reaches specified strength f'_c or until shoring is installed.
      d. Shoring for slabs, beams, and girders: Shore until concrete strength reaches specified strength.
      e. Wall bracing: Brace walls until concrete strength of beams and slabs laterally supporting wall reaches specified strength.

B. Green concrete:
   1. No heavy loading on green concrete will be permitted.

3.04 SURFACE REPAIRS AND FINISHING

A. Immediately after forms are removed, carefully examine concrete surfaces, and repair any irregularities in surfaces and finishes as specified in Section 03300 - Cast-in-Place Concrete.

B. Form ties: Remove form ties from surfaces. Fill tie holes as follows:
   1. Remove form ties from surfaces.
   2. Roughen cone shaped tie holes by heavy sandblasting before repair.
   3. Dry pack cone shaped tie holes with dry-pack mortar as specified in Section 03600 - Grouting.
   4. Taper ties:
      a. After forms and taper ties are removed from wall, plug tie holes with neoprene plug as follows:
         1) Heavy sandblast and then clean tie holes.
         2) After cleaning, drive neoprene plug into each of taper tie holes with steel rod. Final location of neoprene plug shall be in center third of wall thickness. Bond neoprene plug to concrete with epoxy.
         3) Locate steel rod in cylindrical recess and against middle of plug during driving:
            a) At no time are plugs to be driven on flat area outside cylindrical recess.
      b. Dry-pack of taper tie holes:
         1) After installing plugs in tie holes, coat tie hole surface with epoxy bonding agent and fill with dry-pack mortar as specified in Section 03600 – Grouting:
            a) Place dry-pack mortar in holes in layers with thickness not exceeding tie hole diameter and heavily compact each layer.
            b) Dry-pack the outside of the hole no sooner than 7 days after the inside of the hole has been dry packed.

c) Wall surfaces in area of dry-packed tie holes: On the water side of water containing structures and the outside of below grade walls:
   (1) Cover with minimum of 10 mils of epoxy gel.
   (2) Provide epoxy gel coating on wall surfaces that extend minimum of 2 inches past dry-pack mortar filled tie holes.
   (3) Provide finish surfaces that are free from sand streaks or other voids.

3.05 TOLERANCES

A. Finished concrete shall conform to shapes, lines, grades, and dimensions indicated on the Drawings.

B. Construct work within the tolerances in accordance with ACI 117, except as modified in the following paragraphs or as indicated on the Drawings:
   1. General:
      a. At certain locations in the Work, tolerances required for equipment placement and operation may be more restrictive than the general tolerance requirements of this Section.
      b. Confirm equipment manufacturers' required tolerances for location and operation of equipment that will be installed, and construct concrete to satisfy those requirements.
   2. Slabs:
      a. Slope: Uniformly sloped to drain when slope is indicated on the Drawings.
      b. Slabs indicated to be level: Have maximum vertical deviation of 1/8-inch in 10-foot horizontal length without any apparent changes in grade.
   3. Inserts and embedments:
      a. Set inserts and embedments to tolerances required for proper installation and operation of equipment or systems to which insert pertains.
      b. Maximum tolerances: As follows:

Item	Tolerance
Sleeves and inserts	Plus 1/8 Minus 1/8 inches.
Anchor bolts:	
Projected ends	Plus 1/4 Minus 0.0 inches.
Axial alignment	Not more than 2 degrees off the axis indicated on the Drawings.
Setting location	Plus 1/16 Minus 1/16 inches.

C. Remove and replace work that does not conform to required tolerances. Procedures and products employed in and resulting from such re-work shall be acceptable to the Engineer.

END OF SECTION

SECTION 03150

CONCRETE ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Waterstops.
   2. Joint fillers.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D570 - Standard Test Method for Water Absorption of Plastics.
   2. D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
   3. D638 - Standard Test Method for Tensile Properties of Plastics.
   4. D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
   5. D747 - Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam.
   6. D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
   7. D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
   8. D1752 - Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
   9. D2240 - Standard Test Method for Rubber Property - Durometer Hardness.

B. American National Standards Institute (ANSI):
   1. A135.4 - Basic Hardboard.

C. U. S. Army Corps of Engineers (USACE):
   1. CRD-C-572, Specification for Polyvinyl Chloride Waterstop.

1.03 SUBMITTALS

A. Product data:
   1. Polyvinyl chloride waterstops: Complete physical characteristics.
   2. Preformed expansion joint material: Sufficient information on each type of material for review to determine conformance of material to requirements specified.

B. Samples:
   1. Polyvinyl chloride waterstop.

C. Laboratory test reports: Indicating that average properties of polyvinyl chloride waterstops material and finish conform to requirements specified in this Section.

D. Quality control submittals:
   1. Certificates of Compliance:
      a. Written certificates that polyvinyl chloride waterstops supplied on this Project meet or exceed physical property in accordance with USACE CRD-C-572 and the requirements of this Section.
   2. Manufacturer's instructions: For materials specified in this Section that are specified to be installed with such instructions.

1.04 QUALITY ASSURANCE

A. Mock-ups:
   1. Welding demonstration:
      a. Demonstrate ability to weld acceptable joints in polyvinyl chloride waterstops before installing waterstop in forms.

B. Field joints:
   1. Polyvinyl chloride waterstops field joints: Free of misalignment, bubbles, inadequate bond, porosity, cracks, offsets, and other defects which would reduce the potential resistance of material to water pressure at any point. Replace defective joints. Remove faulty material from site and disposed of by Contractor at its own expense.

C. Inspections:
   1. Quality of welded joints will be subject to acceptance of Engineer.
   2. Polyvinyl chloride waterstop: Following defects represent partial list that will be grounds for rejection:
      a. Offsets at joints greater than 1/16 inch or 15 percent of the material thickness, at any point, whichever is less.
      b. Exterior crack at joint due to incomplete bond, which is deeper than 1/16 inch or 15 percent of material thickness, at any point, whichever is less.
      c. Any combination of offset or crack that will result in net reduction in cross section of waterstop in excess of 1/16 inch or 15 percent of material thickness, at any point, whichever is less.
      d. Misalignment of joint that will result in misalignment of waterstop in excess of 1/2 inch in 10 feet.
      e. Porosity in welded joint as evidenced by visual inspection.
      f. Bubbles or inadequate bonding.

PART 2 PRODUCTS

2.01 JOINT FILLERS

A. General:
   1. Use specific type in applications as indicated on the Drawings.
   2. Do not use scrap or recycled materials to manufacture joint fillers.

B. Preformed expansion joint materials:
   1. Bituminous fiber expansion joint material:
      a. Properties:
         1) Thickness: To match joint width indicated on the Drawings.
         2) Asphalt-impregnated fiber in accordance with ASTM D1751.
      b. Manufacturers: One of the following or equal:
         1) Durajoint.
         2) W.R. Meadows, SealTight Fibre Expansion Joint.
   2. Synthetic sponge rubber expansion joint material:
      a. Properties:
         1) Thickness: As recommended for width indicated on the Drawings.
         2) Material in accordance with ASTM D1752, Type I.
      b. Manufacturers: One of the following or equal:
         1) Williams Products Inc., Everlastic 1300.
         2) W.R. Meadows, SealTight Sponge Rubber.

2.02 WATERSTOPS

A. Waterstops - polyvinyl chloride (PVC):
   1. Manufactured from prime virgin polyvinyl chloride plastic compound containing the plasticizers, resins, stabilizers, and other materials necessary to meet the requirements as specified in this Section.
   2. Manufacturers: One of the following or equal:
      a. Vinylex Corp.
      b. Sika Corp., Greenstreak PVC Waterstop.
   3. Type: Ribbed waterstop:
      a. Construction joints: 6-inch wide ribbed type.
      b. Expansion joint for wall penetrations for concrete encased electrical duct banks: 6-inch ribbed type with hollow center bulb.
      c. Expansion joints: 9-inch wide ribbed type with hollow center bulb.
      d. Dumbbell-type waterstop will not be allowed unless otherwise specified or indicated on the Drawings.
      e. No scrap or reclaimed material shall be used.
   4. Properties as indicated in the following table:

Physical Characteristics	Test Method	Required Results
Specific Gravity	ASTM D792	Not less than 1.3.
Hardness	ASTM D2240	70 to 90 Type A15 Shore durometer.
Tensile Strength	ASTM D638	Not less than 2,000 pounds per square inch.
Ultimate Elongation	ASTM D638	Not less than 300 percent.
Alkali Extraction	CRD-C-572	Change in weight after 7 days: Between minus 0.1 percent and plus 0.25 percent. Change in hardness after 7 days: Not more than plus 5 points.
Low Temperature Brittle Point	ASTM D746	No sign of cracking or chipping at -35 degrees Fahrenheit.
Water Absorption	ASTM D570	Not more than 0.15 percent after 24 hours.

Physical Characteristics	Test Method	Required Results
Accelerated Extraction Test	CRD-C-572	Tensile strength: Not less than 1,600 pounds per square inch. Elongation: Not less than 280 percent.
Stiffness in Flexure	ASTM D747	Not less than 600 pounds per square inch.
Tear Resistance	ASTM D624	Not less than 225 pounds per inch.
Thickness	-	3/8 inch.
Center Bulb		
6-inch Waterstops	-	7/8 inch or 1-inch nominal outside diameter.
9-inch Waterstops	-	For expansion joints 1 inch and narrower: 1-inch nominal outside diameter. For expansion joints wider than 1 inch: 2-inch nominal outside diameter.
Allowable Tolerances		
Width	-	Plus or minus 3/16 inch.
Thickness	-	Plus or minus 1/32 inch.

PART 3 EXECUTION

3.01 INSTALLATION

A. Waterstops:
   1. General:
      a. Store waterstops so as to permit free circulation of air around waterstop material and prevent direct exposure to sunlight.
      b. Install waterstops in concrete joints where indicated on the Drawings.
      c. Carry waterstops in walls into lower slabs and join to waterstops in slabs with appropriate types of fittings.
      d. In waterbearing structures: Provide all joints with waterstops, whether indicated on the Drawings or not.
      e. Provide waterstops that are continuous.
      f. Set waterstops accurately to position and line as indicated on the Drawings.
      g. Hold and securely fix edges in position at intervals of not more than 24 inches so that they do not move during placing of concrete.
      h. Position the waterstop so that symmetrical halves of waterstop are equally divided between concrete pours. Center axis of waterstop shall be coincident with centerline of the joint.
      i. Do not drive nails, screws, or other fasteners through waterstops in vicinity of construction joints.
      j. Use wires at not more than 24 inches on centers near outer edge of waterstop to tie waterstops into position.
      k. Special clips may be used in lieu of wires, at Contractor's option.
      l. Terminate waterstops 3 inches from top of finish surfaces of walls and slabs unless otherwise specified or indicated on the Drawings.

m. When any waterstop is installed in concrete on one side of joint, while the other half or portion of the waterstop remains exposed to the atmosphere for more than 2 days, take suitable precautions to shade and protect exposed waterstop from direct rays of sunlight during entire exposure and until exposed portion is embedded in concrete.
n. When placing concrete at waterstops in slabs, lift edge of waterstop while placing concrete below the waterstop. Manually force waterstop against and into concrete, and then cover waterstop with fresh concrete.

2. Polyvinyl chloride waterstop:
   a. Install waterstops so that joints are watertight.
   b. Weld joints such as unions, crosses, ells, and tees, with thermostatically controlled equipment recommended by waterstop manufacturer:
      1) Do not damage material by heat sealing.
      2) Make joints by overlapping, then simultaneously cut ends of sections to be spliced so they will form smooth even joint. Heat cut ends with splicing tool until the plastic melts. Press 2 ends together until plastic cools.
      3) Maintain continuity of waterstop ribs and tubular center axis.
      4) The splices shall have tensile strength of not less than 60 percent of unspliced materials tensile strength.
   c. Butt joints of ends of 2 identical waterstop sections may be made while material is in forms.
   d. Manufacturer shall factory prefabricate joints for crosses and tees.
   e. Split-type waterstops will not be permitted except where specifically indicated on the Drawings.

B. Joints:
   1. Construct construction and expansion joints as indicated on the Drawings.
   2. Preformed expansion joint material: Fasten expansion joint strips to concrete, masonry, or forms with adhesive. No nailing will be permitted, nor shall expansion joint strips be placed without fastening.

END OF SECTION

SECTION 03200

CONCRETE REINFORCING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Reinforcing bars:
      a. Carbon steel.
   2. Thread bars.
   3. Bar supports.
   4. Tie wires.
   5. Welded wire fabric.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 318 - Building Code Requirements for Structural Concrete and Commentary.
   2. SP-66 - ACI Detailing Manual.

B. American Iron and Steel Institute (AISI).

C. American Welding Society (AWS):
   1. D1.4 - Structural Welding Code - Reinforcing Steel.

D. ASTM International (ASTM):
   1. A493 - Standard Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging.
   2. A615 - Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.

E. Concrete Reinforcing Steel Institute (CRSI):
   1. Manual of Standard Practice.

1.03 DEFINITIONS

A. Architectural concrete: Concrete surfaces that will be exposed to view in the finished work.
   1. Additionally, for purposes of this Section includes:
      a. Concrete surfaces that are designated to receive paints or coatings.
      b. Exposed concrete in open basins, channels, and similar liquid containing structures:
         1) Surfaces shall be considered exposed to view if located above a line 2 feet below the normal operating water surface elevation in that structure.

B. Bars: Reinforcement or reinforcing bars as specified in this Section.

C. Evaluation Report: Report prepared by ICC-ES , or by other testing agency acceptable to the Engineer and to the Building Official, that documents testing and review of a product to confirm that it complies with the requirements of designated ICC-ES Acceptance Criteria, and its acceptance for use under the Building Code specified in Section 01410 - Regulatory Requirements.

D. Give away bars: Reinforcing bars that are not required by the Contract Documents, but are installed by the Contractor to provide support for the required reinforcing bars.

E. Wire supports: Metal reinforcing supports constructed of steel wire as specified. Includes individual high chairs, continuous high chairs, bolsters and other similar configurations and shapes.

1.04 SYSTEM DESCRIPTION

A. The drawings contain notes describing the size and spacing of reinforcement and its placement, details of reinforcement at wall corners and intersections, and details of extra reinforcement around openings in concrete, and other related information.

1.05 SUBMITTALS

A. General:
   1. Submit in accordance with Section 01330 - Submittal Procedures.
   2. Changes to reinforcement in Contract Documents:
      a. Indicate in a separate letter submitted with shop drawings any changes to reinforcement indicated on the Drawings or specified.
      b. Such changes will not be acceptable unless Engineer has accepted them in writing.

B. Product data:
   1. Bar supports:
      a. Wire bar supports:
         1) Schedule of support materials to be provided and locations of use.
      b. Precast concrete bar supports ("dobies"):
         1) Manufacturer's data indicating compression strength of concrete and confirming dimensions and thickness(es).height(s) to be provided for each location where used.

C. Shop drawings:
   1. Reinforcement shop drawings:
      a. Submit drawings showing bending and placement of reinforcement required by the Contract Documents.
      b. Clearly indicate structures or portions of structures covered by each submittal:
         1) Submit reinforcement shop drawings for each structure as a complete package. Submittals addressing only a portion of a structure will be rejected and returned without review, unless such presentation is accepted by Engineer in advance.
      c. Shop drawings shall conform to the recommendations of the CRSI Manual of Standard Practice and ACI SP-66.

d. Use the same bar identification marks on bending detail drawings, placement drawings, and shipping tags.
e. Submittals consisting solely of reinforcing bar schedules, without accompanying placement drawings, will not be accepted unless accepted under prior written agreement with Engineer.

2. Reinforcement placement drawings:
   a. Clearly show placement of each bar listed in the bill of materials, including additional reinforcement at corners and openings, and other reinforcement required by details in the Contract Documents.
   b. Clearly identify locations of reinforcement with coatings (e.g., galvanized or epoxy) and with yield strength other than ASTM A615, Grade 60.
   c. Show splice locations.
3. Reinforcement fabrication drawings:
   a. If bend types or nomenclature differs from that recommended in the CRSI Manual of Standard Practice, provide details showing bend types and dimensional designations.
      Clearly identify reinforcement with coatings and with yield strength other than ASTM A615, Grade 60.

D. Samples (when requested by Engineer):
   1. Bar supports/wire reinforcement supports: Samples of each type of chair and bolster proposed for use. Submit with letter stating where each type will be used.
   2. Precast concrete bar supports: Samples of each type of precast support proposed for use. Submit with letter stating where each will be used.

E. Test reports:
   1. Certified copy of mill test for each steel used. Show physical properties and chemical analysis:
      a. Mill test reports may be submitted as record documents at the time the reinforcement from that heat of steel is shipped to the site.
      b. In such cases, submit certificates under the shop drawing submittal number with the letter "R" (for record date) appended to the end (e.g., of the reinforcement was submitted as 03200-002-1, deliver the associated mill certificate as submittal 03200-002-1R).

F. Manufacturer's instructions:

G. Special procedures:
   1. Welding procedures conforming to AWS D1.4 for reinforcement to be field welded:
      a. Procedures qualification record.

H. Qualifications statements:
   1. Welder qualifications.

I. Closeout documents:
   1. Field quality control and inspection reports.
   2. Field quality assurance special inspection and testing reports.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
   1. Deliver bars bundled and tagged with identifying tags.

B. Acceptance at site:
   1. Reinforcing bars: Deliver reinforcing bars lacking grade identification marks with letter containing manufacturer's guarantee of grade.

1.07 SEQUENCING AND SCHEDULING

A. Bar supports:
   1. Do not place concrete until samples and product data for bar supports have been accepted by Engineer.

PART 2 PRODUCTS

2.01 MATERIALS

A. Reinforcing bars:
   1. Provide reinforcement of the grades and quality specified, fabricated from new stock, free from excessive rust or scale, and free from unintended bends or other defects affecting its usefulness.
   2. Reinforcing bars:
      a. ASTM A615 Grade 60 deformed bars, including the following requirements:
         1) Actual yield strength based on mil tests of reinforcement provided shall not exceed the minimum yield strength specified in this Section by more than 18,000 pounds per square inch.
         2) Ratio of actual ultimate tensile strength to actual tensile yield strength shall not be less than 1.25.
   3. Reinforcing bars designated or required to be welded:
      a. Low-alloy, ASTM A706 Grade 60, deformed bars.

B. Bar supports:
   1. Wire supports:
      a. All stainless steel bar supports:
         1) Conforming to CRSI Manual of Standard Practice recommendations for types and details, but custom fabricated entirely from stainless steel wire conforming to ASTM A493, AISI Type 316.
      b. Stainless steel protected bar supports:
         1) Conforming to CRSI Manual of Standard Practice Class 2, Type B, and consisting of bright basic wire support fabricated from cold-drawn carbon steel wire with stainless steel ends attached at the bottom of each leg.
         2) Stainless steel wire ends shall conform to ASTM A493, AISI Type 316 and shall extend at least 3/4 inch inward from the formed surface of the concrete.
      c. Bright basic wire bar supports:
         1) Conforming to CRSI Manual if Standard Practice, Class 3.

2. Plastic supports:
    a. Manufacturers: The following or equal:
        1) Aztec Concrete Accessories.
3. Deformed steel reinforcing bar supports:
    a. Fabricated of materials and to CRSI details recommended for typical reinforcement embedded in concrete and bent to dimensions required to provide specified clearances and concrete cover.
4. Precast concrete bar supports ("dobies"):
    a. Pre-manufactured, precast concrete blocks with cast-in annealed steel wires, 16-gauge or heavier.
    b. Compression strength of concrete: Equal to or exceeding the compression strength of the surrounding concrete.
    c. Block dimensions:
        1) Height to provide specified concrete cover.
        2) Footprint not less than 3 inches by 3 inches, and adequate to support the weight of the reinforcement and maintain specified concrete cover without settling into the underlying surface.

C. Tie wires:
1. General use: Black annealed steel wire, 16-gauge or heavier.

D. Welded wire fabric reinforcement:
1. Material:
    a. Carbon steel conforming to ASTM A1064.
2. Provide welded wire reinforcement in flat sheet form. Rolled wire fabric is not permitted.
3. Fabric may be used in place of reinforcing bars if accepted by Engineer:
    a. Provide welded wire fabric having cross-sectional area per linear foot not less than the cross-sectional area per linear foot of reinforcing bars indicated on the Drawings.

2.02 FABRICATION

A. Shop fabrication and assembly:
1. Cut and bend bars in accordance with provisions of ACI 318 and the CRSI Manual of Standard Practice.
2. Bend bars cold. Use bending collars to develop the recommended bend radius.
3. Provide bars free from defects and kinks and from bends not indicated on the Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
1. Reinforcing bars and welded wire reinforcement:
    a. Verify that reinforcement is new stock, free from rust scale, loose mill scale, excessive rust, dirt, oil, and other coatings that will adversely affect bonding capacity when placed in the Work.
2. Welded wire fabric:
    a. Verify that sheets are not curled or kinked before or after installation.

3.02 PREPARATION

A. Surface preparation:
   1. Reinforcing bars - uncoated:
      a. Clean reinforcement of concrete, dirt, oil and other coatings that will adversely affect bond before embedding bars in subsequent concrete placements.
      b. Thin coating of red rust resulting from short exposure will not be considered objectionable. Thoroughly clean bars having rust scale, loose mill scale, or thick rust coat.
      c. Partially embedded reinforcement: Remove concrete or other deleterious coatings from dowels and other projecting bars by wire brushing or sandblasting before bars are embedded in subsequent concrete placements.

3.03 INSTALLATION

A. Reinforcing bars: General:
   1. Field-cutting of reinforcing bars is not permitted.
   2. Field-bending of reinforcing bars, including straightening and rebending, is not permitted.

B. Placing reinforcing bars:
   1. Accurately place bars to meet position and cover requirements indicated on the Drawings and specified. Secure bars in position.
   2. Tolerances for placement and minimum concrete cover: As listed in Table 1.

Table 1 - Reinforcement Placing Tolerances

Member	Tolerance on Reinforcement Location (1)	Tolerance on Minimum Concrete Cover (1,2)
Slabs, beams, walls and columns except as noted below:		
10 inches thick and less	± 3/8 inch	- 3/8 inch
More than 10 inches thick	± 1/2 inch	- 1/2 inch
Formed soffits:	As noted above	- 1/4 inch
Longitudinal location of bends and ends of reinforcement:		
Conditions not listed below:	± 2 inches	- 1/2 inch
At discontinuous ends of brackets and corbels	± 1/2 inch	- 1/4 inch
At discontinuous ends of other members:	± 1 inch	- 1/2 inch

Notes:
(1) ± indicates "plus or minus;" - indicates "minus;" + indicates "plus."
(2) Tolerance on cover is limited as noted, but decrease in cover shall not exceed one third of the minimum cover indicated on the Drawings.

3. Spacing between bars:
    a. Minimum clear spacing between bars in a layer:
        1) As indicated on the Drawings, but not less than the larger of 1.5 times the bar diameter or 1-1/2 inches.
    b. Minimum clear spacing between bars in 2 or more parallel layers:
        1) Place bars in upper layers directly above bars in lower layers.
        2) Minimum spacing between layers: As indicated on the Drawings, but not less than the larger of 1.5 times the bar diameter or 1-1/2 inches.
    c. Limits on minimum clear spacing between bars also applies to the clear spacing between a lap splice and the adjacent bars and/or lap splices.
4. Lap splices for bars:
    a. Lap splice locations and lap splice lengths: as indicated on the Drawings. Where lap lengths are not indicated, provide in accordance with ACI 318.
    b. Unless otherwise specifically indicated on the Drawings (and noted as "non-contact lap splice"), install bars at lap splices in contact with each other and fasten together with tie wire.
    c. Where bars are to be lap spliced at concrete joints, ensure that bars project from the first concrete placement a length equal to or greater than minimum lap splice length indicated on the Drawings.
    d. Stagger lap splices where indicated on the Drawings.
    e. Where lap splice lengths are not indicated on the Drawings, provide lap splice lengths in accordance with ACI 318.

C. Reinforcing supports:
1. Provide supports of sufficient numbers, sizes, and locations to maintain concrete cover, to prevent sagging and shifting, and to support loads during construction without displacement and without gouging or indentation into forming surfaces:
    a. Quantities and locations of supports shall not be less than those indicated in ACI SP-66 and the CRSI Manual of Standard Practice.
2. Do not use brick, concrete masonry units, concrete spalls, rocks, wood, or similar materials for supporting reinforcement.
3. Do not use "give away bars" that have less cover than that required by the Contract Documents. Do not adjust the location of reinforcement required by the Contract Documents to provide cover for give away bars.
4. Provide bar supports of height required to maintain the clear concrete cover indicated on the Drawings.
5. Provide bar supports at formed vertical faces to maintain the clear concrete cover indicated on the Drawings.
6. Schedule of reinforcement support materials: Provide bar supports as indicated in Table 2.

Table 2 - Reinforcement Support Materials

Case	Location	Material
a.	Concrete placed over earth and concrete seal slabs ("mud mats"):	Precast concrete bar supports.
b.	Concrete placed against forms and exposed to water or wastewater process liquids (whether or not such concrete received additional linings or coatings):	All stainless steel bar supports.

Table 2 - Reinforcement Support Materials		
Case	**Location**	**Material**
c.	Concrete placed against forms and exposed to earth, weather, frequent washdown, or groundwater in the finished work	All stainless steel bar supports.
d.	Concrete placed against forms and exposed to interior equipment/piping areas in the finished work	All stainless steel bar supports.
e.	Between mats of reinforcement, and fully embedded within a concrete member	Bright basic wire bars supports, or deformed steel reinforcing bars.

D. Tying of reinforcing:
   1. Fasten reinforcement securely in place with wire ties.
   2. Tie reinforcement at spacings sufficient to prevent shifting:
      a. Provide at least 3 ties in each bar length. (Does not apply to dowel lap splices or to bars shorter than 4 feet, unless necessary for rigidity).
   3. Tie slab bars at every intersection around perimeter of slab.
   4. Tie wall bars and slab bar intersections other than around perimeter at not less than every fourth intersection, but at not more than the spacing indicated in Table 3:

Table 3 - Maximum Spacing of Tie Wires for Reinforcement		
Bar Size	**Slab Bar Spacing (inches)**	**Wall Bar Spacing (inches)**
Bars Number 5 and Smaller	60	48
Bars Number 6 through Number 9	96	60
Bars Number 10 and Number 11	120	96

   5. After tying:
      a. Bend ends of wires inward towards the center of the concrete section. Minimum concrete cover for tie wires shall be the same as cover requirements for reinforcement.
      b. Remove tie wire clippings from inside forms before placing concrete.

E. Welded wire fabric reinforcement:
   1. Install only where indicated on the Drawings or accepted in advance by Engineer.
   2. Install necessary tie wires, spacing chairs, and supports to keep welded wire fabric at its designated position in the concrete section while concrete is being placed.
   3. Straighten welded wire fabric to make sheets flat in the Work.
   4. Do not allow wire fabric to drape between supports unless such a configuration is specifically indicated on the Drawings:
      a. If fabric is displaced during placement of concrete, make provisions to restore it to the designated location using methods acceptable to Engineer.
   5. Bend welded wire fabric as indicated on the Drawings or required to fit Work.

6. Lap splice welded wire fabric as indicated on the Drawings:
    a. If lap splice length is not indicated, splice in accordance with ACI 318, but not less than 1 1/2 courses of fabric or 8 inches minimum. Tie laps at ends and at not more than 12 inches on center.

F. Welding reinforcing bars:
1. Weld reinforcing bars only where indicated on the Drawings or where acceptance is received from Engineer prior to welding.
2. Perform welding in accordance with AWS D1.4 and welding procedures accepted by Engineer:
    a. Conform to requirements for minimum preheat and interpass temperatures.
3. Submit:
    a. Welding procedures specification.
    b. Procedures qualification record.
    c. Welder qualification test record.
4. Do not tack weld reinforcing bars except where specifically indicated on the Drawings.

3.04 FIELD QUALITY CONTROL

A. Provide quality control for the Work of this Section as specified in Section 01450 - Quality Control.

B. Field inspections and testing:
1. Submit records of inspections and testing to Engineer in electronic format within 24 hours after completion.

3.05 FIELD QUALITY ASSURANCE

A. Provide quality assurance as specified in Section 01450 - Quality Control.

B. Special inspections and tests:
1. Provide as specified in Section 01455 - Special Tests and Inspections.
2. Frequency of inspections:
    a. Unless otherwise indicated on the Drawings or in this Section, provide periodic special inspection as required by the Building Code specified in Section 01410 - Regulatory Requirements.
3. Preparation:
    a. Review Drawings and Specification for the Work to be observed.
    b. Review approved submittal sand shop drawings.
4. Inspections: Special inspection shall include, but is not limited to, the following items:
    a. Reinforcement: General:
        1) Type (material) and location of reinforcement supports.
        2) Bar material/steel grade and bar size.
        3) Location, placement, and spacing of bars.
        4) Clear concrete cover over reinforcement.
        5) Lap splice: Location and lap length. Bars within tolerances for contact (unless non-contact splice is indicated on the Drawings.)

6) Bar hooks and development lengths embedded within concrete sections as indicated on the Drawings.
7) Reinforcement tired in position and tie wire legs turned inward toward the center of the concrete section.

b. Reinforcement: Welding:
1) Inspector qualification and inspections shall be in accordance with the requirements of AWS D1.4.
2) Provide periodic inspection for:
a) Weldability of reinforcement other than ASTM A706.
b) Single pass fillet welds with thickness less than or equal to 5/16 inch.
3) Provide continuous inspection for:
a) Other welds.
b) Welds at mechanical reinforcing bar couplers and end anchors.
4) In addition to visual inspection, Owner may inspect reinforcing bar welds by other methods, including radiographic inspection.

5. Records of inspections:
a. Provide a written record of each inspection using forms acceptable to the Engineer and to the Building Official.
b. Submit electronic copies of inspection reports to Engineer within 24 hours after completion of inspections.

3.06 NON-CONFORMING WORK

A. Before placing concrete, adjust or remove and re-install reinforcement to conform to the requirements of the Contract Documents.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Cast-in-place concrete.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 305 - Hot Weather Concreting Standard.
   2. 306 - Cold Weather Concreting Standard.
   3. 318 - Building Code Requirements for Structural Concrete and Commentary.
   4. 350 - Code Requirements for Environmental Engineering Concrete Structures and Commentary.
   5. Manual of Concrete Practice.

B. ASTM International (ASTM):
   1. C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   2. C33 - Standard Specification for Concrete Aggregates.
   3. C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   4. C40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
   5. C42 - Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   6. C88 - Standard Test Method of Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   7. C94 - Standard Specification for Ready-Mixed Concrete.
   8. C114 - Standard Test Methods for Chemical Analysis of Hydraulic Cement.
   9. C117 - Standard Test Method for Materials Finer that 75-m (No. 200) Sieve in Mineral Aggregates by Washing.
   10. C123 - Standard Test Method for Lightweight Particles in Aggregate.
   11. C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   12. C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   13. C142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregate.
   14. C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.
   15. C150 - Standard Specification for Portland Cement.
   16. C156 - Standard Test Method for Water Loss from a Mortar Specimen Through Liquid Membrane-Forming Curing Compounds for Concrete.
   17. C171 - Standard Specifications for Sheet Materials for Curing Concrete.
   18. C172 - Standard Practice for Sampling Freshly Mixed Concrete.
   19. C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.

20. C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
21. C295 - Standard Guide to Petrographic Examination of Aggregates for Concrete.
22. C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
23. C311 - Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete.
24. C494 - Standard Specification for Chemical Admixtures for Concrete.
25. C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
26. C856 - Standard Practice for Petrographic Examination of Hardened Concrete.
27. C1260 - Standard Test Method of Potential Alkali Reactivity of Aggregates (Mortar Bar Method).
28. C1293 - Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
29. D75 - Standard Practice for Sampling Aggregates.
30. D2103 - Standard Specification for Polyethylene Film and Sheeting.

1.03 DEFINITIONS

A. Alkali: Sum of sodium oxide and potassium oxide calculated as sodium oxide.

B. Cementitious materials: Portland cement and fly ash.

C. Cold weather: A period when for more than 3 consecutive days, the average daily outdoor temperature drops below 40 degrees Fahrenheit. The average daily temperature is the average of the highest and lowest temperatures during the period from midnight to midnight. When temperatures above 50 degrees Fahrenheit occur during more than half of any 24-hour duration, the period shall no longer be regarded as cold weather.

D. Cold weather concreting: Operations for placing, finishing, curing, and protection of concrete during cold weather.

E. Green concrete: Concrete with less than 100 percent of the specified strength.

F. Hairline crack: Crack with a crack width of less than 4 thousandths of an inch.

G. Hot weather: A period when project conditions such as low humidity, high temperature, solar radiation, and high winds, promote rapid drying of freshly placed concrete.

H. Hot weather concreting: Operations for placing, finishing, curing, and protection of concrete during hot weather.

1.04 SYSTEM DESCRIPTION

A. Performance requirements:
   1. General:
      a. Except as otherwise specified, provide concrete composed of portland cement, fly ash, fine aggregate, coarse aggregate, admixtures and water so proportioned and mixed as to produce plastic, workable mixture in

accordance with requirements as specified in this Section and suitable to specific conditions of placement.

b. Proportion materials in a manner that will secure lowest water-cementitious materials ratio that is consistent with good workability, plastic and cohesive mixture, and a mixture that is within specified slump range.

c. Proportion fine and coarse aggregates in manner such as not to produce harshness in placing or honeycombing.

2. It is the intent of this Section to secure for every part of the Work concrete with homogeneous mixture, which when hardened will have required strength, watertightness, and durability:

a. It is recognized that some surface hairline cracks and crazing will develop in the concrete surfaces.

b. Construction and expansion joints have been specified and positioned in structures as indicated on the Drawings, and curing methods specified, for purpose of reducing number and size of cracks, due to normal expansion and contraction expected from specified concrete mixes.

c. Repair cracks which develop in walls or slabs and repair cracks which show any signs of leakage until all leakage is stopped.

d. Pressure inject visible cracks, other than hairline cracks and crazing, in following areas with epoxy as approved by the Owner and Engineer:

1) Floors and walls of water bearing structures.

2) Other items not specified to receive separate waterproof membrane: Slabs over water channels, wet wells, reservoirs, and other similar surfaces.

e. Walls or slabs, as specified above, that leak or sweat because of porosity or cracks too small for successful pressure injection with epoxy: Seal on water or weather side by coatings of surface sealant system, as specified in this Section.

f. Pressure injection and sealing: Continue as specified above until structure is watertight and remains watertight for not less than 1 year after final acceptance or date of final repair, whichever occurs later in time.

3. Workmanship and methods: Provide concrete work, including detailing of reinforcing, conforming with best standard practices and as set forth in ACI 318, ACI 350, Manual of Concrete Practices, and recommended practices.

1.05 SUBMITTALS

A. Cement mill tests:

1. Include alkali content representative of each shipment of cement for verification of compliance with specified requirements.

2. Provide mill test reports dated not more than 90 days before the date of submittal.

B. Cold weather concreting:

1. Procedures for the production, transportation, placement, protection, curing, and temperature monitoring for concrete during cold weather.

2. Procedures to be implemented upon abrupt changes in weather conditions or equipment failures.

C. Concrete mixes: Full details, including mix design calculations for concrete mixes proposed for use for each class of concrete:
   1. Include information on correction of batching for varying moisture contents of fine aggregate.
   2. Source quality test records with mix design submittal:
      a. Include calculations for required compressive strength (f'_{cr}) based on source quality test records.

D. Concrete aggregate tests: Certified copies in triplicate of commercial laboratory tests not more than 90 days old of all samples of concrete aggregates:
   1. Coarse aggregate:
      a. Abrasion loss.
      b. Clay lumps and friable particles.
      c. Coal and lignite.
      d. Materials finer than 200 sieve.
      e. Reactivity.
      f. Shale and chert.
      g. Soundness.
   2. Fine aggregate:
      a. Clay lumps.
      b. Color.
      c. Decantation.
      d. Reactivity.
      e. Shale and chert.
      f. Soundness.

E. Fine or coarse aggregate batched from more than 1 bin: Analyses for each bin, and composite analysis made up from these, using proportions of materials to be used in mix.

F. Fly ash Certificate of Compliance: Identify source of fly ash and certify compliance in accordance with ASTM C618.

G. For conditions that promote rapid drying of freshly placed concrete such as low humidity, high temperature, and wind: Corrective measures for use prior to placing concrete.

H. Hot weather concreting: Procedures for production, placement, finishing, curing, protection, and temperature monitoring for concrete during hot weather and appropriate corrective measures.

I. Heating equipment for cold weather concreting: Information on type of equipment used for heating materials and new concrete in process of curing during excessively cold weather.

J. Information on mixing equipment.

K. Product data: Submit data completely describing products.

L. Sequence of concrete placing: Submit proposed sequence of placing concrete showing proposed beginning and ending of individual placements.

M. Sieve analysis: Submit sieve analyses of fine and coarse aggregates being used in triplicate at least every 3 weeks and at any time there is significant change in grading of materials.

N. Trial batch test data:
   1. Submit data for each test cylinder.
   2. Submit data that identifies mix and slump for each test cylinder.

O. Weather monitoring: Records of:
   1. Relative humidity.
   2. Site ambient temperature.
   3. Wind speed.

P. Temperature of freshly placed concrete.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
   1. Deliver, store, and handle concrete materials in manner that prevents damage and inclusion of foreign substances.
   2. Deliver and store packaged materials in original containers until ready for use.
   3. Deliver aggregate to mixing site and handle in such manner that variations in moisture content will not interfere with steady production of concrete of specified degree of uniformity and slump.

B. Acceptance at site: Reject material containers or materials showing evidence of water or other damage.

1.07 PROJECT CONDITIONS

A. Environmental requirements:
   1. Monitoring weather conditions:
      a. Install an outdoor weather station capable of measuring and recording ambient temperature, wind speed, and humidity. Furnish instruments accurate to within 2 degrees Fahrenheit, 5 percent relative humidity, and 1 mile per hour wind speed.
      b. Measure and record temperature of fresh concrete. Furnish and use sufficient number of maximum and minimum self-recording thermometers to adequately measure temperature of concrete.
      c. Monitor and keep records of the weather forecast starting at least 48 hours prior to placing concrete in order to allow enough time for taking appropriate measures pertaining to Hot or Cold weather concreting.
   2. Hot weather concreting:
      a. Initiate evaporation control measures when concrete and air temperatures, relative humidity of the air, and the wind velocity have the capacity to evaporate water from a free surface at a rate that is equal to or greater than 0.2 pounds per square feet per hour. Determine evaporation rate using the Menzel Formula and monograph in ACI 305 3.1.3.
      b. When ambient air temperature is above 85 degrees Fahrenheit: Prior to placing concrete, cool forms and reinforcing steel by water cooling to below 90 degrees Fahrenheit.
      c. Monitor weather conditions at the site including air temperature, humidity, and wind speed, to assess the need for evaporation control measures

begin monitoring site conditions no later than 1 hour before the start of concrete placement. Continue to monitor site conditions at intervals of 30 minutes until concrete curing has begun.

d. Temperature of concrete mix at time of placement: Keep temperature below 90 degrees Fahrenheit by methods which do not impair quality of concrete.
e. For conditions that promote rapid drying of freshly placed concrete such as low humidity, high temperature, and wind: Take corrective measures to minimize rapid water loss from concrete:
f. Furnish and use sufficient number of maximum and minimum self-recording thermometers to adequately measure temperature around concrete.

3. Cold weather concreting:
   a. Concrete placed below ambient air temperature of 45 degrees Fahrenheit and falling or below 40 degrees Fahrenheit:
      1) Make provision for heating water.
   b. Follow recommendations of ACI 306 for preparation, placement, and protection of concrete during cold weather.
   c. If materials have been exposed to freezing temperatures to degree that any material is below 35 degrees Fahrenheit: Heat such materials.
   d. Heating water, cement, or aggregate materials:
      1) Do not heat in excess of 160 degrees Fahrenheit.
   e. Protection of concrete in forms:
      1) Do not remove forms from concrete when outside ambient air temperature is below 50 degrees Fahrenheit until concrete has attained its minimum specified compressive strength. Evidence of strength shall be based on by testing of cylinders stored in the field under equivalent conditions to those at the concrete structure.
      2) Protect by means of covering with tarpaulins, or other acceptable covering acceptable to Engineer.
      3) Provide means for circulating warm moist air around forms in manner to maintain temperature of 50 degrees Fahrenheit for at least 5 days.

1.08 SEQUENCING AND SCHEDULING

A. Schedule placing of concrete in such manner as to complete any single placing operation to construction, or expansion joint.

PART 2 PRODUCTS

2.01 MATERIALS

A. Admixtures:
   1. General:
      a. Do not use admixtures of any type, except as specified, unless written acceptance has been obtained from the Engineer.
      b. Admixtures shall be compatible with concrete and other admixtures. Admixtures other than pozzolans shall be the products of a single manufacture to ensure compatibility.

c. Do not use admixtures containing chlorides calculated as chloride ion in excess of 0.5 percent by weight of cement.
d. Use in accordance with manufacturer's recommendations. Add each admixture to concrete mix separately.

2. Air entraining admixture:
   a. Provide concrete with 5 percent, within 1 percent, entrained air of evenly dispersed air bubbles at time of placement.
   b. In accordance with ASTM C260.
3. Water reducing admixture:
   a. May be used at the Contractor's option.
   b. In accordance with ASTM C494, Type A or Type D.
   c. Not contain air-entraining agents.
   d. Liquid form before adding to the concrete mix.
   e. No decrease in cement is permitted as result of use of water reducing admixture.
4. Super-plasticizers: Are not to be used without acceptance by Engineer.

B. Aggregate:
1. General:
   a. Provide concrete aggregates that are sound, uniformly graded, and free of deleterious material in excess of allowable amounts specified.
   b. Grade aggregate in accordance with ASTM C136 and D75.
   c. Provide unit weight of fine and coarse aggregate that produces in place concrete with weight of not less than 140 pounds per cubic foot.
   d. Do not use aggregate made from recycled materials such as crushed and screened hydraulic-cement concrete, brick, and other construction materials.
2. Fine aggregate:
   a. Provide fine aggregate for concrete or mortar consisting of clean, natural sand or of sand prepared from crushed stone or crushed gravel.
   b. Do not provide aggregate having deleterious substances in excess of following percentages by weight of contaminating substances.
      1) In no case shall total exceed percent listed.

Table 1: Fine Aggregate, Limits on Deleterious Substances

Item	Test Method	Percent
Removed by decantation (dirt, silt, etc.)	ASTM C117	3
Shale or Chert	ASTM C123 ASTM C295*	1 1
Clay Lumps	ASTM C142	1

* Test Method C123 is used to identify particles in the sample lighter than 2.40 Specific Gravity. Test Method C295 is used to identify which of the lightweight particles are shale or chert. If the results of Test Method C123 are less than 1 percent, Test Method C295 is not required.

   c. Except as otherwise specified, grade fine aggregate from coarse to fine in accordance with ASTM C33.

3. Coarse aggregate:
    a. Provide coarse aggregate consisting of gravel or crushed stone made up of clean, hard, durable particles free from calcareous coatings, organic matter, or other foreign substances.
    b. Not exceeding 15 percent by weight, of thin or elongated pieces having length greater than 5 times average thickness.
    c. Deleterious substances: Not in excess of following percentages by weight, and in no case having total of all deleterious substances exceeding 2 percent.

Table 2: Coarse Aggregate, Limits on Impurities

Item	Test Method	Percent
Shale or chert	ASTM C123 ASTM C295*	1.25 1
Coal and lignite	ASTM C123	1/4
Clay lumps and friable particles	ASTM C142	1/4
Materials finer than Number 200 sieve	ASTM C117	1/2**

* Test Method C123 is used to identify particles in the sample lighter than 2.40 Specific Gravity. Test Method C295 is used to identify which of the lightweight particles are shale, chert, coal, or lignite. If the results of Test Method C123 are less than 1.25 percent (the minimum combined percentage of shale, chert, coal and lignite), Test Method C295 is not required.

** Except when material finer than Number 200 sieve consists of crusher dust, maximum amount shall be 1 percent.

    d. Grading:
        1) Aggregate for Class A, B, C, and D concrete: In accordance with ASTM C33, Size Number 57, except as otherwise specified or authorized in writing by the Engineer.
        2) Aggregate for Class CE concrete for encasement of electrical conduits:
            a) Graded in accordance with ASTM C33, Size Number 8.

C. Concrete sealer:
    1. Manufacturers: One of the following or equal:
        a. Euclid Chemical Co., Diamond Hard.
        b. L&M Construction Chemicals, SealHard.

D. Conduit encasement coloring agent:
    1. Color: Red color concrete used for encasement of electrical ducts, conduits, and similar type items.
    2. Manufacturers: One of the following or equal:
        a. Davis Co., No. 160 Brick Red.
        b. Euclid Chemical Co., Increte Division, “Colorcrete Brick Red.”
    3. Conduit encasement concrete: Mix into each cubic yard of concrete 10 pounds of coloring agent.

E. Evaporation retardant:
   1. Manufacturers: One of the following or equal:
      a. BASF, MasterKure ER 50.
      b. Euclid Chemical Co., Eucobar.

F. Fly ash:
   1. Fly ash in accordance with ASTM C618, Class F, may be used in concrete made with Type II portland cement.
   2. Maximum of 15 percent by weight of fly ash to total weight of cementitious materials:
      a. The total weight of cementitious materials shall not be less than minimum cementitious materials listed in Table 3.
   3. Do not use in concrete made with portland-pozzolan cement.
   4. Loss on ignition: Not exceed 4 percent.

G. Nonslip abrasive:
   1. Aluminum oxide abrasive size 8/16, having structure of hard aggregate that is, homogenous, nonglazing, rustproof, and unaffected by freezing, moisture, or cleaning compounds.
   2. Manufacturers: One of the following or equal:
      a. Abrasive Materials, Inc.
      b. Euclid Chemical Co., Flexolith Summer Grade.

H. Portland cement:
   1. Conform to specifications and tests in accordance with ASTM C150, Types II or III, low alkali, except as specified otherwise.
   2. Have total alkali containing not more than 0.60 percent.
   3. Exposed concrete in any individual structure: Use only one brand of portland cement.
   4. Cement for finishes or repairs: Provide cement from same source and of same type as concrete to be finished or repaired.

I. Sheet membrane for curing:
   1. Polyethylene film:
      a. In accordance with ASTM C171.
      b. Color: White.
      c. Thickness: Nominal thickness of polyethylene film shall not be less than 0.0040 inches when measured in accordance with ASTM D2103. Thickness of polyethylene film at any point shall not be less than 0.0030 inches.
      d. Loss of moisture: Not exceed 0.055 grams per square centimeter of surface when tested in accordance with ASTM C156.

J. Sprayed membrane curing compound: Clear type with fugitive dye in accordance with ASTM C309, Type 1D.

K. Surface sealant system:
   1. Manufacturers: One of the following or equal:
      a. Euclid Chemical Co., Vandex Super.
      b. Kryton International, Inc., Krystol T1.
      c. Xypex Chemical Corp., Xypex Concentrate.

L. Water:
   1. Water for concrete, washing aggregate, and curing concrete: Clean and free from oil and deleterious amounts of alkali, acid, organic matter, or other substances.
   2. Chlorides and sulfate ions:
      a. Water for conventional reinforced concrete: Use water containing not more than 1,000 milligrams per liter of chlorides calculated as chloride ion, nor more than 1,000 milligrams per liter of sulfates calculated as sulfate ion.
      b. Water for prestressed or post-tensioned concrete: Use water containing not more than 650 milligrams per liter of chlorides calculated as chloride ion, or more than 800 milligrams per liter of sulfates calculated as sulfate ion.

2.02 EQUIPMENT

A. Mixing concrete:
   1. Mixers may be of stationary plant, paver, or truck mixer type.
   2. Provide adequate equipment and facilities for accurate measurement and control of materials and for readily changing proportions of material.
   3. Mixing equipment:
      a. Capable of combining aggregates, cementitious materials, and water within specified time into thoroughly mixed and uniform mass and discharging mixture without segregation.
      b. Maintain concrete mixing plant and equipment in good working order and operated at loads, speeds, and timing recommended by manufacturer or as specified.
      c. Proportion cementitious materials and aggregate by weight.

B. Machine mixing:
   1. Batch plant shall be capable of controlling delivery of all material to mixer within 1 percent by weight of individual material.
   2. If bulk cementitious materials are used, weigh them on separate visible scale which will accurately register scale load at any stage of weighing operation from zero to full capacity.
   3. Prevent cementitious materials from coming into contact with aggregate or with water until materials are in mixer ready for complete mixing with all mixing water.
   4. Procedure of mixing cementitious materials with sand or with sand and coarse aggregate for delivery to project site, for final mixing and addition of mixing water will not be permitted.
   5. Retempering of concrete will not be permitted.
   6. Discharge entire batch before recharging.
   7. Volume of mixed material per batch: Not exceed manufacturer's rated capacity of mixer.
   8. Mixers:
      a. Perform mixing in batch mixers of acceptable type.
      b. Equip each mixer with device for accurately measuring and indicating quantity of water entering concrete, and operating mechanism such that leakage will not occur when valves are closed.

c. Equip each mixer with device for automatically measuring, indicating, and controlling time required for mixing:
    1) Interlock device to prevent discharge of concrete from mixer before expiration of mixing period.

C. Transit-mixed concrete:
1. Mix and deliver in accordance with ASTM C94.
2. Total elapsed time between addition of water at batch plant and discharging completed mix:
    a. Not to exceed 90 minutes.
    b. Elapsed time at project site shall not exceed 30 minutes.
3. Under conditions contributing to quick setting, total elapsed time permitted may be reduced by the Engineer.
4. Equip each truck mixer with device interlocked to prevent discharge of concrete from drum before required number of turns and furnish device that is capable of counting number of revolutions of drum.
5. Continuously revolve drum after it is once started until it has completely discharged its batch:
    a. Do not add water until drum has started revolving.
    b. Right is reserved to increase required minimum number of revolutions or to decrease designated maximum number of revolutions allowed, if necessary, to obtain satisfactory mixing. The Contractor will not be entitled to additional compensation because of such increase or decrease.

D. Other types of mixers: In case of other types of mixers, mixing shall be as follows:
1. Mix concrete until there is uniform distribution of materials, and discharge mixer completely before recharging.
2. Neither speed nor volume loading of mixer shall exceed manufacturer's recommendations.
3. Continue mixing for minimum of 1-1/2 minutes after all materials are in drum, and for batches larger than 1 cubic yard increase minimum mixing time 15 seconds for each additional cubic yard or fraction thereof.

2.03 MIXES

A. Measurements of materials:
1. Measure materials by weighing, except as otherwise specified or where other methods are specifically authorized in writing by the Engineer.
2. Furnish apparatus for weighing aggregates and cementitious materials that is suitably designed and constructed for this purpose.
3. Accuracy of weighing devices: Furnish devices that have capability of providing successive quantities of individual material that can be measured to within 1 percent of desired amount of that material.
4. Measuring or weighing devices: Subject to review by the Engineer. Shall bear valid seal of the Sealer of Weights and Measures having jurisdiction.
5. Weighing cementitious materials:
    a. Weigh cementitious materials separately.
    b. Cement in unbroken standard packages (sacks): Need not be weighed.
    c. Weigh bulk cementitious materials and fractional packages.
6. Measure mixing water by volume or by weight.

B. Concrete proportions and consistency:
   1. Provide concrete that can be worked readily into corners and angles of forms and around reinforcement without excessive vibration and without permitting materials to segregate or free water to collect on surface.
   2. Prevent unnecessary or haphazard changes in consistency of concrete.
   3. Ratio of coarse aggregate to fine aggregate: Not less than 1.0 or more than 2.0 for all concrete Classes, with exception of Class CE.
   4. Aggregate:
      a. Obtain aggregate from source that is capable of providing uniform quality, moisture content, and grading during any single day's operation.
   5. Maximum concrete mix water to cementitious materials ratio, minimum cementitious materials content, and slump range: Conform to values specified in Table 3 in this Section.
   6. Concrete batch weights: Control and adjust to secure maximum yield. At all times, maintain proportions of concrete mix within specified limits.
   7. Mix modification: If required, by the Engineer, modify mixture within limits set forth in this Section.

C. Concrete mixes:
   1. Proportioning of concrete mix: Proportion mixes based on required compressive strength f'_{cr}.
   2. Mixes:
      a. Adjusting of water: After acceptance, do not change mixes without acceptance by Engineer, except that at all times adjust batching of water to compensate for free moisture content of fine aggregate.
      b. Total water content of each concrete class: Not exceed those specified in Table 3 in this Section.
      c. Checking moisture content of fine aggregate: Furnish satisfactory means at batching plant for checking moisture content of fine aggregate.
   3. Change in mixes: Submit new mix design and perform new trial batch and test program as specified in this Section.

D. Classes of concrete:
   1. Provide concrete consisting of 5 classes: Classes A, B, C, D, and CE. Use where specified or indicated on the Drawings.
   2. Weight of concrete classes: Provide classes of concrete having minimum weight of 140 pounds per cubic foot.
   3. Class B concrete: Class B concrete may be substituted for Class A concrete, when high-early strength concrete is needed in areas specifically accepted by the Engineer and that do not require sulfate resistant concrete.
   4. Class C concrete: Class C concrete may be used for fill for unauthorized excavation, for thrust blocks and ground anchors for piping, for bedding of pipe, and where indicated on the Drawings.
   5. Class D concrete: Use Class D for precast concrete items.
   6. Class CE concrete: Use Class CE for electrical conduit encasements.
   7. All other concrete, unless specified or otherwise indicated on the Drawings: Use Class A concrete.

Table 3: Concrete				
Class	**Minimum Specified Compressive Strength f'_c at 28 Days (Pounds per Square Inch)**	**Water-to-Cementitious Materials Ratio**	**Cementitious Materials per Cubic Yard of Concrete by Weight (Pounds)**	**Slump Range (Inches)**
A	4,000	0.40 to 0.42	564 to 658	2 to 4
B (Type III cement)	4,000	0.40 to 0.42	564 to 658	2 to 4
C	2,500	Maximum 0.62	Minimum 423	3 to 6
CE	2,500	Maximum 0.62	Minimum 423	3 to 6
D	5,000	0.40 to 0.45	564 to 658	2 to 4

8. Pumped concrete: Provide pumped concrete that complies with all requirements of this Section.
9. Do not place concrete with slump outside limits indicated in Table 3.
10. Classes:
    a. Classes A, C, D, and CE concrete: Make with Type II low alkali portland cement.
    b. Class B concrete: Make with Type III low alkali portland cement.
    c. Admixtures: Provide admixtures as specified in this Section.

E. Air entraining admixture:
1. Add agent to batch in portion of mixing water.
2. Batch solution by means of mechanical batcher capable of accurate measurement.

2.04 SOURCE QUALITY CONTROL

A. Tests:
1. Trial batches:
    a. After concrete mix designs have been accepted by Engineer, have trial batches of the accepted Class A, Class B, and Class D concrete mix designs prepared by testing laboratory acceptable to the Engineer.
    b. Prepare trial batches using cementitious materials and aggregates proposed to be used for the Work.
    c. Prepare trial batches with sufficient quantity to determine slump, workability, consistency, and finishing characteristics, and to provide sufficient test cylinders.
    d. Test cylinders: Provide cylinders having 6-inch diameter by 12-inch length and that are prepared in accordance with ASTM C31 for tests specified in this Section.
    e. Determine slump in accordance with ASTM C143.
    f. Test cylinders from trial batch:
        1) Test 8 cylinders for compressive strength in accordance with ASTM C39:
            a) Test 4 cylinders at 7 days and 4 at 28 days.
            b) Establish ratio between 7 day and 28 day strength for mix. 7-day strength may be taken as satisfactory indication of 28-day

strength provided effects on concrete of temperature and humidity between 7 day and 28 day are taken into account.

2) Average compressive strength of 4 test cylinders tested at 28 days: Equal to or greater than required average compressive strength (f'_{cr}) on which concrete mix design is based.

g. If trial batch tests do not meet specified requirements for slump, strength, workability, consistency, and finishing, change concrete mix design proportions and, if necessary, source of aggregate:
   1) Perform additional trial batches and tests until an acceptable trial batch is produced that meets requirements of this Section.

h. Perform test batches and tests required to establish trial batches and acceptability of materials without change in Contract Price.

i. Do not place concrete until the concrete mix design and trial batch have been accepted by Engineer.

2. Required average compressive strength:
   a. Determine required average compressive strength (f'_{cr}) for selection of concrete proportions for mix design, for each class of concrete, using calculated standard deviation for its corresponding specified compressive strength (f'_c,) in accordance with ACI 318 and ACI 350.
   b. When test records of at least 30 consecutive tests that span period of not less than 45 calendar days are available, establish standard deviation as in accordance with ACI 318 and ACI 350 and as modified in this Section.
   c. Provide test records from which to calculate standard deviation that represent materials, quality control procedures, and conditions similar to materials, quality control procedures, and conditions expected to apply in preparation of concrete for the Work.
   d. Provide test records with materials and proportions that are more restricted than those for the Work.
   e. Specified compressive strength (f'_c) of concrete used in test records: Within 1,000 pounds per square inch of that specified for the Work.
   f. When lacking adequate test records for calculation of standard deviation meeting requirements, determine required average compressive strength f'_{cr} from following Table 4.

Table 4: Required Average Compression Strength

Specified Compressive Strength f'_c (pounds per square inch)	Required Average Compressive Strength f'_{cr} (pounds per square inch)
Less than 3,000	f'_c + 1,000
3,000 to 5,000	f'_c + 1,200
Over 5,000	$1.10f'_c$ + 700

3. Aggregate:
   a. Testing of concrete aggregate is at Contractor's expense.
   b. Provide test reports representing samples of materials taken and tested at the following times:
      1) Not more than 60 days prior to the date on the proposed materials for concrete mixes.
      2) Not more than 60 days prior to any change in the source of aggregates, including suppliers and/or quarries.
      3) Whenever there is a significant change in aggregate quality or gradation from a previously submitted and accepted source.

c. Sample aggregate in accordance with ASTM D75.
d. Fine and coarse aggregates:
    1) Gradation: Test in accordance with ASTM C136. Use sieves with square openings for testing grading of aggregates.
    2) Alkali-silica reactivity:
        a) Provide fine and coarse aggregate with expansion not greater than 0.10 percent at 14 days when tested in accordance with ASTM C1260**.**
e. Fine aggregate:
    1) Provide fine aggregate that does not contain strong alkali nor organic matter which gives color darker than standard color when tested in accordance with ASTM C40.
    2) Provide aggregate having soundness in accordance with ASTM C33 when tested in accordance with ASTM C88.
f. Coarse aggregate:
    1) Soundness when tested in accordance with ASTM C88: Have loss not greater than 10 percent when tested with sodium sulfate.
    2) Abrasion Loss: Not exceed 45 percent after 500 revolutions when tested in accordance with ASTM C131.
g. Fly ash:
    1) Sampling and testing: Sample and test fly ash in accordance with ASTM C311.
h. Portland cement:
    1) Determination of alkali content: In accordance with ASTM C114.

PART 3 EXECUTION

3.01 INSTALLATION

A. Liquid evaporation retardant:
    1. Under conditions that result in rapid evaporation of moisture from the surface of the concrete, immediately after the concrete has been screeded, coat the surface of the concrete with a liquid evaporation retardant.
    2. Apply the evaporation retardant again after each work operation as necessary to prevent drying shrinkage cracks.
    3. Conditions which result in rapid evaporation of moisture may include one or more of the following:
        a. Low humidity.
        b. Windy conditions.
        c. High temperature.

B. Surface sealant system:
    1. Apply as recommended by manufacturer published instructions.
    2. Where concrete continues to sweat or leak, apply additional coats of surface sealant until the sweating or leaks stop.

C. Joints and bonding:
    1. As far as practicable construct concrete work as monolith.
    2. Locations of construction, expansion, and other joints are indicated on the Drawings or as specified in this Section.

3. Time between placement of adjacent concrete separated by joints:
    a. Provide not less than 3 days (72 hours) between placement of adjacent sections for the following:
        1) Slabs.
        2) Walls.
    b. Provide not less than 7 days (168 hours) between placement of upper and lower pours for the following:
        1) Walls over slabs.
        2) Slabs over walls.
        3) Slabs keyed into the sides of walls.
4. Construction joints:
    a. Where construction joints are not indicated on the Drawings, provide construction joints in slabs and walls at intervals not greater than 35 feet.
    b. In order to preserve strength and watertightness of structures, make no other joints, except as authorized the Engineer.
    c. At construction joints, thoroughly clean concrete of laitance, grease, oil, mud, dirt, curing compounds, mortar droppings, or other objectionable matter by means of heavy sandblasting.
    d. Cleaning of construction joints:
        1) Wash construction joints free of sawdust, chips, and other debris after forms are built and immediately before concrete or grout placement.
        2) Should formwork confine sawdust, chips, or other loose matter in such manner that it is impossible to remove them by flushing with water, use vacuum cleaner for their removal, after which flush cleaned surfaces with water.
        3) Provide cleanout hole at base of each wall and column for inspection and cleaning.
    e. At horizontal joints: As initial placement over cold joints, thoroughly spread bed of cement grout as specified in Section 03600 - Grouting with a thickness of not less than 1/2 inch nor more than 1 inch.
5. Take special care to ensure that concrete is well consolidated around and against waterstops and waterstops are secured in proper position.
6. Construction and expansion Joints:
    a. Constructed where and as indicated on the Drawings.
    b. Waterstops, expansion joint material, synthetic rubber sealing compound, and other similar materials: As specified in Sections 03150 - Concrete Accessories and 07900 - Joint Sealants.
7. Repair of concrete: Where it is necessary to repair concrete by bonding mortar or new concrete to concrete which has reached its initial set, first coat surface of set concrete with epoxy bonding agent as specified in Section 03071 - Epoxies.

D. Conveying and placing concrete:
    1. Convey concrete from mixer to place of final deposit by methods that prevent separation or loss of materials.
    2. Use equipment for chuting, pumping, and conveying concrete of such size and design as to ensure practically continuous flow of concrete at delivery end without segregation of materials.

3. Design and use chutes and devices for conveying and depositing concrete that direct concrete vertically downward when discharged from chute or conveying device.
4. Keep equipment for conveying concrete thoroughly clean by washing and scraping upon completion of day's placement.

E. Placing concrete:
1. Place no concrete without prior authorization of the Engineer.
2. Do not place concrete until:
   a. Reinforcement is secure and properly fastened in its correct position and loose form ties at construction joints have been retightened.
   b. Dowels, bucks, sleeves, hangers, pipes, conduits, anchor bolts, and any other fixtures required to be embedded in concrete have been placed and adequately anchored.
   c. Forms have been cleaned and oiled as specified.
3. Do not place concrete in which initial set has occurred, or that has been retempered.
4. Do not place concrete during rainstorms or high velocity winds.
5. Protect concrete placed immediately before rain to prevent water from coming in contact with such concrete or winds causing excessive drying.
6. Keep sufficient protective covering on hand at all times for protection of concrete.
7. After acceptance, adhere to proposed sequence of placing concrete, except when specific changes are requested and accepted by the Engineer.
8. Notify the Engineer in writing of readiness, not just intention, to place concrete in any portion of the work:
   a. Provide this notification in such time in advance of operations, as the Engineer deems necessary to make final inspection of preparations at location of proposed concrete placing.
   b. Place forms, reinforcement, screeds, anchors, ties, and inserts in place before notification of readiness is given to the Engineer.
   c. Depositing concrete:
      1) Deposit concrete at or near its final position to avoid segregation caused by rehandling or flowing.
      2) Do not deposit concrete in large quantities in one place and work along forms with vibrator or by other methods.
      3) Do not drop concrete freely into place from height greater than 5 feet.
      4) Use tremies for placing concrete where drop is over 5 feet.
      5) Commence placement of concrete on slopes, starting at bottom of slope.
9. Place concrete in approximately horizontal layers not to exceed 24 inches in depth and bring up evenly in all parts of forms.
10. Continue concrete placement without avoidable interruption, in continuous operation, until end of placement is reached.
11. After concrete placement begins, continue concrete placement without significant interruption. Plan and implement precautions to prevent any delay, between layers being placed, from exceeding 20 minutes.
12. If concrete is to be placed over previously placed concrete and more than 20 minutes has elapsed, spread layer of cement grout not less than 1/2 inch in thickness nor more than 1 inch in thickness over surface before placing additional concrete.

13. Placement of concrete for slabs, beams, or walkways:
    a. If cast monolithically with walls or columns, do not commence until concrete in walls or columns has been allowed to set and shrink.
    b. Allow set time of not less than 1 hour for shrinkage.

F. Consolidating concrete:
1. Place concrete with aid of acceptable mechanical vibrators.
2. Thoroughly consolidate concrete around reinforcement, pipes, or other shapes built into the work.
3. Provide sufficiently intense vibration to cause concrete to flow and settle readily into place and to visibly affect concrete over radius of at least 18 inches.
4. Vibrators:
    a. Keep sufficient vibrators on hand at all times to vibrate concrete as placed.
    b. In addition to vibrators in actual use while concrete is being placed, have on hand minimum 1 spare vibrator in serviceable condition.
    c. Do not place concrete until it has been ascertained that all vibrating equipment, including spares, are in serviceable condition.
5. Take special care to place concrete solidly against forms to leave no voids.
6. Take every precaution to make concrete solid, compact, and smooth. If for any reason surfaces or interiors have voids or are in any way defective, repair such concrete in manner acceptable to the Engineer.

G. Footings and slabs on grade:
1. Do not place concrete on ground or compacted fill until subgrade is in moist condition acceptable to the Engineer.
2. If necessary, sprinkle subgrade with water not less than 6 or more than 20 hours in advance of placing concrete.
3. If subgrade becomes dry prior to concrete placement, sprinkle again, without forming pools of water.
4. Do not place concrete if subgrade is muddy or soft. Loading concrete.
5. Green concrete:
    a. No heavy loading of green concrete will be permitted.
6. No backfill shall be placed against concrete walls, connecting slabs, or beams until the concrete has reached the specified strength.
7. Use construction methods, sequencing, and allow time for concrete to reach adequate strength to prevent overstress of the concrete structure during construction.

H. Curing concrete:
1. General:
    a. Cure concrete by methods specified in this Section.
    b. Keep concrete continuously moist and at a temperature of at least 50 degrees Fahrenheit for minimum of 7 days after placement.
    c. Cure concrete to be painted with water or sheet membrane.
    d. Do not use sprayed membrane curing or sealing compounds on concrete surfaces that are to receive paint or upon which any material is to be bonded.
    e. Water cure or sheet membrane cure concrete slabs that are specified to be sealed by concrete sealer.

f. Cure other concrete by water curing or sprayed membrane curing compound at the Contractor's option.
g. Floor slabs may be cured using sheet membrane curing.

2. Water curing:
   a. Keep surfaces of concrete being water cured constantly and visibly moist day and night for period of not less than 7 days.
   b. Each day forms remain in place count as 1 day of water curing.
   c. No further curing credit will be allowed for forms in place after contact has once been broken between concrete surface and forms.
   d. Do not loosen form ties during period when concrete is being cured by leaving forms in place.
   e. Flood top of walls with water at least 3 times per day, and keep concrete surfaces moist at all times during 7 day curing period.
3. Sprayed membrane curing compound:
   a. Apply curing compound to concrete surface after repairing and patching, and within 1 hour after forms are removed.
   b. If more than 1 hour elapses after removal of forms, do not use curing compound, but use water curing for full curing period.
   c. If surface requires repairing or painting, water cure such concrete surfaces.
   d. Do not remove curing compound from concrete in less than 7 days.
   e. Curing compound may be removed only upon written request by Contractor and acceptance by Engineer, stating what measures are to be performed to adequately cure concrete.
   f. Take care to apply curing compound to construction joints. Apply to all surfaces along full profile of joints.
   g. After curing period is complete, remove curing compound placed within construction joint profile by heavy sandblasting prior to placing any new concrete.
   h. Contractor's Option: Instead of using curing compound for curing of construction joints, such joints may be water cured.
   i. Apply curing compound by mechanical, power operated sprayer and mechanical agitator that will uniformly mix all pigment and compound.
   j. Apply curing compound in at least 2 coats.
   k. Apply each coat in direction 90 degrees to preceding coat.
   l. Apply curing compound in sufficient quantity so that concrete has uniform appearance and that natural color is effectively and completely concealed at time of spraying.
   m. Continue to coat and recoat surfaces until specified coverage is achieved and until coating film remains on concrete surfaces.
   n. Thickness and coverage of curing compound: Provide curing compound having film thickness that can be scraped from surfaces at any and all points after drying for at least 24 hours.
   o. The Contractor is cautioned that method of applying curing compound specified in this Section may require more curing compound than normally suggested by mapnufacturer of curing compound and also more than is customary in the trade.
   p. Apply amounts specified in this Section, regardless of manufacturer's recommendations or customary practice.
   q. If the Contractor desires to use curing compound other than specified curing compound, coat sample areas of concrete wall with proposed

curing compound and also similar adjacent area with specified compound in specified manner for comparison:
1) If proposed sample is not equal or better, in opinion of the Engineer, in all features, proposed substitution will not be allowed.

r. Prior to final acceptance of the work, remove, by sandblasting or other acceptable method, any curing compound on surfaces exposed to view, so that only natural color of finished concrete is visible uniformly over entire surface.

4. Sheet membrane curing:
   a. Install sheet membrane as soon as concrete is finished and can be walked on without damage.
   b. Seal joints and edges with small sand berm.
   c. Keep concrete moist under sheet membrane.

3.02 CONCRETE FINISHING

A. Provide concrete finishes as specified in Section 03366 - Tooled Concrete Finishing.

B. Edges of joints:
   1. Provide joints having edges as indicated on the Drawings.
   2. Protect wall and slab surfaces at edges against concrete spatter and thoroughly clean upon completion of each placement.

C. Concrete sealer:
   1. Floors and slabs to receive concrete sealer:
      a. Storage Building Mat Foundation.
   2. Apply concrete sealer:
      a. Apply concrete sealer at coverage rate not to exceed 300 square feet per gallon.
      b. Apply as soon as slab or floor will bear weight.
      c. Sealer:
         1) Before applying concrete sealer, sweep entire surface clean with very soft bristled brush that will not mark concrete finish and remove any standing water.
         2) Apply concrete sealer with sprayer.
         3) Use of paint rollers or mop is not acceptable.
         4) Workmen shall wear flat soled shoes which will not mark or scar concrete surface.
         5) Do not allow traffic on floors and slabs until concrete sealer has dried and hardened.

3.03 FIELD QUALITY CONTROL

A. Testing of concrete:
   1. During progress of construction, the Owner will have tests made to determine whether the concrete, as being produced, complies with requirements specified.
   2. Tests will be performed in accordance with ASTM C31, ASTM C39, and ASTM C172.

3. Contractor shall hire a Certified Independent Laboratory that will make and deliver test cylinders to the laboratory and testing expense will be borne by the Owner.
4. Furnish test equipment.
5. Make provisions for and furnish concrete for test specimens, and provide manual assistance to the Engineer in preparing said specimens.
6. Assume responsibility for care of and providing of curing conditions for test specimens in accordance with ASTM C31.
7. Sampling frequency:
    a. 1 set of test cylinders for each 150 cubic yards of each class of concrete.
    b. Minimum of 1 set of test cylinders for each class of concrete placed.
    c. Not less than 1 set of test cylinders for each half-day's placement.
    d. At least 2 sets of test cylinders for each structure.

B. Compressive strength tests:
1. Set of 3 cylinder specimens, 6-inch diameter by 12 inch long.
2. Information: Test 1 cylinder at 7 days.
3. Acceptance: Test 2 cylinders at 28 days.

C. Slump tests:
1. Test slump of concrete using slump cone in accordance with ASTM C143.
2. Do not use concrete that does not meet specification requirements in regards to slump:
    a. Remove such concrete from project site.
    b. Test slump at the beginning of each placement, as often as necessary to keep slump within the specified range, and when requested to do so by the Engineer.

D. Air entrainment tests:
1. Test percent of entrained air in concrete at beginning of each placement, as often as necessary to keep entrained air within specified range, and when requested to do so by the Engineer.
2. Do not use concrete that does not meet Specification requirements for air entrainment:
    a. Remove such concrete from project site.
3. Test air entrainment in concrete in accordance with ASTM C173.
4. The Engineer may at any time test percent of entrained air in concrete received on project site.

E. Enforcement of strength requirement:
1. Concrete is expected to reach a compressive strength (f'_c) equal to or greater than that the minimum specified in Table 3.
2. Strength level of concrete will be considered acceptable if following conditions are satisfied:
    a. Averages of all sets of 3 consecutive strength test results is greater or equal to specified compressive strength(f'_c).
    b. No individual strength test (average of 2 cylinders) falls below specified compressive strength (f'_c) by more than 500 pounds per square inch.
3. Non-compliant strength tests:
    a. Mark non-compliant strength test reports to highlight that they contain non-complying results and immediately forward copies of test reports to all parties on the test report distribution list.

b. Provide treatment of non-compliant concrete at no additional cost to Owner and with no additional time added to project schedule:
c. Initial treatment may consist of additional curing and testing of the affected concrete:
    1) Provide additional curing of concrete using means and duration acceptable to the Engineer.
    2) Upon completion of the additional curing, provide additional testing designated by the Engineer:
        a) Obtain and test core samples for compression strength in accordance with ASTM C42, ACI 318, and ACI 350.
        b) Provide not less than 3 cores for each affected area. Obtain Engineer's acceptance of proposed coring locations before proceeding with that work.
        c) Submit report of compression strength testing for Engineer's review.
        d) If required by the Engineer, provide additional cores and obtain petrographic examination in accordance with ASTM C856. Submit report of petrographic analysis for Engineer's review.
    3) If additional curing does not bring average of 3 cores taken in affected area to at least the minimum specified compressive strength (f'_c), designate such concrete in affected area as defective.

3.04 ADJUSTING

A. Provide repair of defective concrete at no additional cost to Owner and with no additional time added to the project schedule:

B. Make repairs using approach and means acceptable to the Engineer:
    1. Provide repairs having strength equal to or greater than specified concrete for areas involved.
    2. Do not patch, repair, or cover defective work without inspection by the Engineer.
    3. Acceptable means may include, but are not limited to strengthening, repair, or removal and replacement.

C. Strengthening of defective concrete:
    1. By addition of concrete.
    2. By addition of reinforcing.
    3. By addition of both concrete and reinforcing.

D. Repairs:
    1. Methods of repair:
        a. Dry pack method:
            1) Use for holes having depth nearly equal to or greater than least surface dimension of hole, for cone-bolt holes, and for narrow slots cut for repair.
            2) Smooth holes: Clean and roughen by heavy sandblasting before repair.

b. Mortar replacement method:
    1) Use for holes too wide to dry pack and too shallow for concrete replacement.
    2) Comparatively shallow depressions, large or small, which extend no deeper than nearest surface reinforcement.
c. Concrete replacement method:
    1) Use when holes extend entirely through concrete section or when holes are more than 1 square foot in area and extend halfway or more through the section.

2. Preparation of concrete for repair:
    a. Chip out and key imperfections in the work and make them ready for repair.
    b. Obtain Engineer's acceptance of surface preparation methods and of prepared surfaces prior to repair.
    c. Surfaces of set concrete to be repaired: First coat with epoxy bonding agent as specified in Section 03071 - Epoxies.

E. Remove and replace defective concrete.

END OF SECTION

SECTION 03363

EXPOSED AGGREGATE CONCRETE FINISHING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Exposed aggregate concrete finishes.

1.02 SUBMITTALS

A. Product data: Submit data completely describing products.

1.03 QUALITY ASSURANCE

A. Mock-ups:
   1. Exposed aggregate finish: The Owner will furnish 18-inch by 18-inch sample which will be housed at Project site during construction for convenient reference.
   2. Test panels showing horizontal and vertical joints: Prepare test panel showing horizontal and vertical joints proposed for project for review by the Engineer.
   3. Test panels indicating methods for making concrete repairs:
      a. Prepare test panels for proposed repairs at beginning of project for review by Engineer:
         1) Panels will serve as standard for repairs during the project.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
   1. Deliver and store packaged materials in original containers until ready for use.

PART 2 PRODUCTS

2.01 MATERIALS

A. Retarder materials:
   1. Liquid retarder: Provide retarder of proper penetration grade to attain specified aggregate exposure.
   2. Impregnated cloth form liner.

PART 3 EXECUTION

3.01 INSTALLATION

A. Vertical cast-in-place exposed aggregate finish surfaces:
   1. Apply to contact face of outside form thin, even film of retarder acceptable to Engineer.

2. Apply retarder by brush, spray, or roller, as recommended by manufacturer or as retarder impregnated cloth form liner.
3. Take care in placing concrete so that integrity of retarder membrane is not destroyed whether it be applied directly to forms or in impregnated fabric.
4. Curing:
    a. Approximately 24 hours after concrete is placed, depending on curing temperature, strip forms and dry brush or wash retarded mortar from aggregate.
    b. Maintain precise control of curing time and conditions to obtain uniform aggregate exposure from placement to placement.

B. Horizontal exposed aggregate finish surfaces:
1. Use acceptable retarder for exposed aggregate walks, decorative areas, precast or tilt-up panels cast face up, and similar horizontal surfaces.
2. Cast, screed, and float concrete and then lightly trowel to smooth surface.
3. If so specified for increased texture, spread additional aggregate on surfaces and work in with trowels and terrazzo roller, assuring that each aggregate particle is surrounded and embedded in cement mortar.
4. As soon as water sheen has disappeared, uniformly spray retarder over surfaces at rate recommended by manufacturer:
    a. Then cover surfaces with plastic sheeting.
    b. After concrete has set from 12 to 24 hours, partially remove sheeting and check small area to determine if concrete has set sufficiently.
    c. If exposed depth is excessive, allow curing to continue for few hours before checking again.
    d. When temperature is high or Type III cement is used, perform checking earlier.
5. When concrete has cured sufficiently, hose concrete surfaces and unset mortar removed with coarse brush or broom and then allow concrete curing to continue.

C. Precast or tilt-up exposed aggregate finish slabs: Precast or tilt-up slabs may be cast by any of following means with acceptance of the Engineer as to method and resulting surface:
1. Curing in same manner as specified for other concrete specified in Section 03300 - Cast-in-Place Concrete.
2. Cast panels face up using acceptable retarder and procedures specified in this Section for horizontal surfaces:
    a. In using this method, exercise particular by use of sand pads, plywood guards, and other necessary means to protect exposed aggregate during lifting.
3. Exposed aggregate that has been chipped, cracked, spalled, or loosened during lifting may be considered grounds for rejecting panel.
4. Casting panels:
    a. Cast panels face down, using acceptable retarder and techniques specified in this Section for vertical cast-in-place surfaces.
    b. Since time of lifting to provide access to panel face for removal of retarded matrix is critical, exercise extreme care in selecting retarder that will provide proper aggregate exposure at time panels have acquired sufficient strength for lifting.

c. Sand transfer method for casting panels: Cast panels face down in accordance with following requirements:
    1) Spread layer of fine sand on bottom of panel form to depth of 1/3 aggregate size, plus or minus as may be required to provide specified aggregate exposure.
    2) Place uniform layer of aggregate over sand bed and then settle aggregate and sand together with fine spray of water.
    3) Cover aggregate with mortar mixed in same proportions of sand and cement as Class A backing concrete or with mortar of 1 part portland cement to 2-1/2 parts fine white sand, colored as specified in Finish Schedule:
        a) Fill rest of form with Class A concrete, being careful not to vibrate concrete mix down into aggregate bed.
    4) Remove sand from aggregate face by brushing or washing when panel is raised for placing or transfer to curing yard.

3.02 CONCRETE FINISHING

A. Edges of joints:
    1. Provide joints having edges as indicated on the Drawings.
    2. Protect wall and slab surfaces at edges against concrete spatter and thoroughly clean upon completion of each placement.

B. Exposed aggregate finish:
    1. Provide concrete specified or indicated on the Drawings to have exposed aggregate finish with finish complying with following requirements:
        a. Attain exposed aggregate finish for cast-in-place concrete by use of retarder to delay set of mortar on textured face and subsequent removal of partially set mortar.
        b. Precast and tilt-up exposed aggregate panels may be cast face up or face down using suitable retarder, or face down by sand transfer method as specified in this Section.
        c. Match exposed aggregate and mortar or concrete coloring to existing project control sample.
        d. Forms against which exposed aggregate surfaces are to be cast:
            1) Provide sound and nonporous forms.
            2) If form faces are of wood, treat them with suitable sealer, compatible with retarder to be used.
            3) After form has been used for exposed aggregate surfaces, thoroughly clean it with detergent solution or suitable solvent before using it again to form conventional concrete surfaces.
    2. After stripping and exposure of aggregate, water cure concrete for 7 days and then sealed with acceptable sealer.
    3. For exposed aggregate, use coarse aggregate same as that of regular concrete mix as specified in Section 03300 - Cast-in-Place Concrete, unless otherwise specified, but gap grade mix:
        a. If special aggregate is specified or indicated on the Drawings, prepare and use it as specified.

END OF SECTION

SECTION 03366

TOOLED CONCRETE FINISHING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Tooled concrete finishes.

1.02 QUALITY ASSURANCE

A. Mock-ups:
   1. Test panels for concrete finishes:
      a. Prepare test panels for F4 and F5 finishes and tie-hole repairs for review by Engineer.
      b. Accepted test panels serve as standard of quality and workmanship for project.
   2. Prepare test panel showing horizontal and vertical joints proposed for project for review by the Engineer. Refer to finishes specified in this Section.
   3. Test panels indicating methods for making concrete repairs: Prepare test panels for proposed repairs at beginning of project for review by Engineer:
      a. Accepted test panels serve as standard for repairs during the project.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:
   1. Deliver and store packaged materials in original containers until ready for use.

PART 2 PRODUCTS

2.01 MIXES

A. Mortar mix for F4 finish: Consist of 1 part cement and 1-1/2 parts of fine sand passing Number 100 screen. Mix with enough water and emulsified bonding agent to have consistency of thick cream.

B. Mortar mix for F5 finish: Consist of 1 part cement to 1-1/2 parts of sand which passes Number 16 screen.

PART 3 EXECUTION

3.01 CONCRETE FINISHES

A. Cement for finishes:
   1. Addition of white cement may be required to produce finish which matches color of concrete to be finished.

B. Finish vertical concrete surfaces with one of the following finishes as indicated in the Finish Schedule:
   1. F1 finish: No special treatment other than repair defective work and fill depressions 1 inch or deeper and tie holes with mortar after removal of curing compound.
   2. F2 finish: No special treatment other than repair defective work, remove fins, fill depressions 1/2 inch or deeper and tie holes with mortar after removal of curing compound.
   3. F3 finish: Repair defective work, remove fins, offsets, and grind projections smooth. Fill depressions 1/4 inch or larger in depth or width and tie holes with mortar after removal of curing compound.
   4. F4 finish: Receive same finish as specified for F3 finish, and, in addition fill depressions and holes 1/16 inch or larger in width with mortar:
      a. "Brush-Off" sandblast surfaces prior to filling holes to expose all holes near surface of the concrete.
      b. Thoroughly wet surfaces and commence filling of pits, holes, and depressions while surfaces are still damp.
      c. Perform filling by rubbing mortar over entire area with clean burlap, sponge rubber floats, or trowels.
      d. Do not let any material remain on surfaces, except that within pits and depressions.
      e. Wipe surfaces clean and moist cure.
   5. F5 finish: Receive same finish as specified for F3 finish, and, in addition, receive special stoned finish, in accordance with following requirements:
      a. Remove forms and perform required repairs, patching, and pointing as specified in this Section.
      b. Wet surfaces thoroughly with brush and rub with hard wood float dipped in water containing 2 pounds of portland cement per gallon.
      c. Rub surfaces until form marks and projections have been removed.
      d. Spread grindings from rubbing operations uniformly over surface with brush in such manner as to fill pits and small voids.
      e. Moist cure brushed surfaces and allow to harden for 3 days:
         1) After curing, obtain final finish by rubbing with carborundum stone of approximately Number 50 grit until entire surfaces have smooth texture and are uniform in color.
         2) Continue curing for remainder of specified time.
      f. If any concrete surface is allowed to become too hard to finish in above specified manner, sandblast and wash related surfaces exposed to view, whether finished or not:
         1) While still damp, rub over surface, plastic mortar, as specified for brushed surfaces and handstoned with Number 60 grit carborundum stone, using additional mortar for brushed surfaces until surface is evenly filled without an excess of mortar.
         2) Continue stoning until surface is hard.
         3) After moist curing for 3 days, make surface smooth in texture and uniform in color by use of Number 50 or Number 60 grit carborundum stone.
         4) After stoning, continue curing until 7 day curing period is completed.

C. Finish horizontal concrete surfaces with one of the following finishes as indicated in the Finish Schedule after proper and adequate vibration and tamping:
   1. S1 finish: Screeded to grade and leave without special finish.

2. S2 finish: Smooth steel trowel finish.
3. S3 finish: Steel trowel finish free from trowel marks. Provide smooth finish free of all irregularities.
4. S4 finish: Steel trowel finish, without local depressions or high points, followed by light hairbroom finish. Do not use stiff bristle brooms or brushes. Perform brooming parallel to slab-drainage. Provide resulting finish that is rough enough to provide nonskid finish. Finish is subject to review and acceptance by the Engineer.
5. S5 finish: Nonslip abrasive: After concrete has been screeded level and hardened enough to support man standing on a board, sprinkle abrasive from shake screen into surface at uniform rate of 25 pounds for each 100 square feet of surface area, wood float into finish, then trowel abrasive into surface with steel trowel properly exposing abrasive in surface as required to provide nonslip surface.
6. S6 finish: Roughened finish: After concrete has been screeded to grade, apply a roughened finish by use of a jitterbug roller or similar device.

D. Finish concrete floor surfaces to which surfacing material is applied: Finish smooth with tolerance within 1/8 inch in 10 feet in any direction from lines indicated on the Drawings.

3.02 CONCRETE FINISH SCHEDULE

A. Finish concrete surfaces as follows:
1. F4 finish for following vertical surfaces:
   a. Concrete surfaces specified or indicated to be painted.
   b. Concrete surfaces, interior or exterior, exposed to view.
2. Surfaces in open channels, basins, and similar structures:
   a. F3 finish for vertical surfaces which are normally below water surface.
   b. F4 finish for vertical surfaces located above normal water surface and exposed to view.
   c. Remove fins and fill tie holes from concrete surfaces located in closed boxes or channels where there is normally no access or passageway.
3. S1 finish for following surfaces:
   a. Projecting footings which are to be covered with dirt.
   b. Slab surfaces which are to be covered with concrete fill.
4. S2 finish for following surfaces:
   a. Tops of corbels.
   b. Tops of walls and beams not covered above in this Section.
   c. Tops of slabs not covered above in this Section.
   d. All other surfaces not specified to be finished otherwise.
5. S3 finish for following surfaces:
   a. Building and machine room floors which are not covered with surfacing material: Provide floors that are free from trowel marks.
6. S4 finish for following surfaces:
   a. Exterior walkways.
   b. Tops of exterior walls or beams which are to serve as walkways.
   c. Tops of exterior walls or beams which are to support gratings.
   d. Top surface of slabs for basins, channels, digesters, and similar structures.

7. S6 finish for following surfaces:
    a. Basin bottoms, or other similar slab surfaces, over which layer of basin bottom grout will be applied.

END OF SECTION

SECTION 03600

GROUTING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Cement grout.
   2. Cement mortar.
   3. Dry-pack mortar.
   4. Epoxy grout.
   5. Grout.
   6. Non-shrink epoxy grout.
   7. Non-shrink grout.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (using 2-inch cube specimens).
   2. C230 - Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.
   3. C531 - Standard Test Method for Liner Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   4. C579 - Standard Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacings and Polymer Concretes.
   5. C939 - Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
   6. C942 - Standard Test Method for Compressive Strength of Grouts for Preplaced-Aggregate Concrete in the Laboratory.
   7. C1107 - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
   8. C1181 - Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.

B. International Concrete Repair Institute (ICRI):
   1. 310.2R - Selecting and specifying Concrete Surface Preparations for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

1.03 SUBMITTALS

A. Cement grout:
   1. Mix design.
   2. Material submittals.

B. Cement mortar:
   1. Mix design.
   2. Material submittals.

C. Non-shrink epoxy grout:
   1. Manufacturer's literature.

D. Non-shrink grout:
   1. Manufacturer's literature.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to jobsite in their original, unopened packages or containers, clearly labeled with manufacturer's product identification and printed instructions.

B. Store materials in cool dry place and in accordance with manufacturer's recommendations.

C. Handle materials in accordance with the manufacturer's instructions.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Non-shrink epoxy grout:
   1. Manufacturers: One of the following or equal:
      a. Five Star Products, Inc., Five Star DP Epoxy Grout.
      b. BASF Construction Chemicals, Masterflow 648 CP Plus.
      c. L&M Construction Chemicals, Inc., EPOGROUT.
   2. Non-shrink epoxy grout shall be 100 percent solid, premeasured, prepackaged system containing 2-component thermosetting epoxy resin and inert aggregate.
   3. Maintain flowable consistency for at least 45 minutes at 70 degrees Fahrenheit.
   4. Shrinkage or expansion: Less than 0.0006 inches per inch when tested in accordance with ASTM C531.
   5. Minimum compressive strength: 10,000 pounds per square inch at 24 hours and 14,000 pounds per square inch at 7 days when tested in accordance with ASTM C579, Method B.
   6. Compressive creep: Not exceed 0.0037 inches/per inch when tested under 400 pounds per square inch constant load at 140 degrees Fahrenheit in accordance with ASTM C1181.
   7. Coefficient of thermal expansion: Not exceed 0.000018 inches per inch per degree Fahrenheit when tested in accordance with ASTM C531, Method B.

B. Non-shrink grout:
   1. Manufacturers: One of the following or equal:
      a. Five Star Products, Inc., Five Star Grout.
      b. BASF Construction Chemicals, Masterflow 928.
      c. L&M Construction Chemicals, Inc., CRYSTEX.
   2. In accordance with ASTM C1107.
   3. Preportioned and prepackaged cement-based mixture.
   4. Contain no metallic particles such as aluminum powder and no metallic aggregate such as iron filings.
   5. Require only addition of potable water.
   6. Water for pre-soaking, mixing, and curing: Potable water.

7. Free from emergence of mixing water from within or presence of water on its surface.
8. Remain at minimum flowable consistency for at least 45 minutes after mixing at 45 degrees Fahrenheit to 90 degrees Fahrenheit when tested in accordance with ASTM C230:
    a. If at fluid consistency, verify consistency in accordance with ASTM C939.
9. Dimensional stability (height change):
    a. In accordance with ASTM C1107, volume-adjusting Grade B or C at 45 degrees Fahrenheit to 90 degrees Fahrenheit.
    b. Have 90 percent or greater bearing area under bases.
10. Have minimum compressive strengths at 45 degrees Fahrenheit to 90 degrees Fahrenheit in accordance with ASTM C1107 for various periods from time of placement, including 5,000 pounds per square inch at 28 days when tested in accordance with ASTM C109 as modified by ASTM C1107.

2.02 MIXES

A. Cement grout:
    1. Use same sand-to-cementitious materials ratio for cement grout mix that is used for concrete mix.
    2. Use same materials for cement grout that are used for concrete.
    3. Use water-to-cementitious materials ratio that is no more than that specified for concrete.
    4. For spreading over surfaces of construction or cold joints.

B. Cement mortar:
    1. Use same sand-to-cementitious materials ratio for cement mortar mix that is used for concrete mix.
    2. Use same materials for cement mortar that are used for concrete.
    3. Use water-to-cementitious materials ratio that is no more than that specified for concrete being repaired.
    4. At exposed concrete surfaces not to be painted or submerged in water: Use sufficient white cement to make color of finished patch match that of surrounding concrete.

C. Dry-pack mortar:
    1. Proportions by weight: 1 part portland cement to 2 parts concrete sand:
        a. Portland cement: As specified in Section 03300 - Cast-in-Place Concrete.
        b. Concrete sand: As specified in Section 03300 - Cast-in-Place Concrete.

D. Epoxy grout:
    1. Consist of mixture of epoxy or epoxy gel and sand:
        a. Epoxy: As specified in Section 03071 - Epoxies.
        b. Epoxy gel: As specified in Section 03071 - Epoxies.
        c. Sand: Clean, bagged, graded, and kiln-dried silica sand.
    2. Proportioning:
        a. For horizontal work: Consist of mixture of 1 part epoxy with not more than 2 parts sand.
        b. For vertical or overhead work: Consist of 1 part epoxy gel with not more than 2 parts sand.

E. Grout:
   1. Mix in proportions by weight: 1 part portland cement to 4 parts concrete sand:
      a. Portland cement: As specified in Section 03300 - Cast-in-Place Concrete.
      b. Concrete sand: As specified in Section 03300 - Cast-in-Place Concrete.

F. Non-shrink epoxy grout:
   1. Mix in accordance with manufacturer's installation instructions.

G. Non-shrink grout:
   1. Mix in accordance with manufacturer's installation instructions such that resulting mix has flowable consistency and is suitable for placing by pouring.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect concrete surfaces to receive grout or mortar and verify that they are free of ice, frost, dirt, grease, oil, curing compounds, paints, impregnations, and loose material or foreign matter likely to reduce bond or performance of grout or mortar.

3.02 PREPARATION

A. Surface preparation for grouting other baseplates:
   1. Remove grease, oil, dirt, dust, curing compounds, laitance, and other deleterious materials that may affect bond to concrete and bottoms of baseplates.
   2. Roughen concrete surfaces in contact with grout to ICRI CSP-6 surface profile or rougher:
      a. Remove loose or broken concrete.
   3. Metal surfaces in contact with grout: Grit blast to white metal surface.

3.03 INSTALLATION

A. Mixing:
   1. Cement grout:
      a. Use mortar mixer with moving paddles.
      b. Pre-wet mixer and empty out excess water before beginning mixing.
   2. Cement mortar:
      a. Use mortar mixer with moving paddles.
      b. Pre-wet mixer and empty out excess water before beginning mixing.
   3. Dry-patch mortar:
      a. Use only enough water so that resulting mortar will crumble to touch after being formed into ball by hand.
   4. Non-shrink epoxy grout:
      a. Keep temperature of non-shrink epoxy grout from exceeding manufacturer's recommendations.
   5. Non-shrink grout:
      a. May be drypacked, flowed, or pumped into place. Do not overwork grout.
      b. Do not retemper by adding more water after grout stiffens.

B. Placement:
   1. Cement grout:
      a. Exercise care in placing cement grout because it is required to furnish structural strength, impermeable water seal, or both.
      b. Do not use cement grout that has not been placed within 30 minutes after mixing.
   2. Cement mortar:
      a. Use mortar mixer with moving paddles.
      b. Pre-wet mixer and empty out excess water before beginning mixing.
   3. Epoxy grouts:
      a. Wet surfaces with epoxy for horizontal work or epoxy gel for vertical or overhead work prior to placing epoxy grout.
   4. Non-shrink epoxy grout:
      a. Mix in complete units. Do not vary ratio of components or add solvent to change consistency of mix.
      b. Pour hardener into resin and mix for at least 1 minute and until mixture is uniform in color. Pour epoxy into mortar mixer wheelbarrow and add aggregate. Mix until aggregate is uniformly wetted. Over mixing will cause air entrapment in mix.
   5. Non-shrink grout:
      a. Add non-shrink cement grout to premeasured amount of water that does not exceed the manufacturer's maximum recommended water content.
      b. Mix in accordance with manufacturer's instructions to uniform consistency.

C. Curing:
   1. Cement based grouts and mortars:
      a. Keep continuously wet for minimum of 7 days. Use wet burlap, soaker hose, sun shading, ponding, and in extreme conditions, combination of methods.
      b. Maintain above 40 degrees Fahrenheit until it has attained compressive strength of 3,000 pounds per square inch, or above 70 degrees Fahrenheit for minimum of 24 hours to avoid damage from subsequent freezing.
   2. Epoxy based grouts:
      a. Cure grouts in accordance with manufacturers' recommendations:
         1) Do not water cure epoxy grouts.
      b. Do not allow any surface in contact with epoxy grout to fall below 50 degrees Fahrenheit for minimum of 48 hours after placement.

D. Grouting equipment bases, baseplates, soleplates, and skids: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

E. Grouting other baseplates:
   1. General:
      a. Use non-shrink grout as specified in this Section.
      b. Baseplate grouting shall take place from one side of baseplate to other in continuous flow of grout to avoid trapping air in grout.
      c. Maintain hydrostatic head pressure by keeping level of grout in headbox above bottom of baseplate. Fill headbox to maximum level and work grout down.
      d. Vibrate, rod, or chain non-shrink grout to facilitate grout flow, consolidate grout, and remove trapped air.

2. Forms and headboxes:
    a. Build forms using material with adequate strength to withstand placement of grouts.
    b. Use forms that are rigid and liquidtight. Caulk cracks and joints with elastomeric sealant.
    c. Line forms with polyethylene for easy grout release. Coating forms with 2 coats of heavy-duty paste wax is also acceptable.
    d. Headbox shall be 4 to 6 inches higher than baseplate and shall be located on one side of baseplate.
    e. After grout sets, remove forms and trim back grout at 45 degree angle from bottom edges of baseplate.

3.04 FIELD QUALITY CONTROL

A. Non-shrink epoxy grout:
    1. Test for 24-hour compressive strength in accordance with ASTM C579, Method B.

B. Non-shrink grout:
    1. Test for 24-hour compressive strength in accordance with ASTM C942.

END OF SECTION

SECTION 05120

STRUCTURAL STEEL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Structural steel shapes and plate.
   2. Fasteners and structural hardware:
      a. All thread rods.
      b. High-strength bolts.
   3. Welding.
   4. Bolting.

1.02 REFERENCES

A. American Institute of Steel Construction (AISC):
   1. 303 - Code of Standard Practice for Steel Buildings and Bridges.
   2. 360 - Specification for Structural Steel Buildings.

B. American Iron and Steel Institute (AISI):
   1. Steel and stainless steel alloys (“types”) as indicated.

C. American Welding Society (AWS):
   1. A5.1 - Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
   2. A5.17 - Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding.
   3. A5.20 - Specification for Carbon Steel Electrodes for Flux Cored Arc Welding.
   4. D1.1 - Structural Welding Code - Steel.
   5. D1.6 - Structural Welding Code - Stainless Steel.

D. ASTM International (ASTM):
   1. A6 - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
   2. A36 - Standard Specification for Carbon Structural Steel.
   3. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   4. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   5. A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   6. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
   7. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   8. A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

9. A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
10. A563 - Standard Specification for Carbon and Alloy Steel Nuts.
11. A992 - Standard Specification for Structural Steel Shapes.
12. F436 - Standard Specification for Hardened Steel Washers.
13. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
14. F594 - Standard Specification for Stainless Steel Nuts.
15. F959 - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
16. F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.
17. F3125 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength.

E. Research Council on Structural Connections (RCSC):
1. Specification for Structural Joints Using High-Strength Bolts (RCSC Specification).

1.03 DEFINITIONS

A. Snug-tight: At bolted joints, the tightness attained with a few impacts of an impact wrench, or by the full effort of an ironworker using a spud wrench to bring the connected plies into firm contact.

B. Stainless steel related terms:
1. Descaling: Removal of heavy, tightly adherent oxide films resulting from hot-forming, heat-treatment, welding, and other high-temperature operations.
2. Pickling: Chemical descaling of stainless steel using aqueous solutions of nitric and hydrofluoric acid, or various proprietary formulations as specified.
3. Passivation: Chemical treatment of stainless steel with a mild oxidant for the purpose of enhancing the spontaneous formation of the steel's protective passive film.

1.04 SUBMITTALS

A. Product data.

B. Shop drawings:
1. Fabrication and erection drawings.

C. Quality control submittals:
1. Welding procedure specifications (WPS) in accordance with AWS D1.1 and D1.6:
   a. Submit WPS for each type of welded joint used, whether prequalified or qualified by testing:
      1) State electrode manufacturer and specific electrodes used.
      2) Indicate required AWS qualification for joint.
   b. Submit WPS with shop drawings that indicate those welds.
   c. Submit Procedure Qualification Record (PQR) in accordance with AWS D1.1 and D1.6 for welding procedures qualified by testing.

2. Welder qualifications: For each welding process and position:
    a. Welder's qualification certificates.
    b. Contractor's statement that certificate will be "in effect" at the time(s) welding will be performed based on the "Period of Effectiveness" provisions of AWS D1.1 and D1.6.
3. Test reports:
    a. Certified copies of mill tests and analyses made in accordance with applicable ASTM standards, or reports from a recognized commercial laboratory, including chemical and tensile properties of each shipment of structural steel or part thereof having common properties.

1.05 QUALITY ASSURANCE

A. Welding:
1. Perform welding of structural metals in accordance with AWS D1.1 and D1.6 using welders who have current AWS qualification certificate for the process, position, and joint configuration to be welded.
2. Make Welding Procedure Specifications available at the locations where welding is performed.
3. Notify Engineer at least 24 hours before starting shop or field welding.
4. Engineer may check materials, equipment, and qualifications of welders.
5. Remove welders performing unsatisfactory Work, or require requalification.
6. Engineer may use gamma ray, magnetic particle, dye penetrant, trepanning, or other aids to visual inspection to examine any part of welds or all welds.
7. Contractor shall bear costs of retests on defective welds.
8. Contractor shall also bear costs in connection with qualifying welders.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping: Deliver structural steel free from mill scale, rust, and pitting.

B. Storage and protection: Until erection and painting, protect from weather items not galvanized or protected by a shop coat of paint.

PART 2 PRODUCTS

2.01 MATERIALS

A. Unless otherwise specified or indicated on the Drawings, materials shall conform to the following:

Item	ASTM Standard	Class, Grade, Type, or Alloy Number
Carbon Steel		
Plate, bars, rolled shapes (except W and WT shapes), and miscellaneous items	A36	--
Rolled W and WT shapes	A992	Grade 50
Hollow structural sections/HSS: Round, square, or rectangular (including “pipe” where indicated for structural members and supports)	A500	Grade C
Stainless Steel		
Plate, sheet, and strip	A240	Type 304* or 316**
* Use Type 304L (low-carbon stainless steel) if material will be welded.		
** Use Type 316L (low-carbon stainless steel) if material will be welded.		

2.02 FASTENERS AND STRUCTURAL HARDWARE

A. General:
   1. Materials: Of domestic manufacture.
   2. Where fasteners and hardware are specified to be galvanized, hot-dip galvanize in accordance with ASTM A153 or ASTM F2329, unless otherwise specified.

B. All thread rods:
   1. Carbon steel:
      a. In accordance with ASTM A36 unless otherwise indicated on the Drawings.
      b. Nuts: ASTM A194.
      c. Washers: ASTM F436.
   2. Galvanized carbon steel:
      a. In accordance with ASTM A36 unless otherwise indicated on the Drawings, and hot dip galvanized in accordance with ASTM A153.
      b. Nuts: ASTM A194, hot-dip galvanized in accordance with ASTM A153.
      c. Washers: ASTM F436, hot-dip galvanized in accordance with ASTM A153.
   3. Stainless steel:
      a. Units descaled, pickled, and passivated as specified in “Fabrication” in this Section.
      b. Threaded rods and nuts to be the products of a single manufacturer/fabricator to ensure proper fit without galling. Ship all thread rods with properly fitting nuts attached.
      c. Alloy Type 304 or Type 316 as indicated on the Drawings.

d. Type 304:
    1) Rod: ASTM F593, Group 1, Condition CW, coarse threads.
    2) Nuts: ASTM F594. Match alloy of rod (group and UNS designation).
    3) Washers: Type 304 stainless steel.
e. Type 316:
    1) Rod: ASTM F593, Group 2, Condition CW, coarse threads.
    2) Nuts: ASTM F594. Match alloy of rod (group and UNS designation).
    3) Washers: Type 316 stainless steel.

C. Anchor bolts, anchor rods, and post-installed steel anchors: As indicated on the Drawings and as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

D. High-strength bolts:
1. Provide high-strength bolt assembly, with nuts, hardened flat washers, and compressible-washer-type direct tension indicators. Carbon steel - Uncoated:
    a. Bolts: Plain heavy hex structural bolts in accordance with ASTM F3125, Grade A325, Type 1.
    b. Nuts: Heavy hex nuts in accordance with ASTM A563, Grade C.
    c. Washers:
        1) Adjacent to normal, oversized, and short-slotted holes: Circular, square or rectangular beveled, clipped, or extra thick washers in accordance with ASTM F436, Type 1. Flat circular washers unless otherwise indicated on the Drawings.
        2) Adjacent to long slotted holes: Fabricated from 5/16-inch thick plate conforming to ASTM A36.

E. Stainless steel bolts (for use in stainless steel structures):
1. General:
    a. Bolts and nuts shall be the products of a single manufacturer/fabricator to ensure proper fit without galling.
    b. Units descaled, pickled and passivated as specified in “Fabrication."
2. Alloy: Type 304 or Type 316 to match alloy of structural members being connected.
3. Type 304:
    a. Bolts: ASTM F593, Group 1, Condition CW, coarse threads.
    b. Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
    c. Washers: Type 304 stainless steel.
4. Type 316:
    a. Bolts: ASTM F593, Group 2, Condition CW, coarse threads.
    b. Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
    c. Washers: Type 316 stainless steel.

2.03 ISOLATING SLEEVES AND WASHERS

A. As indicated on the Drawings and as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

2.04 SUPPLEMENTARY PARTS

A. Furnish as required for complete structural steel erection, whether or not such parts and Work are specified or indicated on the Drawings.

2.05 FABRICATION

A. Shop assembly:
   1. Fabricate structural steel in accordance with AISC 360 and AISC 303 unless otherwise specified or modified by applicable regulatory requirements.
   2. Where anchors, connections, or other details of structural steel are not specifically indicated on the Drawings or specified, their material, size and form shall be equivalent in quality and workmanship to items specified.
   3. Round off sharp and hazardous projections and grind smooth.
   4. Take measurements necessary to properly fit work in the field. Take responsibility for and be governed by the measurements and proper working out of all the details.
   5. Take responsibility for correct fitting of metalwork.
   6. Welded connections:
      a. Comply with AWS requirements for the metals to be welded.
      b. Weld only in accordance with approved Welding Procedure Specifications.
      c. Keep Welding Procedure Specifications readily available for welders and inspectors during fabrication processes.
   7. Cleaning and passivation:
      a. Following shop fabrication of stainless steel members and bolts, clean and passivate fabrications at point of manufacture.
      b. Finish requirements: Remove free iron, heat tint oxides, weld scale and other impurities, and obtain a bright passive finished surface with no etching, pitting, frosting, or discoloration.
      c. Provide quality control testing to verify effectiveness of cleaning agents and procedures and to confirm that finished surfaces are clean and passivated:
         1) Conduct sample runs using test specimens with proposed cleaning agents and procedures as required to avoid adverse effects on surface finishes and base materials.
      d. Pre-clean, chemically de-scale (“pickle”), passivate, and final-clean fabrications in accordance with the requirements of ASTM A380:
         1) If degreasing is required before cleaning (pickling) to remove scale or iron oxide, cleaning with citric acid treatments is permissible; however, such treatments shall be followed inorganic cleaners.
         2) Pickle and passivate stainless steel using a nitric acid solution in accordance with ASTM A380, Annex A2, Table A2.1, Part II.
         3) Pickling by citric acid treatment or sulfuric acid treatment is not considered to satisfy the requirements of this Section.
      e. Inspect after cleaning using methods specified for “gross inspection” in ASTM A380.
      f. Improperly or poorly cleaned and passivated materials shall not be shipped and will not be accepted at the site.

B. Galvanized carbon steel:
   1. Where galvanizing is required, hot-dip structural steel after fabrication in accordance with ASTM A123:
   2. Do not electro-galvanize or mechanically-galvanize unless specified or accepted by Engineer.
   3. Re-straighten galvanized items that bend or twist during galvanizing.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.02 ERECTION

A. General:
   1. Fabricate structural and foundry items to true dimensions without warp or twist.
   2. Form welded closures neatly, and grind off smooth where weld material interferes with fit or is unsightly.
   3. Install structural items accurately and securely, true to level, plumb, in correct alignment and grade, with all parts bearing or fitting structure or equipment for which intended.
   4. Do not shift out of alignment, re-drill, re-shape, or force fit fabricated items.
   5. Place anchor bolts or other anchoring devices accurately and make surfaces that bear against structural items smooth and level.
   6. Rigidly support and brace structural items needing special alignment to preserve straight, level, even, and smooth lines. Keep structural items braced until concrete, grout, or dry pack mortar has hardened for 48 hours minimum.
   7. Erect structural steel in accordance with AISC 303 unless otherwise specified or modified by applicable regulatory requirements.
   8. Where anchors, connections, and other details of structural steel erection are not specifically indicated on the Drawings or specified, form, locate, and attach with equivalent in quality and workmanship to items specified.
   9. Round off sharp or hazardous projections and grind smooth.
   10. Paint or coat steel items as specified in Section 09960 - High-Performance Coatings.

B. Stainless steel. Take all necessary precautions to avoid iron contamination of stainless steel during delivery, storage, and handling:
   1. Segregate stainless steel from iron.
   2. Tools and handling devices:
      a. Do not use iron tools clamps, chokes, working surfaces, or brushes when fabricating, handling, and erecting stainless steel.
      b. Do not use tools that have been contaminated by contact with iron.
      c. Use stainless steel, polymer coated, or wood tools and handling equipment. Do not use tools that have been contaminated by contact with iron or steel.

C. Welding: General:
   1. Make welds full penetration type, unless otherwise indicated on the Drawings.
   2. Remove backing bars and weld tabs after completion of weld. Repair defective welds observed after removal of backing bars and weld tabs.

D. Welding: Carbon steel:
   1. General: In accordance with AWS D1.1:
      a. Weld ASTM A36 and A992 structural steel, and ASTM A500 and A501 structural tubing with electrodes in accordance with AWS A5.1, using E70XX electrodes; AWS A5.17, using F7X-EXXX electrodes; or AWS A5.20, using E7XT-X electrodes.

E. Welding - stainless steel:
   1. General: In accordance with AWS D1.6.
   2. Field welding of stainless steel will not be permitted.
   3. Passivation of field-welded surfaces:
      a. Provide cleaning, pickling and passivating as specified under “Fabrications” of this Section. Clean using Derustit Stainless Steel Cleaner, or equal.

F. Interface with other products:
   1. Where steel members and fasteners come in contact with dissimilar metals (aluminum, stainless steel, etc.), separate or isolate the dissimilar metals with isolating sleeves and washers as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

G. Fasteners: General:
   1. Install bolts to project 2 threads minimum, but 1/2 inch maximum beyond nut.
   2. Anchor bolts and anchor rods: Install as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry:
      a. Unless otherwise specified, tighten nuts on anchor bolts and anchor rods specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry to the "snug-tight" condition.
   3. All thread rods in drilled holes bonded to concrete with adhesive: Install as specified in Section 03055 - Adhesive-Bonded Reinforcing Bars and All Thread Rods in Concrete.

H. Fasteners: High-strength carbon steel bolts:
   1. Connections with high-strength bolts shall in accordance with RCSC Specification for Structural Joints Using High-Strength Bolts.
   2. Joints: Slip-critical:
      a. Confirm that faying surfaces at connections are free of dirt and other foreign material, have been blast cleaned, and are free of coatings and inadvertent overspray in accordance with RCSC Specification.
      b. Furnish hardened flat washers in accordance with ASTM F436:
         1) On outer plies with slotted holes.
         2) When 1 or more plies of the connected material has a yield strength less than 40 ksi.
         3) Under element, nut, or bolt head, turned in tightening.
      c. Install tension indicator washers, placed in accordance with ASTM F959 Figure X1, to confirm adequate tightening of bolts.
      d. Tighten bolts to full pretension.

I. Fasteners: Stainless steel bolts:
   1. Connections shall be snug-tight joints unless otherwise indicated on the Drawings.
   2. Prior to installing nuts, coat threads of stainless steel fasteners with thread coating to prevent galling of threads.
   3. Rotate nuts using a slow, smooth action without interruptions. Avoid over-tightening.

3.03 FIELD QUALITY CONTROL

A. Provide quality control as specified in Section 01450 - Quality Control.

3.04 FIELD QUALITY ASSURANCE

A. Provide quality assurance as specified in Section 01450 - Quality Control.

B. Special inspections, special tests, and structural observation:
   1. Provide as specified in Section 01455 - Special Tests and Inspections.

END OF SECTION

SECTION 05140

STRUCTURAL ALUMINUM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Structural aluminum products, including sheet, pipe, extrusions, and associated accessories.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   2. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
   3. B308 - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.

B. American Welding Society (AWS):
   1. A5.10 - Specification for Bare Aluminum and Aluminum-Alloy Welding Electrodes and Rods.
   2. D1.2 - Structural Welding Code - Aluminum.

1.03 SUBMITTALS

A. Quality control submittals:
   1. Test Reports: Certified copies of mill tests or reports from a recognized commercial laboratory including chemical and tensile properties of each shipment of structural metal or part thereof having common properties. Tests and analyses shall be made in accordance with applicable ASTM Standards.
   2. Welder’s certificates.

1.04 QUALITY ASSURANCE

A. Qualifications:
   1. Perform welding of structural metals with welders who have current AWS certificate for the type of welding to be performed.
   2. Notify Engineer 24 hours minimum before starting shop or field welding.
   3. Engineer may check materials, equipment, and qualifications of welders.
   4. Remove welders performing unsatisfactory work, or require to requalify.
   5. Engineer may use gamma ray, magnetic particle dye penetrant, or other aids to visual inspection to examine any part of welds or all welds.
   6. Contractor shall bear costs of retests on defective welds.
   7. Contractor shall bear costs in connection with qualifying welders.

PART 2 PRODUCTS

2.01 MATERIALS

A. Structural sheet aluminum: ASTM B209, Alloy 6061-T6.

B. Structural aluminum: ASTM B308, Alloy 6061-T6.

C. Extruded aluminum: ASTM B221, Alloy 6063-T42.

D. Isolating sleeves and washers:
   1. As indicated on the Drawings and as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

E. Miscellaneous materials:
   1. Furnish supplementary parts necessary to complete each item even where such work is neither definitely indicated on the Drawings nor specified.
   2. Size, form, attachment, and location shall conform to the best of current practice.
   3. Conform to applicable ASTM Standards for materials not otherwise specified.

2.02 FABRICATION

A. Aluminum layout:
   1. Center punch hole centers, and punch or scribe cutoff lines, except where marks would remain on fabricated material.
   2. Apply temperature correction where necessary in layout of critical dimensions. Use a coefficient of expansion of 0.000013 per degree of Fahrenheit.

B. Cutting aluminum:
   1. Material 1/2-inch thick or less: Shear, saw, or cut with a router.
   2. Material more than 1/2-inch thick: Saw or rout.
   3. Make cut edges true and smooth, free from excessive burrs or ragged breaks.
   4. Avoid reentrant cuts wherever possible. Where used, fillet by drilling prior to cutting.
   5. Do not flame cut aluminum alloys.
   6. Punch or drill rivet or bolt holes to finished size before assembly:
      a. Make finished diameter of holes for bolts 1/16-inch maximum larger than nominal bolt diameter.
      b. Make holes cylindrical and perpendicular to principal surface.
      c. Do not permit holes to drift in a manner to distort metal.

C. Aluminum forming and assembly:
   1. Do not heat structural aluminum, except as follows:
      a. Heat aluminum to 400 degrees Fahrenheit for 30 minutes maximum, to facilitate bending or welding.
      b. Heat only when proper temperature controls and supervision can ensure that limitations on temperature and time are observed.

D. Before assembly, remove chips lodged between contacting surfaces.

E. Welding aluminum:
   1. Perform welding of aluminum in accordance with AWS D1.2.

2. Weld aluminum in accordance with the following:
    a. Preparation:
        1) Remove dirt, grease, forming or machining lubricants, and organic materials from areas to be welded by cleaning with a suitable solvent or by vapor degreasing.
        2) Additionally, etch or scratch brush to remove oxide coating just prior to welding when inert gas tungsten arc welding method is used.
        3) Oxide coating may not need to be removed if welding is performed by automatic or semi-automatic inert gas shielded metal arc.
        4) Suitably prepare edges to ensure 100 percent penetration in butt welds by sawing, chipping, machining, or shearing. Do not cut with oxygen.
    b. Filler metal: Aluminum alloys conforming to the requirements of AWS A5.10 and AWS classification ER 4043, ER 5654, ER 5554, ER 5183, ER 5356, or ER 5556.
    c. Perform welding of structures which are to be anodized using filler alloys which will not discolor when anodized, AWS ER 5654, ER 5554, ER 5183, ER 5356, or ER 5556.
    d. Perform welding by using a non-consumable tungsten electrode with filler metal in an inert gas atmosphere (TIG) or using a consumable filler metal electrode in an inert gas atmosphere (MIG).
    e. Do not use welding process that requires use of a welding flux.
    f. Neatly make welded closures.
    g. Where weld material interferes with fit or is unsightly in appearance, grind it smooth.
    h. Make welds full penetration welds unless otherwise indicated on the Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions: Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.02 INSTALLATION

A. Install structural aluminum products as indicated on the Drawings and specified.

B. Install structural aluminum products accurately and securely, true to level, plumb, in correct alignment and grade, with all parts bearing or fitting structure or equipment for which intended.

C. Do not cock out of alignment, redrill, reshape, or force fit fabricated items.

D. Place anchor bolts or other anchoring devices accurately and make surfaces that bear against structural items smooth and true to level.

E. Rigidly support and brace structural products needing special alignment to preserve straight, level, even, smooth lines, and keep braced until concrete, grout, or dry pack mortar has hardened for a minimum 48-hour period.

F. Interface with other products:
   1. Where aluminum comes in contact with dissimilar metals, use stainless steel bolts or anchors and separate or isolate the dissimilar metals with isolating sleeves and washers as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
   2. Coat those parts of aluminum that will be cast into concrete or that will be in contact with concrete, grout, masonry, wood, or other materials that will cause the aluminum to corrode, as specified in Section 09960 - High-Performance Coatings.

END OF SECTION

SECTION 05190

MECHANICAL ANCHORING AND FASTENING TO CONCRETE AND MASONRY

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Cast-in anchors and fasteners:
      a. Anchor bolts.
   2. Post-installed steel anchors and fasteners:
      a. Concrete anchors.
   3. Appurtenances for anchoring and fastening:
      a. Isolating sleeves and washers.
      b. Thread coating for threaded stainless steel fasteners.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 355.2 - Qualification of Post-Installed Mechanical Anchors in Concrete & Commentary.

B. American National Standards Institute (ANSI):
   1. B212.15 - Cutting Tools - Carbide-tipped Masonry Drills and Blanks for Carbide-tipped Masonry Drills.

C. American Welding Society (AWS):
   1. D1.1 - Structural Welding Code - Steel.
   2. D1.6 - Structural Welding Code - Stainless Steel.

D. ASTM International (ASTM):
   1. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   2. A108 - Standard Specification for Steel Bars, Carbon and Alloy, Cold Finished.
   3. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   4. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   5. A240 - Standard Specification for Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   6. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   7. A563 - Standard Specification for Carbon and Alloy Steel Nuts.
   8. B633 - Standard Specification for *Electrodeposited* Coatings of Zinc on Iron and Steel.
   9. B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
   10. E488 - Standard Test Methods for Strength of Anchors in Concrete Elements.
   11. F436 - Standard Specification for Hardened Steel Washers.

12. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws and Studs.
13. F594 - Standard Specification for Stainless Steel Nuts.
14. F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength.
15. F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

E. International Code Council Evaluation Service, Inc. (ICC-ES):
1. AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements.

1.03 DEFINITIONS

A. Built-in anchor: Headed bolt or assembly installed in position before filling surrounding masonry units with grout.

B. Cast-in anchor: Headed bolt or assembly installed in position before placing plastic concrete around.

C. Overhead installations: Fasteners installed on overhead surfaces where the longitudinal axis of the fastener is more than 60 degrees above a horizontal line so that the fastener resists sustained tension loads.

D. Passivation: Chemical treatment of stainless steel with a mild oxidant for the purpose of enhancing the spontaneous formation of the steel's protective passive film.

E. Post-installed anchor: Fastener or assembly installed in hardened concrete or finished masonry construction, typically by drilling into the structure and inserting a steel anchor assembly.

F. Terms relating to structures or building environments as used with reference to anchors and fasteners:
1. Corrosive locations: Describes interior and exterior locations as follows:
    a. Locations used for delivery, storage, transfer, or containment (including spill containment) of chemicals used for plant treatment processes.
2. Wet and moist locations: Describes locations, other than "corrosive locations," that are submerged, are immediately above liquid containment structures, or are subject to frequent wetting, splashing, or wash down. Includes:
    a. Exterior portions of buildings and structures.
    b. Liquid-containing structures:
        1) Locations at and below the maximum operating liquid surface elevation.
        2) Locations above the maximum operating liquid surface elevation and:
            a) Below the top of the walls containing the liquid.
            b) At the inside faces and underside surfaces of a structure enclosing or spanning over the liquid (including walls, roofs, slabs, beams, or walkways enclosing the open top of the structure).
    c. Liquid handling equipment:
        1) Bases of pumps and other equipment that handles liquids.

d. Indoor locations exposed to moisture, splashing, or routine wash down during normal operations, including floors with slopes toward drains or gutters.
e. Other locations indicated on the Drawings.

3. Other locations:
   a. Interior dry areas where the surfaces are not exposed to moisture or humidity in excess of typical local environmental conditions.

1.04 SUBMITTALS

A. General:
1. Submit as specified in Section 01330 - Submittal Procedures.
2. Submit information listed for each type of anchor or fastener to be used.

B. Action submittals:
1. Product data:
   a. Cast-in anchors:
      1) Manufacturer's data including catalog cuts showing anchor sizes and configuration, materials, and finishes.
   b. Post-installed anchors:
      1) For each anchor type, manufacturer's data including catalog cuts showing anchor sizes and construction, materials and finishes, and load ratings.
2. Samples:
   a. Samples of each type of anchor, including representative diameters and lengths, if requested by the Engineer.
3. Certificates:
   a. Cast-in anchors:
      1) Mill certificates for steel anchors that will be supplied to the site.
   b. Post-installed anchors:
      1) Manufacturer's statement or certified test reports demonstrating that anchors that will be supplied to the site comply with the materials properties specified.
4. Test reports:
   a. Post-installed anchors: For each anchor type used for the Work:
      1) Current ICC-ES Report (ESR**)**, or equivalent acceptable to the Engineer and the authority having jurisdiction, demonstrating:
         a) Acceptance of that anchor for use under the building code specified in Section 01410 - Regulatory Requirements.
5. Manufacturer's instructions:
   a. Requirements for storage and handling.
   b. Recommended installation procedures including details on drilling, hole size (diameter and depth), hole cleaning and preparation procedures, anchor insertion, and anchor tightening.
   c. Requirements for inspection or observation during installation.
6. Qualification statements:
   a. Post-installed anchors: Installer qualifications:
      1) Submit list of personnel performing installations and include date of manufacturer's training for each.

1.05 QUALITY ASSURANCE

A. Qualifications:
   1. Post installed anchors shall be in accordance with building code specified in Section 01410 - Regulatory Requirements:
      a. Installations shall be performed by trained installers having at least 3 years of experience performing similar installations with similar types of anchors.

B. Special inspection:
   1. Provide special inspection of post-installed anchors as specified in Section 01455 - Special Tests and Inspections and this Section.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver post-installed anchors in manufacturer's standard packaging with labels visible and intact. Include manufacturer's installation instructions.

B. Handle and store anchors and fasteners in accordance with manufacturer's recommendations and as required to prevent damage.

C. Protect anchors from weather and moisture until installation.

1.07 PROJECT CONDITIONS

A. As specified in Section 01610 - Project Design Criteria.

B. Seismic Design Category (SDC) for structures is indicated on the Drawings.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. General:
   1. Furnish threaded fasteners with flat washers and hex nuts fabricated from materials corresponding to the material used for threaded portion of the anchor:
      a. Cast-in anchors: Provide flat washers and nuts as listed in the ASTM standard for the anchor materials specified.
      b. Post-installed anchors: Provide flat washers and nuts supplied for that product by the manufacturer of each anchor.
   2. Size of anchors and fasteners, including diameter and length or minimum effective embedment depth: As indicated on the Drawings or as specified in this Section. In the event of conflicts, contact Engineer for clarification.
   3. Where anchors and connections are not specifically indicated on the Drawings or specified, their material, size and form shall be equivalent in quality and workmanship to items specified.

B. Materials:
   1. Provide and install anchors of materials as in this Section.

2.02 CAST-IN ANCHORS AND FASTENERS

A. Anchor bolts:
   1. Description:
      a. Straight steel rod having one end with an integrally forged head, and one threaded end. Embedded into concrete with the headed end cast into concrete at the effective embedment depth indicated on the Drawings or specified, and with the threaded end left to project clear of concrete face as required for the connection to be made.
      b. Furnish anchor bolts with heavy hex forged head or equivalent acceptable to Engineer:
         1) Rods or bars with angle bend for embedment in concrete (i.e., “L” or “J” shaped anchor bolts) are not permitted in the Work.
   2. Materials:
      a. Type 316 stainless steel:
         1) Surfaces descaled, pickled, and passivated in accordance with ASTM A380.
         2) Bolts: ASTM F593, Group 2, Condition CW, coarse threads.
         3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
         4) Washers: Type 316 stainless steel.
      b. Type 304 stainless steel:
         1) Surfaces descaled, pickled, and passivated in accordance with ASTM A380.
         2) Bolts: ASTM F593, Group 1, Condition CW, coarse threads.
         3) Nuts: ASTM F594. Match alloy (group and UNS designation) and threads of bolts.
         4) Washers: Type 304 stainless steel.
      c. Galvanized steel:
         1) Hot-dip galvanized coating in accordance with ASTM F2329.
         2) Bolt: ASTM F1554, Grade 36, heavy hex, coarse thread.
         3) Nuts: ASTM A563, Grade A, heavy hex, threads to match bolt.
         4) Washers: ASTM F436, Type 1.

2.03 POST-INSTALLED ANCHORS AND FASTENERS - ADHESIVE

A. Epoxy bonding of reinforcing bars, all thread rods, and threaded inserts in concrete: As specified in Section 03055 - Adhesive-Bonded Reinforcing Bars and All Thread Rods in Concrete.

2.04 POST-INSTALLED ANCHORS AND FASTENERS - MECHANICAL

A. General:
   1. Post-installed anchors used for the Work shall hold a current ICC Evaluation Service Report demonstrating acceptance for use under the building code specified in Section 01410 - Regulatory Requirements. Reports prepared by other recognized evaluation agencies may be submitted for consideration if acceptable to the Engineer and to the authority having jurisdiction:
      a. Conditions of use: The acceptance report shall indicate acceptance of the product for use under the following conditions:
         1) In regions of concrete where cracking has occurred or may occur.

2) To resist short-term loads due to wind forces.
3) To resist short-term loading due to seismic forces for the Seismic Design Category of the structure where the product will be used.

2. Substitutions: When requesting product substitutions, submit calculations, indicating the diameter, effective embedment depth and spacing of the proposed anchors, and demonstrating that the substituted product will provide load resistance that is equal to or greater than that provided by the anchors listed in this Section:
   a. Calculations shall be prepared by and shall bear the signature and seal of a Civil or Structural Engineer licensed in the State of California.
   b. Decisions regarding the acceptability of proposed substitutions shall be at the discretion of the Engineer.

B. Concrete anchors:
   1. Description. Post-installed anchor assembly consisting of a threaded stud and a surrounding wedge expansion sleeve that is forced outward by torquing the center stud to transfer loads from the stud to the concrete through bearing, friction, or both. (Sometimes referred to as “expansion anchors” or “wedge anchors.”):
      a. Do not use slug-in, lead cinch, and similar systems relying on deformation of lead alloy or similar materials to develop holding power.
   2. Concrete anchors for anchorage to concrete:
      a. Acceptance criteria:
         1) Concrete anchors shall have a current ICC-ES Report demonstrating that the anchors have been tested and qualified for performance in both cracked and un-cracked concrete, and for short-term loading due to wind and seismic forces for Seismic Design Categories A through F in accordance with ACI 355.2 and with ICC-ES AC193 (including all mandatory tests and optional tests for seismic tension and shear in cracked concrete).
         2) Concrete anchor performance in the current ICC-ES Report shall be “Category 1” as defined in ACI 355.2.
      b. Manufacturers: One of the following or equal:
         1) Hilti, Kwik Bolt TZ Expansion Anchor.
         2) DEWALT/Powers, PowerStud.
         3) Simpson Strong-Tie, Strong Bolt 2 Wedge Anchor.
      c. Materials. Integrally threaded stud, wedge, washer, and nut:
         1) Stainless steel: Type 316:
            a) Type 304 stainless steel acceptable for use at wet and moist locations when accepted in writing by the Engineer.
         2) Galvanized: Carbon steel, zinc plated in accordance with ASTM B633, minimum 5 microns (Fe/Zn 5).

C. Flush shells:
   1. Description: Post-installed anchor assembly consisting of an internally threaded mandrel that is forced into a pre-drilled concrete hole with a setting tool until the top of the anchor is flush with the face of the concrete. Once installed, a removable threaded bolt is installed in the mandrel.
   2. Flush shell anchors are not permitted in the Work.

2.05 APPURTENANCES FOR ANCHORING AND FASTENING

A. Anchor bolt sleeves:
   1. Having inside diameter approximately 2 inches greater than bolt diameter and minimum 10-bolt diameters long.
   2. Plastic sleeves:
      a. High-density polyethylene, corrugated sleeve, threaded to provide adjustment of location on the anchor bolt.
      b. Manufacturers: The following or equal:
         1) Portland Bolt & Manufacturing Co.

B. Isolating sleeves and washers:
   1. Manufacturers: One of the following or equal:
      a. Central Plastics Co.
      b. Allied Corrosion Industries.
   2. Sleeves: Mylar, 1/32-inch thick, 4,000 volts per mil dielectric strength, of proper size to fit bolts and extending half way into both steel washers.
   3. One sleeve required for each bolt.
   4. Washers: The inside diameter of all washers shall fit over the isolating sleeve, and both the steel and isolating washers shall have the same inside diameter and outside diameter:
      a. Proper size to fit bolts.
      b. Two 1/8-inch thick steel washers for each bolt.
      c. G3 Phenolic: 2 insulating washers are required for each bolt:
         1) Thickness: 1/8 inch.
         2) Base material: Glass.
         3) Resin: Phenolic.
         4) Water absorption: 2 percent.
         5) Hardness (Rockwell): 100.
         6) Dielectric strength: 450 volts per mil.
         7) Compression strength: 50,000 pounds per square inch.
         8) Tensile strength: 20,000 pounds per square inch.
         9) Maximum operating temperature: 350 degrees Fahrenheit.

C. Coating for repair of galvanized surfaces:
   1. Manufacturers: The following or equal:
      a. Jelt, Galvinox.

D. Thread coating: For use with threaded stainless steel fasteners:
   1. Manufacturers: One of the following or equal:
      a. Bostik, Never-Seez.
      b. Oil Research, Inc., WLR No. 111.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, do not begin this Work until such conditions have been corrected.

3.02 INSTALLATION: GENERAL

A. Where anchors and fasteners are not specifically indicated on the Drawings or specified, make attachments with materials specified in this Section.

B. Substitution of anchor types:
   1. Post-installed anchors may not be used as an alternative to cast-in/built-in anchors at locations where the latter are indicated on the Drawings.
   2. Cast-in/built-in anchors may be used as an alternative to post-installed mechanical anchors at locations where the latter are indicated on the Drawings.

C. Protect products from damage during installation. Take special care to protect threads and threaded ends.

D. Accurately locate and position anchors and fasteners:
   1. Unless otherwise indicated on the Drawings, install anchors perpendicular to the surfaces from which they project.
   2. Install anchors so that at least 2 threads, but not more than 1/2 inch of threaded rod, projects past the top nut.

E. Interface with other products:
   1. Where steel anchors come in contact with dissimilar metals (aluminum, stainless steel, etc.), use stainless steel anchors and separate or isolate dissimilar metals using isolating sleeves and washers.
   2. Prior to installing nuts, coat threads of stainless steel fasteners with thread coating to prevent galling of threads.

3.03 INSTALLATION: CAST-IN ANCHORS

A. General:
   1. Accurately locate cast-in and built-in anchors:
      a. Provide anchor setting templates to locate anchor bolts and anchor rods. Secure templates to formwork.
      b. Brace or tie off embedments as necessary to prevent displacement during placement of plastic concrete or of surrounding masonry construction.
      c. Position and tie cast-in and built-in anchors in place before beginning placement of concrete or grout. Do not “stab” anchors into plastic concrete, mortar, or grout.
      d. Do not allow cast-in anchors to touch reinforcing steel. Where cast-in anchors are within 1/4 inch of reinforcing steel, isolate the metals by wrapping the anchors with a minimum of 4 wraps of 10-mil polyvinyl chloride tape in area adjacent to reinforcing steel.
   2. For anchoring at machinery bases subject to vibration, use 2 nuts, with 1 serving as a locknut.
   3. Where anchor bolts or anchor rods are indicated on the Drawings as being for future use, thoroughly coat exposed surfaces that project from concrete or masonry with non-oxidizing wax. Turn nuts down full length of the threads, and neatly wrap the exposed thread and nut with a minimum of 4 wraps of 10-mil waterproof polyvinyl tape.

B. Anchor bolts:
   1. Minimum effective embedment: 10-bolt diameters, unless a longer embedment is indicated on the Drawings.

C. Where indicated on the Drawings, set anchor bolts in plastic, galvanized steel or stainless steel sleeves to allow for adjustment. Seal top of sleeve to prevent grout from filling sleeve.

3.04 INSTALLATION: POST-INSTALLED ADHESIVE ANCHORS

A. Epoxy and acrylic adhesive bonding of reinforcing bars, all thread rods, and internally threaded inserts in concrete: As specified in Section 03055 - Adhesive-Bonded Reinforcing Bars and All Thread Rods in Concrete.

3.05 INSTALLATION: POST-INSTALLED MECHANICAL ANCHORS

A. General:
   1. Install anchors in accordance with the manufacturer's instructions, ACI 355.2, the anchor's ICC-ES Report. Where conflict exists between the ICC-ES Report and the requirements in this Section, the requirements of the ICC-ES Report shall control.
   2. Where anchor manufacturer recommends the use of special tools and/or specific drill bits for installation, provide and use such tools.
   3. After anchors have been positioned and inserted into concrete or masonry, do not:
      a. Remove and reuse/reinstall anchors.
      b. Loosen or remove bolts or studs.

B. Holes drilled into concrete and masonry:
   1. Do not drill holes in concrete or masonry until the material has achieved its minimum specified compression strength (f'c or f'm).
   2. Accurately locate holes:
      a. Before drilling holes, use a reinforcing bar locator to identify the position of all reinforcing steel, conduit, and other embedded items within a 6-inch radius of each proposed hole.
      b. If the hole depth exceeds the range of detection for the rebar locator, the Engineer may require radiographs of the area designated for investigation before drilling commences.
   3. Exercise care to avoid damaging existing reinforcement and other items embedded in concrete and masonry:
      a. If embedments are encountered during drilling, immediately stop work and notify the Engineer. Await Engineer's instructions before proceeding.
   4. Unless otherwise indicated on the Drawings, drill holes perpendicular to the concrete surface into which they are placed.
   5. Drill using anchor manufacturer's recommended equipment and procedures:
      a. Unless otherwise recommended by the manufacturer, drill in accordance with the following:
         1) Drilling equipment: Electric or pneumatic rotary type with light or medium impact. Where edge distances are less than 2 inches, use

lighter impact equipment to prevent micro-cracking and concrete spalling during drilling process.

2) Drill bits: Carbide-tipped in accordance with ANSI B212-15. Hollow drills with flushing air systems are preferred.

6. Drill holes at manufacturer's recommended diameter and to depth required to provide the effective embedment indicated.
7. Clean and prepare holes as recommended by the manufacturer and as required by the ICC-ES Report for that anchor:
   a. Unless otherwise recommended by anchor manufacturer, remove dust and debris using brushes and clean compressed air.
   b. Repeat cleaning process as required by the manufacturer's installation instructions.
   c. When cleaning holes for stainless steel anchors, use only stainless steel or non-metallic brushes.

C. Insert and tighten (or torque) anchors in full compliance with the manufacturer's installation instructions:
   1. Once anchor is tightened (torque), do not attempt to loosen or remove its bolt or stud.

D. Concrete anchors: Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Concrete Anchors			
Nominal Diameter	**Minimum Effective Embedment Length**		**Minimum Member Thickness**
	In Concrete	**In Grouted Masonry**	
3/8 inch	2 1/2 inch	2 5/8 inch	8 inch
1/2 inch	3 1/2 inch	3 1/2 inch	8 inch
5/8 inch	4 1/2 inch	4 1/2 inch	10 inch
3/4 inch	5 inch	5 1/4 inch	12 inch

E. Flush shell anchors:
   1. Flush shell anchors are not permitted in the Work.
   2. If equipment manufacturer's installation instructions recommend the use of flush shell anchors, contact Engineer for instructions before proceeding.

F. Sleeve anchors:
   1. Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Sleeve Anchors			
	Minimum Effective Embedment Length		
Nominal Diameter	In Concrete	In Grouted Masonry	Minimum Member Thickness
M8 (1/2 inch)	70 mm (2 3/4 inch)	Not accepted	100 mm (8 inch)
M10 (5/8 inch)	76 mm (3 inch)	Not accepted	250 mm (10 inch)
M12 (3/4 inch)	80 mm (3 1/4 inch)	Not accepted	300 mm (12 inch)

   2. Install with the sleeve fully engaged in the base material.

G. Screw anchors:
   1. Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Screw Anchors			
	Minimum Effective Embedment Length		
Nominal Diameter	In Concrete	In Grouted Masonry	Minimum Member Thickness
3/8 inch	2 1/2 inch	3 1/4 inch	8 inch
1/2 inch	3 1/4 inch	4 1/2 inch	8 inch
5/8 inch	4 inch	5 inch	10 inch
3/4 inch	5 1/2 inch	6 1/4 inch	12 inch

   2. Install screw anchors using equipment and methods recommended by the manufacturer. Continue driving into hole until the washer head is flush against the item being fastened.

H. Undercut concrete anchors:
   1. Minimum effective embedment lengths unless otherwise indicated on the Drawings:

Undercut Anchors			
Nominal Diameter (bolt)	**Minimum Effective Embedment Length**		**Minimum Member Thickness(1)**
	In Concrete	**In Grouted Masonry**	
M10 (3/8 inch)	100 mm (4 inch)	Not accepted	200 mm (8 inch)
M12 (1/2 inch)	125 mm (5 inch)	Not accepted	350 mm (14 inch)
M16 (5/8 inch)	190 mm (7 1/2 inch)	Not accepted	460 mm (18 inch)
M20 (7/8 inch)	250 mm (10 inch)	Not accepted	510 mm (20 inch)
Notes: (1) Thickness indicated is for pre-set units. If through-set units are accepted, obtain minimum member thickness requirements from the Engineer.			

   2. Installations of undercut anchors shall not be allowed where edge distances are less than 12 times the nominal diameter of the anchor stud.
   3. Undercut bottom of hole using cutting tools manufactured for this purpose by the manufacturer of the undercut anchors being placed.

3.06 FIELD QUALITY CONTROL

A. Contractor shall provide quality control over the Work of this Section as specified in Section 01450 - Quality Control:
   1. Expenses associated with work described by the following paragraphs shall be paid by the Contractor.

B. Post-installed anchors:
   1. Review anchor manufacturer’s installation instructions and requirements of the Evaluation Service Report (hereafter referred to as “installation documents”) for each anchor type and material.
   2. Observe hole-drilling and cleaning operations for conformance with the installation documents.
   3. Certify in writing to the Engineer that the depth and location of anchor holes, and the torque applied for setting the anchors conforms to the requirements of the installation documents.

3.07 FIELD QUALITY ASSURANCE

A. Owner will provide on-site observation and field quality assurance for the Work of this Section:
   1. Expenses associated with work described by the following paragraphs shall be paid by the Owner.

B. Field inspections and special inspections:
   1. Required inspections: Observe construction for conformance to the approved Contract Documents, the accepted submittals, and manufacturer’s installation instructions for the products used.

2. Record of inspections:
    a. Maintain record of each inspection.
    b. Submit copies to Engineer upon request.
3. Statement of special inspections: At the end of the project, prepare and submit to the Engineer and the authority having jurisdiction inspector's statement that the Work was constructed in general conformance with the approved Contract Documents, and that deficiencies observed during construction were resolved.

C. Special inspections: Anchors cast into concrete.
1. Provide special inspection during positioning of anchors and placement of concrete around the following anchors:
    a. Anchor bolts.
2. During placement, provide continuous special inspection at each anchor location to verify that the following elements of the installation conform to the requirements of the Contract Documents:
    a. Anchor:
        1) Type and dimensions.
        2) Material: Galvanized steel, Type 304 stainless steel, or Type 316 stainless steel as specified in this Section or indicated on the Drawings.
        3) Positioning: Spacing, edge distances, effective embedment, and projection beyond the surface of the construction.
        4) Reinforcement at anchor: Presence, positioning, and size of additional reinforcement at anchors indicated on the Drawings.
3. Following hardening and curing of the concrete surrounding the anchors, provide periodic special inspection to observe and confirm the following:
    a. Base material (concrete):
        1) Solid and dense concrete material within required distances surrounding anchor.
        2) Material encapsulating embedment is dense and well-consolidated.

D. Special Inspections: Post-installed mechanical anchors placed in hardened concrete and in grouted masonry:
1. Provide special inspection during installation of the following anchors:
    a. Concrete anchors.
2. Unless otherwise noted, provide periodic special inspection during positioning, drilling, placing, and torquing of anchors:
    a. Provide continuous special inspection for post-installed anchors in "overhead installations" as defined in this Section.
3. Requirements for periodic special inspection:
    a. Verify items listed in the following paragraphs for conformance to the requirements of the Contract Documents and the Evaluation Report for the anchor being used. Observe the initial installation of each type and size of anchor, and subsequent installation of the same anchor at intervals of not more than 4 hours:
        1) Any change in the anchors used, in the personnel performing the installation, or in procedures used to install a given type of anchor shall require a new "initial inspection."
    b. Substrate: Concrete or masonry surfaces receiving the anchor are sound and of a condition that will develop the anchor's rated strength.

c. Anchor:
    1) Manufacturer, type, and dimensions (diameter and length).
    2) Material (galvanized, Type 304 stainless steel, or Type 316 stainless steel).
d. Hole:
    1) Positioning: Spacing and edge distances.
    2) Drill bit type and diameter.
    3) Diameter, and depth.
    4) Hole cleaned in accordance with manufacturer's required procedures. Confirm multiple repetitions of cleaning when recommended by the manufacturer.
    5) Anchor's minimum effective embedment.
    6) Anchor tightening/installation torque.

4. Requirements for continuous special inspection:
    a. The special inspector shall observe all aspects of anchor installation, except that holes may be drilled in his/her absence provided that he/she confirms the use of acceptable drill bits before drilling, and later confirms the diameter, depth, and cleaning of drilled holes.

E. Field tests:
1. Owner may, at any time, request testing to confirm that materials being delivered and installed conform to the requirements of the Specifications:
    a. If such additional testing shows that the materials do not conform to the specified requirements, the Contractor shall pay the costs of these tests.
    b. If such additional testing shows that the materials do conform to the specified requirements, the Owner shall pay the costs of these tests.

3.08 NON-CONFORMING WORK

A. Remove misaligned or non-performing anchors.

B. Fill empty anchor holes and repair failed anchor locations as specified in Section 3.07 using high-strength, non-shrink, non-metallic grout.

C. If more than 10 percent of all tested anchors of a given diameter and type fail to achieve their specified torque or proof load, the Engineer will provide directions for required modifications. Make such modifications, up to and including replacement of all anchors, at no additional cost to the Owner.

3.09 SCHEDULES

A. Stainless steel. Provide and install stainless steel anchors at the following locations:
1. "Corrosive locations" as defined in this Section: Type 316 stainless steel
2. "Wet and moist locations" as defined in this Section: Type 316 stainless steel.
3. "Other locations:"
    a. For connecting steel or stainless steel members to concrete or masonry: Type 304 stainless steel.
    b. For connecting aluminum members to concrete or masonry.
4. At locations indicated on the Drawings.

B. Galvanized: Provide and install galvanized carbon steel anchors at the following locations:
   1. Locations not requiring stainless steel.
   2. At locations indicated on the Drawings.

C. Provide and install anchor materials as scheduled in the following Table.

Required Anchoring Materials by Location			
Location/Exposure		**Materials**	**Notes**
1.	**Anchors into concrete and grouted masonry for attachment of carbon steel, including structural steel and other steel fabrications:**		
a)	Interior dry areas	Carbon steel - galvanized	
b)	Locations with galvanized steel structures or fabrications	Stainless steel - Type 304 or 316	1
c)	Exterior and interior wet and moist locations	Stainless steel - Type 316	1
d)	Corrosive locations	Stainless steel - Type 316	1
2.	**Anchors into concrete and grouted masonry for attachment of aluminum, stainless steel, or fiber-reinforced plastic (FRP) shapes and fabrications:**		
a)	Interior dry areas	Stainless steel - Type 304 or 316	1
b)	Exterior and interior wet and moist locations	Stainless steel - Type 316	1
c)	Corrosive locations	Stainless steel - Type 316	1
3.	**Anchors for attaching equipment and its appurtenances:**		
a)	All locations	Stainless steel - Type 316 (unless Type 304 is specifically indicated in the specifications for the equipment.)	1
Notes: (1) Where anchors are in contact with a metal that differs from that of the anchor, provide isolation sleeves and washers.			

END OF SECTION

SECTION 05500

METAL FABRICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
1. Aluminum grating stair tread.
2. Aluminum stair nosing.
3. Concrete inserts.
4. Handrails and guardrails.
5. Ladders.
6. Manhole frames and covers.
7. Metal gratings.
8. Metal tread plate.
9. Preformed channel pipe supports.
10. Stairs.
11. Miscellaneous metals.
12. Associated accessories to the above items.

1.02 REFERENCES

A. Aluminum Association (AA):
1. DAF-45: Designations from Start to Finish.
a. M12-C22-A41.

B. American Association of State Highway and Transportation Officials (AASHTO):
1. Standard Specifications for Highway Bridges.

C. ASTM International (ASTM):
1. A36 - Standard Specification for Carbon Structural Steel.
2. A48 - Standard Specification for Gray Iron Castings.
3. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded, and Seamless.
4. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
5. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels for General Applications.
6. A276 - Standard Specification for Stainless Steel Bars and Shapes.
7. A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
8. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
9. A489 - Standard Specification for Carbon Steel Lifting Eyes.
10. A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
11. A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

12. A635 - Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.
13. A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
14. A992 - Standard Specification for Structural Steel Shapes.
15. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
16. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
17. B308 - Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
18. B429 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
19. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws and Studs.
20. F3125 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength.

D. American Welding Society (AWS):
   1. A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.

E. Occupational Safety and Health Administration (OSHA).

1.03 DEFINITIONS

A. Passivation: Removal of exogenous iron or iron compounds from the surface of a stainless steel by means of chemical dissolution resulting from treatment with an acid solution that removes the surface contamination but does not significantly affect the stainless steel itself.

1.04 SUBMITTALS

A. Product Data:
   1. Aluminum grating stair tread.
   2. Aluminum stair nosing.
   3. Handrails and guardrails.
   4. Manhole frames and covers.
   5. Metal grating.

B. Shop drawings:
   1. Handrails and guardrails:
      a. Including details on connection attachments, gates, kick plates, ladders, and angles.
      b. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.
      c. Include erection drawings, elevations, and details where applicable.
      d. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
   2. Ladders.
   3. Metal grating.
   4. Metal tread plate.

5. Stairs.
6. Miscellaneous metals.

C. Samples:
1. Guardrails with specified finishes.

D. Quality control submittals:
1. Design data.
2. Test reports:
a. Guardrails: 3 copies of certified tests performed by an independent testing laboratory certifying that guardrails meet current State and OSHA strength requirements.
b. Gratings:
1) Grating manufacturers' calculations showing that gratings will meet specified design load, stress, and deflection requirements for each size grating for each span.
2) Reports of tests performed.
c. Planks:
1) Plank manufacturers' calculations showing that planks will meet specified load-bearing and deflection requirements for each size plank for each span.
2) Reports of tests performed.

PART 2 PRODUCTS

2.01 MATERIALS

A. General: Unless otherwise specified or indicated on the Drawings, structural and miscellaneous metals in accordance with the standards of the ASTM, including the following:

Item	ASTM Standard No.	Class, Grade Type or Alloy No.
Cast Iron		
Cast iron	A48	Class 40B
Steel		
Galvanized sheet iron or steel	A653	Coating G90
Coil (plate)	A635	--
Structural plate, bars, rolled shapes, and miscellaneous items (except W shapes).	A36	--
Rolled W shapes	A992	Grade 50
Standard bolts, nuts, and washers	A307	--
High strength bolts, nuts, and hardened flat washers	F3125, Grade A325	--
Eyebolts	A489	Type 1

Item	ASTM Standard No.	Class, Grade Type or Alloy No.
Tubing, cold-formed	A500	--
Tubing, hot-formed	A501	--
Steel pipe	A53	Grade B
Stainless Steel		
Plate, sheet, and strip	A240	Type 304* or 316**
Bars and shapes	A276	Type 304* or 316**
Bolts (Type 304)	F593	Group 1 Condition CW
Bolts (Type 316)	F593	Group 2 Condition CW
Aluminum		
Flashing sheet aluminum	B209	Alloy 5005-H14, 0.032 inches minimum thickness
Structural sheet aluminum	B209	Alloy 6061-T6
Structural aluminum	B209 B308	Alloy 6061-T6
Extruded aluminum	B221	Alloy 6063-T42
* Use Type 304L if material will be welded. ** Use Type 316L if material will be welded.		

1. Stainless steels are designated by type or series defined by ASTM.
2. Where stainless steel is welded, use low-carbon stainless steel.

2.02 MANUFACTURED UNITS

A. Aluminum grating stair tread:
   1. Manufacturers: One of the following or equal:
      a. Harsco Industrial IKG, Aluminum Grating Stair Tread with Mebac® nosing.
      b. McNichols Co., Type A-Standard with Corrugated Angle Nosing.
   2. Material: Welded aluminum grating tread with non-slip nosing and integral end plates for bolt on attachment to stair stringers.
   3. Size:
      a. Tread width: To equal tread spacing plus 1 inch minimum.
      b. Tread length: Length to suit stringer-to-stringer dimension on the Drawings.
      c. Depth: 1-3/4 inches.
   4. Bolts: Type 316 stainless steel.

B. Aluminum stair nosing:
   1. Manufacturers: One of the following or equal:
      a. Wooster Products, Inc., Type 101 Nosing.
      b. American Safety Tread Co., Inc., Style 801 Nosing.
   2. Material: Cast aluminum abrasive nosings with aluminum oxide granules integrally cast into metal, forming permanent, nonslip, long-wearing surface.

3. For installation in cast-in-place stairs.
4. Configuration: 4 inches wide, fabricated with integrally cast stainless steel anchors at approximately 12-inch centers. Length to extend within 3 inches of stair edge on each side.

C. Cast iron stop plank grooves:
   1. Manufacturers: One of the following or equal:
      a. Neenah Foundry Co., R-7500 Series, Type A.
      b. McKinley Iron Works, Type L.
   2. Size: 2-inch wide groove opening by 1-1/2 inch deep, unless otherwise indicated on the Drawings.
   3. Recess groove with the cast iron surface of the groove set flush with the concrete surface.

D. Concrete inserts:
   1. Concrete inserts for supporting pipe and other applications are specified in Section 15061 - Pipe Supports.

E. Handrails and guardrails:
   1. General:
      a. Design and fabricate assemblies to conform to current local, State, and OSHA standards and requirements.
      b. Coordinate layout of assemblies and post spacings to avoid conflicts with equipment and equipment operators:
         1) Indicate on the shop drawings locations of such equipment.
         2) Highlight locations where railings cannot be made continuous, and obtain Engineer's directions on how to proceed before fabricating or installing railings.
   2. Aluminum handrails and guardrails (nonwelded pipe):
      a. Rails, posts, and fitting-assembly spacers:
         1) In accordance with ASTM B429, 6005, 6063 or 6105, minimum Schedule 40, extruded aluminum pipe of minimum 1.89-inch outside diameter and 0.14-inch wall thickness.
      b. Kick plates: 6061 or 6105 aluminum alloy.
      c. Fastenings and fasteners: As recommended or furnished by the manufacturer.
      d. Other parts: 6063 extruded aluminum, or F214 or F514.0 aluminum castings:
         1) Fabrications: In accordance with ASTM B209 or ASTM B221 extruded bars:
            a) Bases: 6061 or 6063 extruded aluminum alloy.
         2) Plug screws or blind rivets: Type 305 stainless steel:
            a) Other parts: Type 300 series stainless steel.
      e. Finish of aluminum components:
         1) Anodized finish, 0.7 mil thick, applied to exposed surfaces after cutting. Aluminum Association Specification M12-C22-A41, mechanical finish non specular as fabricated, chemical finish-medium matte, anodic coating-clear Class I Architectural.
         2) Pretreat aluminum for cleaning and removing markings before anodizing.
      f. Fabrication and assembly:
         1) Fabricate posts in single, unspliced pipe length.

2) Perform without welding.
3) Do not epoxy bond the parts.
4) Maximum clear opening between assembled railing components as indicated on the Drawings.

g. Manufacturers: One of the following or equal:
1) Moultrie Manufacturing Co., Wesrail.
2) Golden Railings, Riveted System.
3) Craneveyor Corp. Enerco Metals, C-V Rail.

3. Fastenings and fasteners: As recommended or furnished by guardrail manufacturer for use with this system.

F. Ladders:
1. General:
a. Type: Safety type conforming to local, State, and OSHA standards as minimum. Furnish guards for ladder wells.
b. Size: 18 inches wide between side rails of length, size, shape, detail, and location indicated on the Drawings.
2. Aluminum ladders:
a. Materials: 6063-T5 aluminum alloy.
b. Rungs:
1) 1-inch minimum solid square bar with 1/8-inch grooves in top and deeply serrated on all sides.
2) Capable of withstanding 1,000 pound load without failure.
c. Side rails: Minimum 4-inch by 1/2-inch flat bars.
d. Finish of aluminum components:
1) Anodized finish, 0.7 mil thick, applied to exposed surfaces after cutting. Aluminum Association Specification M12-C22-A41, mechanical finish non specular as fabricated, chemical finish-medium matte, anodic coating-clear Class I Architectural.
2) Pretreat aluminum for cleaning and removing markings before anodizing.
e. Fabrication:
1) Welded construction, of size, shape, location, and details indicated on the Drawings.
2) For ladders over 20 feet high, furnish standard ladder cages or fall prevention system designed in accordance with State and OSHA requirements.
f. Fall prevention system: Include but not limit to railing, brackets, clamps, 2 sleeves, and 2 belts, satisfying OSHA safe climbing requirements:
1) Manufacturers: One of the following or equal:
a) North Consumer Products, Saf-T-Climb.
b) Swager Communications, Climbers Buddy System.

G. Manhole frames and covers:
1. Material: Gray iron castings, in accordance with ASTM A48, Class 30-B.
2. Type: Heavy-duty traffic type, with combined minimum set weight of 265 pounds.
3. Machine horizontal and vertical bearing surfaces to fit neatly, with easily removable cover bearing firmly in frame without rocking.
4. Frame:
a. Bottom flange type.
b. Approximately 4-1/2 inches frame height.

c. Dimensions as indicated on the Drawings.
1) Minimum inside clear dimension may not be smaller than nominal diameter minus 2 inches.

5. Cover:
a. Skid-resistant grid pattern design stamped with name of utility service provided by manhole, such as "ELECTRICAL," "SEWER," "TELEPHONE," or "WATER."
b. Solid type without ventilation holes.

6. Finish: Unpainted.

H. Metal gratings:
1. General:
a. Fabricate grating to cover areas indicated on the Drawings.
b. Unless otherwise indicated on the Drawings, grating over an opening shall cover entire opening.
c. Make cutouts in grating where required for equipment access or protrusion, including valve operators or stems, and gate frames.
d. Band ends of grating and edges of cutouts in grating:
1) End banding: 1/4 inch less than height of grating, with top of grating and top edge of banding flush.
2) Cutout banding: Full-height of grating.
3) Use banding of same material as grating.
4) Panel layout: Enable installation and subsequent removal of grating around protrusions or piping.
5) Openings 6 inches and larger: Lay out grating panels with edges of 2 adjacent panels located on centerline of opening.
6) Openings smaller than 6 inches: Locate opening at edge of single panel.
7) Where an area requires more than 1 grating section to cover area, clamp adjacent grating sections together at 1/4-points with fasteners acceptable to Engineer.
8) Fabricate aluminum grating sections in units of weighing not more than 80 pounds each.
9) Gaps between adjacent grating sections shall not be more than the clear spacing between bearing bars.
e. When requested by Engineer, test 1 section of each size grating for each span length involved on the job under full load:
1) Furnish a suitable dial gauge for measuring deflections.
f. Grating shall be aluminum, unless otherwise specified or indicated on the Drawings.

2. Aluminum grating:
a. Material for gratings, shelf angles, and rebates: 6061-T6 or 6063-T6 aluminum alloy, except crossbars may be 6063-T5 aluminum alloy.
b. Shelf angle concrete anchors: Type 304 or Type 316 stainless steel.
c. Grating rebate rod anchors: 6061-T6 or 6063-T6 aluminum alloy.
d. Bar size and spacing: As determined by manufacturer to enable grating to support design load.
e. Design live load: A minimum of 100 pounds per square foot uniform live load on entire grating area, but not less than the live load indicated on the Drawings for the area where grating is located.
f. Maximum fiber stress for design load: 12,000 pounds per square inch.

g. Maximum deflection due to design load: 1/240 of grating clear span.
h. Maximum spacing of main grating bars: 1-1/8 inches clear between bars.
i. Minimum grating height: 1-1/2 inches.
j. Manufacturers: The following or equal:
1) Harsco Industrial IKG, Swaged Aluminum I-Bar with striated finish.

3. Aluminum grating planks:
a. Materials: Meet requirements previously specified for aluminum grating.
b. Fabrication:
1) Meet requirements previously specified for aluminum grating.
c. Have unpunched surface with cross hatched anti-skid surface.
d. Minimum weight of 3-1/4 pounds per square foot.
e. Provide 1 inch diameter hole with smooth edges at each end for each plank.
f. Furnish planks in 2 foot widths.
g. Manufacturers: The following or equal:
1) Harsco Industrial IKG, Heavy Duty Aluminum Plank Grating HD-P.
h. Planks shall not lock with adjacent planks allowing the removal of individual planks without disturbing the adjacent planks.

I. Metal tread plate:
1. Plate having a raised figured pattern on 1 surface to provide improved traction.

J. Preformed channel pipe supports:
1. Preformed channel pipe supports for pipe supports and other applications are specified in Section 15062 - Preformed Channel Pipe Support System.

K. Stairs:
1. Aluminum stairs:
a. Stringers: 6061-T6 aluminum alloy.
b. Stair treads:
1) Aluminum of same type specified under Aluminum Grating.
2) Of sizes indicated on the Drawings, and 1-3/4 inch minimum depth with cast abrasive type safety nosings.
c. Handrails and guardrails: Aluminum pipe specified under Aluminum Handrails and Guardrails (Nonwelded Pipe).
d. Fasteners: Type 304 or Type 316 stainless steel.

L. Miscellaneous aluminum:
1. Fabricate aluminum products, not covered separately in this Section, in accordance with the best practices of the trade and field assemble by riveting or bolting.
2. Do not weld or flame cut.

M. Miscellaneous cast iron:
1. General:
a. Tough, gray iron, free from cracks, holes, swells, and cold shuts.
b. Quality such that hammer blow will produce indentation on rectangular edge of casting without flaking metal.
c. Before leaving the foundry, clean castings and apply 16-mil dry film thickness coating of coal-tar epoxy, unless otherwise specified or indicated on the Drawings.

N. Miscellaneous stainless steel:
    1. Provide miscellaneous stainless steel items not specified in this Section as indicated on the Drawings or specified elsewhere.
        a. Fabricate and install in accordance with the best practices of the trade.
    2. Cleaning and passivation:
        a. Following shop fabrication of stainless steel members, clean and passivate fabrications.
        b. Finish requirements: Remove free iron, heat tint oxides, weld scale and other impurities, and obtain a passive finished surface.
        c. Provide quality control testing to verify effectiveness of cleaning agents and procedures and to confirm that finished surfaces are clean and passivated.
            1) Conduct sample runs using test specimens with proposed cleaning agents and procedures as required to avoid adverse effects on surface finishes and base materials.
        d. Pre-clean, chemically descale (pickle), and final clean fabrications in accordance with the requirements of ASTM A380 to remove deposited contaminants before shipping.
            1) Passivation by citric acid treatment is not allowed.
                a) If degreasing is required before cleaning to remove scale or iron oxide, cleaning (pickling) treatments with citric acid are permissible; however, these treatments shall be followed by inorganic cleaners such as nitric-hydrofluoric acid.
            2) Provide acid descaling (pickling) in accordance with Table A1.1 of Annex A1 of ASTM A380.
            3) After pickling, final cleaning of stainless steel shall conform to Part II of Table A2.1 of Annex A2 of ASTM A380.
        e. After cleaning, inspect using methods specified for “gross inspection” in ASTM A380.
        f. Improperly or poorly cleaned and passivated materials shall not be shipped and will not be accepted at the job site.

O. Miscellaneous structural steel:
    1. Provide miscellaneous steel items not specified in this Section as indicated on the Drawings or specified elsewhere.
        a. Fabricate and install in accordance with the best practices of the trade.

P. Isolating sleeves and washers:
    1. As indicated on the Drawings and as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
    1. Examine work in place to verify that it is satisfactory to receive the work of this Section.
    2. If unsatisfactory conditions exist, do not begin this work until such conditions have been corrected.

3.02 INSTALLATION

A. General:
   1. Install products as indicated on the Drawings, and in accordance with shop drawings and manufacturer's printed instructions, as applicable except where specified otherwise.
   2. Interface between materials:
      a. Dissimilar metals: Where steel comes in contact with dissimilar metals (aluminum, stainless steel, etc.), separate or isolate the dissimilar metals:
         1) Make application so that the isolating or protective barrier is not visible in the completed construction.
         2) Isolating sleeves and washers: As specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
      b. Aluminum in contact with concrete or masonry: Coat aluminum surfaces as specified in Section 09960 - High Performance Coatings.
      c. Aluminum in contact with concrete or masonry.

B. Aluminum stair nosing:
   1. Install stair nosings on treads of concrete stairs, including top tread on upper concrete slab.
   2. Omit stair nosings where concrete is submerged.
   3. Cast stair nosings in fresh concrete, flush with tread and riser faces. Install nosing in center of step.

C. Handrails and guardrails:
   1. General:
      a. Fasten pipe rails to fittings with Series 300 stainless steel pop rivets or flush set screws.
      b. Make pipe cuts clean and straight, free of burrs and nicks, and square and accurate for minimum joint-gap.
      c. Drill and countersink holes to proper size, as required for a tight flush fit of screws and other component parts.
      d. Space attachment brackets as indicated in the manufacturer's instructions.
   2. Aluminum pipe handrails and guardrails:
      a. During construction, keep exterior surfaces of handrails and guardrails covered with minimum 0.4 millimeters of heat shrink polyethylene film.
      b. Do not remove protective film before handrails and guardrails have been accepted by Engineer nor before other work in proximity of handrails and guardrails has been completed.
      c. Discontinue handrails and guardrails at lighting fixtures.
      d. Provide 1/8-inch diameter weep hole at base of each post.
      e. Space posts as indicated on the Drawings.
      f. Anchor posts into concrete by grouting posts into formed holes in concrete, into stainless steel sleeves cast in concrete; or bracket mount to face of concrete surfaces as specified and indicated on the Drawings.
      g. Space rails as indicated on the Drawings.
      h. Make adequate provision for expansion and contraction of kick plates and rails:
         1) Make provisions for removable sections where indicated on the Drawings.
      i. Make lower rails a single, unspliced length between posts, or continuous.

j. Make top rails continuous whenever possible, and attach single, unspliced lengths to 3 posts minimum.
k. Draw up fasteners tight with hand wrench or screw driver.
l. Space attachment brackets as indicated on shop drawings or in manufacturer's installation instructions.
m. Completed installation shall have handrails and railings rigid and free of play at joints and attachments.
n. Protect handrail and guardrail finish from scratches, gouges, dents, stains, and other damage.
o. Replace damaged or disfigured handrails and guardrails with new.
p. Shortly before final acceptance of the work, and after removal of protective polyethylene film, clean handrails and guardrails with mild detergent or with soap and water.
1) After cleaning, thoroughly rinse handrails and guardrails and wipe with soft cloth.
q. Erect guardrail straight, level, plumb, and true to the positions as indicated on the Drawings. Correct deviations from true line of grade, which are visible to the eye.

D. Ladders:
1. Secure to supporting surface with bent plate clips providing minimum 8 inches between supporting surface and center of rungs.
2. Where exit from ladder is forward over top rung, extend side rails 3 feet 3 inches minimum above landing, and return the rails with a radius bend to the landing.
3. Where exit from ladder is to side, extend ladder 5 feet 6 inches minimum above landing and rigidly secure at top.
4. Erect rail straight, level, plumb, and true to position indicated on the Drawings:
a. Correct deviations from true line or grade which are visible to the eye.

E. Manhole frames and covers:
1. Installation: As specified in Section 02084 - Precast Drainage Structures.

F. Metal gratings:
1. General:
a. Allow 1/8-inch maximum clearance between ends of grating and inside face of vertical leg of shelf angles.
b. Horizontal bearing leg of shelf angles shall be 2 inches minimum.
c. Install aluminum plate or angles where necessary to fill openings at changes in elevation and at openings between equipment and grating.
d. Install angle stops at ends of grating.
e. Installed grating shall not slide out of rebate or off support.
f. Weld stops in place, unless otherwise specified or indicated on the Drawings.
g. Top surfaces of grating sections adjacent to each other shall lie in same plane.
2. Aluminum grating:
a. Aluminum grating: Support on aluminum shelf angles or rebates.
3. Aluminum grating planks:
a. Support and install planks as specified for aluminum grating.

G. Stairs:
    1. General:
        a. Install guard railings around stair wells as indicated on the Drawings or specified.

H. Stainless Steel:
    1. Welding:
        a. Passivate field-welded surfaces:
            1) Provide cleaning, pickling and passivating as specified in this Section.
            2) Clean using Derustit Stainless Steel Cleaner, or equal.

END OF SECTION

SECTION 07110

DAMPPROOFING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Dampproofing.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D1227 - Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing.

B. California Air Resources Board (ARB):
   1. Architectural Coatings Suggested Control Measure.

1.03 SUBMITTALS

A. Product data.

B. Shop drawings.

C. Manufacturer's Installation Instructions.

D. Warranty.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Store materials in original, unopened containers in compliance with manufacturer's printed instructions.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Conform to volatile organic compound limits specified in Table 1 of the California ARB Architectural Coatings Suggested Control Measure.

B. Do not apply bituminous dampproofing when temperatures are 40 degrees Fahrenheit or lower or when rain is forecast for the 24 hours following application.

PART 2 PRODUCTS

2.01 MATERIALS

A. Dampproofing: ASTM D1227, Asbestos Free, Emulsified Asphalt Coatings:
   1. Manufacturers: One of the following or equal:
      a. Karnak Corp., Karnak 220 AF.
      b. W.R. Meadows, Inc., Sealmastic Type 2 Asphalt Emulsion Dampproofing.

B. Sealing mastic: Type compatible with dampproofing and free of toxic solvents with thick mastic consistency and smooth and uniform in composition product as recommended by dampproofing manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that conditions are satisfactory for application of products in accordance with manufacturer's recommendations.

B. Verify that surfaces to receive dampproofing are clean, dry, reasonably smooth, free of dust, dirt, voids, cracks, or sharp projections.

3.02 APPLICATION

A. Completely cover surfaces to receive dampproofing with 2 coats:
   1. Applied by brush or spray.
   2. Apply dampproofing at manufacturer's recommended rate of application or minimum 2 gallons per 100 square feet, whichever is greater.

B. Extend dampproofing to 6 inches above finish grade.

C. Apply each coat evenly so surfaces have uniform black appearance.

D. Apply second coat at right angles to first, allowing not less than 24 hours between coats.

E. Seal around items and services projecting through dampproofing surfaces in accordance with manufacturer's recommendations.

F. Ensure sealed areas are moisture tight.

G. Backfill completely against dampproofing application within time recommended by manufacturer.

END OF SECTION

SECTION 07900

JOINT SEALANTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Acrylic-Latex sealant.
   2. Precast concrete joint sealant.
   3. Silicone sealant.
   4. Synthetic rubber sealing compound.
   5. Synthetic sponge rubber filler.
   6. Related materials.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. M198 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

B. ASTM International (ASTM):
   1. C920 - Standard Specification for Elastomeric Joint Sealants.
   2. C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
   3. C1330 - Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.
   4. C1521 - Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints.
   5. D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
   6. D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomer.

1.03 SUBMITTALS

A. Product data.

B. Samples, include color selections.

C. Manufacturer's Installation Instructions.

D. Warranty.

1.04 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufacturer of proposed product for minimum 5 years with satisfactory performance record.

B. Installer qualifications: Manufacturer approved installer of products similar to specified products on minimum 5 projects of similar scope as Project with satisfactory performance record.

1.05 PROJECT/SITE CONDITIONS

A. Environmental requirements: Do not apply sealant on wet or frosty surfaces or when surface temperature is higher than 100 degrees Fahrenheit or lower than recommended by the manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products in accordance with manufacturer's recommendations.

B. Code date packages. Do not use material older than manufacturer’s published shelf life. Store materials at temperatures lower than 80 degrees Fahrenheit. Condition materials in accordance with manufacturer’s instructions prior to installation.

1.07 SEQUENCING AND SCHEDULING

A. Caulk joints prior to painting.

1.08 WARRANTY

A. Warrant to correct defective products for minimum 1 year in accordance with manufacturer's standard warranty.

PART 2 PRODUCTS

2.01 SEALANTS

A. General:
   1. Provide colors matching materials being sealed.
   2. Where compound is not exposed to view in finished work, provide manufacturer's color which has best performance.
   3. Nonsagging sealant for vertical and overhead horizontal joints.
   4. Sealants for horizontal joints: Self-leveling pedestrian/traffic grade.
   5. Joint cleaner, primer, bond breaker: As recommended by sealant manufacturer.
   6. Sealant backer rod and/or compressible filler made from closed cell polyethylene, polyethylene jacketed polyurethane foam, or other flexible, nonabsorbent, non-bituminous material recommended by sealant manufacturer to:
      a. Control joint depth.
      b. Break bond of sealant at bottom of joint.

c. Provide proper shape of sealant bead.
d. Serve as expansion joint filler.

2.02 ACRYLIC-LATEX SEALANT

A. Permanently flexible, nonstaining, and nonbleeding latex modified acrylic sealant compound, colors as selected by Engineer from manufacturer's standard options:
1. Manufacturers: One of the following or equal:
a. Tremco, Tremflex 834.
b. Pecora Corp., Number AC-20.
c. Sonneborn, Sonolac.

2.03 PRECAST CONCRETE JOINT SEALANT

A. Preformed, cold-applied, ready-to-use, flexible joint sealant in accordance with ASTM C990 and AASHTO M 198:
1. Manufacturers: One of the following or equal.
a. Henry Corp., Ram-Nek.
b. Concrete Sealants Division, ConSeal.

2.04 SILICONE SEALANT

A. ASTM C920, Type S, Grade NS, Class 25, single component silicone sealant:
1. Manufacturers: One of the following or equal:
a. Tremco, Proglaze.
b. Pecora Corp., Number 864.
c. Dow Corning, Number 795.
d. General Electric, Number 1200 Series.

2.05 SYNTHETIC RUBBER SEALING COMPOUND

A. Manufacturer: One of the following or equal:
1. Sika Corporation, Sikaflex 2c NS or SL.
2. Pacific Polymers, Elastothane 227R.

B. Material: In accordance with ASTM C920 Type M, Grade P (pourable), Class 25 and Type M, Grade NS (non-sag), Class 25; multi-part polyurethane; able to cure at room temperature to firm, highly resilient polymer; able to perform satisfactory when continuously submerged in water or sewage and exposed to direct sunlight in dry condition; with the following properties determined at 75 degrees Fahrenheit and 50 percent relative humidity:
1. Base: Polyurethane rubber.
2. Application time: Minimum 2 hours.
3. Cure time: Maximum 3 days.
4. Tack free time: Maximum 24 hours.
5. Ultimate hardness: Non-sag 25, Pourable/SL 40, within 5 Shore A.
6. Tensile strength: Non-sag 95 pounds per square inch minimum and self-leveling minimum 170 pounds per square inch when tested in accordance with ASTM D412.
7. Ultimate elongation: Minimum 340 percent when tested in accordance with ASTM D412.

8. Tear resistance: Non-sag 45 pounds per inch minimum and self-leveling minimum 85 pounds per inch when tested in accordance with ASTM D624, Die C.
9. Service temperature range: Minus 25 degrees to 158 degrees Fahrenheit.

C. Color: Gray to match concrete, unless indicated on the Drawings.

2.06 SYNTHETIC SPONGE RUBBER FILLER

A. Closed-cell expanded sponge rubber manufactured from synthetic polymer neoprene base, or resilient polyethylene foam backer rod. In accordance with ASTM C1330, Type C:
1. Manufacturers: The following or equal:
a. Presstite, No. 750.3 Ropax Rod Stock.

B. Characteristics:
1. Suitable for application intended.
2. Strength: As necessary for supporting sealing compound during application.
3. Resiliency: Resistance to environmental conditions of installation.
4. Bonding: No bonding to the sealing compound.
5. Structure: Cellular, prevents absorption of water.
6. Compatibility with other materials in joint and acceptance by manufacturer of sealing compound.
7. Size: Minimum 25 percent greater than nominal joint width.

2.07 RELATED MATERIALS

A. Primer: Nonstaining type, recommended by sealant manufacturer to suit application.

B. Joint cleaner: Noncorrosive, nonstaining, compatible with joint forming materials and as recommended by sealant manufacturer.

C. Bond breaker tape: Pressure-sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify acceptability of joint dimensions, physical, and environmental conditions.

B. Verify that surfaces are dry, clean, and free of dirt, grease, curing compound, and other residue which might interfere with adhesion of sealants.

3.02 PREPARATION

A. Allow concrete to cure thoroughly before caulking.

B. Synthetic sponge rubber filler:
1. Prepare surfaces designated to receive filler in accordance with manufacturer's installation instructions.
2. Do not stretch filler beyond its normal length during installation.

C. Caulking:
   1. Verify that surfaces are dry, clean, and free of dirt, grease, curing compounds, and other residue that might interfere with adhesion of sealant.
   2. Concrete, masonry, wood, and steel surfaces: Clean and prime in accordance with manufacturer's instructions prior to caulking.

D. Synthetic rubber sealing compound:
   1. Ensure surfaces to which synthetic rubber must bond are dry and free of dust, dirt, and other foreign residue.
   2. Heavy sandblasted caulking groove to sound surface, and prime with manufacturer's recommended primer for particular surface.

E. For sidewalks, pavements, and similar joints sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to depth equal to 75 percent of joint width, but neither more than 5/8 inches deep nor less than 3/8 inches deep.

F. For normal moving building joints sealed with elastomeric sealants not subject to traffic, fill joints to depth equal to 50 percent of joint width, but neither more than 1/2 inch deep nor less than 1/4 inch deep.

G. For joints sealed with acrylic-latex sealants, fill joints to depth in range of 75 percent to 125 percent of joint width.

H. Use joint filler to achieve required joint depths, to allow sealants to perform properly.

I. Prepare surfaces and install synthetic sponge rubber filler in accordance with manufacturer's recommendations.

J. Do not stretch filler beyond normal length during installation.

K. Apply bond breaker when recommended by joint sealer manufacturer.

3.03 INSTALLATION

A. Synthetic sponge rubber filler: Install filler in accordance with manufacturer's installation instructions.

B. Caulking, joints, and sealing:
   1. Construct expansion, contraction, and construction joints as indicated on the Drawings.
   2. Install pipe and conduit in structures as indicated on the Drawings.
   3. Caulk doors, windows, louvers, and other items installed in or over concrete openings inside and out.
   4. Use synthetic rubber sealing compound for caulking where indicated on the Drawings or as specified, except for masonry construction and where specified otherwise.
   5. Complete caulking prior to painting.
   6. Verify that concrete is thoroughly cured prior to caulking.
   7. When filler compressible material is used, use untreated type.
   8. Apply caulking with pneumatic caulking gun.
   9. Use nozzles of proper shape and size for application intended.

10. Maintain continuous bond between caulking and sides of joint to eliminate gaps, bubbles, or voids and fill joint in continuous operation without layering of compound.
11. Employ experienced applicators to caulk joints and seams in neat workmanlike manner.
12. To hasten curing of compound when used on wide joints subject to movement, apply heat with infrared lamps or other convenient means.
13. Apply synthetic rubber sealing compound with pneumatic caulking tool or other acceptable method.

3.04 CLEANING

A. Clean surfaces adjacent to sealant as work progresses.

B. Remove excess uncured sealant by soaking and scrubbing with sealant cleaning solvent.

C. Remove excess cured sealant by sanding with Number 80 grit sandpaper.

D. Leave finished work in neat, clean condition.

3.05 SCHEDULE

A. Acrylic latex:
   1. Use where indicated on the Drawings.
   2. Interior joints with movement less than 7.5 percent and not subject to wet conditions.

B. Silicone:
   1. Use where indicated on the Drawings.
   2. Joints and recesses formed where window, door, louver and vent frames, and sill adjoin masonry, concrete, stucco, or metal surfaces.
   3. Door threshold bedding.
   4. Moist or wet locations, including joints around plumbing fixtures.
   5. Stainless steel doors and frames, including joints between applied stops and frames, and around anchor bolts.
   6. Plenum joints.

C. Synthetic rubber sealing compound, non-sag Type II:
   1. Use where indicated on the Drawings.
   2. Water-bearing and earth-bearing concrete structures.
   3. Joints in masonry, concrete vertical surfaces, and metal-faced panels in vertical surfaces.
   4. Joints between sheet metal flashing and trim.
   5. Joints between sheet metal flashing and trim, and vertical wall surfaces.
   6. Small voids between materials requiring filling for weathertight performance in vertical surfaces.
   7. Perimeters of frames of doors, windows, louvers, and other openings where bonding is critical to airtight performance.
   8. Expansion and control joints in masonry vertical surfaces.

D. Synthetic rubber sealing compound, self-leveling Type I:
   1. Use where indicated on the Drawings.
   2. Expansion and control joints in masonry, concrete horizontal surfaces, and metal panels in horizontal surfaces.
   3. Small voids between materials requiring filling for weathertight performance in horizontal surfaces.
   4. Pavement joints.
   5. Perimeters of frames of doors, windows, louvers, and other openings in horizontal surfaces where bonding is critical to airtight performance.

3.06 FIELD QUALITY CONTROL

A. Adhesion testing:
   1. Perform adhesion tests in accordance with ASTM C1521 per the following criteria:
      a. Water bearing structures: 1 test per every 1,000 LF of joint sealed.
      b. Exterior precast concrete wall panels: 1 test per every 2,000 LF of joint sealed.
      c. Chemical containment areas: 1 test per every 1,000 LF of joint sealed.
      d. Building expansion joints: 1 test per every 500 LF of joint sealed.
      e. All other type of joints except butt glazing joints: 1 test per every 3,000 LF of joint sealed.
      f. Manufacturer's authorized factory representative provide written recommendations for remedial measures on failing tests.

END OF SECTION

SECTION 08117

ALUMINUM FLUSH DOORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Aluminum flush doors with aluminum frames.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   2. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tube.
   3. D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
   4. D1623 - Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics.
   5. D2126 - Standard Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging.
   6. D6670- Standard Practice for Full-Scale Chamber Determination of Volatile Organic Emissions from Indoor Materials/Products
   7. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
   8. E283 - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
   9. E330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
   10. E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.
   11. F2927 - Standard Test Method for Door Systems Subject to Airblast Loadings.

B. National Fenestration Rating Council (NFRC):
   1. 102-2010 - Thermal Performance Test.

1.03 PERFORMANCE REQUIREMENTS

A. General: Provide door assemblies that have been designed and fabricated to comply with specified performance requirements, as demonstrated by testing manufacturer's corresponding standard systems.

B. Air infiltration:
   1. For a single door, test specimen shall be tested in accordance with ASTM E283 at pressure differential of 6.27 pounds per square foot.
   2. Door shall not exceed 0.18 cubic feet per minute per square foot.

C. Uniform structural load: For a single door, test specimen shall be tested in accordance with ASTM E330, plus or minus 240 pounds per square foot.

D. Blast test in accordance with ASTM F2927, 6.91 pounds per square inch, 41 pounds per square inch - meters per second: Minimal hazard.

E. Water penetration resistance in accordance with ASTM E331: Pass.

F. Thermal transmission, exterior doors, U-value, NFRC 102-2010: Maximum of 0.47 BTU/hr x sf x degrees Fahrenheit.

G. Indoor air quality testing in accordance ASTM D6670: GREENGUARD Environmental Institute Certified including GREENGUARD for Children and Schools Certification.

H. Compressive strength, foam core, nominal value, ASTM D1621: 79.9 pounds per square inch.

I. Compressive Modulus, foam core, nominal value, ASTM D1621: 370 pounds per square inch.

J. Tensile adhesion, foam core, nominal value, ASTM D1623: 45.3 pounds per square inch.

K. Thermal and humid aging, nominal value, 158 degrees Fahrenheit and 100 percent humidity for 14 days, ASTM D2126: Minus 5.14 percent volume change.

1.04 SUBMITTALS

A. In accordance with Section 01330 - Submittal Procedures.

B. Product data: Submit manufacturer's product data, including description of materials, components, fabrication, finishes, and installation.

C. Shop drawings: Submit manufacturer's shop drawings, including elevations, sections, and details, indicating dimensions, tolerances, materials, fabrication, doors, panels, framing, hardware schedule, finish, options, and accessories.

D. Samples:
   1. Door: Submit manufacturer's sample of door showing face sheets, core, framing, finish, and accessories.
   2. Color: Submit manufacturer's samples of standard colors of doors and frames.

E. Test reports: Submit test reports from qualified independent testing agency indicating doors comply with specified performance requirements.

F. Manufacturer's project references: Submit list of successfully completed projects including project name and location, name of Engineer and type and quantity of doors manufactured.

G. Maintenance manual: Submit manufacturer's maintenance and cleaning instructions for doors, including maintenance and operating instructions for hardware.

H. Warranty: Submit manufacturer's standard warranty.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying opening door mark and manufacturer.

B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer's instructions.

C. Handling: Protect materials and finish from damage during handling and installation.

1.06 WARRANTY

A. As specified in General Conditions.

B. Special warranty:
   1. Warrant doors, frames, and factory hardware against failure in materials and workmanship, including excessive deflection, faulty operation, defects in hardware installation, and deterioration of finish or construction in excess of normal weathering.
   2. Duration: 10 years warranty starting on date of shipment. In addition, a limited lifetime (while the door is in its specified application in its original installation) warranty covering: failure of corner joinery, core deterioration, delamination or bubbling of door skin.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following or equal:
   1. Special-Lite, Inc.

2.02 ALUMINUM FLUSH DOORS

A. Model: SL-16 aluminum flush doors with aluminum frames.

B. Door opening size: As indicated on the Drawings.

C. Construction:
   1. Door thickness: 1-3/4 inches.
   2. Stiles and rails: Aluminum extrusions made from prime-equivalent billet that is produced from 100 percent reprocessed 6063-T6 alloy recovered from industrial processes, minimum of 2-5/16-inch depth.
   3. Corners: Mitered.
   4. Provide joinery of 3/8-inch diameter full-width tie rods through extruded splines top and bottom integral to standard tubular shaped stiles and rails reinforced to accept hardware as specified.

5. Securing internal door extrusions:
    a. 3/16-inch angle blocks and locking hex nuts for joinery.
    b. Welds, glue, or other methods are not acceptable.
6. Furnish extruded stiles and rails with integral reglets to accept face sheets. Lock face sheets into place to permit flush appearance.
7. Rail caps or other face sheet capture methods are not acceptable.
8. Extrude top and bottom rail legs for interlocking continuous weather bar.
9. Meeting stiles:
    a. Pile brush weather seals.
    b. Extrude meeting stile to include integral pocket to accept pile brush weather seals.
10. Bottom of door: Install bottom weather bar with nylon brush weatherstripping into extruded interlocking edge of bottom rail.
11. Glue: Use of glue to bond sheet to core or extrusions is not acceptable.

D. Face sheet:
1. Material: 0.125-inch thick aluminum.
2. Texture: Smooth.

E. Core:
1. Material: Poured-in-place polyurethane foam.
2. Density: Minimum of 5 pounds per cubic foot.
3. R-Value: Minimum of 9.
4. ASTM E84: Class A.

F. Cutouts:
1. Manufacture doors with cutouts for required vision lites, louvers, and panels.
2. Factory install vision lites, louvers, and panels.

G. Hardware:
1. Pre-machine doors in accordance with templates from specified hardware manufacturers and hardware schedule.
2. Factory installed hardware.

2.03 MATERIALS

A. Aluminum members:
1. Aluminum extrusions made from prime-equivalent billet that is produced from 100 percent reprocessed 6063-T6 alloy recovered from industrial processes: ASTM B221.
2. Sheet and plate: ASTM B 209.
3. Alloy and temper: As required by manufacturer for strength, corrosion resistance, application of required finish, and control of color.

B. Components: Door and frame components from same manufacturer.

C. Fasteners:
1. Material: Aluminum, 18-8 stainless steel, or other non-corrosive metal.
2. Compatibility: Compatible with items to be fastened.
3. Exposed fasteners: Screws with finish matching items to be fastened.

2.04 FABRICATION

A. Sizes and profiles: Required sizes for door and frame units, and profile requirements shall be as indicated on the Drawings.

B. Coordination of fabrication: Field measure before fabrication and show recorded measurements on shop drawings.

C. Assembly:
   1. Complete cutting, fitting, forming, drilling, and grinding of metal before assembly.
   2. Remove burrs from cut edges.

D. Welding: Welding of doors or frames is not acceptable.

E. Fit:
   1. Maintain continuity of line and accurate relation of planes and angles.
   2. Secure attachments and support at mechanical joints with hairline fit at contacting members.

2.05 ARCHITECTURAL PANELS

A. Model: SL-36 Aluminum Architectural Panels.
   1. Size: As indicated on the Drawings.
   2. Thickness: As indicated on the Drawings.
   3. Finish: As selected by Owner from manufacturers standard colors.
   4. Texture: Smooth.
   5. Insulated panels:
      a. Core: Foam polyurethane, minimum 5 pounds per cubic foot density.
      b. Face sheets:
         1) Material: 0.125-inch thick aluminum.
   6. Rigid backing: 1/8-inch thick hardboard.
   7. 1/4-Inch panels:
      a. Core: 1/8-inch thick hardboard.
      b. Face sheets: 0.062-inch thick aluminum.

2.06 ALUMINUM DOOR FRAMING SYSTEMS

A. Tubular framing:
   1. Size and type: As indicated on the Drawings.
   2. Materials: Aluminum extrusions made from prime-equivalent billet that is produced from 100 percent reprocessed 6063-T6 alloy recovered from industrial processes, 1/8-inch minimum wall thickness.
   3. Applied door stops:
      a. 0.625-inch high, with screws and weatherstripping.
      b. Doorstop shall incorporate pressure gasketing for weathering seal.
      c. Counterpunch fastener holes in door stop to preserve full metal thickness under fastener head.
   4. Frame members:
      a. Box type with 4 enclosed sides.
      b. Open-back framing is not acceptable.
   5. Caulking: Caulk joints before assembling frame members.

6. Joints:
    a. Secure joints with fasteners.
    b. Provide hairline butt joint appearance.
7. Field fabrication: Field fabrication of framing using stick material is not acceptable.
8. Applied stops:
    a. For side, transom, and borrowed lites and panels.
    b. Applied stops shall incorporate pressure gasketing for weathering seal.
    c. Reinforce with solid bar stock fill for frame hardware attachments.
9. Hardware:
    a. Pre-machine and reinforce frame members for hardware in accordance with manufacturer's standards and hardware schedule.
    b. Factory installed hardware.
10. Anchors:
    a. Anchors appropriate for wall conditions to anchor framing to wall materials.
    b. Doorjamb and header mounting holes shall be spaced no more than 24 inches apart.
    c. Secure head and sill members of transom, side lites, and similar conditions.
11. Side lites:
    a. Factory pre-assemble side lites to greatest extent possible.
    b. Mark frame assemblies according to location.

2.07 HARDWARE

A. Pre-machine doors in accordance with templates from specified hardware manufacturers and hardware schedule.

B. Factory installed hardware.

C. Hardware schedule: As specified in Section 08710 - Door Hardware:
1. Concealed adjustable bottom brush:
    a. Install door manufacturer’s multidirectional adjustable bottom with double nylon brush weatherstripping.
    b. Door bottom must be concealed and adjust to accommodate irregular tapered floor conditions.
2. Concealed adjustable meeting stile astragal. Install door manufacturer’s adjustable astragal with double pile and weather seal weatherstripping.

D. Finish: As specified in Section 08710 - Door Hardware.

2.08 LOUVERS

A. Type: Aluminum, inverted Y-type, fixed blade, 12 inches minimum from bottom of door.

B. Size: As indicated on the Drawings.

C. Installation: Factory installed into standard vision lite kit. Exterior side of louver to be free of fasteners.

D. Insect screen.

2.09 ALUMINUM FINISHES

A. Anodized finish: Class I finish, 0.7 mils thick: As selected by Owner:
   1. Clear 215 R1, AA-M10C12C22A41, Class I, 0.7 mils thick.
   2. Champagne, AA-M10C12C22A44, Class I, 0.7 mils thick.
   3. Light bronze, AA-M10C12C22A44, Class I, 0.7 mils thick.
   4. Medium bronze, AA-M10C12C22A44, Class I, 0.7 mils thick.
   5. Dark bronze, AA-M10C12C22A44, Class I, 0.7 mils thick.
   6. Black, AA-M10C12C22A44, Class I, 0.7 mils thick.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas to receive doors. Notify Engineer of conditions that would adversely affect installation or subsequent use. Do not proceed with installation until unsatisfactory conditions are corrected.

3.02 PREPARATION

A. Ensure openings to receive frames are plumb, level, square, and in tolerance.

3.03 INSTALLATION

A. Install doors in accordance with manufacturer's instructions.

B. Install doors plumb, level, square, true to line, and without warp or rack.

C. Anchor frames securely in place.

D. Separate aluminum from other metal surfaces with bituminous coatings or other means approved by Engineer.

E. Set thresholds in bed of mastic and backseal.

F. Install exterior doors to be weathertight in closed position.

G. Repair minor damages to finish in accordance with manufacturer's instructions and as approved by Engineer.

H. Remove and replace damaged components that cannot be successfully repaired as determined by Engineer.

3.04 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Manufacturer's representative shall provide technical assistance and guidance for installation of doors.

3.05 ADJUSTING

A. Adjust doors, hinges, and locksets for smooth operation without binding.

3.06 CLEANING

A. Clean doors promptly after installation in accordance with manufacturer's instructions.

B. Do not use harsh cleaning materials or methods that would damage finish.

3.07 PROTECTION

A. Protect installed doors to ensure that, except for normal weathering, doors will be without damage or deterioration at time of substantial completion.

END OF SECTION

SECTION 08320

FLOOR ACCESS DOORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Non-fire-rated floor access doors.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO).
   1. Standard Specifications for Highway Bridges.

B. Occupational Safety and Health Administration (OSHA):
   1. 29 CFR 1910-Occupational Safety and Health Standards.

1.03 SUBMITTALS

A. Product data.

B. Shop drawings: Show the following:
   1. Floor access door installation recommendations.
   2. Locations of floor access doors.
   3. Door size and configuration.
   4. Live load capacity.
   5. Materials of construction and finishes provided.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Identify type and size of each floor access door in way not to damage finish prior to delivery.

B. Deliver products only after proper facilities are available.

C. Deliver and store packaged products in original containers with seals unbroken and labels intact until time of use.

D. Handle carefully to prevent damage and store on clean concrete surface or raised platform in safe, dry area:
   1. Do not dump onto ground.

E. Protect floor access doors during shipment and storage to prevent warping, bending, and corrosion.

1.05 WARRANTY

A. Provide manufacturer’s warranty against defects in material and workmanship for a period of 5 years.

1.06 MAINTENANCE

A. Deliver 2 keys for each cylinder lock to Owner.

PART 2 PRODUCTS

2.01 HEAVY-DUTY OFF-STREET FLOOR ACCESS DOORS

A. Manufacturers: One of the following or equal:
   1. The Bilco Co., Model JH-20 or JDH-20 (double leaf).
   2. Babcock Davis Associates, Inc., Model BFDDH-SAL or BFDDH-DAL (double leaf).

B. Style: Single leaf or double leaf as indicated on the Drawings, steel capable of withstanding minimum Standard Specifications for Highway Bridges, H-20 wheel load with a maximum deflection of 1/150 of the span, live load channel frame, with drainage couplings.

C. Door leaf: Minimum 1/4 inch, diamond-pattern plate reinforced with stiffeners as required to meet specified live load.

D. Frame: 1/4-inch channel with anchor flange around perimeter.

E. Hardware:
   1. Hinges: Each leaf equipped with a minimum of 2 heavy forged-brass hinges with stainless steel pins.
   2. Lock: Snap lock with removable handle mounted on door leaf.
   3. Grip handle: Provide vinyl grip handle designed to release cover for closing.
   4. Operating mechanism: Spring operators designed for ease of operation and automatic hold-open arm with release handle.
   5. Drainage assembly: Provide 1-1/2-inch drainage coupling located in corner of the channel frame.

2.02 HEAVY-DUTY IN-STREET ACCESS DOORS AND MANHOLE COVERS

A. As specified in Section 05500 - Metal Fabrications.

2.03 FALL PROTECTION GRATING SYSTEM

A. Furnish and install on vault access doors, where indicated on the Drawings, fall protection grating system:
   1. Door manufacturer shall install the grating system when the door is fabricated or field installed (by others) on existing doors already in use.
   2. If field installation is necessary grating system shall be installed per the manufacturer’s instructions.

B. Performance characteristics:
   1. Grating panel(s) shall be high visibility safety yellow in color.
   2. Grating panel(s) shall lock automatically in the full open position.
   3. Grating system shall have a 25 year warranty.
   4. Grating panel(s) shall have a provision for locking to prevent unauthorized opening.

C. Grating: Panels shall be aluminum with a powder coat paint finish and designed to meet OSHA 29 CFR 1910 requirements for fall protection.

D. Hold open feature: A Type 316 stainless steel hold open device shall be provided to lock the cover in the fully open 90 degree position.

E. Hardware: All hardware shall be Type 316 stainless steel**.**

2.04 FINISHES

A. Floor access door finishes:
   1. Aluminum: Manufacturer's standard mill finish.
   2. Aluminum in contact with dissimilar metals and concrete: Manufacturer's standard bituminous coating.
   3. Steel: Manufacturer's standard red oxide primer.

B. Hardware finishes:
   1. Provide optional Type 316 stainless steel hardware throughout, including parts of the latch and lifting mechanism assemblies, hold-open arms, and all brackets, hinges, pins, and fasteners.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine construction to receive floor access door and verify correctness of dimensions and other supporting or adjoining conditions.

3.02 PREPARATION

A. Coordinate details with other work supporting, adjoining, or requiring floor access doors.

B. Verify dimensions and profiles for each opening.

C. Verify that location will serve portion of work to which access is required:
   1. Where proposed functional location conflicts with other work, notify the Engineer before installation.

D. Apply coating to aluminum surfaces that will be in contact with dissimilar metals or concrete when there is none.

3.03 INSTALLATION

A. Install floor access doors in accordance with manufacturer's instructions.

B. Ensure correct types and adequate sizes at proper locations.

C. Securely attach frames to supporting work and ensure doors, frames, and hardware operate smoothly and are free from warp, twist, and distortion.

3.04 ADJUSTING

A. Adjust doors, frames, and hardware to operate smoothly, freely, and properly without binding.

3.05 CLEANING

A. Thoroughly clean surfaces of grease, oil, or other impurities; touch up abraded prime coat where applicable.

END OF SECTION

SECTION 08412

ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Aluminum entrance and storefront framing systems, including entrance door hardware and accessories.

1.02 REFERENCES

A. Aluminum Association (AA):
   1. 45 - Designation System for Aluminum Finishes.

B. American Society of Civil Engineers (ASCE):
   1. SEI 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures.

C. Architectural Aluminum Manufacturers Association (AAMA):
   1. 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.

D. ASTM International (ASTM):
   1. A36 - Standard Specification for Carbon Structural Steel.
   2. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   3. B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
   4. B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   5. E283 - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.
   6. E330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Uniform Static Air Pressure Difference.
   7. E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference.

E. International Code Council (ICC):
   1. A117.1 - Standard and Commentary: Accessible and Usable Buildings and Facilities.

1.03 SUBMITTALS

A. Product data: Include cleaning instructions and maintenance data.

B. Shop drawings: Include the following:
   1. Shop drawings must be prepared by a qualified engineering service under the employ of the window wall manufacturer and/or the installer.
      a. Detail fabrication and assembly of systems.
      b. Included design calculation
   2. Entrance door types, construction including hardware reinforcement, installation details, and locations referenced to Engineer's door mark and hardware group.
   3. Storefront framing systems, glass and glazing, and details including components and attachments or junction with adjacent work.

C. Samples: Sufficient number of sections to show extremes of color range for each color selected.

D. Certificates of compliance: Include the following:
   1. Manufacturer's certificate, or certified test report from and accepted testing agency stating that entrance doors and storefront framing system meet or exceed performance requirements.
   2. Manufacturer's certificate stating that anodic finishes comply with requirements.

E. Quality assurance:
   1. Installer qualifications: Manufacture’s authorized representative who is trained and approved for installation of units required for this project.
   2. Engineering responsibility: Prepare data for aluminum-framed systems, including Shop Drawings, based on testing and engineering analysis of manufacturer’s standard units in systems similar to those indicated for this Project.
   3. Product options:
      a. Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assembles.
      b. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
      c. Performance characteristics are indicated by criteria subject to verification by 1 or more methods including preconstruction testing, field testing, and in-service performance:
         1) Do not change intended aesthetic effects, as judged solely by Architect/Engineer, except with Architect/Engineer’s approval. If changes are proposed, submit comprehensive explanatory data to Architect/Engineer for review.
   4. Source Limitations for Aluminum-Framed Systems; Obtain from single source from single manufacturer.

F. Manufacturer's Installation Instructions.

G. Pre-installation meetings:
   1. Conduct pre-installation meeting at project site minimum 30 days before beginning Work of this Section.
      a. Required participants:
         1) Contracting Officer’s Representative.
         2) Architect/Engineer.

3) Contractor.
4) Installer.
5) Manufacturer's field representative.
6) Other installers responsible for adjacent and interesting work.

1.04 WARRANTY

A. As specified in General Conditions.

B. Special warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period:
   1. Warranty duration: 2 Years.

C. Special finish warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finished do not comply with requirements or that fail in material or workmanship within specified warranty period. Warranty does not include normal weathering:
   1. Warranty duration: 10 years.

DELIVERY, STORAGE, AND HANDLING

D. Deliver entrances and storefront units and components marked with type and location of installation.

E. Protect aluminum from damage with protective sleeves, polyethylene sheets, removable coatings, or other suitable means:
   1. Protect prefinished aluminum surfaces with strippable coating.

F. Deliver products when proper facilities are available.

G. Ship and store products in manner that prevents damage such as warping, bending, stains, discolorations, scratches, abrasions, or soiling.

H. Remove protective devices only when required to perform work or in absence of damage-producing conditions prior to final acceptance.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated design: Prepare submittal documents including design calculations and drawings signed and sealed by registered design professional, licensed in state where work is located:
   1. Minor deviations to details indicated on the Drawings to accommodate manufacturer's standard products may be accepted by Contracting Officer's Representative when deviations do not affect design concept and specified performance.

B. Structural loads:
   1. Wind loads: As indicated on the Drawings.
   2. Other design loads: As indicated on the Drawings.

C. Air infiltration of single acting offset pivot or butt hung entrance doors: As follows per linear foot of perimeter crack of 3-by-7-foot doors when tested in accordance with ASTM E283:
   1. Single: Maximum 0.50 cubic feet per minute.
   2. Pair: Maximum 1.00 cubic feet per minute.

D. Air infiltration of storefront: Maximum 0.06 cubic feet per minute at 6.24 pounds per square foot when tested in accordance with ASTM E283.

E. Water infiltration of storefront: No water penetration when tested in accordance with ASTM E331 at 8 pounds per square foot.

F. Deflection of storefront: Maximum 1/175 of span when subjected to wind loading specified in Section 01614 - Wind Design Criteria and tested in accordance with ASTM E330.

G. Safety factor: Minimum 1.65 of allowable stress when tested in accordance with ASTM E330.

H. Seismic requirements:
   1. Aluminum-Framed entrances and storefronts shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.
   2. As specified in Section - Seismic Design Criteria.

I. Average thermal conductance: Provide storefront systems with average U-values of not more than 0.63 Btu/sq. ft. x h x deg F when tested in accordance with AAMA 1503.

J. Condensation Resistance Factor (CRF): When tested to AAMA Specification 1503, the condensation resistance shall not be less than 45.

2.02 STOREFRONT

A. Manufacturers: One of the following or equal:
   1. Arcadia Inc. AG451T.
   2. Kawneer Co., Trifab VG 451.
   3. OldCastle Building Envelope, equivalent product.

B. Aluminum framing material:
   1. Sheet metal; ASTM B209, minimum 1.6mm (0.063 inch) thick.
   2. Extrusions: Extruded 6063- T6 allow and temper in accordance with ASTM B221:
      a. Framing: Minimum 0.125 inch wall thickness.
      b. Glazing beads, moldings, and trim: minimum 1.25mm (0.050 inch) thick
   3. Extruded bars, rods, profiles, and tubes: ASTM B221.
   4. Extruded structural pipe and tubes.

C. Extruded 6063-T6 allow and temper in accordance with ASTM B221 alloy G.S. 10A-T6, minimum 0.125 inches thick.

D. Dimensions: 2-inch face by 4-1/2 inch overall depth.

E. Glazing/Insulated Panels provisions: Center glazed in minimum 1-inch deep by 1-5/16 wide pockets, able to conceal insulating glass spacers, for flush glazing without projecting stops, capable of being inside or outside glazed.

F. Glazing/Insulated Panels gaskets: EPDM elastomeric extrusions, manufacturer's standard sizes and shapes.

G. Glass: Insulating, as specified in Section 08800 - Glazing.

H. Adapters and mountings for trim moldings and face materials: Capable of installation without interfering with normal assembly and weathering of storefront.

I. Steel reinforcing: ASTM A36.

J. Flashings: Minimum 0.63-inch thick aluminum sheet.

K. Closures: Minimum 0.125-inch thick aluminum sheet.

L. Fasteners:
   1. Exposed fasteners: Aluminum, stainless steel or plated steel in accordance with ASTM B633.
   2. Perimeter anchors: Aluminum or steel.

M. Anchorage and alignment brackets: Capable of concealed support of storefront from building structure.

N. Coating to isolate dissimilar metals: Bituminous paint, minimum 2 coats having minimum total thickness of 5 mils.

O. Coating to isolate aluminum from concrete, wood or other absorptive material: Zinc chromate metal primer, minimum 2 coats having minimum thickness of 3 mils.

P. Sealants: As specified in Section 07900 - Joint Sealants.

2.03 FABRICATION

A. Extrude sections true to details with clean, straight, sharply defined profiles, smooth surfaces of uniform texture, and free from defects impairing strength and durability.

B. Accurately mill and fit sections to provide flush hairline joints.

C. Execute cutting, fitting, forming, drilling, and grinding of metalwork prior to cleaning, finishing, treatment, and application of coatings.

D. Maintain continuity of line and accurate relations of planes and angles.

E. Securely attach and support mechanical joints with hairline fit of contacting members.

F. Install stiffeners to reinforce framing when necessary to meet performance requirements.

G. Separate dissimilar metals with bituminous paint or preformed separators which will prevent corrosion.

H. Separate metal surfaces at moving joints with nonmetallic separators to prevent freeze-up of joints.

I. Fabricate frame assemblies for exterior walls with flashing and weeps to drain penetrating moisture to exterior.

J. Allow for thermal expansion of exterior units.

K. Accurately make cutouts, recesses, mortising or milling, and reinforce doors for hardware.

L. Weld door joints along concealed lines of contact to prevent pitting, halo, and other imperfections after finishing:
   1. Thoroughly penetrate material with welds to produce complete fusion of metal between stiles and rails.
   2. Door corner construction to have manufacturer’s limited lifetime warranty.

M. Mechanically join door sections with interlocking aluminum channel clips and flat head stainless steel screws.

N. Both mechanically clip fasten and weld door corners by manufacturer's standard methods.

O. Drill, tap, cut out, and reinforce frames and doors for mortise hardware and surface mounted hardware in accordance with templates supplied by hardware manufacturers.

P. Make total thickness of reinforcement equal to nominal diameter of hardware fasteners.

2.04 FINISHING

A. Exposed aluminum surfaces: Anodized in accordance with AA 45 Architectural Class 1, Anodic Coating AAM12C22A42/44; without gripper marks on exposed surfaces; with uniform color from exposed faces onto exposed edges, dark bronze color.

B. Concealed aluminum surfaces: Same as exposed aluminum surfaces or anodized in accordance with AA 45 Architectural Class 2, Anodic Coating AAM12C22A31, clear.

C. Exposed fasteners: Match adjacent material in color and appearance or 300 series stainless steel heat-tempered to match color of anodized surface.

D. Concealed steel fasteners:
   1. In contact with aluminum: Stainless steel, 300 Series.
   2. Not in contact with aluminum: Structural or mild steel hot-dip galvanized after fabrication and touched-up when welded.

E. Steel: Mill scale and rust cleaned or ground off, grease and dirt cleaned off, chemically etched and 1 prime coat applied.

2.05 MARKING UNITS AND COMPONENTS

A. Mark entrances and storefront units and components with type and location of installation:
   1. Mark without damaging surfaces.
   2. Use designations indicated on the Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify wall openings and adjoining work are ready to receive work of this Section.

B. Examine receiving frames and reviewed hardware schedules to verify coordination with doors.

3.02 INSTALLATION OF STOREFRONT

A. Install aluminum entrance and storefront systems in accordance with manufacturer's instructions and Engineer accepted shop drawings.

B. Separate or isolate dissimilar metals and materials with coatings prior to installation.

C. Set plumb, square, level, and in alignment with other work.

D. Use anchorage devices to securely attach framing assembly to structure.

E. Align assemblies plumb and level, free of warp or twist.
   1. Maintain assemblies' dimensional tolerances, aligning with adjacent work.

F. Install watertight flashings.
   1. Set sill members in double bead of sealant.

G. Lead collected moisture or water to outside as directly as possible.

H. Seal joints between framing and building structure as specified in Section 07900 - Joint Sealants.

3.03 ADJUSTING

A. After completion of glazing and finish painting, adjust doors and door hardware as required for smooth operation and correct function.

B. Lubricate hardware and moving parts.

3.04 CLEANING

A. Remove protective material from prefinished aluminum surfaces just before inspection for final acceptance.

B. Clean in accordance with recommendations of AA and manufacturer's cleaning instructions using only materials approved by aluminum manufacturer:
   1. Where doubt exists, make spot tests.

C. Remove soil or other sources of discoloration.

END OF SECTION

SECTION 08710

DOOR HARDWARE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Door hardware.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
   2. E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

B. Builders Hardware Manufacturers Association (BHMA):
   1. A156.7 - Template Hinge Dimensions.
   2. A156.18 - Materials and Finishes.

C. Underwriters Laboratories, Inc.

1.03 SUBMITTALS

A. Product data.

B. Hardware schedule: Include references to Engineer's hardware group number, door type designations, locations, other pertinent data, and manufacturer names or suitable abbreviation opposite items scheduled.

C. Samples: Include for each different type and manufacturer for review of finish.

D. Construction key distribution list: Submit upon Owner's request.

E. Templates:
   1. Furnish hardware templates to fabricators of doors, frames, and other work to be factory-prepared for hardware.
   2. Check shop drawings of other work to confirm that adequate hardware backing is available.

F. Project record documents: Include corrected hardware schedule.

1.04 REGULATORY REQUIREMENTS

A. Provide hardware for fire-resistive rated openings that complies with UL and listed by UL.

B. Provide State Fire Marshall approved fire-rated cross-corridor assemblies and panic devices.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver hardware where directed in unopened packages with items packed separately, complete and ready for installation with necessary fittings, trim, fasteners, and accessories.

B. Provide packages bearing the manufacturers' labels with each item or group of items identified according to the accepted hardware schedule.

1.06 MAINTENANCE

A. Require lockset manufacturers to deliver permanent removable cylinder cores keys and minimum 2 extractor keys to Owner directly.

1.07 SCHEDULING AND SEQUENCING

A. Upon receipt of accepted hardware schedule, coordinate accepted hardware schedule, templates, reinforcing units, and template instructions to door and frame sections.

B. Restrict distribution of construction keys to superintendents and foremen. Maintain record of persons who have received keys on construction distribution list.

PART 2 PRODUCTS

2.01 FASTENERS

A. Types:
   1. To concrete, marble, or masonry: Machine screws and flush shells.
   2. To wood: Wood screws.
   3. On gypsum board or plaster: Screws of sufficient length to provide solid connection to framing or backing behind gypsum board or plaster.
   4. To mineral and hollow core doors: Hex bolts.
   5. Of exit devices to doors: Thru-bolts, unless otherwise specified.

B. Screws, exposed: Phillips-head type, full-threaded screws, not combination type.

C. Sizes: Suitable for heavy use.

D. Finish: Stainless steel, unless otherwise required to match material and hardware finish.

2.02 HINGES

A. Manufacturers: One of the following or equal:
   1. Stanley.
   2. Hager.
   3. McKinney.
   4. Ives.

B. Material:
   1. Interior fire resistive rated doors: Steel.
   2. Interior doors in corrosive environments: Stainless steel.
   3. Interior office doors: Brass.
   4. Interior doors in operation areas: Brass.
   5. Exterior doors: Stainless steel.

C. Knuckles, number of: Minimum 5.

D. Ball bearings: Concealed with interior self-lubricating bushings.

E. Type for doors with closers: Ball bearing.

F. Material for fire-resistive rated doors: Steel.

G. Pins for interior doors: Non-rising.

H. Pins for exterior doors: Non-removable.

I. Template hinges: BHMA A156.7.

J. Tips: Flat button.

K. Height: As follows, unless otherwise specified:
   1. Doors 1-3/8-inch thick: 3-1/2 inches.
   2. Doors 1-3/4-inch thick and up to 41 inches wide: 4-1/2 inches.
   3. Doors 1-3/4-inch thick and from 41 to 48 inches wide: 4-1/2 inches, extra heavy.
   4. Doors 2 inches thick or over 48 inches wide: 5 inches, extra heavy.

L. Widths: Sufficient to clear trim projection when door swings 180 degrees, unless otherwise specified.

M. Number per door leaf: As follows, unless otherwise specified:
   1. 3 hinges on door to 7 feet, 6 inches in height.
   2. 1 additional hinge for each additional 2 feet, 6 inches of height or fraction thereof.

2.03 LOCKSETS

A. Manufacturers typical: One of the following or equal:
   1. Schlage ND Series Rhodes design with removable core cylinders.
   2. Sargent, Division of Essex Industries, Inc., Model 10-Line with removable core cylinders, and Model L levers and roses.

B. Manufacturers for corrosive environments: Suitable for marine use or other severe climate conditions, having only stainless steel or bronze parts. One of the following or equal:
   1. Schlage L Series with removable core cylinders, and 06A lever and rose.
   2. Sargent, Division of Essex Industries, Inc., Model 8200 with removable core cylinders, and Model L levers, and Model LN roses.

C. Cylinders:
   1. Number of pins: Minimum 6.
   2. Cases: Steel, cylindrical.
   3. Interior parts: Non-corrosive with non-plastic, non-die-cast, non-aluminum mechanisms.
   4. Accessibility to key-in-knob type cylinders: Not requiring removal of lockset from door.
   5. Plugs: Extruded brass bar material fully round without flattened areas.
   6. Cores: Removable.

D. Strikes:
   1. Material: Same as lock trim.
   2. Lock and latch boxes: Wrought.
   3. Lips: Extended, able to protect trim from marring by latch bolt.
   4. Cutouts at metal frames: In accordance with ANSI, unless otherwise specified.

E. Levers: Type that returns to within 1/2 inch of door.

F. Backset: 2-3/4 inches.

G. Trim materials: As follows, unless otherwise specified:
   1. Typical: Stainless steel.
   2. Corrosive environments: Stainless steel.

2.04 CONSTRUCTION KEYING

A. Type: Removable core system.

2.05 CLOSERS

A. Manufacturers:
   1. Features:
      a. Heavy-duty.
      b. Non-handed and non-sized.
      c. Adjustable spring power from size 1 through 4.
      d. Hold open feature where specified.
   2. One of the following or equal:
      a. Sargent, 351 Series.
      b. LCN, Super Smoothee Model 4041 Series.
      c. Norton Door Controls, Multi-Size Door Closers Model 7500BF Series.

B. Type: Full rack and pinion type with steel spring and non-gumming, non-freezing hydraulic fluid.

C. Controls: Separate set for regulating sweep speed, latch speed, backcheck and backcheck positioning, or where schedules, spring power.

D. Sizes: As recommended by accepted manufacturer.

E. Covers: Plastic, capable of being spray painted to match adjacent hardware finishes, unless otherwise specified.

F. Narrow frame provisions: Drop plates.

G. Effort to operate: As follows:
   1. Exterior: Maximum 8-1/2 pounds.
   2. Interior: Maximum 5 pounds.
   3. Fire-resistive rated doors: Maximum 15 pounds.

H. Adjust closers in accordance with manufacturer's directions for size of door.

2.06 MISCELLANEOUS DOOR HARDWARE

A. Wall stops: As scheduled:
   1. Manufacturers: One of the following or equal:
      a. Ives.
      b. Trimco.
      c. Rockwood.

B. Floor stops: As scheduled with strike of suitable height to compensate for clearance between door and floor:
   1. Manufacturers: One of the following or equal:
      a. Ives.
      b. Trimco.
      c. Rockwood.

C. Gasketing systems: As scheduled, self-adhesive silicone seal, continuous at head and jambs, rated for fire and smoke in accordance with ASTM E283, sound rated in accordance with ASTM E90:
   1. Manufacturers: One of the following or equal:
      a. Pemko Mfg. Co.
      b. National Guard Products Inc.
      c. Reese.

D. Weatherstripping for exterior doors and smoke, light, and sound seals for interior doors.

E. Thresholds: As scheduled, extruded aluminum, maximum 1/2-inch high, maximum slope of 1 foot in 2 feet:
   1. Manufacturers: One of the following or equal:
      a. National Guard Products Inc.
      b. Pemko Mfg. Co.

F. Dustproof strike: As scheduled:
   1. Manufacturers: One of the following or equal:
      a. Ives.
      b. Trimco.

G. Door bottoms: As scheduled, extruded aluminum with vinyl insert, surface mounted, length equal to door width minus 2 inches, automatic, recessed in bottom of door:
   1. Manufacturers: One of the following or equal:
      a. Pemko.
      b. Reese.

H. Silencers: As scheduled, pneumatic gray rubber:
   1. Manufacturers: One of the following or equal:
      a. Trimco.
      b. Ives.
      c. Rockwood.

2.07 FINISHES

A. Brass and bronze: BHMA A156.18 626 (US26D), satin chrome.

B. Steel: BHMA A156.18 652 (US26D), satin chrome.

C. Stainless steel: BHMA A156.18 630 (US32D), satin stainless steel.

D. Aluminum: BHMA A156.18 628 (US28).

E. Plastic closer covers: Spray paint to match typical door hardware finish.

F. Metal closer covers: Plate covers to match typical door hardware finish.

G. Electromagnetic hold open devices: Manufacturer's standard brushed zinc finish.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect doors and door frames for damage or defects and examine hardware for compatibility with receiving conditions and suitable to intended use.

B. Verify that required wall backing has been installed.

3.02 INSTALLATION

A. Install finish hardware in accordance with manufacturer's templates and instructions.

B. Accurately and properly fit hardware.

C. Securely fasten fixed parts for smooth, trouble-free, non-binding operation.

D. Fit faces of mortise parts snug and flush.

E. Ensure that operating parts move freely and smoothly without binding, sticking, or excessive clearance.

F. Protection:
   1. Protect door hardware from damage or marring of finish during construction, use strippable coatings, removable tapes, or other acceptable means.
   2. Ensure door hardware displays no evidence of finish paint after final building cleanup with exception of prime-coated door hardware installed for finish painting.

G. Latch guard and dead bolts: Install so that bolts automatically engage in keeper, whether activated by closer or by manual pressure.

H. Closers:
   1. Mount on opposite sides of corridors or vestibules, except at exterior doors.
   2. Mount for 180-degree swing wherever possible.
   3. Mount with drop plates at narrow top rail doors.
   4. Adjust to operate noiselessly and evenly.
   5. Have closer manufacturer regulate closers prior to final acceptance of project.

I. Kick plates: Screw on push side of doors, unless otherwise indicated on the Drawings.

J. Gasketing: Mount to provide complete contact between door and frame, finished floor, or both; and weathertight enclosure.

K. Thresholds:
   1. Install immediately before inspection for Substantial Completion or protect from heavy traffic damage during construction.
   2. Cope to fit door frame profile and drill to suit required flush bolts and panic bolts.
   3. Unless indicated on the Drawings to be set in grout, set in double bead of sealant, tightly fit at jambs, and make waterproof.
   4. Fasten to concrete slab with 5/16-inch stainless steel flat head countersunk machine screws and concrete anchors at 8-inch centers.

L. Silencers: Insert into predrilled holes in frames.

3.03 CONSTRUCTION KEYING

A. Insert construction cores in cylinders of exterior doors, and doors requiring security and access for workman, unless otherwise directed by the Engineer.

3.04 ADJUSTING

A. Examine hardware in place for complete and proper installation. Lubricate bearing surfaces for proper function.

B. Replace, rework or otherwise correct defective door hardware, including incorrect hand or function.

3.05 CLEANING

A. Remove protective materials and devices and thoroughly clean exposed surfaces of hardware.

B. Check for surface damage prior to final cleaning for acceptance of project.

3.06 HARDWARE SCHEDULE

A. While the Hardware Schedule is intended to cover all doors and other moveable parts of the building and establish a type and standard of quality, it shall be the specific duty and responsibility of the finish hardware supplier to examine the Drawings and Specifications and furnish proper hardware for all openings.

3.07 HARDWARE GROUPS

A. HW-1: D22-01: Per specification section 08412 Aluminum-Framed Entrances and Storefronts.

B. HW-1: D22-02:

3 EA	Hinge	BB1191 4 1/2 X 4 1/2	US26D	HA
1 EA	Lockset	ND40S	626	SC
1 EA	Closer	7500 SN-134	689	NO
1 SET	Weatherstripping	303AS		PE
1 EA	Door Bottom	216AV		PE
1 EA	Threshold	170 A		PE
1 EA	Raindrip	346 C		PE

C. HW-1: D07-01:

3 EA	Hinge	BB1191 4 1/2 X 4 1/2	US26D	HA
1 EA	Lockset	ND40S	626	SC
1 EA	Closer	7500 SN-134	689	NO
1 SET	Silencers	1229A	GREY	TR

END OF SECTION

SECTION 08800

GLAZING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Glass and glazing.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. Z97.1 - Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test.

B. ASTM International (ASTM):
   1. C1036 - Standard Specification for Flat Glass.
   2. C1048 - Standard Specification for Heat-Treated Flat Glass - Kind HS, Kind FT Coated and Uncoated Glass.
   3. E773 - Standard Test Method for Accelerated Weathering of Sealed Insulating Glass Units.

C. Glass Association of North America (GANA):
   1. GANA Glazing Manual.

D. Insulating Glass Certification Council (IGCC):
   1. Certified Products Directory.

E. U.S. Consumer Product Safety Commission (CPSC):
   1. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials.

1.03 DEFINITIONS

A. Full height windows: Windows meeting the following conditions:
   1. Lowest edge is less than 18 inches above floor.
   2. Area is greater than 9 square feet.
   3. Walking surface is on both sides either of which is within 36 inches of window.
   4. Window has no minimum 1-1/2-inch railing or mullion at from 24 to 36 inches above floor.

1.04 SUBMITTALS

A. Product data.

B. Shop drawings: Locations of glass types and typical glazing details.

C. Samples: As follows:
   1. Glazing sealants, 2-inch long beads, for color selection.
   2. Glass, 1 square foot of each type specified.

D. Certificates of compliance: Certification that tempered glass in accordance with ANSI Z97.1 and CPSC 16 CFR 1201.

E. Manufacturer's Installation Instructions.

1.05 REGULATORY REQUIREMENTS

A. As specified in Section 01410 - Regulatory Requirements.

B. Wind loading: As specified in Section 01614 - Wind Design Criteria.

C. Provide glass and glazing that conforms to CPSC 16 CFR, Part 1201, and exit requirements of the building code.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle materials in manner to prevent damage.

B. Deliver and store packaged materials in original containers bearing manufacturer's name.

C. Deliver glass affixed with manufacturer's labels showing strength, grade, thickness, type and quality of glass, and for insulating glass, IGCC certification label.

D. Remove labels after installation, inspection, and final acceptance.

1.07 PROJECT CONDITIONS

A. Perform glazing when ambient air temperature is 40 degrees Fahrenheit or above.

PART 2 PRODUCTS

2.01 GLASS

A. Tinted: ASTM C1036, Type I, Class 2, Quality q3; tinted light bronze; minimum 1/4-inch thick:
   1. Manufacturers: One of the following or equal:
      a. PPG Industries, Inc., Solarbronze.
      b. Guardian Industries Corp., Sunguard, bronze.

B. Tempered: ASTM C1048, Kind FT, Condition A, Type I, Class 1 or Class 2 as scheduled below, Quality q3; tempered without visible tong marks when installed; minimum 1/4-inch thick:
   1. Manufacturers: One of the following or equal:
      a. PPG Industries, Inc., Herculite.
      b. Guardian Industries Corp., equivalent product.

C. Insulating glass units: IGCC Rating Level CBA when tested in accordance with ASTM E773 and E774; hermetically sealed units consisting of minimum 1/4-inch thick, tinted exterior light, minimum 1/4-inch thick, clear interior light, and 1/2-inch wide air space, dehydrated with blended molecular sieve and silica gel desiccant,

with metal spacer channel with bent corners and welded splice on 1 vertical side, and polyisobutylene primary and silicone secondary seals:

1. Manufacturers: One of The following or equal:
    a. PPG Industries, Inc., Twindow.
    b. Guardian Industries Corp., equivalent product.

2.02 GLAZING MATERIALS

A. Setting blocks: Neoprene, 80 to 90 durometer.

B. Spacer blocks: 30 to 40 durometer, thickness equal or greater than insulated window thickness by minimum 6 inches long.

C. Pressure tape: Butyl rubber tape:
    1. Manufacturers: One of the following or equal:
        a. Tremco Mfg. Co., Tremco 440 Tape.
        b. 3-M Co., Weatherban 5422.

D. Sealant: Silicone:
    1. Manufacturers: One of the following or equal:
        a. General Electric Co., Silicone Construction Sealant Series SCS-1200.
        b. Dow Corning Corp., 999-A, Silicone Building and Glazing Sealant.

E. Glazing gaskets and other materials for exterior openings:
    1. As specified in Section 08412 - Aluminum-Framed Entrances and Storefronts.

2.03 SOURCE QUALITY CONTROL

A. Allowable bow and warp tolerances: As measured with glass resting on edge upon two 1 inch wide supports:
    1. Typical: Maximum 1/8 inch in 48 inches.
    2. Tempered glass: Maximum allowed in accordance with ASTM C1048.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine openings to receive glass for defects that would affect glass and glazing work.

B. Verify removal of rivets, screws, bolts, welding fillets, or other projections from clearances in glazing rabbets.

3.02 PREPARATION

A. Examine frames receiving glass and ensure surfaces are clean and dry.

B. Remove dust and oil from glass by wiping clean immediately before installation.

C. Verify that sealants are compatible with glazing materials.

3.03 INSTALLATION OF INSULATED GLASS UNITS

A. In accordance with GANA Glazing Manual, manufacturer's instructions, and accepted shop drawings by the Engineer.

B. Use wet and dry glazing method.

C. Cut glazing tape to length and set against permanent stops to project 1/16 inch above sight line.

D. Place setting blocks at quarter points and no closer than 6 inches from corners.

E. Rest glazing on setting blocks and push against tape for full contact at perimeter of unit.

F. Place glazing gasket.

G. Install removable stop with concealed leg notched to accommodate setting blocks.

H. Align top of gasket with stops.

3.04 INSTALLATION OF GASKETS

A. Gaskets: Install in accordance with manufacturer's instructions.

B. Glazing of interior metal frames: Use pressure or foamed tape and sealant as indicated as required to eliminate rattle and reduce sound transmission.

3.05 SEALANT APPLICATION

A. As specified in Section 07900 - Joint Sealants, unless specifically noted otherwise.

B. Ensure protective coatings have been removed from aluminum surfaces.

C. Where setting blocks and spacer shims are required to be set in sealant, butter with sealant, place into position, and allow to set prior to installation of glass.

D. Neatly tool sealant or compound joints to compress material and improve adhesion. Repair or replace pockets exposed by tooling.

3.06 CLEANING

A. After inspection by Engineer, remove labels and marks from glass in accordance with manufacturer's published recommendations.

B. Clean glass and surrounding surfaces from spatter and blemishes resulting from glazing operations.

C. Clean and polish glass inside and outside.

D. Clean glass with a soft, clean, grit-free cloth and mild soap, detergent, or slightly acidic cleaning solution:
   1. Immediately rinse with clean water and remove excess rinse water with a clean squeegee.
   2. Do not use an abrasive cleaner.

E. Remove grease and miscellaneous glazing materials with commercial solvent. Follow with normal wash and rinse.
   1. Be careful not to damage joint sealers.

3.07 GLASS AND LOCATION SCHEDULE

A. Exterior locations: Glass as follows, unless otherwise scheduled or indicated on the Drawings:
   1. Typical: Insulating, tempered, and tinted.

END OF SECTION

SECTION 09960

HIGH-PERFORMANCE COATINGS

TABLE OF CONTENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Coatings, including coating systems, surface preparation, application requirements, and quality control requirements.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D16 - Standard Terminology for Paint, Related Coatings, Materials, and Applications.
   2. D2200 - Standard Practice for Use of Pictorial Surface Preparation Standards and Guides for Painting Steel Surfaces.
   3. D3359 - Standard Test Methods for Rating Adhesion by Tape Test.
   4. D3960 - Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings.
   5. D4262 - Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
   6. D4263 - Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
   7. D4285 - Standard Test Method for Indicating Oil or Water in Compressed Air.
   8. D4414 - Standard Practice for Measurement of Wet Film Thickness by Notch Gages.
   9. D4417 - Standard Test Methods for Field Measurement of Surface Profile of Blast-Cleaned Steel.
   10. D4541 - Standard Test Methods for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
   11. D4787 - Standard Practice for Continuity Verification of Liquid or Sheet Linings Applied to Concrete Substrates.
   12. D5162 - Standard Practice for Discontinuity (Holiday) Testing of Nonconductive Protective Coating on Metallic Substrates.
   13. D7234 - Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers.
   14. E337 - Standard Test Method for Measuring Humidity with a Psychrometer (the Measurement of Wet- and Dry-Bulb Temperatures).
   15. F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
   16. F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using In-situ Probes.

B. International Concrete Repair Institute (ICRI):
   1. 310.2 - Guideline for Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.

C. NACE International (NACE):
   1. SP0178 - Design, Fabrication, and Surface Finish Practices for Tanks and Vessels to Be Lined for Immersion Service.
   2. SP0188 - Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.

D. National Association of Pipe Fabricators (NAPF):
   1. 500-03 - Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings.

E. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

F. Occupational Safety and Health Administration (OSHA).

G. Society of Protective Coatings (SSPC):
   1. Glossary - SSPC Protective Coatings Glossary.
   2. Guide 6 - Guide for Containing Surface Preparation Debris Generated during Paint Removal Operations.
   3. Guide 15 - Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates.
   4. PA 1 - Shop, Field, and Maintenance Painting of Steel.
   5. PA 2 - Procedure for Determining Conformance to Dry Coating Thickness Requirements.
   6. PA 9 - Measurement of Dry Coating Thickness Using Ultrasonic Gages.
   7. QP 1 - Standard Procedure for Evaluating the Qualifications of Industrial/Marine Painting Contractors.
   8. SP 1 - Solvent Cleaning.
   9. SP 3 - Power Tool Cleaning.
   10. SP 5 - White Metal Blast Cleaning.
   11. SP 10 - Near-White Metal Blast Cleaning.
   12. SP 11 – Power Tools Cleaning to Bare Metal.
   13. SP 13 - Surface Preparation of Concrete.
   14. SP 16 - Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.
   15. SP COM - Surface Preparation Commentary.
   16. SP VIS 1 - Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning.
   17. SP WJ-1 - Waterjet Cleaning of Metals - Clean to Bare Substrate.
   18. SP WJ-2 - Waterjet Cleaning of Metals - Very Thorough Cleaning.
   19. SP WJ-3 - Waterjet Cleaning of Metals - Thorough Cleaning.
   20. SP WJ-4 - Waterjet Cleaning of Metals - Light Cleaning.

1.03 DEFINITIONS

A. Definitions used in this Section are in accordance with definitions referenced in ASTM D16, ASTM D3960, and SSPC Glossary of Definitions.

B. Specific definitions:
   1. Abrasive: Material used for blast cleaning, such as sand, grit, or shot.
   2. Abrasive Blast Cleaning: Cleaning/surface preparation by abrasive propelled at high speed.

3. Anchor Pattern: Profile or texture of prepared surface(s).
4. Biogenic Sulfide Corrosion: Corrosion caused by sulfuric acid formed when *Thiobacillus* bacteria metabolizes hydrogen sulfide.
5. Bug Holes: Small cavities resulting when air bubbles are entrapped in the surface of formed concrete during placement and consolidation.
6. System: Protective film with 1 or more coats applied in a predetermined order, including surface preparation and quality control requirements.
7. Coating/Paint/Lining Thickness: Total thickness of primer, intermediate, and/or finish coats after drying or curing.
8. Dew point: Temperature a given air/water vapor mixture starts to condense.
9. Drying Time: Time interval between application and material curing.
10. Dry to Recoat: Time interval between material application and its ability to receive the next coat.
11. Dry to Touch: Time interval between material application and its ability to tolerate a light ouch without coating damage.
12. Exposed Surface: Any indoor or outdoor surface not buried or encased.
13. Feather Edging: Reducing coating thickness at its edge to blend with existing surrounding coating.
14. Feathering: Tapering off a wet edge with a comparatively dry brush.
15. Ferrous: Cast iron, ductile iron, wrought iron, and all steel alloys except stainless steel.
16. Field Coat: Application of a surface coating system at the work site.
17. Finish Coat: Final coat in a paint system, including texture, color, smoothness of surface, and other properties affecting appearance.
18. Hold Point: A defined point, specified in this Section, at which work shall be halted for inspection.
19. Holiday: A discontinuity, skip, void, or pinhole in coating or coating system film that exposes the substrate.
20. Honeycomb: Segregated and porous surface of hardened concrete due to insufficient consolidation.
21. Hydroblast: High or ultra-high pressure water jet surface preparation.
22. Incompatibility: One coating's inability to overlay another coating or surface as evidenced by bleeding, poor bonding, or lifting of old coating; inability of a coating to bond to a substrate.
23. Immersed/Immersion: A service condition in which substrate is submerged, is immediately above liquids, or is subject to frequent wetting, splashing, or washdown.
24. Laitance: A thin, weak, brittle layer of cement and aggregate fines on a concrete surface.
25. Mil: 0.001 inch.
26. Overspray: Dry spray, particularly paint bonded to an unintended surface.
27. Pinhole: A small diameter discontinuity in a coating or coating system film, created by offgassing from a void in a concrete or masonry substrate causing a void between coats or exposing the substrate. Usually caused by coating application while temperature is rising.
28. Pot Life: Time interval after components are mixed and coating can be satisfactorily applied.
29. Prime Coat: First full paint coat applied to a surface when using a multicoat system. Primers adhere to a new substrate, protect the substrate, and promote adhesion of subsequent coats of paint. The prime coat on metal surfaces is the first full coat and does not include solvent wash, grease emulsifiers, or other pretreatment applications.

30. Resurfacer/Resurfacing Material: A layer of cementitious and/or resin-based material used to fill or otherwise restore surface continuity to worn or damaged concrete surfaces.
31. Shelf Life: Maximum storage time a material may be stored without losing its usefulness.
32. Shop Coat: 1 or more coats applied in an off-site shop or plant before shipment to work site where field or finishing coat(s) are applied.
33. Spreading Rate: Area covered by a unit volume of paint at a specific thickness.
34. Stripe Coat: A separate brush coat of paint applied to all weld seams, pits, nuts/bolts/washers, and edges. This coat shall not be applied until previous coats have cured. Once applied, the coat shall be allowed to cure before subsequent coats are applied.
35. Tie Coat: An intermediate coat that bonds different types of paint material, improving succeeding coat adhesion.
36. Thick Film Coating System: A coating system applied with a minimum dry film thickness of 25 mils.
37. Touch-Up Painting: Application of paint on previously painted surfaces to repair marks, scratches, and deteriorated or damaged areas to restore the appearance and performance of the coating.
38. Water Blast: An alternative to air abrasive blast cleaning that can be used with or without abrasive injection. Water cleaning at pressures up to 5,000 pounds per square inch is called low-pressure water cleaning or power washing. High-pressure water cleaning uses water pressures between 5,000 and 10,000 pounds per square inch. Water jetting is water blasting with added abrasive at pressures between 10,000 and 25,000 pounds per square inch. Ultra-high-pressure water jetting is water blasting at pressures above 25,000 pounds per square inch.
39. Weld Splatter: Beads of non-structural weld metal that adhere to the surrounding surface, removed as part of surface preparation.

1.04 ABBREVIATIONS

A. CSM - Coating System Manufacturer.

B. CMU - Concrete Masonry Units.

C. CSA - Coating System Applicator. Specialty subcontractor retained by the Contractor to install the coating systems specified in this Section.

D. CTR - Coating System Manufacturer's Technical Representative.

E. DFT - Dry-Film Thickness**.** Thickness of cured film, usually expressed in mils (0.001 inch).

F. SSD - Surface Saturated Dry. Refers to concrete surface condition where the surface is saturated (damp) without the presence of standing water.

G. TPC - Technical Practice Committee.

H. VOC - Volatile Organic Compound. Portion of the coating that is a compound of carbon, is photochemically reactive, and evaporates during drying or curing;

expressed in grams per liter (g/l) or pounds per gallon (lb/gal). VOC is determined by EPA Method 24.

I. WFT - Wet Film Thickness. Coating thickness as measured immediately after application. Usually expressed in mils (0.001 inch).

1.05 PERFORMANCE REQUIREMENTS

A. Coating materials shall be formulated for environments encountered in water and wastewater treatment processes.

B. Coating materials that come in contact with water distributed as potable water shall be certified in accordance with NSF 61.

1.06 SUBMITTALS

A. As specified in Section 01330 - Submittal Procedures, submit the following:
   1. Schedule of proposed coating materials.
   2. Schedule of surfaces to be coated with each coating material.
   3. Dehumidification and heating plan.
   4. Product data:
      a. Physical properties of coatings, including the following:
         1) Solids content.
         2) Ingredient analysis.
         3) VOC content.
         4) Temperature resistance.
         5) Typical exposures and limitations.
         6) Manufacturer's standard color chips.
      b. Compliance with regulatory requirements:
         1) VOC limitations.
         2) Lead compounds and polychlorinated biphenyls.
         3) Abrasives and abrasive blast cleaning techniques and disposal.
         4) Methods for tenting blasting areas and methods to protect existing equipment from dust and debris.
         5) NSF certification of coatings for potable water supply systems.
      c. CSM's current printed recommendations and product data sheets for coating systems, including:
         1) Surface preparation recommendations.
         2) Primer type.
         3) Maximum dry and wet-mil thickness per coat and number of coats:
            a) Coating Coverage Worksheets.
         4) Minimum and maximum curing time between coats, including atmospheric conditions for each.
         5) Curing time before submergence in liquid.
         6) Thinner to be used for each coating.
         7) Ventilation requirements.
         8) Minimum and maximum atmospheric conditions during which the paint shall be applied.
         9) Allowable application methods.
         10) Maximum allowable substrate moisture content.
         11) Maximum shelf life.
         12) Requirements for transportation and storage.

13) Mixing instructions.
14) Shelf life.
15) Material Pot life.
16) Precautions for applications free of defects.
17) Method of application.
18) Drying time of each coat, including prime coat.
19) Compatible prime coats.
20) Limits of ambient conditions during and after application.
21) Required protection from sun, wind, and other conditions.
22) Touch-up requirements and limitations.
23) Minimum adhesion of each system submitted in accordance with ASTM D4541 and ASTM D7234.

d. Samples: Include 8-inch square drawdowns or brushouts of topcoat finish when requested. Identify each sample as to finish, formula, color name and number, sheen name, and gloss units.
e. Affidavits signed by an officer of the CSM's corporation attesting to full compliance of each coating system component with current federal, state, and local air pollution control regulations and requirements.
f. List of cleaning and thinner solutions allowed by the CSMs.
g. Storage requirements, including temperature, humidity, and ventilation for Coating System Materials as recommended by the CSMs.
h. Thick film coating systems (greater than 25 mils):
1) CSM's detailed written instructions for coating system treatment and graphic details for coating system terminations in coated structures, including pipe penetrations, metal embedments, gate frames, and other terminations encountered.
2) Include detail treatment for coating system at concrete joints.
3) Manufacturer's Representative's (CTR) Field Reports.

5. Quality assurance submittals:
a. Quality assurance plan.
b. Qualifications of CSA, including:
1) List of Similar Projects:
a) Name and address of project.
b) Year of installation.
c) Year placed in operation.
d) Point of contact: Name and phone number.
2) Provide a minimum of 5 project references, each including contact name, address, and telephone number where similar coating work has been performed by their company in the past 5 years.
c. CSA Reports:
1) Written daily quality control inspection reports.
d. CTR Reports:
1) Reports on visits to project site to view and approve surface preparation of structures to be coated.
2) Reports on visits to project site to observe and approve coating application procedures.
3) Reports on visits to coating plants to observe and approve surface preparation and coating application on shop-coated items.

1.07 QUALITY ASSURANCE

A. CSA qualifications:
   1. Minimum of 5 years of experience applying specified type or types of coatings under conditions similar to those of the Work:
      a. Provide qualifications of applicator and references listing 5 similar projects completed in the past 5 years.
   2. SSPC QP 1 certified.
   3. Manufacturer-approved applicator when manufacturer has approved applicator program or when required in these specifications.

B. CTR qualifications:
   1. Certification, one of the following:
      a. NACE Level 2 or 3 Certified Coating Inspector.
      b. SSPC Level 3 Protective Coatings Inspector.
   2. Minimum of 5 years of experience evaluating application of manufacturer's coatings under conditions similar to those of the Work:
      a. Provide CTR qualifications and references listing 5 similar projects completed in the past 5 years.

C. Regulatory requirements: Comply with governing agencies' regulations by using coatings conforming to their VOC limits:
   1. Lead-based coatings are not permitted.
   2. Do not use coal-tar epoxy in contact with drinking water or exposed to ultraviolet radiation.

D. Pre-installation conference: Conduct as specified in Section 01312 - Project Meetings:
   1. Coordinate Hold Point schedule.

E. Obtain approval before coating other surfaces. Use products by same manufacturer for prime coats, intermediate coats, and finish coats on same surface, unless specified otherwise.

F. CSM services:
   1. CSA shall arrange for CTR to attend pre-installation conferences.
   2. Visit the project site periodically to consult on and inspect specified surface preparation and application Hold Points.
   3. Visit coating plants to observe and approve surface preparation procedures and coating application of items to be shop primed and coated.
   4. CTR shall provide written inspection reports.

G. Quality control requirements:
   1. Contractor shall be responsible for the workmanship and quality of the coating system installation:
      a. Inspections by Owner, Engineer, CSA, or CTR will not relieve or limit Contractor’s responsibilities.
   2. Conform to this specification's requirements and the standards referenced in this Section. Changes in the coating system application requirements will be allowed only with the Engineer's written acceptance.

3. Specially trained crews with experience applying the specified coating system coating are required for:
    a. Coating application using plural component spray equipment or other specialty equipment.
    b. Coating with specialty linings for severe service conditions, including floor coatings, and with linings for corrosive headspaces or secondary containment areas.
4. CTR shall specially train personnel for coating systems as specified in Appendix B Coating Detail Sheets.
    a. CSM shall approve personnel in writing applying the coating system.
5. Do not use contaminated, outdated, diluted materials, and/or materials from previously opened containers.
6. Identify inspection access points used by Owners or Engineers.
7. Provide ventilation, ingress, egress, or other means as necessary for Owner's or Engineer’s personnel to safely access the work areas.
8. Conduct and continually inspect work so the coating system is installed as specified. The CSM shall provide written directions to correct coating work not conforming to the specifications or is otherwise unacceptable.
9. Provide written daily reports summarizing test data, work progress, surfaces covered, ambient conditions, quality control inspection test findings, and other information pertinent to the coating system application:
    a. Determine relative humidity in accordance with ASTM E337. Confirm other conditions, such as proper protective measures for surfaces not to be coated and safety requirements for personnel:
        1) Measure daily at shift's beginning and end and at intervals not to exceed 4 hours during the shift.
        2) Determine the acceptability of weather and/or environmental conditions within the structure in accordance with the CSM's requirements.
    b. Monitoring surface preparation: Spot check cleanliness, surface profile, and surface pH testing at least 3 times daily. Check each surface at least once. In accordance with:
        1) ASTM D4262.
        2) ASTM D4263.
        3) ASTM D4417.
        4) ICRI 310.2 requirements.
        5) SSPC Surface Preparation Standards.
    c. Confirm that compressed air used for surface preparation or blow-down cleaning is free of oil and moisture.
    d. Monitor surface preparation daily at shift's beginning and end and at intervals not to exceed 4 hours during the shift.
    e. Do not apply coatings when environmental conditions are outside of the CSM's published limits.
    f. Monitoring coatings application: Continuously inspect, measure, and record the wet film thickness and general film quality (visual inspection) for runs, sags, pinholes, holidays, etc. during coating:
        1) Perform WFT measurements in accordance with ASTM D4414.
    g. Post cure evaluation: Measure and inspect the overall dry film thickness on all surfaces. Conduct a DFT survey and perform adhesion testing, holiday detection, or cure testing as required in this Section and/or the CSM’s written instructions. Perform all applicable tests in accordance with ASTM D4541, ASTM D4787, ASTM D5162, ASTM D7234, SSPC-PA 1,

SSPC-PA 2, SSPC-PA 9, and other pertinent standards and recommended practices.

H. Inspection at Hold Points:
   1. Conduct inspections at Hold Points during the coating system application and record the results.
   2. Coordinate Hold Points with the Engineer so the Engineer can observe Contractor’s inspections on a scheduled basis.
   3. Provide the Engineer a minimum of 24 hours of notice before conducting Hold Point Inspections.
   4. Hold Points shall be as follows:
      a. Conditions before surface preparation: Before starting surface preparation, observe, record, and confirm that oil, grease, and/or soluble salts are gone from the surface.
      b. Post surface preparation: After completing surface preparation, measure and inspect for cleanliness and proper surface profile as specified in this Section and in the CSM’s written instructions.
      c. Coatings application: At the beginning of any coating system application, measure, record, and confirm acceptability of surface and ambient air temperature and humidity. Inspect applicator's equipment for serviceability and suitability for coatings application.
      d. Post application inspection: Identify defects in application work on all surfaces, including pinholes, holidays, excessive runs or sags, inadequate or excessive film thickness, and other problems.
      e. Follow-up corrective actions and final inspection: Measure and re-inspect corrective coating work performed to repair defects at prior Hold Points, and repeat until the surface condition is acceptable. Conduct final visual inspection with follow-up tests, such as holiday detection, adhesion tests, and DFT surveys.

1.08 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products as specified in Section 01600 - Product Requirements.

B. Immediately remove unspecified and unapproved coatings from Project site.

C. Deliver new labeled, unopened containers:
   1. Do not deliver materials after manufacturer's expiration date or over 12 months from manufacturing date, whichever is more stringent. Store materials in well-ventilated enclosed structures and protect from weather and excessive heat or cold in accordance with the CSM’s recommendations:
      a. Store flammable materials in accordance with federal, state, and local requirements.
      b. Store rags and cleanup materials appropriately to prevent fire and spontaneous combustion.
   2. Store and dispose of hazardous waste in accordance with federal, state, and local requirements. This requirement specifically applies to waste solvents and coatings.
   3. Container labels shall show the following:
      a. Brand name or product title.
      b. CSM's batch number.

c. CSM's manufacture date.
d. CSM's name.
e. Generic material type.
f. Application and mixing instructions.
g. Hazardous material identification label.
h. Shelf life expiration date.
i. Color.
j. Mixing and reducing instructions.

4. Clearly mark containers to indicate safety hazards associated with the use of or exposure to materials.

1.09 PROJECT CONDITIONS

A. Apply coatings to dry surfaces.
1. Surface moisture: Comply with manufacturer's requirements or as specified in this Section:
a. Plaster and gypsum wallboard: 12 percent.
b. Masonry and concrete block: 12 percent.
c. Interior located wood: 15 percent.
d. Concrete floors: Moisture vapor transmission rate of no more than 3.0 pounds per 1,000 square feet per 24 hours in accordance with ASTM F1869 or relative humidity no greater than 80 percent if tested in accordance with ASTM F2170 unless the CSM's recommendations are more restrictive.
e. Concrete structures: Negative results from Plastic Sheet Test in accordance with ASTM D4263, and maximum of 80 percent relative humidity in accordance with ASTM F2170.

B. Do not apply coatings when the following conditions exist. If such conditions exist, provide containment, covers, environmental controls, and other necessary measures:
1. During rainy, misty, or damp weather, or to surfaces with frost or condensation.
2. When the surface temperature is below 10 degrees Fahrenheit above the dew point.
3. When ambient or surface temperature:
a. Is less than 55 degrees Fahrenheit unless manufacturer allows a lower temperature.
b. Is less than 65 degrees Fahrenheit for clear finishes, unless manufacturer allows a lower temperature.
c. Exceeds 90 degrees Fahrenheit, unless manufacturer allows a higher temperature.
d. Exceeds manufacturer's recommendation.
4. When relative humidity is higher than 85 percent.
5. Under dusty or adverse environmental conditions.
6. When light on surfaces measures less than 15 foot-candles.
7. When wind speed exceeds 15 miles per hour.

C. Apply coating only under evaporation conditions rather than condensation:
1. Use dehumidification equipment, fans, and/or heaters inside enclosed areas to maintain required atmospheric and surface temperature requirements for proper coating application and cure.

2. Measure and record relative humidity and air and surface temperatures at the start and end of each shift to confirm proper humidity and temperature levels inside the work area:
    a. Submit test results.

D. Continuously ventilate, dehumidify, and heat enclosed spaces with high humidity during surface preparation, coating application, and curing.
    1. Maintain minimum air temperature of 55 degrees Fahrenheit and 10 degrees Fahrenheit above the dew point.
    2. Maintain dew point of at least 10 degrees Fahrenheit less than the temperature of the coldest part of the structure where work is performed.
    3. Reduce dew point temperature in conditioned space by at least 10 degrees Fahrenheit within 20 minutes.
    4. Seal work areas and maintain positive pressure per dehumidification equipment supplier's recommendations.
    5. Maintain these conditions before, during, and after application to ensure proper adhesion and cure of coatings for no less than:
        a. Entire curing period.
        b. 8 hours after coating.

E. Systems:
    1. Site electrical power availability as specified in Section 01500 - Temporary Facilities and Controls.
    2. Internal combustion engine generators may be used.
        a. Obtain required permits and provide air pollution and noise control devices on equipment as required by permitting agencies require.
        b. Comply with state, federal, and local fire and explosion protection measures when locating and operating generator.
        c. Locate engine generator outside hazardous classified areas per NFPA 820.
        d. Provide daily fuel service for generator for duration of use.
    3. Dehumidification:
        a. Provide desiccant or refrigeration drying.
        b. Use only desiccant types with a rotary desiccant wheel capable of continuous operation.
        c. Liquid, granular, or loose lithium chloride drying systems are not acceptable.
    4. Heating:
        a. Use electric, indirect combustion, or steam coil.
        b. Direct-fired combustion heaters are not acceptable heat sources during abrasive blasting, coating application, or coating cure.
    5. Filters:
        a. Use a filtration system for dust removal designed to not interfere with dehumidification equipment’s ability to control dew point and relative humidity inside the reservoir.
        b. Do not allow air from the working area or dust filtration equipment to recirculate through thein dehumidifier during coating application or when solvent vapors are present.

6. Design and submittals:
    a. Prepare and submit dehumidification and heating plan, including all equipment and operating procedures.
    b. Suppliers of services and equipment shall have at least 3 years of experience in similar applications.

F. Provide containment and ventilation system components in accordance with SSPC-Guide 6, Level 3 and as required for hazardous materials.

1.10 MAINTENANCE

A. Provide table of products applied organized by surface type. List coating manufacturer, color, color formulation, distributor name, telephone number, and address.

1.11 CTR RESPONSIBILITIES

A. General:
    1. Attend pre-installation conference.
    2. Perform onsite application training.
    3. Periodically inspect coating system application.

B. Coating system installation training:
    1. Provide a minimum of 8 hours of classroom and off-site training for application personnel and supervisory personnel in one of the following ways:
        a. Train a minimum of 2 supervisory personnel and 2 application personnel.
        b. Submit a letter from the CSM stating that CSM approves the supervisory and application personnel, listed by name and responsibility, and no additional training is required.
    2. CTR can train up to 14 application personnel and 3 supervisory personnel at a time.
    3. Minimum training requirements:
        a. Explain in detail the mixing, application, curing, and termination requirements.
        b. Provide hands-on demonstration of coating system mixing.
        c. Explain in detail the ambient condition requirements for temperature and humidity.
        d. Explain in detail the surface preparation requirements.
        e. Explain in detail the re-coat times, cure times, and related ambient condition requirements.
        f. Write a letter stating that training was satisfactorily completed by the personnel, listed by name and responsibility.
    4. Provide special training as specified in the Coating Detail Sheets.

C. Coating system inspection:
    1. CTR inspection is in addition to the CSA's inspection as specified in this Section.
    2. Be on-site to oversee:
        a. Coating application at least once a week.
        b. End of surface preparation.
        c. During coating application.
        d. Post-cure inspection.

3. Routinely inspect and verify in writing that application personnel have successfully performed surface preparation, filler/surfacer application, coating system application, and Quality Control Inspection in accordance with this Section and to warrantable quality.
4. Perform the following activities to confirm conformance with the specifications:
    a. Inspect ambient conditions during coating system installation at Hold Points for conformance with the specified requirements.
    b. Inspect each coated surface type and coating system applied to verify the following:
        1) Cleanliness.
        2) Surface pH for concrete substrates.
        3) Confirm surface preparation of substrates where coating system will terminate or will be applied for conformance to the specified application criteria.
    c. Verify surface profile of substrates by completing the following:
        1) Inspect preparation and application of coating detail treatment at terminations, transitions, metal embedments in concrete, and joints and cracks in substrates.
        2) Inspect application of filler/surfacer materials for concrete and masonry substrates.
        3) Verify proper mixing of coating materials.
        4) Inspect application of primers and finish coats, including wet and dry film thickness.
        5) Inspect coating systems for proper cure times and conditions.
    d. Review adhesion testing of cured coating systems.
    e. Review coating system continuity testing.
    f. Inspect and record representative-localized repairs.
    g. Conduct final review of completed coating system installation.
    h. Prepare and submit site visit reports after each site visit to document that the coating work is in accordance with the CSM’s Recommendations.

D. Final report:
1. Prepare a final report, after coating work ends, summarizing each day's test data, observations, drawings, and photographs. Include substrate conditions, ambient conditions, and application procedures observed during the CTR's site visits. Include a statement that completed work was performed in accordance with the requirements of the CSM’s recommendations.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
1. Product requirements as specified in Section 01600 - Product Requirements.

2.02 COATING SYSTEMS IDENTIFICATION

A. Naming Conventions: Coating Systems Identifications contain the elements defined in Table 1.

Table 1 Coating System Identification Elements						
First Element	**-**	**Second Element**	**-**	**Third Element**	**-**	**Fourth Element (optional)**
3 or 4 alpha characters		1-3 alpha characters		1 number		3 or 4 alpha characters
Coating Type		Substrate		System Number		Additional Substrate or Special Condition
Example: EPX	-	C	-	6	-	BSC

1) First element identifies the coating type using the following abbreviations:
   a) ACR: acrylic.
   b) CTE: coal tar epoxy.
   c) ELA: elastomeric acrylic.
   d) EPU: epoxy-polyurethane.
   e) EPX: epoxy.
   f) POL: polyurethane.
   g) SIL: silicone.
   h) SILX: siloxane or silane.
   i) VE: vinyl ester.
2) Second element identifies the substrate using the following abbreviations:
   a) C: concrete or masonry.
   b) F: concrete flooring.
   c) FRP: fiber-reinforced plastic.
   d) GM: galvanized metal.
   e) M: metal.
   f) PVC: polyvinyl chloride, chlorinated polyvinyl chloride.
3) Third element identifies the sequential system number.
   a) For example, EPX-C-2 is the second standard epoxy coating system for concrete substrates.
4) Fourth element is optional and identifies the additional substrate or special condition with the following abbreviations:
   a) PWS: Potable water service applications (NSF-61 approved).
   b) BSC: Biogenic sulfide corrosion-resistant applications in wastewater.
   c) BG: Below grade or buried.
   d) OZ: Organic zinc primer, epoxy polyurethane system.
   e) SC: Secondary containment.

2.03 PRODUCTS FOR COATING SYSTEMS

A. Products: As specified in Appendix B Coating Detail Sheets.

B. Cleaning solvents:
   1. Requirements for solvent wash, solvent wipe, or cleaner used, including, but not limited to, those used for surface preparation in accordance with SSPC-SP 1:
      a. Emulsifying type.
      b. Containing no phosphates.

c. Biodegradable.
d. Does not damage zinc.
e. Compatible with the specified primer.
f. Complying with applicable air-quality control board requirements.

2. Use clean white cloths and clean fluids in solvent cleaning.

PART 3 EXECUTION

3.01 GENERAL PROTECTION REQUIREMENTS

A. Protect adjacent coated surfaces from coatings and damage associated with coating work. Repair damage resulting from inadequate or unsuitable protection.

B. Use drop cloths and other coverings to protect adjacent surfaces not to be coated against spatter and droppings.

C. Mask off surfaces of items not to be coated or remove items from area.

D. Furnish and deploy sufficient drop cloths, shields, and protective equipment to prevent spray or droppings from fouling surfaces not being coated and, in particular, surfaces within storage and preparation areas.

E. Place coating waste, cloths, and material that may pose a fire hazard in closed metal containers and remove daily from site.

F. Remove electrical plates, surface hardware, fittings, and fasteners before coating application. Carefully store, clean, and replace items after completing coating in each area. Do not use solvent or degreasers to clean hardware that may remove permanent lacquer finishes.

G. Erect and maintain protective enclosures in accordance with SSPC-Guide 6.

H. Protect the following surfaces from abrasive blasting by masking or by other means:
1. Threaded portions of valve and gate stems, grease fittings, and identification plates.
2. Machined surfaces for sliding contact.
3. Surfaces to be assembled against gaskets.
4. Surfaces of shafting where sprockets will be fit.
5. Surfaces of shafting where bearings will be fit.
6. Machined bronze surfaces, including slide gates.
7. Cadmium-plated items, except cadmium-plated, zinc-plated, or sherardized fasteners used to assemble equipment requiring abrasive blasting.
8. Galvanized items, unless scheduled to be coated.

I. Protect installed equipment, mechanical drives, and adjacent coated equipment from abrasive blasting to prevent damage caused by spent abrasive blast media, dust, or dirt entering such equipment.

J. Schedule cleaning and coating to keep dust and spray from the cleaning process from falling on wet, newly coated surfaces.
1. Whenever possible, coordinate with other trades and complete surface preparation and coating work before installing hardware, hardware

accessories, nameplates, data tags, electrical fixtures, and similar uncoated items that will be in contact with coated surfaces. Mask machined surfaces, sprinkler heads, and other small items that will not be coated.
2. After completing coating, reinstall removed items.
3. Disconnect and move equipment adjacent to walls to clean and coat equipment and walls. Replace and reconnect equipment after coating.

3.02 GENERAL SURFACE PREPARATION REQUIREMENTS

A. Prepare surfaces in accordance with CSM's instructions unless more stringent requirements are specified in this Section.

B. Coating detail sheets in Appendix B include additional surface preparation requirements.

C. Follow more stringent requirement if information conflicts.

D. Where required by the Owner's representative, a NACE International certified coatings inspector, provided by the Owner, will inspect and approve surfaces to be coated before applying a coating:
1. CSA shall coordinate coating inspections:
   a. Identify coating inspection Hold Points during the pre-installation conference.
   b. Provide at least 2 days notice before inspection.
2. Contractor shall correct surface defects identified by the inspector at no additional cost to Owner.

3.03 MECHANICAL AND ELECTRICAL EQUIPMENT PREPARATION

A. Identify equipment, ducting, piping, and conduit as specified in Section 15075 - Equipment Identification, Section 15076 - Pipe Identification, and Section 16075 - Identification for Electrical Systems.

B. Remove grilles, covers, and access panels for mechanical and electrical system and coat separately.

C. Prepare and finish coat equipment primed by the manufacturer using specified intermediate and top coats, as applicable, and color selected by the Owner.

D. Prepare, prime, and coat both insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars, and supports, except where items are covered with material not requiring coating, or with a prefinished coating.

E. Replace identification markings on mechanical or electrical equipment when coated over or spattered.

F. Prepare and coat interior surfaces of air ducts and convector and baseboard heating cabinets visible through grilles and louvers with 1 coat of flat black paint to limit of sight line.

G. Prepare and coat dampers exposed immediately behind louvers, grilles, and convector and baseboard heating cabinets to match face panels.

H. Prepare and coat exposed conduit and appurtenances occurring in finished areas with color and texture to match adjacent surfaces.

I. Prepare and coat sides' front, back, and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them.

J. Color code equipment, piping, conduit, and exposed ductwork and apply color banding and identification, such as flow arrows, naming, and numbering, in accordance with the Contract Documents.

3.04 CLEANING OF NEW AND PREVIOUSLY COATED OR NEW SURFACES

A. Utilize cleaning agent to remove soluble salts, such as chlorides, from concrete and metal surfaces:
   1. Cleaning agent: Biodegradable non-flammable and containing no VOC.
   2. Manufacturers: The following or equal:
      a. CHLOR*RID International, Inc.:
         1) Complete soluble salt removal with steam or warm water cleaning.
   3. Test cleaned surfaces to ensure removal of soluble salts. Carry out additional cleaning as needed.
   4. Complete final surface preparation before applying new coating system in strict accordance with CSM's printed instructions.

3.05 BLAST CLEANING

A. Surface preparation requirements:
   1. Do not reuse spent blast abrasive.
   2. Ensure that filter compressed air used for blast cleaning is free of condensed water and oil. Clean moisture traps at least once every 4 hours or more frequently, as required, to prevent moisture from entering the abrasive blasting equipment air supply. Check blast air for moisture and oil after each cleaning in accordance with ASTM D4285.
   3. Install oil separators just downstream of compressor discharge valves and at the discharge point of blast pot discharges. Check separators on the same frequency as the moisture traps.
   4. Keep regulators, gauges, filters, and separators on compressor air lines to blasting nozzles operational at all times.
   5. Install an air dryer or desiccant filter drying unit to dry the compressed air before blast pot connections. Use and maintain the dryer throughout surface preparation work.
   6. Use a venturi-type, or other high velocity-type, abrasive blast nozzles supplied with at least 100 pounds per square inch gauge air pressure at the nozzle and enough volume to obtain appropriate blast cleaning production rates and surface cleanliness.
   7. Provide airborne particulate evacuation and filtering that meets OSHA safety standards. Maintain optimal visibility both to clean and provide the specified surface profile and to allow inspection of the substrate during surface preparation work.
   8. If prepared and cleaned metallic substrates become contaminated between final surface preparation work and coating system application, or if the prepared substrate darkens or changes color, re-clean by water blasting, or

abrasive blast cleaning as appropriate until the specified degree of cleanliness is restored.

B. Water jetting or water blasting:
   1. Use water jetting or water blasting for recoating or relining where an adequate surface profile exists.
   2. Perform water jetting or water blasting in accordance with SP 13 and SSPC-WJ-1, WJ-2, WJ-3, WJ-4.

3.06 PREPARATION REQUIREMENTS FOR CONCRETE SURFACES

A. Cure for at least 28 days before coating.

B. Remove degraded concrete using abrasive blast cleaning or high or ultrahigh pressure water jetting, chipping, or other abrading tools until achieving a sound, clean substrate. Remove all bruised or cracked concrete.

C. Prepare substrate cracks and areas requiring resurfacing; perform detail treatment, including, but not limited to, terminating edges per the CSM's recommendations and as indicated on the Drawings:
   1. Prepare concrete surfaces in accordance with SSPC-SP 13.

D. Prepare concrete surfaces in accordance with SSPC-SP 13:
   1. Inspect concrete surfaces to select appropriate surface preparation method to provide a suitable substrate for the specified coating system.
   2. Use blast cleaning or other means to expose the complete perimeter of air voids or bug holes. Do not leave shelled over, hidden air voids beneath the exposed concrete surface.
   3. Repair concrete defects and physical damage.
   4. Clean concrete surfaces of dust, mortar, formwork, fins, loose concrete particles, form release materials, oil, and grease.
   5. Fill voids to provide surface as specified in Section 03366 - Tooled Concrete Finishing.

E. Provide clean substrate visually free of calcium sulfate, loose, coarse, or fine aggregate, laitance, loose hydrated cement paste, and otherwise harmful substances:
   1. Confirm concrete surface minimum pH of 9.0 with surface pH testing.
   2. If after surface preparation the surface pH remains below 9.0, perform additional water blasting, cleaning, or abrasive blast cleaning until additional pH testing indicates an acceptable pH level.

F. Prepare concrete surface for coating in accordance with SSPC-SP 13:
   1. Provide ICRI 310.2 minimum No. 3 concrete surface profile (CSP) or as specified on Coating Detail Sheets.
   2. Evaluate profile of the prepared concrete using ICRI 310.2 surface profile replicas.

G. Blast clean cementitious repair mortars or grouts to the same profile and degree of cleanliness requirements required for concrete substrates.

H. Blast clean polymer-based surfacers or waterborne modified cementitious surfaces only if they have exceeded the CSM's recommended recoat time.

I. Vacuum all concrete surfaces before coating application, leaving a dust free, sound concrete substrate:
   1. Thoroughly clean concrete surfaces to be coated to remove loose dirt and spent abrasive.
   2. Remove debris produced by blast cleaning from the structures to be coated, and legally dispose of it off-site.

J. Test moisture content of concrete to be coated:
   1. Conduct ASTM D4263 plastic sheet test at least once for every 500 square feet of surface area to be coated:
      a. Any moisture on plastic sheet after test period constitutes a non-acceptable test, and the concrete must be dried further.
   2. Conduct ASTM F1869 test at least once for every 1,000 square feet of concrete floor surface area to be coated.
   3. Conduct ASTM F2170 one relative humidity moisture test at least once for each 500 square feet of non-floor concrete surface area where the opposite side is exposed to soil or water:
      a. Waterproof surfaces exposed to soil or water where specified in Section 07110 - Dampproofing.
   4. Comply with specified minimum moisture content and CSM's written recommendations for moisture vapor transmission rates or relative humidity values.

K. Masonry surfaces:
   1. Cure for at least 28 days before coating.
   2. Prepare masonry surfaces to remove chalk, laitance, loose dirt, dried mortar splatter, dust, peeling, or loose existing coatings, or otherwise deleterious substances to leave a clean, sound substrate.
   3. Wash and scrub masonry surfaces with clear water. Do not use muriatic acid.
   4. Seal or fill masonry surfaces with a sealer or block filler compatible with the specified primer after cleaning.
   5. Confirm that masonry surfaces are dry before coating application:
      a. If using pressure washing or low-pressure water blast cleaning for preparation, allow the masonry to dry for at least 5 days under dry weather conditions or until the minimum ambient temperature is 70 degrees Fahrenheit before coating.

3.07 GENERAL PREPARATION REQUIREMENTS FOR METALLIC SURFACES

A. Remove rust, scale, and welding slag and spatter:
   1. Remove and grind smooth all excessive weld material and weld spatter on metal surfaces before blast cleaning in accordance with NACE SP0178, Appendix C, Level C.
   2. Grind sharp edges on metal substrate to approximately 1/16-inch radius before abrasive blast cleaning.

B. Prepare metallic surfaces in accordance with applicable portions of surface preparation specifications of the SSPC specified for each coating system:
   1. Remove grease and oil in accordance with SSPC-SP 1.
   2. Use solvent as recommended by the CSM.

3. Measure profile depth of the surface to be coated in accordance with Method C of ASTM D4417. Contractor shall select blast particle size and gradation to produce the specified surface profile.
4. Constantly monitor and maintain ambient environmental conditions to ensure cleanliness and that no “rust back” occurs before coating material application.

C. Prepare metallic surfaces by blast cleaning in accordance with SSPC-VIS 1 (ASTM D2200). Prepare abrasive blast representative areas for the Owner's representative to inspect on the first day of cleaning.

D. Unless otherwise specified, the requirements for blast cleaning steel, ductile iron, and stainless steel substrates are as follows:
1. Ferrous metal surfaces not to be submerged: Abrasive blast in accordance with SSPC-SP 10 unless blasting may damage adjacent surfaces, is prohibited, or is specified otherwise. Where abrasive blasting is not possible, clean surfaces to bare metal with power tools in accordance with SSPC-SP 11.
2. Ferrous metal surfaces to be submerged: Abrasive blast in accordance with SSPC-SP 5, unless specified otherwise, to clean and provide roughened surface profile with a depth between 2 and 4 mils.
3. Remove traces of grit, dust, dirt, rust scale, friable material, loose corrosion products, or embedded abrasive from substrate before coating application.
4. When abrasive blasted surfaces rust or discolor before coating, abrasive blast clean surfaces again.

E. Field preparation of shop-primed surfaces:
1. Smooth welds and prominences with power tools before applying field-applied coatings.
2. Clean and dry shop-primed ferrous metal surfaces and fabricated assemblies before applying field coats.
3. Prepare shop epoxy primed surfaces with light abrasive blasting or abrading and then vacuum before applying finish coats:
    a. Follow CSM instructions for surface preparation when the primer recoat limit has been exceeded.
4. Non-immersion service: Clean in accordance with SSPC-SP 2 (Hand Tool Cleaning) or SSPC-SP 3 (Power Tool Cleaning) and uniformly roughen.
5. Immersion, BSC, and SC service: Remove shop primer in accordance with SSPC-SP 5 (Near-White Blast Cleaning).

F. Damaged shop primer or rust bleeding:
1. Ferrous metals: Clean in accordance with SSPC-SP 1 (Solvent Cleaning) and spot blast in accordance with SSPC-SP 10 (Near-White Metal Blast Cleaning) to achieve a uniform surface profile between 2.0 and 2.5 mils before recoating.
2. Reject galvanized steel with rust bleeding.

G. Damaged coating: Repair by abrasive blast cleaning surfaces as specified for the coating system; feather to a smooth transition before touching up.

3.08 PREPARATION REQUIREMENTS BY SURFACE TYPE

A. Galvanized steel and non-ferrous metal surfaces:
   1. Degrease or solvent clean (SSPC-SP 1) to remove oily residue.
   2. Abrasive blast clean in accordance with SSPC-SP 16:
      a. If abrasive blast cannot be performed, abrade in accordance with SSPC-SP 3 (Power Tool Cleaning).
   3. Apply metal pretreatment within 24 hours before coating galvanized surfaces that cannot be thoroughly abraded, such as bolts, nuts, or preformed channels.
   4. Test surface for contaminants using copper sulfate solution.

B. Stainless-steel surfaces:
   1. Abrasive blast clean in accordance with SSPC-SP 16 to leave a clean, uniform appearance with surface profile between 1.5 and 2.5 mils.

C. Ductile iron pipe and fittings to be lined or coated: Abrasive blast clean in accordance with NAPF 500-03.

D. Sherardized, aluminum, copper, and bronze surfaces:
   1. Abrasive blast clean in accordance with SSPC-SP 16.
   2. Prepare in accordance with CSM's instructions.

E. Cadmium-plated, zinc-plated, or sherardized fasteners:
   1. Abrasive blast in the same manner as uncoated metal when assembling equipment designated for abrasive blasting.

F. PVC and FRP surfaces:
   1. Lightly sand surfaces to be coated:
      a. Sand to remove gloss and establish uniform surface profile.
   2. Vacuum to remove loose dust, dirt, and other materials.
   3. Solvent clean with clean white rags and allow solvent to evaporate completely before applying coating materials.

3.09 APPLICATION REQUIREMENTS

A. Apply coatings in accordance with manufacturer's instructions.

B. Empty aboveground piping to be coated of contents when applying coatings.

C. Mechanical equipment shop primed by the manufacturer:
   1. Pumps and valves: Shop coat with manufacturer's highest quality coating system meeting the project specifications:
      a. Contractor shall provide CTR shop coating reports.
   2. Non-immersed equipment: Touch up shop primer, and coat in the field with specified coating system after installation:
      a. If project requires equipment removal and reinstallation, complete touch-up coating after final installation.
   3. Immersed equipment not shop coated: Remove shop primer before surface preparation and field apply coating.

D. Verify surface preparation immediately before applying coating in accordance with SSPC SP COM and the SSPC visual standard for the specified surface preparation method.

E. Allow surfaces to dry, except where coating manufacturer requires surface wetting before coating.

F. Wash coat and prime sherardized, aluminum, copper, and bronze surfaces, or prime with manufacturer's recommended special primer.

G. Do not apply coatings to a surface until it has been prepared as specified.

H. Use equipment designed to apply materials specified:
   1. Use compressors with moisture traps and filters that remove water and oils from the air:
      a. Perform a paper blotter test at the Engineer's request to verify air is sufficiently free of oil and moisture. Do not allow the amount of oil and moisture to exceed CSM-recommended amount.
   2. Equip spray equipment with properly sized mechanical agitators, pressure gauges, pressure regulators, and spray nozzles.

I. Where 2 or more coats are required, tint prime coat intermediate coats as necessary to distinguish each coating and to help indicate coverage:
   1. Do not use color additives with chromium, lead or lead compounds that hydrogen sulfide, other corrosive gases, might destroy or alter. Apply the specified number of coats.

J. Apply coating by brush, roller, trowel, or spray unless a specific application method is required by coating manufacturer's instructions or these Specifications:
   1. Apply primer or first coat by brush to power tool cleaned ferrous surfaces.
   2. Brush or spray-apply coats for blast-cleaned ferrous surfaces and subsequent coats for non-blast cleaned ferrous surfaces.
   3. After prime coat dries, mark, repair, and retest pinholes and holidays before intermediate or top coats are applied.

K. Spray application:
   1. With a brush, stripe coat edges, welds, corners, nuts, bolts, and difficult-to-reach areas, as necessary, before spray application to ensure specified coating thickness along edges.
   2. When using spray application, apply each coat to thickness no greater than recommended in coating manufacturer's instructions.
   3. Use airless spray method unless air spray method is required by CSM's instruction or these Specifications.
   4. Conduct spray coating under controlled conditions. Protect adjacent construction and property from coating mist, fumes, or overspray.

L. Lightly sand and thoroughly clean surfaces to receive high-gloss finishes unless CSM instructs otherwise.

M. Remove all dust on coatings between coats.

N. Shop and field coats:
   1. Prime coat: Shop-apply or field-apply prime coats as specified. Use shop-applied primer compatible with the specified field coating system and apply at the minimum dry film thickness recommended by the finish coat CSM:
      a. Provide data sheets identifying the shop primer to on-site coating application personnel.
      b. Perform adhesion tests on the shop primer.
      c. Remove and recoat damaged, deteriorated, and poorly applied shop coatings.
      d. If shop primer coat meets this Section's requirements, spot prime exposed metal of shop-primed surfaces before spray applying primer over the entire surface.
   2. Field coats: Apply field coats with 1 or more prime coats and finish coats to build up coating to dry film thickness specified for the coating system:
      a. Do not apply finish coats until other work in the area is complete and previous coats are inspected.
   3. Adhesion confirmation: Perform adhesion tests after proper coating cure in accordance with ASTM D3359. Demonstrate that:
      a. Prime coat adheres to the substrate:
      b. Coatings adhere to the prime and intermediate coats:
         1) Coating 5 mils or more DFT: Achieve adhesion test result of 5A on immersed surfaces and 4A or better on other surfaces.
         2) Coating less than 5 mils DFT: Achieve adhesion test results of 5B on immersed surfaces and 4B or better on other surfaces.

O. Brush, roll, trowel, or spray and back roll coats for concrete and masonry.

P. Plural component coating application:
   1. Premix contents of component drums if required by the CSM each day.
   2. Before starting application:
      a. Verify gauges are working properly.
      b. Complete ratio checks.
      c. Sample the mix on plastic sheeting to ensure set time is appropriate and complete.
      d. Label and retain all spray samples. Submit to Engineer when requested.

Q. Drying and recoating:
   1. Provide fans, heating devices, or other means to prevent condensate or dew on substrate surface or between coats and during curing after applying the last coat.
   2. Allow each coat to cure or dry thoroughly, in accordance with if required in CSM’s printed instructions, before recoating.
   3. Use CSM's printed instructions and the requirements specified in this Section to determine minimum required drying time:
      a. Do not allow excessive drying time or exposure, which may impair bond between coats.
      b. Recoat all coatings within time limits recommended by CSM.
      c. If time limits are exceeded, abrasive blast clean and de-gloss clean before applying another coat.
   4. If limitations on time between abrasive blasting and coating are not met before attaching components to surfaces that cannot be abrasive blasted, coat components before attachment.

5. Ensure primer and intermediate coats of coating are unscarred and completely integral when applying each succeeding coat.
6. Touch up suction spots between coats and apply additional coats where required to produce finished surface of solid, even color, free of defects.
7. Leave no holidays. Repair all holidays in accordance with the requirements on pertinent Coating Detail Sheets or as recommended by the CSM.
8. Sand and feather in to a smooth transition and recoat scratched, contaminated, or otherwise damaged coating surfaces so repairs are invisible to the naked eye.

R. Workmanship:
1. Ensure that coated surfaces are free from runs, drips, ridges, waves, laps, and brush marks. Coats shall be applied to produce a smooth, even film of uniform thickness completely coating corners and crevices.
2. Coat surfaces without drops, overspray, dry spray, excessive runs, ridges, waves, holidays, laps, or brush marks.
3. Remove splatter and droppings after coating work is completed.
4. Evenly apply each coat of material and sharply cut to a line created with masking tape or other suitable materials.
5. Avoid over spraying or spattering paint on surfaces not to be coated. Protect glass, hardware, floors, roofs, vehicles, and other adjacent areas and installations by taping, drop cloths, or other suitable measures.
6. When coating complex steel shapes, stripe coat welds, edges of structural steel shapes, metal cut-outs, pits in steel surfaces, or rough surfaces with the primer before overall coating system application:
    a. Brush apply stripe coat to ensure proper coverage.
    b. Do not stripe coat with spray or roller.
7. Ensure that finish coat, including repairs, has a uniform color and gloss.

S. Coating properties, mixing, and thinning:
1. Thin prime coat and apply as recommended by the CSM. .Thinned coating must comply with prevailing air pollution control regulations.
2. If maximum recoat time is exceeded, prepare surface with solvent washing, light abrasive blasting, or other procedures per CSM’s instructions.
3. Allow adequate drying time between coats as instructed by the CSM, adjusted as necessary for the site conditions.
4. Ensure that coatings, when applied, provide a satisfactory film and a smooth even surface. Lightly sand glossy undercoats to provide a surface suitable for proper application and adhesion of subsequent coats. Thoroughly stir and strain coating materials during application and maintain uniform consistency.
5. Mix coatings with 2 or more components in accordance with CSM’s instructions.
6. Where necessary to suit conditions of the surface, temperature, weather and method of application, thin the coating per CSM's recommendations:
    a. Ensure that volatile organic content (VOC) of the thinned coating complies with prevailing air pollution control regulations.
    b. Thin coatings to only what is necessary to obtain proper application characteristics.
    c. Use a thinner recommended by the CSM.

T. Film thickness and continuity:
    1. Apply coating to the specified thicknesses:
        a. Apply additional coats when necessary to achieve specified thicknesses, especially at edges and corners.
    2. Verify WFT of the coating system first coat and after applying each subsequent coat.
    3. Do not allow the minimum thickness at any point to deviate more than 25 percent from the required average.
    4. Do not allow the surface area covered per gallon of coating for various types of surfaces to exceed those recommended by the CSM:
        a. Provide coating coverage worksheets listing the maximum and minimum coverage for each unit volume of coating for concrete surfaces.
    5. Apply additional coats to achieve the specified dry film thickness if brush or roller application methods cannot achieve the specified film thicknesses per coat.

U. Protecting coated surfaces:
    1. Do not handle, work on, or otherwise disturb coated items until the coating is completely dry and hard.
    2. After installation, recoat shop-coated surfaces with specified coating system as necessary to match surrounding surfaces, and to coordinate with the specified color identification requirements.

V. Special requirements:
    1. Before erection, apply all but the final finish coat to interior surfaces of roof plates, roof rafters and supports, pipe hangers, piping in contact with hangers, and contact surfaces inaccessible after assembly. Apply final coat after erection.
    2. Coat structural slip-critical connections and high strength bolts and nuts after erection.
    3. Areas damaged during erection:
        a. Prepare surface for spot repairs as specified for the coating system.
        b. Recoat with prime coat before applying subsequent coats.
        c. Touch up surfaces after installation.
        d. Clean and dry surfaces to be coated at time of application.
    4. Coat underside of equipment bases and supports not galvanized with at least 2 coats of primer specified before setting the equipment in place.
    5. Coat aluminum in contact with concrete.

3.10 APPLICATION REQUIREMENTS FOR CONCRETE COATING SYSTEMS

A. Apply filler/surfacer as recommended by CSM to fill bug holes and air voids in concrete or block texture in CMU, leaving a uniformly filled surface that does not produce blowholes or outgassing causing the coating system to pinhole:
    1. Allow filler/surfacers to cure sufficiently before applying prime coat as required by the CSM. Use the CSM-recommended drying time between coats.

B. Apply surfacer or filler and let dry before coating application:
    1. Use the drying time between filler/surfacer and coating system specified by the CSM for the site conditions:
        a. Let concrete substrate dry before applying filler/surfacers or coating system materials.

2. If the maximum recoat time is exceeded, prepare surfaces by solvent washing, light abrasive blasting, and other procedures per CSM's instructions.
3. Apply a complete parge coat of the specified filler/surfacer material over the entire substrate before applying the coating system.
    a. Scrub filler/surfacer into the substrate to completely fill open air voids and bug holes.
    b. Completely cover the substrate, unless otherwise specified, above such filled voids by 1/8-inch of thickness.
    c. Provide relatively flat, uniformly even surface before coating application.
4. Secondary containment: Place surfacer or filler 1/16 inch thick above concrete plane to create a monolithic surface free of pinholes:
    a. Floor surfaces: Broadcast with aggregate to create a non-slip surface texture.
    b. Remove excess aggregates and apply base coat to encapsulate embedded non-slip aggregate.

C. Concrete substrate temperatures:
1. Apply filler/surfacers and the coating system when temperatures are falling, typically late afternoon or evening:
    a. Do not coat concrete with rising concrete substrate surface temperatures or substrates in direct sunlight, to minimize outgassing from the substrate and formation of pinholes, and/or blistering.
2. Should bubbles, pinholes, or other discontinuities form in the applied coating system material, they shall be repaired:
    a. Should discontinuities develop in the filler/surfacer material or in the first coat of the coating material, repair them before the next coat.
    b. When discontinuities occur, open the air void behind or beneath the discontinuities and completely fill with specified coating material. Then, abrade the coated area around the discontinuities repair reapply coating over that area.

D. Perform application detail work in accordance with these Specifications, the CSM’s current written recommendations, and drawings, whichever is stricter.

E. Concrete coating systems application requirements:
1. Concrete coating minimum dry film thickness excludes parge coat, block filler, and sealer.

3.11 COATING SYSTEM SCHEDULE

A. Appendix A specifies surfaces to be coated in the field with the coating systems required.

3.12 SURFACES NOT REQUIRING COATING

A. Stainless steel piping, valves, pipe supports, instrument sunshades.

B. Sliding surfaces on expansion joints, motor and pump shafts, machined surfaces at bearings and seals, grease fittings, etc.

C. Galvanized structural steel framing, galvanized roof decking, galvanized pipe supports.

D. Copper and brass pipe, fittings, valves, etc.

E. Bronze valves, bearings, bushings, and fasteners.

F. Corrosion resistant special alloys: Inconel, Alloy 20, Hastelloy, etc.

G. Exterior Concrete.

H. Plastic surfaces except coat PVC, CPVC, and other plastic piping system exposed to sunlight.

I. Buried Piping that is encased in concrete or cement mortar.

3.13 QUALITY CONTROL

A. Owner-provided inspection or inspection by others does not limit the Contractor's or CSA's responsibilities for quality workmanship or quality control as specified or as required by the CSM's instructions. Owner inspection is in addition to any inspection required of the Contractor.

B. Owner may perform, or contract with an inspection agency to perform, quality control inspection and testing of the coating work covered by this Section. These inspections may include the following:
   1. Inspect materials upon receipt to ensure that the CSM supplied them.
   2. Verify that specified storage conditions for the coating system materials, solvents, and abrasives are provided.
   3. Inspect and record findings for substrate cleanliness.
   4. Inspect and record pH of concrete and metal substrates.
   5. Inspect and record substrate profile (anchor pattern).
   6. Measure and record ambient air and substrate temperature.
   7. Measure and record relative humidity.
   8. Check for substrate moisture in concrete.
   9. Verify that mixing of coating system materials is in accordance with CSM's instructions.
   10. Inspect, confirm, and record that coating system materials' "pot life" is not exceeded during installation. Inspect to verify that recoat limitations for coating materials are not exceeded.
   11. Perform adhesion testing.
   12. Measure and record the coating system's thickness.
   13. Verify proper curing of the coating system in accordance with the CSM's instructions.
   14. Holiday or continuity testing in accordance with NACE SP0188 for coatings that will be immersed or exposed to aggressively corrosive conditions.

C. Contractor shall perform holiday testing in accordance with NACE SP0188 to identify holidays or pinholes needing repair for coating over 100 percent of surfaces:
   1. Coated steel that will be immersed or exposed to aggressively corrosive conditions.
   2. Coated concrete.
   3. Perform holiday tests after proper application and coating system cure.

3.14 CORRECTIVE MEASURES

A. Repair pinholes or holidays identified by Holiday Testing as follows:
   1. Remove the coating system with a grinder or other suitable power tool.
   2. Remove coating system at all pinholes and holidays at least 2 inches diameter around the defect back to expose substrate.
   3. Concrete voids: chip back to expose entire cavity in all directions:
      a. Completely fill void with approved filler/surfacer material using a putty knife or other suitable tool, and strike off. Cure per CSM's recommendations.
   4. Aggressively abrade or sand the intact coating system surface at least 3 inches beyond the removal area in all directions to produce a uniform 6- to 8-mil profile in the intact coating system.
   5. Vacuum the prepared area to remove all dust, dirt, etc., leaving clean, sound surfaces.
   6. Tape to mask the periphery of the prepared intact coating area to prevent coating repair application onto the prepared area.
   7. Apply the coating system with enough coats to achieve the specified finish coat thickness over the defect and coating removal area. Feather the coating onto the abraded coated surfaces around the removal area to avoid a lip and to achieve a neat repair outline.
   8. Follow curing time between coats as specified by CSM for the site conditions. Solvent wash and abrasive blast per CSM's instructions, if the maximum recoat time is exceeded.
   9. Apply coating at specified dry film thickness.

3.15 CLEANUP

A. Remove surplus materials, protective coverings, and accumulated rubbish after completing coating. Thoroughly clean surfaces and repair overspray or other coating-related damage.

3.16 FINAL INSPECTION

A. Conduct final inspection of coating system work to determine whether it meets specifications requirements.

B. Conduct subsequent final inspection with Engineer to ensure work conforms to contract documents requirements.

C. Mark any rework required:
   1. Re-clean and repair, as specified, at no additional cost to the Owner.

END OF SECTION

APPENDIX A
Schedule of Surfaces to be Coated

A. The following schedule is incomplete. Coat unlisted surfaces with same coating system as similar listed surfaces. Contact Engineer for clarification.

EPU-M-1	Metals, exterior, non-immersed
EPX-M-3	Metals, immersed
EPX-M-5	Aluminum surfaces in contact with concrete or masonry. Locations where Alkali-resistant bitumastic is specified.

Notes:

1: Non-immersed ferrous metal surfaces include:
a. Doors, doorframes, ventilators, louvers, grilles, exposed sheet metal, and flashing.
b. Pipe, valves, pipe hangers, supports and saddles, conduit, cable tray hangers, and supports.
c. Motors and motor accessory equipment.
d. Drive gear, drive housing, coupling housings, and miscellaneous gear drive equipment.
e. Valve and gate operators and stands.
f. Structural steel.
g. Crane and hoist rails.
h. Exterior of tanks and other containment vessels.
i. Mechanical equipment supports, drive units, and accessories.
j. Bare electrical equipment: boxes, exposed conduit, and accessories.
k. Pumps not submerged.
l. Other miscellaneous metals.

2: Immersed ferrous metal surfaces include:
a. Interior surfaces of ferrous metal tanks.
b. Field priming of ferrous metal surfaces with defective shop-prime coat; including non-submerged service.
c. Bell rings, underside of manhole covers and frames.
d. Sump pumps, including underside of base plates and submerged suction and discharge piping.
e. Exterior of submerged piping and valves other than stainless steel or PVC piping.
f. Submerged pipe supports and hangers.
g. Stem guides.
h. Other submerged iron and steel metal unless specified otherwise.

Appendix B			
Coating Detail Sheet			
Coating System	EPU-M-1		
Coating Material	Two coats epoxy with polyurethane finish coat		
Substrate	Metal		
Products	Primer	Intermediate Coat	Finish Coat
Carboline	Carboguard 890	Carboguard 890	Carbothane 134 VOC
International Paint	Devran 224V	Devran 224V	Devthane 379H
PPG	Amerlock 2VOC	Amerlock 2VOC	Amershield VOC
Sherwin Williams	Macropoxy 646 100	Macropoxy 646 100	Hi Solids Polyurethane 100
Tnemec	Series 66HS	Series 66HS	Series 1095
Service Condition	Interior or Exterior, subject to direct sunlight. Non-immersion.		
Surface Preparation			
General	Prepare surfaces as specified in this Section and as follows.		
Ferrous Metal	Bare surfaces: SSPC-SP10, Near-White Blast Cleaning. Shop primed surfaces: SSPC-SP2, Hand Tool Cleaning or SSPC-SP3, Power Tool Cleaning. Damaged primer or rust: SSPC-SP10, Near White Blast Cleaning and spot prime.		
Nonferrous Metal	SSPC-SP16, Brush Blast Cleaning.		
Galvanized Metal	SSPC-SP16, Brush Blast Cleaning. Test for surface contaminants.		
Surface profile			
Ferrous Metal	2.5 to 3.0 mils		
Nonferrous Metal	1.5 to 2.0 mils		
Galvanized Metal	1.5 to 2.0 mils		
System Thickness (Dry Film)			
Total	10 to 13 mils		
Primer	4 to 5 mils		
Intermediate Coat	4 to 5 mils		
Finish Coat	2 to 3 mils		
Application			
Special CTR Training	Not required.		

Appendix B			
Coating Detail Sheet			
Coating System	EPX-M-3		
Coating Material	Epoxy		
Substrate	Metal		
Products	Primer	Intermediate Coat	Finish Coat
Carboline	Carboguard 891VOC	Carboguard 891VOC	Carboguard 891VOC
International Paint	Bar-Rust 236	Bar-Rust 236	Bar-Rust 236
PPG	Amercoat 240	Amercoat 240	Amercoat 240
Sherwin Williams	Tank Clad HS	Tank Clad HS	Tank Clad HS
Tnemec	Series 104	Series 104	Series 104
Service Condition	Immersed; non-immersed, corrosive environment. Not for Biogenic Sulfide Corrosion areas in wastewater.		
Surface Preparation			
General	Prepare surfaces as specified in this Section and as follows.		
Ferrous Metal	Bare surfaces: SSPC-SP5, White Metal Blast Cleaning. Shop primed surfaces: SSPC-SP7, Brush-Off Blast Cleaning. Damaged primer or rust: SSPC-SP5, White Metal Blast Cleaning and spot prime.		
Nonferrous Metal	SSPC-SP16, Brush-Off Blast Cleaning.		
Galvanized Metal	SSPC-SP16, Brush-Off Blast Cleaning.		
Surface profile			
Ferrous Metal	2.5 to 3.0 mils		
Nonferrous Metal	1.5 to 2.0 mils		
Galvanized Metal	1.5 to 2.0 mils		
System Thickness (Dry Film)			
Total	16 to 20 mils		
Primer	4 to 8 mils		
Intermediate Coat	4 to 8 mils		
Finish Coat	4 to 8 mils		
Application			
Special CTR Training	Not required.		

Appendix B			
Coating Detail Sheet			
Coating System	EPX-M-5		
Coating Material	Epoxy mastic		
Substrate	Ferrous Metal		
Products	Primer	Intermediate Coat	Finish Coat
Carboline	CSM recommended	None applied	Carbomastic 15
International Paint	CSM recommended	Bar-Rust 231LV	Bar-Rust 231LV
PPG	No product specified	No product specified	No product specified
Sherwin Williams	CSM recommended	No product specified	No product specified
Tnemec	CSM recommended	Series 135	Series 135
Service Condition	Interior, corrosive environment, confined enclosures, where minimal surface preparation is possible.		
Surface Preparation			
General	Prepare surfaces as specified in this Section and as follows.		
Ferrous Metal	Bare surfaces: SSPC-SP11, Power to Cleaning to Bare Metal. Shop primed surfaces: SSPC-SP3, Power Tool Cleaning. Damaged primer or rust: SSPC-SP11, Power to Cleaning to Bare Metal.		
Surface profile			
Ferrous Metal	2.0 to 2.5 mils		
System Thickness (Dry Film)			
Total	15 to 19 mils		
Primer	2 to 4 mils		
Finish Coat	15 mils		
Application			
Special CTR Training	Not Required.		

SECTION 09997

PIPELINE COATINGS AND LININGS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Pipeline coatings and linings.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. B1000 - Standard Practices for Casting Preparation and Test Procedure of Porcelain Enamel-lined Pipe, Fittings, and Valves for Use in the Municipal Wastewater, Sewage, and Water Treatment Industry.
   2. C33 - Standard Specification for Concrete Aggregates.
   3. C150 - Standard Specification for Portland Cement.
   4. C283 - Standard Test Methods for Resistance of Porcelain Enameled Utensils to Boiling Acid.
   5. D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
   6. D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.

B. American Water Works Association (AWWA):
   1. C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
   2. C105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
   3. C203 - Coal-Tar Protective Coatings and Linings for Steel Water Pipes.
   4. C205 - Cement-Mortar Protective Lining and Coating for Steel Water Pipe 4 In, and Larger-Shop Applied.
   5. C210 - Liquid Epoxy Coatings and Linings for Steel Water Pipe and Fittings.
   6. C214 - Tape Coatings for Steel Water Pipelines.
   7. C216 - Heat-Shrinkable Cross-Linked Polyolefin Coatings for Steel Water Pipe and Fittings.
   8. C217 - Microcrystalline Wax and Petrolatum Tape Coating Systems for Steel Water Pipe and Fittings (PDF).
   9. C222 - Bolted, Split-Sleeve Restrained and Nonrestrained Couplings for Plain-End Pipe.
   10. C225 - Fused Polyolefin Coatings for Steel Water Pipelines
   11. C301 - Prestressed Concrete Pressure Pipe, Steel-Cylinder Type.
   12. C303 - Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type.

C. National Association of Pipe Fabricators (NAPF):
   1. 500-03 - Surface Preparation Standard for Ductile Iron Pipe and Fittings in Exposed Locations Receiving Special External Coatings and/or Special Internal Linings.

D. International Organization for Standardization (ISO):
   1. 8179-1 - Ductile iron pipe, fittings, accessories and their joints - External zinc-based coating - Part 1: Metallic zinc with finishing layer.

E. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

F. Society for Protective Coatings (SSPC):
   1. PA 2 - Procedure for Determining Conformance to Dry Coating Thickness Requirements.
   2. QP 1 - Standard Procedure for Evaluating the Qualifications of Industrial/Marine Painting Contractors Field application to Complex industrial and Marine Steel Structures.
   3. SP 1 - Solvent Cleaning.
   4. SP 3 - Power Tool Cleaning.
   5. SP 5 - White Metal Blast Cleaning.
   6. SP 6 - Commercial Blast Cleaning.
   7. SP 10 - Near-White Metal Blast Cleaning.
   8. SP 11 - Power Tool Cleaning to Bare Metal.
   9. SP 13 - Surface Prep of Concrete.

1.03 SUBMITTALS

A. Manufacturer's qualifications:
   1. Manufacturer qualifications and list of projects using the specified material: 5 years minimum.
   2. Plural component epoxy and polyurethane field repair: SSPC-QP 1 certification required.

B. Manufacturer's Quality Assurance Manual:
   1. Submit manufacturer's coating and lining application quality assurance manual to Engineer prior to beginning coating application.
      a. Strict conformance to the requirements of the manual will be required.
      b. Deviation from the requirements of the manual will be grounds for the Engineer to reject the applied coating.

C. Product information.

D. Manufacturer's Certificate of Source Testing for ceramic epoxy and glass lined pipe:
   1. Certify successful performance of holiday detection tests on 100 percent of lining in accordance with ASTM B1000.
   2. Identify each test piece by mark designation and show the actual test results during the final inspection by manufacturer prior to shipment.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Block piping and associated fittings for shipment to prevent damage to coatings and linings.

B. Carefully handle piping and associated fittings during loading, unloading, and installation:
   1. Do not drop piping material from cars or trucks.
   2. Lower piping by mechanical means.
   3. Do not drop or pound pipe to fit grade.

C. Handle ceramic epoxy and glass lined pipe and fittings only from the outside:
   1. Do not place chains, straps, hooks, or other lifting device inside the pipe or fittings for lifting, positioning, or laying.

D. Store piping, fittings, and other accessories such that they do not accumulate and hold rainwater, dirt, and debris.

PART 2 PRODUCTS

2.01 COATING AND LINING MATERIALS

A. As specified in Section 01600 - Product Requirement.

B. Prepare, install, and repair in accordance with manufacturer's requirements.

C. Contractor is responsible for:
   1. That coating selected is suitable for the application conditions anticipated, such as temperature, humidity, etc.
   2. Managing the project schedule to allow adequate cure time before backfill or immersion based on surface temperatures at the time of application.

2.02 CEMENT MORTAR

A. Cement mortar mixture in accordance with AWWA C205 and as specified in this Section):
   1. Cement: Type II.

B. Water for cement mortar in accordance with AWWA C205 and as specified in this Section.

C. Provide silica sand or other aggregate that is not subject to leaching in accordance with ASTM C33.

D. Shop apply cement mortar in uniform thickness over the full length of the pipe.

2.03 PLURAL COMPONENT EPOXY

A. Plural component, 100 percent solids, non-extended in accordance with AWWA C210 and as specified in this Section.

B. Surface preparation: SSPC-SP 10 or SSPC-SP 11.

C. Primer: In accordance with coating manufacturer’s requirements.

D. High build epoxy coating:
   1. 2 component, high build polyamide or polyamine cured epoxy coating, suitable for direct burial or immersion, dries to touch in 2 or more hours, suitable for immersion or burial after full cure of coating.

2. Manufacturers: One of the following or equal:
    a. Carboline.
    b. ICI Devoe.
    c. Sherwin Williams.
    d. Warren Environmental.

E. Fast cure epoxy coating:
1. 2 component, 100 percent solids by volume, fast cure epoxy coating suitable for direct burial or immersion, dry to touch in less than 1 hour at 72 degrees Fahrenheit, capable of curing while immersed or buried.
2. Manufacturers: One of the following or equal:
    a. North American Denso, Protal 7125 or Protal 7200.
    b. Tapecoat Inc., TC 7010.

F. Application:
1. Apply coating using plural component spray equipment by a manufacturer certified coating applicator.
2. Perform coating application in an environmentally controlled shop area that meets or exceeds the written environmental application requirements of the coating manufacturer:
    a. It is not acceptable to apply coating in outdoor conditions without adequate environmental shelter, environmental controls, and/or dehumidification.
3. In potable water applications, provide epoxy lining suitable for potable water contact in accordance with NSF 61, unless otherwise approved by Engineer.
4. Concrete embedded pipe penetrations: Extend epoxy coating a minimum of: 6 inches outside of interior and exterior surfaces of concrete walls or floors.
5. Concrete penetrations minimum dry film thickness: 12 mils.
6. Apply heat shrink sleeves to buried transitions from epoxy to tape wrap or extruded polyolefin coating systems:
    a. Backfill as soon as practical to limit exposure to direct sun or heat and potential thermal creep of sleeve.

G. Self-priming, plural component, 100 percent solids, suitable for burial or immersion, and in accordance with AWWA C210 and the following, whichever is more stringent:
1. Non-NSF certified: Ceramic fill.
2. NSF certified: Poly amine epoxy or poly amide epoxy.
3. Shop applied coating thickness:
    a. Minimum: 1 coat, 35 mils total dry film thickness.
4. Shop applied lining thickness:
    a. Minimum: 1 coat, 35 mils total dry film thickness.

H. Adhesion test procedures:
1. Use self-aligning pneumatic pull off equipment and test procedures in accordance with ASTM D4541, Method E, using Delfesko Positest AT-A except as modified in this Section:
    a. Perform at an applied load rate of 100 pounds per square inch per second, plus or minus 10 pounds per square inch.
    b. Use automatic adhesion test equipment.
    c. Perform tests to coating or glue failure or maximum test load, whichever is happens first.
    d. In accordance with ASTM D4541 using standard 20 millimeter dollies.

e. Base adhesion testing on 3 tests:
    1) Conduct the tests by the same person, test equipment, and test procedure.
    2) Complete the tests within a 30 minute period.
f. Conduct adhesion tests within an area not to exceed 6 inches by 6-inches.
g. Score coatings with more than 10 percent elongation or 25 mils thick around dolly to metal substrate using manual methods and tools, normal to the pipe surface, and in a manner that does not stress or over heat the coating.

2. Attach dollies for adhesion testing to the coating surface using a 2 part epoxy or cyanoacrylate glue and cured for a minimum of 12 hours before testing or until full cure, whichever is greater:
    a. Pipe fabricator and coating manufacturer determine glue type for the pipe diameter, temperatures, and environmental conditions.
3. Perform adhesion testing at temperatures between 55 and 90 degrees Fahrenheit or at temperatures in accordance with coating manufacturer's requirements:
    a. Testing up to 115 degrees Fahrenheit or below 55 degrees Fahrenheit will be permitted if tests can demonstrate no statistically detectable effect on test results and in accordance with coating manufacturer's requirements and Engineer's approval.
4. Epoxy coating and lining adhesion criteria:
    a. Coating is acceptable if first dolly pull test exceeds 1,750 pounds per square inch, minimum.
    b. If first dolly pull is less than 1,750 pounds per square inch, perform 2 additional tests with acceptance based on "Best of 3" evaluation method as defined in this Section.
5. Pipe lot performance criteria:
    a. Minimum median value for coating or lining adhesion tests: 2,000 pounds per square inch.
    b. Classify failing pipe lots as rejected until 100 percent of the pipe within the pipe lot has been tested for adhesion:
        1) Reject each pipe that fails the coating adhesion criteria.
6. Adhesion test evaluation and records:
    a. Definition: "Best of 3" evaluation method is when 2 of 3 test values meet the adhesion criteria.
    b. Consider adhesion tests as valid and suitable for acceptance or rejection of the coating, except where retesting is required.
    c. Adhesion test failure:
        1) Adhesive or substrate failure:
            a) Definition: A percentage of separation of the coating from the steel substrate or between distinct coating layers.
        2) Cohesive test failure:
            a) Definition: A percentage of failure within the coating, resulting in coating remaining both on the steel substrate and test dolly.
    d. Retest coating adhesion tests:
        1) When any test is glue failure at 25 percent or more of dolly surface area and the test value is less than the Acceptance Criteria or the Minimum Criteria.
        2) Within the same 6-inch by 6-inch test area as the original adhesion testing.

3) Retest disputed adhesion tests:
a) Owner's representative will witness dolly attachment and adhesion retesting.

e. Adhesion tests will be conducted on pipe coating and lining independently and will be accepted or rejected independently.

f. Maintain adhesion test records in an electronic spreadsheet that includes the following information:
1) Pipe identification.
2) Pipe coating date.
3) Adhesion test date.
4) Surface tested (interior or exterior).
5) Surface temperature at time of test.
6) Coating thickness.
7) Tensile force applied.
8) Applied load rate per second.
9) Mode of failure.
10) Percentage of failure types, previously defined, relative to dolly surface area.
11) Dolly size and attachment glue used.
12) If different coatings are tested, include coating manufacturer and product number.

7. Adhesion test repairs:
a. Fabricator or contractor to complete adhesion repairs as specified this Section.
b. Randomly select repair patches on epoxy or polyurethane coating for adhesion testing in a manner as described in this Section and at the discretion of the coating inspector.

I. Long term adhesion test:
1. Acceptance criteria:
a. Not more than 10 percent loss of adhesion over duration of test.
b. Differential based on the highest average adhesion result to the lowest average adhesion result.
2. Test durations, cumulative:
a. 1 day.
b. 7 days.
c. 3 weeks.
d. 2 months.
3. Sample preparation:
a. SSPC-SP 5, 3.00 mils profile, minimum.
b. Test area minimum: 18-inches by 18-inches.
c. Curved steel plate:
1) Minimum radius of 15-inches.
2) Inclined between 30 and 45 degrees.
4. Test procedure:
a. Expose samples to ambient, outdoor conditions, and facing in a southern direction for maximum UV exposure for the full duration of the test.
5. Adhesion test results:
a. Based on 8 pulls per test period with the 3 lowest pulls discarded.
b. Based an average of the 5 highest pulls and identify the values used.
6. Record adhesion pulls and their failure mode.

7. Repair sample after adhesion tests to prevent water from causing any effects on subsequent adhesion tests.
8. Plural component, polyurethane coating system (referred to as a polyurethane).

2.04 POLYETHYLENE ENCASEMENT

A. General:
   1. Polyethylene encasement: Supplied by pipe manufacturer.

B. Materials: Supply one of the following polyethylene encasements in accordance with AWWA C105 and as specified in this Section.
   1. Linear low-density polyethylene (LLDPE) film:
      a. Minimum thickness: 8 mils.
      b. Minimum layers: 2.
   2. High-density, cross-laminated polyethylene (HDCLPE) film:
      a. Minimum thickness: 4 mils.
      b. Minimum layers: 1.
   3. V-Bio® enhanced polyethylene encasement:
      a. Product description: 3 layers of co-extruded LLDPE film with anti-microbial additive and volatile corrosion inhibitor infused on the inside surface.
      b. Minimum thickness: 8 mils.
      c. Minimum layers: 1.

2.05 TAPE WRAP

A. In accordance with AWWA C214 and as specified in this Section.

B. Manufacturers: The following or equal:
   1. Liquid adhesive: Polyken 1019, 1027, 1029, or in accordance with coating manufacturer's requirements.
   2. Weld stripe tape: Polyken 931 (no backing), 4-inches wide minimum.
   3. Corrosion layer (Inner wrap): Polyken, 989.
   4. Mechanical layer of tape wrap: Polyken, 955.
   5. Mechanical layer **(**Outer wrap): Polyken 956.

C. Ultraviolet resistance:
   1. Able to resist above grade exposure for a minimum of 12 months or the proposed storage and construction time, whichever is greater.

D. Tape width maximum: 12-inches:
   1. Engineer can approve conditional use of wider tape will be if the coating applicator can demonstrate that proper tensioning can be maintained and mechanical wrinkling prevented throughout the coating application:
      a. If at any time during the pipe fabrication, tape quality becomes inconsistent, the Engineer can require the remainder of the pipe to be coated using the maximum specified tape width.

E. Manufacturing requirements:
   1. Monitoring system:
      a. Provided by applicator.
      b. Approved by the tape manufacturer that constantly records pipe and tape conditions during coating application.
      c. Recorded monitoring parameters include, but not be limited to the following: Pipe temperature; line speed, primer and tape roll body temperature, and tape tension.
   2. Pipe surface temperature: Between 45 and 120 degrees Fahrenheit and 5 degrees Fahrenheit above dew point, whichever is greater.
   3. Apply a uniform liquid adhesive layer in accordance with manufacturer's requirements:
      a. Rug type application is not acceptable.
      b. Finish with skips, runs, or sags is not acceptable.
   4. Weld seams stripping tape:
      a. In accordance with AWWA C214 and as specified in this Section.
      b. Corrosion layer adherence to pipe surface:
         1) 100 percent adhering to the metal surface.
         2) No visible damage, wrinkles, voids, contamination, or holidays.
         3) Perform tape coating adhesion test.

F. Tape-coating system thickness:
   1. Pipe 24 inch diameter and larger: 80 mil (nominal).
      a. Liquid adhesive layer.
      b. Corrosion layer:
         1) Layer 1 of 20 mil (nominal), black colored tape.
      c. Mechanical layer:
         1) Layer 1 of 30 mil (nominal), grey color tape.
         2) Layer 2 (Outer Layer) of 30 mil (nominal), white color tape.
   2. Pipe less than 24 inch diameter: 50 mil (nominal).
      a. Adhesive layer.
      b. Corrosion layer:
         1) Layer 1 of 20 mil (nominal), black colored tape.
      c. Mechanical layer:
         1) Layer 1 (Outer Layer) of 30 mil (nominal), white color tape.

G. Adhesion testing:
   1. Apply continuous pulling tension without stopping:
      a. Monitor throughout at least 12-inches length of the pull.
   2. Sample preparation:
      a. Conduct on pipe in either of the following conditions:
         1) Prior to application of the cement mortar overcoat, where applicable.
         2) Pipe that has been mortar coated prior to adhesion testing:
            a) Contractor remove mortar coating of sufficient dimensional area to permit the adhesion test to be conducted as directed by the Engineer.
   3. Adhesion pull evaluation:
      a. Adhesive failure, defined as separation of the adhesive from the metal substrate, will be rejected.
      b. Failure: Cohesive failure of the adhesive only.

c. Delamination failure, defined as separation of the adhesive from the backing material, requires the following additional testing:
    1) Pipe that fails the test by delamination will be retested on 2 other pipes within the same lot of coated pipe.
    2) Failure of any 2 pipes within the tape lot will result in rejection of each pipe coated with the rejected tape lot.

2.06 DUCTILE IRON PIPE

A. Coating:
    1. Polyethylene encasement.
    2. Plural component epoxy:
        a. Ductile iron pipe: SSPC-SP 10 as specified in ductile iron surface preparation, this Section.
            1) Blast profile in accordance with coating manufacturer's requirements.

B. Lining:
    1. Cement mortar:
        a. In accordance with AWWA C104 and as specified in this Section.
        b. Extend to faces of flanges and ends of spigots.
        c. Provide cement mortar lining of uniform thickness.
        d. Finish to a smooth dense surface.
        e. Cement: In accordance with ASTM C150, Type II.
    2. Cement mortar with seal coat:
        a. In accordance with AWWA C104 and as specified in this Section.
        b. Apply seal coat.
        c. Provide cement mortar lining of uniform thickness.
        d. Finish to a smooth dense surface.

2.07 STEEL PIPE

A. Coating:
    1. Cement mortar:
        a. Apply cement mortar coating:
            1) In accordance with AWWA C205 and as specified in this Section.
            2) As indicated on the Drawings.
        b. Thickness minimum: 1 inch.
        c. Cement: In accordance with ASTM C150, Type II.
        d. Reinforcement:
            1) Steel plate specials: Reinforced with 2-inch by 4-inch, No. 13 gage welded wire mesh in lieu of steel wire reinforcing wire:
                a) 1 layer of mesh positioned approximately in center of mortar coating.
                b) Lap ends of reinforcement strips 4 inches and tie or loop free ends to assure continuity of reinforcement.
            2) Pipe and specials smaller than 48 inches in diameter: Reinforce coating with spirally-wound steel wire positioned approximately in center of mortar coating:
                a) No. 12 gage spaced at maximum 1 inch centers.
                b) No. 14 gage steel wire at maximum 1/2 inch centers.
            3) Pipe and specials 48 inches in diameter and larger: Reinforce coating with 2 layers spirally-wound steel wire positioned

approximately in center of mortar coating positioned approximately at the third points of mortar coating:
a) No. 12 gage spaced at maximum 1 inch centers.
b) No. 14 gage steel wire at maximum 1/2 inch centers.

2. Tape wrap:
   a. Surface preparation by material type: SSPC-SP 6, 1 to 3 mils blast profile.

B. Lining:
1. Cement mortar:
   a. In accordance with AWWA C205 and as specified in this Section.
   b. Cement: In accordance with ASTM C150, Type II.
   c. Provide cement mortar lining of uniform thickness.
   d. Finish to a smooth dense surface.
   e. Line special pieces or fittings by mechanical, pneumatic, or hand placement:
      1) Extend to faces of flanges and ends of spigots.
      2) Less than 12 inches in width: Coat with epoxy bonding agent prior to applying cement mortar.
      3) Larger than 12 inches in width: Reinforced with 2-inch by 4-inch No. 13 gauge welded steel wire mesh prior to applying cement mortar.
   f. Provide plastic end caps of sufficient thickness and strength to resist shipping, handling, and storage stresses.
   g. Repair damage to the cement mortar lining, including disbondment, or cracking caused by improper curing, shipping, handling, or installation in accordance with AWWA C205 and approved by the Engineer.
2. Plural component epoxy:
   a. In accordance with AWWA C210 and as specified in this Section.
3. Plural component polyurethane:
   a. In accordance with AWWA C222 and as specified in this Section.

PART 3 EXECUTION

3.01 GENERAL

A. Apply coating or lining and repair in accordance with manufacturer's requirements and as specified in this Section.

B. Inspect coating prior to backfilling of pipe and associated items.

3.02 DEFECTS IN COATINGS EXCEPT TAPE WRAP AND CEMENT MORTAR COATING

A. Engineer will identify defective coating to be field repaired in accordance with the applicable AWWA standard:
1. Pipe joints exceeding the following defect maximum will be rejected:
   a. Minor defects:
      1) No more than 1.5 per 100 square feet of surface area.
      2) 2 or more minor repairs within an 8-inches diameter circle will be considered a single repair.
      3) Repairs for adhesion testing will not be included in the total number of repairs.
      4) Repair in accordance with manufacturer's requirements.

b. Major defects:
    1) No more than 3 major repairs on each pipe joint.
    2) No more than 30 percent repairs on the pipe surface area with defects.
2. Minor repairs:
    a. Repairs less than 8-inches in the greatest dimension.
    b. Repair in accordance with manufacturer's requirements.
3. Major repairs:
    a. Repairs that exceed 8-inches in the greatest dimension.
    b. Repair in accordance with manufacturer's requirements.

3.03 TAPE WRAP

A. Engineer will identify defective tape wrap coating to be field repaired in accordance with AWWA C214:
    1. Pipe joints exceeding the defect maximum will be rejected:
        a. No more than 5 repairs.
        b. No more than 2 areas of coating damage greater than 5 square feet.

B. Minor repairs:
    1. Repairs less than 8 inches in the greatest dimension.
    2. Complete minor repairs using a heat applied coating patch material.
    3. Limit material removal to only damaged layers:
        a. Carefully remove damaged layers by cutting the coating with a sharp knife without cutting undamaged layers.
        b. Cut in a stepped fashion to expose 1-inch or more of the underlying tape layer for the circumference of the repair.
    4. Cut patch material to overlap onto the undamaged coating a minimum of 2 inches on each side with 1-inch radius on each corner of the patch.
    5. Apply patch material in accordance with manufacturer's requirements.

C. Major repairs:
    1. Repairs that exceed 8-inches in the greatest dimension.
    2. Complete major repairs:
        a. With heat shrink sleeves as specified for joints.
    3. Limit material removal to only damaged layers:
        a. Carefully remove damaged layers by cutting the coating with a sharp knife without cutting undamaged layers.
        b. Cut in a stepped fashion to expose 1-inch or more of the underlying tape layer for the circumference of the repair.
        c. If corrosion layer is exposed:
            1) Holiday test:
                a) If a holiday is detected:
                    (1) Cut outer layers back to fully expose the holiday(s).
                    (2) Retest for holidays.
    4. Apply repair material in accordance with manufacturer's requirements or as specified in this Section:
        a. Clean surfaces by solvent wiping and applying primer over the inner tape layer for a minimum of 6-inches onto the outer wrap in all directions.

b. Cigarette wrap coating:
    1) Apply first layer of repair coating, over lapping 1-inch or more onto undamaged coating in all directions:
        a) On larger areas, lap the repair tape within a minimum of 1-inch overlap, offsetting the overlap from the previous layer overlap, until the area is properly covered.
        b) If corrosion layer is repaired:
            (1) Holiday test:
                (a) If a holiday is detected.
                (b) Cut outer layers back to fully expose the holiday(s).
                (c) Retest for holidays.
    2) Repeat for each tape layer damaged with each succeeding layer applied at 90 degrees to the preceding layers and overlapping onto the undamaged coating a minimum of 2-inches.
    3) Apply the last tape layer, use the cigarette wrap method for the full pipeline circumference covering any previous repair layers and overlapping a minimum of 2-inches onto undamaged coating:
        a) Point ends of the cigarette wrap downward.
c. Heat shrink sleeves:
    1) Width of sleeve: Equal to width of the damaged area plus 4-inch overlap.
    2) Multiple sleeves may be used for larger repairs, but must be overlapped a minimum of 2 inches.

3.04 DUCTILE IRON PIPE

A. Coating:
    1. Polyethylene encasement:
        a. Wrap buried ductile iron pipe and fittings in accordance with AWWA C105 and as specified in this Section.
        b. Wrap polyethylene encasement to be continuous and terminated neatly at connections to below grade equipment or structures.
        c. At wall penetrations, extend encasement to the wall and neatly terminate.
        d. At slab penetrations, extend encasement to 2 inches below the top of slab and neatly terminate.
        e. When rising vertically in unimproved areas, extend encasement on pipe 6 inches above existing grade and neatly terminate.

B. Lining:
    1. Cement mortar:
        a. Cement mortar with seal coat.
    2. Ceramic epoxy and glass lining:
        a. Field testing:
            1) Test random samples, as directed by Engineer, in accordance with ASTM B1000.
            2) Discard lined piping and fittings found to have pinholes, crazing, or fish scales that expose the metal substrate.

3.05 STEEL PIPE

A. Coating:
   1. Cement mortar:
      a. Engineer will identify defective cement mortar coating to be field repaired in accordance with AWWA C205:
         1) Reject pipe with mortar coating defects on greater than 25 percent of the pipe surface.

B. Lining:
   1. Cement mortar:
      a. Field applied interior joint lining:
         1) After the backfill has been completed to final grade, fill interior joint recess with tightly packed cement mortar:
            a) Trowel flush with the interior surface with no indentation or projection of the mortar exceeding 1/16-inch.

END OF SECTION

SECTION 10400

SIGNAGE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Plastic and metal signs for building and site use.

1.02 REFERENCES

A. National Fire Protection Association (NFPA):
   1. 704 - Standard System for the Identification of the Hazards of Materials for Emergency Response.

B. Occupational Safety and Health Administration (OSHA).

1.03 SUBMITTALS

A. Product data.

B. Shop drawings: Include lists of sign types, sizes, text, and colors; mounting details; locations; and cast metal plaque rubbings and templates.

C. Samples: Include actual materials.

D. Manufacturer's installation instructions.

1.04 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufacturer of proposed products for minimum 5 years with satisfactory performance record of minimum 5 years.

B. Installer qualifications: Manufacturer approved installer of products similar to specified products on minimum 10 projects of similar scope as Project with satisfactory performance record.

C. Regulatory requirements: Provide signage in accordance with Americans with Disabilities Act as published in the Federal Register, Volume 56, No. 144, Friday, July 26, 1991.

PART 2 PRODUCTS

2.01 PLASTIC SIGNAGE SYSTEM

A. Manufacturers:
   1. One of the following or equal:
      a. Best Manufacturing Sign Systems, System 900013.
      b. Andco Industries Corp., equivalent product.
      c. Vomar Products, Inc., equivalent product.

B. Attachment:
   1. Vinyl tape, self-adhering.

C. Lettering:
   1. Helvetica medium, 3/4 inches high.

D. Material for interior use:
   1. Plastic 1/8-inch thick raised letters.

E. Material for exterior use:
   1. Fiberglass 1/4 inch thick with high gloss finish, raised letters, blasted from single piece of fiberglass for integral letter and background.
   2. No adhesive as mechanical fastening of letters shall be allowed.

F. Colors:
   1. As selected by Engineer from manufacturer's standard colors.

G. See Schedule A for specific sign size, location, text, pictogram, and quantity.

2.02 METAL SAFETY SIGNS

A. Manufacturer: Meeting OSHA Requirements; 40-mil thick aluminum with baked enamel finish. One of the following or equal:
   1. Seton Name Plate Co., Special Wording.
   2. Emedco.

B. Danger sign colors:
   1. Background: White.
   2. Heading: White lettering on red oval with white border in black rectangular panel.
   3. Message: Black lettering on white.
   4. Size: As scheduled.

C. Caution sign colors:
   1. Background: Yellow.
   2. Heading: Yellow lettering on black rectangular panel.
   3. Message: Black lettering on yellow.
   4. Size: As scheduled.

D. Safety instruction signs:
   1. Background: White.
   2. Heading: White lettering on green rectangular panel.
   3. Message: Black lettering.
   4. Size: As scheduled.

E. Warning sign colors:
   1. Background: Orange.
   2. Heading: Black lettering on orange diamond in black rectangular panel.
   3. Message: Flack lettering on orange.
   4. Size: As scheduled.

F. Notice information signs:
   1. Background: White.
   2. Heading: White lettering on blue rectangular panel.
   3. Message: Black lettering.
   4. Size: As scheduled.

G. Fasteners: Round head stainless steel bolts or screws.

H. See Schedule B for specific sign size, location, text, and quantity.

PART 3 EXECUTION

3.01 PREPARATION

A. Protect adjacent surfaces which may be damaged by installation of signs.

B. Prepare substrates in accordance with sign manufacturer's instructions.

C. Remove scale, dirt, grease, and other contaminates from substrates.

3.02 INSTALLATION

A. Install signs in accordance with sign manufacturer's instructions.

B. Fasten signs securely in level, plumb, and true to plane positions.

C. Install signs where or as indicated in the following schedules.

3.03 SCHEDULES

A. Plastic Signage System Schedule.

B. Metal Safety Sign Schedule.

END OF SECTION

SCHEDULE A

PLASTIC SIGNAGE SYSTEM SCHEDULE

A. Room Numbers:
   1. Location: On wall outside room adjacent to latch side of doors or when not enough space on latch side, on nearest adjacent wall.
   2. Height: 60 inches above floor to center of sign.
   3. Size: 6 inches square.
   4. Colors: As selected by the Engineer.
   5. Text: Room number as indicated on the Drawings.

B. Room Names:
   1. Location: On wall outside room adjacent to latch side of doors or when not enough space on latch side, on nearest adjacent wall.
   2. Height: 60 inches above floor to center or sign.
   3. Size: 6 inches square.
   4. Colors: As selected by Engineer.
   5. Text: Sign per door describing room function as indicated on the Drawings**.**

C. Stair Doors:
   1. Location: On wall outside room adjacent to latch side of doors or when not enough space on latch side, on nearest adjacent wall.
   2. Height: 60 inches above floor to center of sign.
   3. Size: 6 inches square.
   4. Colors: As selected by Engineer.
   5. Pictogram: Means of egress indication.

D. Stair Landings:
   1. Location: At each floor landing in stairwells.
   2. Height: 60 inches above floor to center of sign.
   3. Size: 6 inches square.
   4. Colors: As selected by Engineer.
   5. Text: Stair number, access or no access to roof to suit application, and floor level, as follows:

E. Fire Extinguishers:
   1. Location: Adjacent to fire extinguishers.
   2. Height: 60 inches above floor to center of sign.
   3. Size: 8 inches square projecting.
   4. Colors: White letters on OSHA Red background.
   5. Text: FIRE EXTINGUISHER.

F. Nonpotable Water:
   1. Location: At impure water and nonpotable water hose valves in accordance with Typical Detail M276.
   2. Height: In accordance with Typical Detail.
   3. Size: 10 inches wide by 7 inches high.
   4. Heading: CAUTION
   5. Text: IMPURE WATER
      DO NOT DRINK

END OF SCHEDULE A

SCHEDULE B

METAL SAFETY SIGN SCHEDULE

A. NONPOTABLE WATER:
   1. Location: At impure water and nonpotable water hose valves in accordance with Typical Detail M276.
   2. Height: In accordance with Typical Detail.
   3. Size: 10 inches wide by 7 inches high.
   4. Heading: DANGER
   5. Wording: DO NOT DRINK THIS WATER

B. HIGH PRESSURE HOSE VALVES:
   1. Location: At designated hose valves.
   2. Height: In accordance with Typical Detail.
   3. Size: 10 inches wide by 7 inches high.
   4. Heading: DANGER
   5. Wording: HIGH PRESSURE

C. HIGH VOLTAGE WARNING:
   1. Location: On front and back of equipment, adjacent to doors to rooms containing devices, and devices that operate at 600 volts or greater.
   2. Height: In accordance with Typical Detail.
   3. Size: 10 inches wide by 7 inches high.
   4. Heading: DANGER
   5. Wording: HIGH VOLTAGE
      KEEP OUT

D. NO SMOKING WITHIN 25 FEET OF BUILDING ENTRY:
   1. Location: As indicated on the Drawings.
   2. Height: Pole mounted with top of sign at 5 feet above grade.
   3. Size: 14 inches wide by 10 inches high.
   4. Heading: NOTICE
   5. Wording: NO SMOKING WITHIN 25 FEET OF BUILDING.
   6. Pictogram: International “No Smoking” symbol.

END OF SCHEDULE B

SECTION 10520

FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Fire extinguishers.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. E814-11a - Standard Test Method for Fire Tests of Penetration Firestop Systems.

B. National Fire Protection Association (NFPA):
   1. 10 - Standard for Portable Fire Extinguishers.

C. Underwriters Laboratories, Inc. (UL):
   1. 711 - Rating and Fire Testing of Fire Extinguishers.

1.03 SUBMITTALS

A. Product data:
   1. Extinguishers: Materials description for fire extinguishers; include ratings and classifications.
   2. Installation instructions for each product specified.

B. Shop drawings:
   1. Small-scale plans showing locations of individual fire extinguishers.
   2. Schedule showing each type of extinguisher to ensure proper fit and function.
   3. Indicate installation procedures and accessories required for a complete installation.

C. Samples.

1.04 QUALITY ASSURANCE

A. Manufacturer qualifications: Minimum 5 years with satisfactory performance record.

1.05 WARRANTY

A. As specified in General Conditions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following or equal:
   1. Activar Construction Products Group – JL Industries.

2.02 FIRE EXTINGUISHERS

A. Multi-purpose chemical type:
   1. Extinguisher unit containing a fluidized and siliconized mono ammonium phosphate powder; nonconductive and nontoxic.
   2. Construction: Heavy duty steel cylinder with metal valve and siphon tube, o-ring seal, replaceable valve stem seal, visual pressure gage, pull pin and upright squeeze grip.
   3. Finish: Factory powder-coated: Red.
   4. UL Effectiveness Rating in accordance with UL 711: Class A, B, and C fires.
   5. UL Rating in accordance with UL 711: 4A-80BC.
   6. Drawing will use the symbol FE for “Fire Extinguisher”.

2.03 WALL BRACKETS

A. Type: Standard as manufactured by fire extinguisher manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance NFPA 10, Standard for Portable Fire Extinguishers.

3.02 LOCATIONS

A. Install fire extinguisher type, FE, as indicated on the Drawings.

B. Install fire extinguisher wall brackets as indicated on the Drawings.

END OF SECTION

SECTION 11312G

SUBMERSIBLE LARGE CAPACITY CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for provision of pump systems including submersible non-clog motor-driven pumps for service as scheduled.

B. Tag numbers: As specified in Pump Schedule.

C. Pre-negotiated price. The purchase price of the submersible pumps, as specified herein has been pre-negotiated with the manufacturer to match existing. The pre-negotiated price is $140,100, not including taxes. The price shall be used in preparing the lump sum base bid. The purchase price shall include the Scope of Supply identified in this specification as outlined in the attached Scope of Supply letter from the manufacturer, dated March 27, 2023. The Contractor shall review the scope of supply and provide all additional appurtenances, equipment, installation labor, testing, and other services for a complete system. This price is based on completed equipment delivery during the time from Notice to Proceed to January 2024. If the Contractor elects to have delivery after this time, the purchase price shall be adjusted in accordance with the change in value of the overall Engineering News Record Construction Cost Index for 20 cities. Change in value shall be borne by the Contractor and shall be computed from January 2024 to the completed delivery date.

D. Cost of pre-negotiated items:
   1. The Contractor shall carefully review the applicable pre-negotiated proposal to determine those items required by the Contract Documents which are not part of the proposal or specified Supplier/Manufacturer's scope of supply. In addition to the cost indicated for the applicable bid item in the pre-negotiated proposal, the Contractor shall include in his bid the costs for the following:
      a. All items not specifically itemized in the Supplier/Manufacturer's Scope of Supply provided as part of the pre-negotiated proposal, but required by the Contract Documents and/or necessary to provide a complete and operational system.
      b. All items specifically itemized in the Supplier/Manufacturer's Scope of Supply provided as part of the pre-negotiated proposal which are designated to be provided by others, provided by customer, provided by Owner, or any similar designation.
      c. All labor, materials, and all other associated costs not included in the pre-negotiated proposal but required by the Contract Documents and required to provide a complete and operational system.
      d. Any additional cost required by the supplier due to any charges the Contractor may wish to make to the terms and/or conditions of the pre-negotiated proposal, including but not limited to payment terms, delivery schedule, scope or work, etc.

1.02 REFERENCES

A. American Bearing Manufacturers' Association (ABMA):
   1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. A108 - Standard Specification for Steel Bars, Carbon and Alloy, Cold-Finished.
   3. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   4. A582 - Standard Specification for Free-Machining Stainless Steel Bars.
   5. A743 - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion-Resistant, for General Application.
   6. B148 - Standard Specification for Aluminum-Bronze Sand Castings.
   7. B505 - Standard Specification for Copper Alloy Continuous Castings.
   8. B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
   9. E10 - Standard Test Method for Brinell Hardness of Metallic Materials.
   10. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   11. F594 - Standard Specification for Stainless Steel Nuts.

C. CSA International (CSA).

D. Food and Drug Administration (FDA).

E. FM Global (FM).

F. Hydraulic Institute (HI):
   1. 1-1.2 - Rotodynamic (Centrifugal) Pumps for Nomenclature and Definitions.
   2. 1.3 - Rotodynamic (Centrifugal) Pumps for Design and Application.
   3. 9.1-9.5 - Pumps - General Pump Standards for Types, Definitions, Application, and Sound Measurements and Decontamination.
   4. 14.6 - Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.

G. Insulated Cable Engineer's Association (ICEA).

H. National Electrical Code (NEC).

I. National Electrical Manufacturers Association (NEMA).

J. Underwriters Laboratories, Inc. (UL).

1.03 DEFINITIONS

A. Pump head (total dynamic head, TDH), flow capacity, pump efficiency, net positive suction head available (NPSHa), and net positive suction head required (NPSHr): As defined in HI 1.1-1.2, 1.3, 9.1-9.5 and 14.06 and as modified in the Specifications.

B. Suction head: Gauge pressure available at pump intake flange or bell in feet of fluid above atmospheric; average when using multiple suction pressure taps, regardless of variation in individual taps.

C. Allowable Operating Region (AOR): The region over which the service life of the pump is not seriously compromised by hydraulic loads, vibration, or flow separation where the pump's vibration, noise, and cavitation are within acceptable limits.

D. Preferred Operating Region (POR): The region over which the service life of the pump will not be significantly affected by hydraulic loads, vibration, or flow separation where the pump's vibration, noise, and cavitation are within acceptable limits.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

C. Shop drawings: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

D. Calculations: As specified in Section 15050 - Common Work Results for Mechanical Equipment:
   1. Torsional analysis: Submit when scheduled and as specified in Section 15050 - Common Work Results for Mechanical Equipment.

E. Vendor operation and maintenance manuals: As specified in Section 01782 - Operation and Maintenance Data.

F. Commissioning submittals:
   1. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756 - Commissioning.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.05 WARRANTY

A. As specified in General Conditions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Pump: One of the following or equal:
   1. ITT Flygt, CP series.

B. Variable frequency drives:
   1. As specified in Section 16262 - Variable Frequency Drives 0.50 - 50 Horsepower.

2.02 SYSTEM DESCRIPTION

A. Submersible pumps and components: Submersible pumps, drivers, motors, variable frequency drives, electrical cable, lifting eyes, lifting cable or chain and guide rails, guide rail supports, self-aligning discharge connection, and other items specified in the Pump Schedule as required for complete operational units.

B. Design requirements:
   1. Pump performance characteristics:
      a. As specified in the Pump Schedule.
      b. Performance tolerances shall be the same as the test tolerances specified in Section 15958 - Mechanical Equipment Testing.
   2. Motor characteristics: As specified in Pump Schedule.

C. Product requirements as specified in Section 01600 - Product Requirements and Section 15050 - Common Work Results for Mechanical Equipment.

2.03 MATERIALS

A. General: When materials are referenced in this Section or on the pump schedule, the compositions shall be the UNS Alloys, Types, or Grades unless specified or scheduled otherwise.

B. Cast iron: ASTM A48, Class 35 B minimum.

C. Nickel cast iron: ASTM A48, Class 35 minimum with 3 percent nickel added.

D. Steel: ASTM A108, Grade or UNS Alloy as specified or scheduled.

E. Stainless steel: ASTM A276 or ASTM A582, Type or UNS Alloy as specified or scheduled.

F. Bronze: ASTM B505 or ASTM B584, UNS Alloy C83600.

G. Zincless bronze: ASTM B505 or ASTM B584, Leaded Tin Bronze, UNS Alloy C92700.

H. Aluminum bronze: ASTM B148, ASTM B505 or ASTM B584, UNS Alloy C95200.

I. Fasteners: Stainless steel, ASTM F593 or ASTM F594, type or grade as specified.

2.04 PUMP CASINGS

A. Type: 2 piece; pump and motor casing bolted together; machined seal faces with Nitrile or Buna N rubber o-ring seal; Type 304 stainless steel bolting.

B. Material: As scheduled.

C. Construction: Of sufficient strength, weight, and thickness to provide accurate alignment and watertightness.

D. Design working pressure: Minimum 1.10 times maximum shutoff total dynamic head with maximum installable impeller diameter at maximum operating speed plus maximum suction static head; suitable for submergence in up to 65 feet of water.

E. Hydrostatic test: 5-minute hydrostatic test minimum 1.5 times Design Working Pressure.

F. Discharge interface:
   1. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal-to-metal watertight contact.
   2. Self-aligning without bolting or having to enter the wet well.

2.05 IMPELLERS

A. Type: As scheduled.

B. Material: As scheduled.

C. Maximum number of vanes: As scheduled.

D. Water passages: Smooth, able to prevent clogging by stringy or fibrous and to pass spherical solids of size scheduled.

E. Method of securing to shafts: Keyed and secured by bronze nut or Allen head bolt locked in place, but readily removable without use of special tools.

F. Rotation: Clockwise looking from driver, unless otherwise indicated on the Drawings.

G. Balance: As specified in Section 15050 - Common Work Results for Mechanical Equipment to meet the vibration criteria as specified in Section 15958 - Mechanical Equipment Testing.

2.06 WEAR RINGS AND WEAR PLATES

A. Provide one of the following systems:
   1. Wear ring system:
      a. General: Used to provide efficient sealing between the volute and suction inlet of the impeller.
      b. Volute wear ring:
         1) Material: Steel coated with Nitrile rubber.
         2) Fitted to the volute inlet.
      c. Impeller wear ring:
         1) Material: Type 316 stainless steel.
         2) Heat-shrunk fitted onto the suction inlet of the impeller.
   2. Wear plate system:
      a. Material: Cast iron, ASTM A48, Class 40.
      b. Attached to the pump volute to prevent rotation.
      c. Replaceable and adjustable to maintain proper clearances between the wear plate and the impeller.

2.07 PUMP SHAFTS

A. Material: As scheduled at the end of Execution section of this Section, turned, ground, and polished.

B. Strength: Able to withstand minimum 1.5 times maximum operating torque and other loads.

C. Resonant frequency: As specified in Sections 15050 - Common Work Results for Mechanical Equipment and 15958 - Mechanical Equipment Testing.

D. Deflection: Maximum 0.002 inches under operating conditions.

2.08 MECHANICAL SEALS

A. Provide dual tandem mechanical seal system with oil for seal lubrication and cooling:
   1. Shaft sealing system shall be capable of withstanding volute pressure up to 1.5 times pump shutoff head.
   2. No seal damages shall result from operating the pumping unit in its liquid environment, from running pump dry, or from reverse pump operation.

B. Oil chamber:
   1. Provide oil chamber for shaft sealing system. Design oil chamber to ensure that air is left in the oil chamber to absorb the expansion of the oil due to temperature variations.
   2. Provide drain and inspection plug, with positive anti-leak seal, easily accessible from the outside.
   3. Oil-in-oil chamber shall be FDA-approved, paraffin-type, colorless, odorless, and non-toxic.
   4. Provide capacitive type leakage sensor for the detection of water in the oil chamber or a moisture sensor in the lower motor chamber to detect any fluid in the motor.

C. Upper seal:
   1. Tungsten carbide or silicon carbide rotating seal and tungsten carbide stationary seal as specified in Section 15050 - Common Work Results for Mechanical Equipment.
   2. Submerged in oil chamber located below the stator housing.

D. Lower seal:
   1. Tungsten Carbide rotating and stationary seals as specified in Section 15050 - Common Work Results for Mechanical Equipment.

E. Springs and other hardware: Stainless steel, 300 or 400 series.

2.09 BEARINGS

A. Pump shaft shall rotate on a minimum of 2 permanently sealed, grease lubricated bearings:
   1. Upper bearing for radial forces.
   2. Lower bearing for combined axial and radial forces.

B. Bearing type: Anti-friction in accordance with ABMA standards.

C. Provide lower bearing with independent thermal sensor to monitor the bearing temperature. If a high temperature occurs, the sensor shall activate an alarm and shut down the motor.

D. Bearing lubrication system shall be sized sufficiently to safely absorb heat energy normally generated in bearing under maximum ambient temperature of 60 degrees Celsius when pump scheduled for dry running. Bearing life: Minimum L10 life of 100,000 hours at rated design point or 24,000 hours in accordance with ABMA 9 or 11 at bearing design load imposed by pump shutoff with maximum sized impeller at rated speed, whichever provides longest bearing life in intended service.

2.10 MOTORS AND POWER CABLES

A. Motors: Features as specified and as scheduled:
   1. Provide motors that are rated suitable for continuous operation in 40 degrees Celsius ambient temperature at project site altitude.
   2. Horsepower:
      a. As scheduled in the Pump Schedule:
         1) Listed motor horsepower is the minimum to be supplied. Increase motor horsepower if required to prevent motor overload while operating at any point on the supplied pump operating head-flow curve, including runout. However, variable frequency drives, generator, and other electrical equipment are sized for scheduled motor horsepower.
         2) Make all structural, mechanical, and electrical changes required to accommodate increased horsepower.
   3. Revolutions per minute: As scheduled in the Pump Schedule.
   4. Enclosure: As scheduled in the Pump Schedule.
   5. Electrical characteristics: As scheduled in the Pump Schedule.

B. Motor construction:
   1. Squirrel cage induction motor, shell design.
   2. If explosion proof motor is scheduled, provide motor that is UL or FM listed for NEC Class I, Division 1, Groups C and D service, whether submerged or unsubmerged.
   3. NEMA design type: B.
   4. Motor insulation, either one:
      a. Class F, moisture resistant, rated for 155 degrees Celsius.
      b. Class H, moisture resistant, rated for 185 degrees Celsius.
   5. The motor shall be designed for continuous duty handling pumped media of 40 degrees Celsius and capable of a minimum of 15 evenly spaced starts per hour.
   6. The motor shall be capable of continuous operation under load with the motor submerged, partially submerged, or exposed, without derating the motor
   7. Motor cooling system:
      a. Design to provide adequate cooling:
         1) At the minimum operating speed with a variable frequency drive.
         2) With motor submerged.
         3) With motor dry.

b. Provide external motor cooling water jacket:
    1) Material: As scheduled.
    2) With non-clogging ports and channels.
    3) Using the pumped fluid as the cooling media.
    4) With inspection ports or other means of access for cleaning/flushing.
c. Provide capability to relieve entrapped air from the system.
d. Shall be upgradable to include connections for external seal flushing and cooling water.
e. Spray systems, air moving equipment or other secondary cooling systems are not acceptable.

8. Motor sealing: Design motor case and seals to withstand 65 feet of submergence.
9. When variable frequency drive is scheduled, motor shall be capable of continuous inverter duty over the speed range specified.

C. Power cables:
1. Submersible to same water depth as motor casing.
2. Type SPC with Hypalon/Buna N jacket.
3. Insulation rated for 90 degrees Celsius.
4. Non-wicking fillers.
5. Length: Sufficient to connect to surface junction box (without the need of splices) as indicated on the Drawings or 30 feet, whichever is greater.
6. Sized to conform to NEC, ICEA, and CSA specifications.
7. Provide stainless steel cable and stainless steel wire braid sleeve to support power cable from underside of wet well roof slab or access frame.

D. Cable entry seal and junction chamber:
1. Cable entry seal design shall not require specific torque requirements to insure a watertight and submersible seal.
2. Cable entry seal shall consist of dual cylindrical elastomer grommets, flanked by stainless steel washers.
3. The cable entry seal shall provide strain relief for the cable.
4. The cable entry junction chamber shall be separate from the motor chamber to prevent foreign material from gaining access to the top of the pump.
5. Provide a moisture detection sensor in the cable junction chamber. If leakage is detected, the sensor shall activate an alarm and shut down the pump/motor.

E. Control/protection module:
1. Each pump shall be supplied with its own self-contained control/protection module to provide for the direct connection to all internal pump monitoring devices, including:
    a. Thermal protection: Provide automatic reset motor stator temperature detectors, 1 switch in each phase winding. If any detector is activated, the sensor shall activate an alarm and shut down the motor. The thermal detectors shall activate when the stator temperature exceeds 125 degrees Celsius.

b. Moisture detection: One of the following:
   1) Provide capacitive type leakage sensor for the detection of water in the oil chamber or a moisture sensor in the lower motor chamber to detect any fluid in the motor. The sensor shall have an explosion proof rating.
   2) Provide a small float to detect the presence of water in the stator chamber.

F. The module shall signal an alarm condition if any of the internal monitoring devices is activated.

2.11 SUPPORT BASE AND DISCHARGE ELBOW

A. Provide cast-iron support base and discharge elbow for installation in wet pit.

B. Discharge elbow to mate to pump discharge and transition to discharge piping.

C. The entire weight of the pump/motor shall be borne by the pump discharge elbow.

2.12 GUIDE RAILS AND LIFTING DEVICES

A. General: Provide guide rails and lifting devices suitable for wet pit installation as scheduled in Execution and as indicated on the Drawings.

B. Materials:
   1. Guide rails, lifting cable or chain and wall supports: Type 304 stainless steel.
   2. Anchor bolts: As specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

C. Wet pit guide rails.

D. Lifting device.

2.13 SPARE PARTS AND SPECIAL TOOLS

A. Special tools: Deliver 1 set for every furnished pump type and size needed to assemble and disassemble pump system. Spare parts: Provide 1 of the following for each size or type of pump; deliver as specified in Section 01600 - Product Requirements.

B. Spare parts: Deliver the following as specified in Section 01600 - Product Requirements:
   1. Upper bearing set.
   2. Lower bearing set.
   3. Upper and lower mechanical seal set.
   4. Wear ring set (rotating and stationary).
   5. Casing seal gaskets or o-rings.
   6. Power cable entry seal set.
   7. Pump impeller.

PART 3 EXECUTION

3.01 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Source Testing.
      b. Manufacturer's Certificate of Installation and Functionality Compliance.
   2. Manufacturer's Representative onsite requirements:
      a. Installation: 1 trip, 1-day minimum.
      b. Functional Testing: 1 trip, 1-day minimum each.
   3. Training:
      a. Maintenance: 4 hours per session, 2 sessions.
      b. Operation: 2 hours per session, 2 sessions.
   4. Process operational period:
      a. As required by Owner or Contractor.

C. Source testing: As specified in Pump Schedule.

D. Functional testing: As specified in Pump Schedule.

3.02 PUMP SCHEDULE

Tag Numbers	**06-PMP-6004 06-PMP-6005**
General Characteristics:	
Service	Secondary Effluent
Quantity	2
Max. Noise, dBA at 3 Feet	Not Required
Torsional Analysis	Not Required
Minimum Pumped Fluid Degrees Fahrenheit	60
Normal Pumped Fluid Degrees Fahrenheit	70
Max. Pumped Fluid Degrees Fahrenheit	80
Installation Configuration	Wet Pit
Pump Characteristics:	
Impeller Type	Non-Clog
Impeller, Maximum Number Vanes	2
Pass Minimum Sphere Size, Inch	3
Speed Control	Variable Frequency Drive
Maximum Pump Speed, rpm	1170
Minimum Pump Speed, rpm	585

Tag Numbers	06-PMP-6004 06-PMP-6005
Rated Design Point: (at Maximum Revolutions per Minute):	
Flow, gpm	1800
Head, Feet	42
Minimum Hydraulic Efficiency, Percent	68
Maximum Active Input, Horsepower	37
Required Condition 2: (at Maximum Revolutions per Minute):	
Flow, gpm	2500
Head Range, Feet	37 to 40
Minimum Overall Efficiency, Percent	68
Required Condition 3: (at Maximum Revolutions per Minute):	
Flow Range, gpm	1400
Head, Feet	53 to 58
Minimum Overall Efficiency, Percent	61
Required Condition 4: (at Maximum Revolutions per Minute):	
Flow Range, gpm	1000
Head, Feet	58 to 64
Minimum Overall Efficiency, Percent	53
Required Condition 5: (at Maximum Revolutions per Minute):	
Flow Range, gpm	1400
Head, Feet	14 to 18
Minimum Hydraulic Efficiency, Percent	50
Required Condition 6: (at Intermediate Revolutions per Minute):	
Flow, gpm	900
Head, Feet	14 to 17
Minimum Hydraulic Efficiency, Percent	50
Other Conditions:	
Maximum NPSHr at Every Specified Flow, Feet	16
Minimum NPSHa at Every Specified Flow, Feet	10
Minimum Suction Static Head, Feet	8
Maximum Suction Static Head, Feet	11

Tag Numbers	06-PMP-6004 06-PMP-6005
Pump Materials:	
Pump and Motor Casing	Cast Iron
Impeller	ASTM A-532 (Alloy III A) 25 percent chrome cast iron
Shaft	420 Stainless Steel
Shaft Key	316 Stainless Steel
Motor Cooling Water Jacket	Cast Iron
Motor Characteristics:	
Variable Frequency Drive	As specified in Section 16262 - Variable Frequency Drives 0.50 - 50 Horsepower
Minimum Submergence	Exposed
Maximum Driver Speed, rpm	1170
Motor Horsepower, Minimum	40
Voltage/Phases/Hertz	460/3/60
Service Factor	1.15
Full Load Current, Amperes	42
Locked Rotor Current, Amperes	225
Motor Efficiency (At 100 Percent Load) Minimum	Percent
Enclosure Type	Submersible, Explosion Proof
Source Testing:	
Test Witnessing	Not Witnessed
Performance Test Level	3
Vibration Test Level	None
Noise Test Level	None
Functional Testing:	
Performance Test Level	1
Vibration Test Level	None
Noise Test Level	None

END OF SECTION

ATTACHMENT A - SCOPE OF SUPPLY LETTER

SHAPE INCORPORATED
– a UFT Company –

SANITATION ● HYDRAULIC ● AND PROCESSING EQUIPMENT

PLEASANTON	***SACRAMENTO***	***STOCKTON***
5976 W. Las Positas Blvd. #226 Pleasanton, CA 94588 Phone (925) 485-9720	2200 Sunrise Ave, Ste 240 Gold River, CA 95670 Phone (916) 309-4132	119 Val Dervin Parkway # 2 Stockton, CA 95206 Phone (209) 234-5909

QUOTATION

TO:	City of Petaluma - Finance PO Box 61 Petaluma, CA 94953	**DATE:**	03-27-2023
		QUOTE #:	111641
		DESC:	
		JOB:	Petaluma Tertiary Upgrade
		LOCATION:	
ATTN:	Estimating	**PHONE:**	
		EMAIL:	

WE ARE PLEASED TO QUOTE ON THE FOLLOWING EQUIPMENT SUBJECT TO CONDITIONS PRINTED ON LAST PAGE HEREOF, THESE CONDITIONS MAY BE CHANGED ONLY BY A WRITTEN STATEMENT SIGNED BY AN OFFICER OF SHAPE, INCORPORATED.

☐ F.O.B. FACTORY
☒ F.F.A. TO FIRST DESTINATION

Qty	Item	Price
2	Flygt NP3202 w/ 642 Trim Hard Iron "N" Impeller. 8" Discharge 35HP, 460V 3Ph, FM Rated. Equipped w/ Thermal and Moisture Protection. Inc 50' Cable	
2	8" Discharge Elbow - Standard Coating	
2	Mini Cas - Thermal Relay - Installed in panel by others	
2	3" Upper Guide Rail Bracket - 316 SS	
80	3" Guide Rail (20' Lengths)	
1	Cable Holder - 316SS	
80	3/8" Chain - 316SS	
4	1/2" Shackle - 316SS	
1	Engineering Support and Documentation	
1	Start Up Support and Training	
1	Non- Witnessed Factory Testing	
1	Freight	
	Total for Above Equipment:	**$140,100.00**

Notes and Clarifications:

Grand Total:	**$140,100.00**

Notes:

1. QUOTE IS VALID FOR 45 DAYS, See attached TOCs for details
2. Price DOES NOT INCLUDE ANY APPLICABLE TAXES
3. Price INCLUDES Freight: F.F.A.
4. Price does not include: installation, equipment unloading, pipe, conduit, anchor bolts, guide bars/rails or any other items not listed.
5. *ESTIMATED* EQUIPMENT LEAD TIME: A) Pumps 12-14 WEEKS B) ACCESSORIES 10-12 WEEKS

SHAPE, INC.
travis headen - theaden@shapecal.com

QUOTATION DOES NOT INCLUDE ANY SALES OR USE TAX PAYABLE UNDER ANY STATE OR FEDERAL STATURE. THIS QUOTATION PRICE IS FOR MATERIAL LISTED ABOVE. ANY ADDITIONS OR MODIFICATIONS THAT BECOME NECESSARY FOR APPROVED SUBMITTALS, UPON AWARDING OF THIS CONTRACT, MAY RESULT IN NECESSARY PRICE CHANGES.

NOTE: ITEMS NOT SPECIFIED ON THIS QUOTATION ARE NOT INCLUDED IN OUR PRICE AND ARE TO BE SUPPLIED BY OTHERS. PRICES ARE FOR IMMEDIATE ACCEPTANCE AND SUBJECT TO CHANGE WITHOUT NOTICE. SALE SUBJECT TO MANUFACTURERS STANDARD TERMS AND CONDITIONS. 30% Re-stocking fee.

SHAPE, INC. - CONDITIONS OF SALE

Quote is valid for 45-days. Prices can only be guaranteed if scope is released for production within 120-days of quote date. Please note a PO does not constitute equipment release.

Interest of 1% per month will be charged on all past due accounts.

No retention will be allowed.

This quotation is based on the quantity and description of the material shown in the quotation. We do not guarantee quantities, types, or arrangements of equipment listed – the correct takeoff is the responsibility of the contractor or customer.

We do not guarantee acceptance or approval of the equipment listed in this quotation since the selection and sizing of this equipment is, to the best of our knowledge, the equipment specified of as nearly equal as possible with the equipment listed.

The price stated in this proposal is for immediate acceptance.

Any sales or other tax not specifically mentioned in this proposal, applicable to the sale of any equipment or material listed herein which may become effective before the date of the final shipment, is to be added to the price quote herein.

All equipment shall remain the personal property of SHAPE, INC. until all payments have been made in cash, and the giving and accepting of drafts, notes, and/or trade acceptances to evidence the payments due shall not constitute or be construed as payment so as to pass title until said drafts, notes and/or trade acceptances are paid in full in cash.

If shipment is postponed at the request of the purchaser after manufacturer has been commenced, payment will be due on notice from us that the equipment is ready for shipment. Pro rata payments shall be made for partial shipments.

We make every effort to ship on dates promised, and to maintain production schedules consistent therewith, but we are not liable for claims of damage or any other expense due to failure to meet the scheduled shipping date.

We guarantee that the equipment herein described will, when properly erected and operated in accordance with our instructions, perform the work for which it is sold.

We will assume no responsibility or expense for repairs made on the apparatus when done outside our factory without our written authority.

We do not guarantee prime movers, starting equipment, electrical apparatus, or materials not manufactured by us, same being covered by guarantees of their respective manufacturers.

We guarantee this equipment for one year from date of shipment against defects of workmanship or material, and will furnish F.O.B. our factory ant parts proven defective. We assume no liability for corrosion or fouling of the equipment by any foreign material that may be deposited.

It is expressly understood we are not responsible for and will not be held liable for damage and/or injury caused to buildings, contents, products, or persons by reason of the installation of any of our products.

If attorney's fees and costs must be incurred to enforce the condition of sale (whether or not legal action is instituted), the prevailing party shall be entitled to recover reasonable attorney's fees and costs.

SECTION 11312J

SUBMERSIBLE PROCESS LIQUID SUMP PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Packaged submersible sump pumps, with a control panel and instrumentation.

B. Tag numbers: As specified in Pump Schedule.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   3. D2000 - Standard Classification System for Rubber Products in Automotive Applications.

B. Hydraulic Institute (HI):
   1. 1.1-1.2 - Rotodynamic (Centrifugal) Pumps for Nomenclature and Definitions.
   2. 1.3 - Rotodynamic (Centrifugal) Pumps for Design and Application.
   3. 9.1-9.5 - Pumps - General Guidelines for Types, Definitions, Application, Sound Measurement, and Documentation.
   4. 11.6 - Rotodynamic Submersible Pump for Hydraulic Performance, Hydrostatic Pressure, Mechanical, and Electrical Acceptance Tests.

C. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

1.03 DEFINITIONS

A. NEMA:
   1. Type 4X enclosures in accordance with NEMA 250.

B. Pump head (Total Dynamic Head, TDH), flow capacity, pump efficiency, net positive suction head available (NPSHa), and net positive suction head required (NPSHr): As defined in HI 1.1-1.2, 1.3, 9.1-9.5 and 11.6 and as modified in this Section.

C. Suction head: Gauge pressure available at pump intake flange or bell in feet of fluid above atmospheric; average when using multiple suction pressure taps, regardless of variation in individual taps.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

C. Shop drawings: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

D. Vendor operation and maintenance manuals: As specified in Section 01782 - Operation and Maintenance Data.

E. Commissioning submittals:
   1. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756 - Commissioning.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.05 WARRANTY

A. As specified in General Conditions.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Components: Overhung impeller, close coupled, single stage, volute style, end suction submersible sewage pump. Other items include: Control panel, level control instrumentation, discharge piping, necessary valves, gauges, taps, lifting eyes, stands, and other items as required for a complete and operational system.

B. Design requirements:
   1. Pump performance characteristics: As specified in the Pump Schedule, Pump Performance Characteristics:
      a. As specified in the Pump Schedule.
      b. Performance tolerances shall be the same as the test tolerances specified in Section 15958 - Mechanical Equipment Testing.
   2. Motor characteristics: As specified in the Pump Schedule.
   3. Suitable for pumping raw sewage.

C. Product requirements as specified in Section 01600 - Product Requirements and Section 15050 - Common Work Results for Mechanical Equipment.

2.02 GENERAL USE SUMP PUMP

A. Pumps: Manufacturers: One of the following or equal:
   1. Barnes. (Crane Pumps & Systems), SE series.
   2. ITT Goulds Pumps, WS series.
   3. Hydromatic, SKHS series.

B. Materials:
   1. Cast Iron: ASTM A48, Class 30 minimum.
   2. Stainless Steel: ASTM A276 or equal.
   3. Buna N: ASTM D2000.

C. Pump casing:
   1. Material: Cast iron.
   2. Design Working Pressure: 1.5 times the shut off pressure.

3. Provide support legs on sump bottom and clearance for suction entrance.
4. The discharge connection shall be a 2 or 3-inch NPT vertical connection.

D. Impellers:
1. Material: Cast iron.
2. 2-vane; maximum enclosed; non-clogging; with pump-out vanes on backside; dynamically balanced; close coupled to motors.
3. Method of securing to shafts: Threaded lock nut or similar connection.

E. Pump shafts:
1. Material: 400 series stainless steel.

F. Bearings:
1. Upper bearing: Single row; oil lubricated.
2. Lower bearing: Single row; oil lubricated.

G. Shaft seal:
1. Single mechanical seal.
2. Materials:
a. Silicon carbide versus silicon carbide seal faces.
b. Carbon versus ceramic seal faces.
3. Elastomer and hardware: Buna-N and 300 series stainless steel.

H. Drivers:
1. Motors:
a. NEMA B design.
b. Oil filled submersible motor.
c. Insulation:
1) 1.5 horsepower and above: Class B.
2) Under 1.5 horsepower: Class F.
d. Power: 230/460 volt, 3 phase, 60 hertz.
e. 1.15 service factor.
f. Pumps shall be able to operate continuously without exceeding pumps service capacity when immersed in water up to 104 degrees Fahrenheit.
g. Cable: Minimum length sump depth to the VCP, plus 15 feet, armored, waterproof cable securely attached to motors with watertight fittings.

I. Accessories:
1. Lifting chains or cables:
a. Material: Type 304 stainless steel.
b. Attached to balance point of pump; suitable for lifting pump from sump; long enough to extend from sump cover or grating.
c. Hooks: Suitable to provide storage of chain or cable at top of sump.
2. Lifting hangars:
a. Material: Type 304 stainless steel.
b. Suitable to provide storage of chain or cable at top of sump.

J. Finishes:
1. Pump manufacturer to factory prime and coat pump/motor and discharge elbow as specified in Section 09960 - High-Performance Coatings.
2. Contractor to provide touch-up field coatings as specified in Section 09960 - High-Performance Coatings.

2.03 CONTROLS

A. General:
   1. Provide a vendor control panel at each installation for control of the pumps, except as indicated on the pump schedule.

B. Vendor control panel:
   1. Construction and components as specified in Section 17710 - Control Systems: Panels, Enclosures, and Panel Components.
   2. Enclosure:
      a. As indicated in the pump schedule.
   3. Electrical components:
      a. Main circuit breaker:
         1) As specified in Section 16412 - Low Voltage Molded Case Circuit Breakers.
         2) Flange-mounted operator:
            a) Pad-lockable in the off position.
         3) Disconnects all power to the panel.
         4) Interlock with the panel door:
            a) Defeat mechanism.
      b. Motor starter for each pump:
         1) Motor circuit protector circuit breaker.
         2) Full voltage non-reversing magnetic starter.
         3) Thermal or electronic overloads.
      c. Control power transformer:
         1) Primary voltage: 230/460 VAC, 3 phase, 60 hertz.
         2) Secondary voltages:
            a) Control and status points to the facility SCADA system: 120 volt.
            b) Additional voltages as required by the application.
         3) Sized for all panel components plus 10 percent spare capacity.
         4) Primary and secondary fuses.
   4. Control components:
      a. Terminal strips:
         1) Provide terminal strips for landing all external wiring.
      b. Relays, timers, and other components as required providing the specified functionality and remote monitoring connections.
   5. Duplex operation:
      a. Front Panel Controls:
         1) HAND/OFF/AUTO switch.
         2) START pushbutton for each pump.
         3) STOP pushbutton for each pump.
         4) LEAD-STANDBY selector switch which will permit operator selection of either Pump Number 1 or Pump Number 2 as the lead pump during automatic operation.
         5) Momentary LOW-LEVEL OVERRIDE pushbutton.
         6) Running pilot light for each pump.
         7) Stopped pilot light for each pump.
         8) Power pilot light.
         9) Pump fault pilot light for each pump.
         10) High-High-level alarm.

11) Audible alarm horn.
12) Alarm beacon:
a) Alarm silence pushbutton.

b. Remote monitoring and control:
1) Provide dry relay contact outputs for the following:
a) Pump Fault alarm: one for each pump.
b) Pump Run status: each pump.
c) High-High Level Alarm.

c. Operation:
1) Hand:
a) The pump shall run when the START pushbutton is pressed.
b) The pump shall stop when the STOP pushbutton is pressed.
c) The LOW-level switch shall stop the pump.
d) The LOW-level switch shall be over ridden by the momentary LOW-LEVEL OVERRIDE pushbutton.
2) Off: Pump shall stop operation:
a) Placing the hand switch in the OFF position shall reset all alarm conditions.
3) Auto: The pump shall operate automatically in response to level switch signals:
a) The lead pump shall start when the rising water level in the sump causes level switch HIGH-level switch to activate.
b) The lead pump shall stop when the falling water level in the sump causes level switch LOW-level switch to activate.
c) If the lead pump fault alarm is activated the standby pump shall replace the lead pump.
d) A high- high level shall cause the HIGH-HIGH-level switch to activate and activate the HIGH-HIGH-level alarm.

2.04 SPARE PARTS AND SPECIAL TOOLS

A. Special tools: For each type or size of pump specified, provide 1 set of all special tools required for complete assembly or disassembly of the pump system components.

PART 3 EXECUTION

3.01 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
1. Provide certificates:
a. Manufacturer’s Certificate of Source Testing.
b. Manufacturer’s Certificate of Installation and Functionality Compliance.
2. Manufacturer’s Representative onsite requirements:
a. Installation: 1 trip, 1-day minimum.
b. Functional Testing: 1 trip, 1-day minimum each.
3. Training:
a. Maintenance: 4 hours per session, 2 sessions.
b. Operation: 2 hours per session, 2 sessions.

4. Process operational period:
   a. As required by Owner or Contractor.

C. Source testing: As specified in Pump Schedule.

D. Functional testing: As specified in Pump Schedule.

3.02 PUMP SCHEDULE

A. Pump characteristics:

Tag Numbers	**EX-06-PMP-101** **EX-06-PMP-102**
Location	Filter Piping Gallery (Existing Continuous Backwash Filters)
Service	Washdown Water, Drainage
Service Material	General
Pump Type	Duplex
Capacity, gpm	100 gpm
Total Dynamic Head (TDH), Feet	20 feet
Motor Horsepower	1.0 minimum
Motor Speed, revolutions per minute	1,800 rpm
VCP Required	Yes
VCP Enclosure	NEMA 4X Stainless Steel

END OF SECTION

SECTION 11366B

CLOTH MEDIA DISK FILTER

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Pre-engineered cloth media filter systems.

B. As specified in Section 15050 - Common Work Results for Mechanical Equipment.

C. Pre-negotiated price. The purchase price of the Cloth Media Disk Filter Equipment, as specified herein has been pre-negotiated with the Supplier. The total pre-negotiated price is to be updated by Addendum. The price shall be used in preparing the lump sum base bid. The purchase price shall include the scope of supply identified in this specification as outlined in the attached Scope of Supply letter from the manufacturer, dated April 28, 2023 (to be added by Addendum). The Contractor shall review the scope of supply and provide all additional appurtenances, equipment, installation labor, testing, and other services for a complete system. This price is based on an order placed by August 1, 2023, and completed mechanical equipment delivery prior to March 15, 2024, and electrical equipment delivery prior to June 16, 2024. If the Contractor elects to have delivery after this time, the purchase price shall be adjusted in accordance with the change in value of the mutually agreeable Bureau of Labor Statistics indices. Changes in value shall be borne by the Contractor and shall be computed from the completed delivery to June 16, 2024.

1.02 REFERENCES

A. American Gear Manufacturers Association (AGMA).

B. Institute of Electrical and Electronic Engineers (IEEE):
   1. 841 - IEEE Standard for Petroleum and Chemical Industry - Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors - Up to and Including 370 kW (500 hp).

C. National Electrical Manufacturer’s Association (NEMA).

1.03 SYSTEM DESCRIPTION

A. A complete cloth media filter system including, but not limited to items stated in this Section, shall be supplied by Aqua-Aerobic Systems, Inc.

B. Cloth media filter system including provisions for sludge wasting or tank draining, backwashing, and all appurtenances necessary for a complete and operational modular assembly:
   1. All mechanisms and components that are required to complete a functional cloth media filter system should be furnished by manufacturer consisting of center tube assemblies with cloth media disks, drive assemblies,

backwash/sludge discharge assemblies, automatic valves, instruments, electrical controls, and local control panels for each filter.

C. Contractor shall install each cloth media filter system as supplied by the manufacturer. The Contractor shall furnish all labor, materials, equipment, basins, control panels, associated instrumentation and control, and other incidentals required for installation of the cloth disk filter units as specified herein and/or indicated on the Drawings.

D. Two (2) disk cloth media filter systems shall be provided.

E. Process description:
   1. Secondary clarifier effluent (SCE) is pumped to the existing flash mix, and flows by gravity from the flocculation tanks to tertiary filter influent channel and then feeds the existing continuous backwash sand media filter and into each cloth media filter unit, which permeates through the filter cloth. Under normal operation, the disks are stationary and submerged in SCE.
   2. The filtrate, or filtered effluent (FEF), is collected in the center tube and flows through effluent channel and into an 18 inch effluent line then a combined 24-inch filter effluent pipeline to Ultraviolet (UV) disinfection basins.
   3. Along with filtration, solids are removed in the cloth media filter system by sedimentation. The heavier solids settle out before reaching the filter cloth, and a sludge pump that operates intermittently to remove an intermittent sludge pump removes the settled solids through a sludge manifold at the bottom of the tank.
   4. As the SCE flows through the filters, solids are accumulated on and within the disks or vacuum head the depth of the filter cloth, forming a mat that subsequently provides additional filtration:
      a. As the mat is formed, headloss through the cloth increases, causing the liquid level in the tank to rise.
      b. At a predetermined liquid level in the tank, the backwash cycle is initiated.
      c. During backwash, the disks remain submerged while they are rotated at 1 revolution per minute by a drive mechanism.
      d. While the disks are rotating, backwash water, collected in filtrate header (or center tube), is drawn back through the filter cloth through the vacuum suction heads located on either side of each disk.
      e. The reversal of flow removes most particles that have accumulated on the surface of, and within, the filter cloth.
      f. The frequency and duration of backwash depends on the influent feed characteristics, filtration rate, and amount of particles contained on and within the filter cloth not removed by previous backwash cycles.

F. Design criteria:
   1. Treatment capacity:
      a. Number of units: Two (2).
      b. Total design flow: 4 million gallons per day (mgd) (with all units in service).
      c. Total peak flow: 7.6 mgd (with all units in service).
      d. Each filter will be sized to accommodate up to 20 disks (based on center tube size), with initial installation of 16 disks.
      e. With both units online, average hydraulic loading rate (HLR) to be 1.6 gallons per minute (gpm) per square feet, and maximum HLR to be 3.1 gpm per square feet.

2. Influent characteristics:
    a. Maximum total suspended solids: 15 milligrams per liter.
    b. Average total suspended solids: 10 milligrams per liter.
    c. Minimum wastewater temperature: 59.0 degrees Fahrenheit.
3. Effluent characteristics:
    a. The effluent characteristics from the cloth media filter units shall meet the following average day limit under stated treatment capacity and influent characteristic conditions:
        1) State of California Title 22 Code of Regulations (§60301.320).
        2) For filtered wastewater:
            a) 24-hour average turbidity: 2 NTU or less.
            b) Not to exceed maximum turbidity for more than 5 percent of the time within a 24-hour period: 5 NTU
            c) Not to exceed turbidity at any time: 10 NTU
        3) Total suspended solids: 5 milligrams per liter or less (24-Hour composite average).

G. Design requirements:
1. Manufacturer will provide the following components as listed in their proposal. The Contractor shall provide any additional items required for complete functioning filters:
    a. 2 center tube assemblies.
    b. 2 drive system assemblies.
    c. 2 cloth filter media assemblies, each with 861 square feet of minimum effective submerged filtration area and consisting of 16 filter disk assemblies.
    d. 4 backwash pumps (2 pumps per filter).
    e. 8 3-inch ball valves.
    f. 2 backwash support assemblies.
    g. 2 backwash system assemblies.
    h. 2 external piping accessory kits.
    i. 2 pressure transducer assemblies.
    j. 16 electric backwash valves (8 valves per filter).
    k. 4 electric sludge valves.
    l. 2 PLC - based control panels (one per filter).
    m. Basin mounting brackets and hardware.
2. Additional equipment and appurtenances required by the manufacturer.
3. Fit in space as indicated on the Drawings.
4. Align with piping as indicated on the Drawings.
5. All components shall be suitable for outdoor installation, including, but not limited to; controls, wiring and electrical devices, valve operators, materials, piping, and valves.
6. Each equipment shall be delivered to the job site as an assembled unit, when practical, ready for operation after connection to utilities provided by the Contractor.

H. Prefabrication:
1. Manufacturer and Contractor shall coordinate all instrumentation and other device supports to be fabricated with the cloth media filter system and include these supports on the submittal drawings to the Engineer.

2. Submittal shall include preliminary program sequences for PLC as described in Sections 17100 - Control Strategies and 17101 - Specific Control Strategies.
3. Final program sequences shall be submitted for acceptance prior to installation.

I. Provide supports for piping, instrumentation, and other equipment mounted within, against or adjacent to the cloth disk filter units.

J. Piping supports external to the filter units shall be provided by the Contractor.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: As specified in Section 15050 - Common Work Results for Mechanical Equipment:
1. List of parts recommended by the Manufacturer to be replaced after 1 and 3 year(s) service.
2. List of special tools for each type of equipment furnished including special tools necessary for adjustment, operation, maintenance, and disassembly.

C. Shop drawings: As specified in Section 15050 - Common Work Results for Mechanical Equipment:
1. Submit wiring, control schematics, and control logic diagrams for all electrical and control components furnished.
2. Include a completed data sheet (ISA data sheet) for each instrument supplied.

D. Calculations: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

E. Vendor operation and maintenance manuals: As specified in Section 01782 - Operations and Maintenance Data.

F. Commissioning submittals:
1. Provide Manufacturer’s Certificate of Source Testing as specified in Section 01756 - Commissioning.
2. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.05 WARRANTY

A. Provide warranty as specified in General Conditions.

B. Special warranty:
1. Duration: Provide 4-year warranty.
2. Respond to written notification of a warranty problem within 48 hours:
   a. The response will consist of an immediate remedy in which the manufacturer will correct the problem, or if the problem cannot be immediately corrected due to insufficient materials, the manufacturer will notify the Owner of the anticipated schedule for equipment repair.

C. The Manufacturer shall provide a written warranty against non-compliance for use under the design operating conditions for 2 years from date of substantial

completion. This warranty shall begin upon completion of installation (in accordance with approved installation manual), successful start-up by Contractor, successful completion of Owner's training, and acceptance by Owner. All warranties shall be transferred to the Owner from the Contractor at acceptance. All warrantees and support shall be provided directly by the Supplier and not the local manufacturer's representative. No warranties will be pro-rated.

D. The filter system is deemed to be non-compliant if any of following scenarios occur under the design operating conditions:
   1. Tertiary filter effluent quality in any one of the two basins exceeds the design effluent criteria specified herein for any rolling 5-day average.
   2. The proportion of backwash water to tertiary filter influent flow exceeds the backwash criteria specified herein for any rolling 30-day average.
   3. Any filter system component supplied by the filter manufacturer breaks, fails, or otherwise falls out of compliance with its specified function due to defect in materials and workmanship, including damages that may be incurred during shipping, storage, and installation.

E. In the event of filter system non-compliance, the Manufacturer shall provide a response to Owner within 48 hours following written notification of a problem by the Owner. The response will consist of an immediate remedy in which the Manufacturer will correct the problem, or if the problem cannot be immediately corrected due to insufficient materials, the Manufacturer will notify the Owner of the anticipated schedule for equipment repair. The warranty shall cover all the costs associated with problem diagnosis, testing, shipping, problem part replacement (including onsite removal and reinstallation), and additional equipment as necessary for the warranty period at no cost to the Owner. In no event will the cumulative liability to the equipment supplier exceed 100 percent of the purchase price of the equipment.

F. The Manufacturer shall guarantee that both operational support and filter system components will have replacement parts available to the Owner for a period of 20 years upon completion of installation if Manufacturer or Manufacturer's product line is sold. If a specified system component comes out of compliance, the equipment manufacturer may provide an improved component if it meets the same functional intent.

G. Several components of the filter system (e.g. valves, actuators, flow meters, and AFDs) are addressed with dedicated specification sections, which include item-specific warranties. All such filter system components shall be warranted under the longest applicable warranty expressed herein.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 15050 - Common Work Results for Mechanical Equipment.

1.07 MAINTENANCE

A. As specified in Section 15050 - Common Work Results for Mechanical Equipment.

B. Spare Parts: Deliver as specified in Section 01600 - Product Requirements.

1.08 WORK BY OTHERS

A. The following items are provided by the Contractor but shall be coordinated by the Supplier. These items will include:
   1. Structural:
      a. Foundation and concrete structure for supplied CMD filter equipment.
      b. Anchor bolts will be provided and installed by Contractor; anchor bolt design by Filter Supplier.
   2. Mechanical:
      a. Installation materials for instrumentation and automatic valves including but not limited to fittings, and mountings.
      b. Installation of all CMD filter system components.
   3. Electrical:
      a. Electrical wiring interconnections (including wiring, conduit, cable trays, transformers, and other appurtenances required to provide power connections as needed) from the electrical power source to the UV disinfection equipment and master control panels. Contractor shall also be responsible for determining the correct wire sizing and coordinate this information with the Filter Supplier if not shown.
      b. Ethernet communications connection to the Owner's Plant Control System.
      c. Installation of all electrical enclosures for a complete CMD filter disinfection system.
   4. Other:
      a. Receiving, unloading, and safe storage of equipment at site or a storage facility until ready for installation.
      b. Raw materials and utilities during equipment testing.
      c. Laboratory services, operating and maintenance personnel during equipment checkout, startup and operations.
      d. Any onsite painting or touch-up painting of equipment supplied.

PART 2 PRODUCTS

2.01 GENERAL

A. The system equipment covered by these Specifications shall call attention to certain features but may not cover all details of the construction of the media filter system. Ancillary and accessory devices, within the confines of the manufacturer's scope, necessary for the treatment system performance shall be included by the manufacturer whether specified or not.

2.02 MANUFACTURER

A. Manufacturer:
   a. Aqua-Aerobic Systems, Inc. Model: AquaDisk®.

2.03 BASIN

A. Each cloth media filter shall be installed in a concrete basin as indicated on the Drawings and as specified in this Section.

2.04 FILTER EQUIPMENT

A. Drive assembly:
   1. The drive assembly shall consist of gearbox, drive sprocket, drive chain, and a chain guard. Belt drive systems or systems with multiple drive units per filter shall not be acceptable.
   2. Gearbox: Parallel in-line helical-type, AGMA Class 1 with a 1 HP drive motor rated for 460 volt, 3 phase, and 60 Hertz. Provide IEEE 841 compliant motor.
   3. Drive sprocket: Nylon.
   4. Chain: Acetal with 316 Stainless Steel link pins.
   5. Chain guard: Type 316L stainless steel.

B. Center tube assembly:
   1. Each center tube assembly shall include a Type 316L minimum 3/16-inch thick stainless steel center tube weldment, driven sprocket, wheel assemblies, and frame and cloth assemblies.
   2. Effluent port seal: Include a chlorine resistant Viton V-ring effluent port seal.
   3. Drive sprocket: Multi-segment U.H.M.W. polyethylene.
   4. Fasteners: Type 316 stainless steel.

C. Mounting brackets and hardware:
   1. Each filter basin shall be fitted with Type 316 stainless steel mounting brackets to accommodate attachment of the filter components to the basin.
   2. All mounting brackets shall be attached to the basin wall with Type 316 stainless steel wedge anchors and hardware.
   3. Through-the-wall spool piping and all filter external piping shall be provided by the Contractor.

D. Filter cloth assemblies:
   1. General:
      a. Each of the 2 concrete filter basins shall include 16 disk assemblies.
      b. Each cloth disk assembly shall be comprised of 6 individual segments; each consisting of a cloth media sock supported by an injection molded polypropylene co-polymer frame.
      c. During filtration, the filter assemblies shall operate in a static condition with no moving parts. The filter system shall provide for the collection of filtered solids on the outside of the cloth media surface to allow for the direct contact of cleaning systems. Filtered effluent shall be used for backwash. The filter flow path shall be from the outside of the disk to the inside. Systems with flow paths from the inside to the outside of the disk that collect filtered solids and plastic debris on the interior surfaces of the disk will not be acceptable.
   2. Cloth/frame assemblies:
      a. Shall be constructed such that each segment is easily removable from the center tube, without special tools, to allow for removal and replacement of the cloth at the point of installation. Systems requiring special tools and/or the return of media segments to the factory for replacement shall not be considered.
      b. Each cloth disk assembly shall have a minimum of 53.8 square feet of effective submerged filtration area. Effluent filtration area is defined as

only the portion of the disk that is submerged during filtration. Any disk area that is not submerged shall not be considered as effective area.

c. Each disk shall be divided into no more than 6 segments and shall be easily removable for service.

3. Cloth media:

a. Cloths shall be of chlorine-resistant polyester (PES) fiber pile construction with polyester backing material having a nominal filtration rating of 10 microns to withstand a sodium hypochlorite dosage of 5 milligrams per liter. Granular media and screens having structured identical openings shall not be allowed.

b. The cloth media shall have an active filter depth of 3 to 5 millimeters to provide additional collisions between solids particles and the media within the media depth, resulting in capture of solids across a broader particle range. The cloth depth shall also provide storage of captured solids, reducing backwash volumes while maintaining an operational headloss. Woven mesh or microstrainer type disk with no filtration depth are not acceptable.

E. Influent weir box:

1. Each filter shall include a Type 316 stainless steel influent weir box as indicated on the Drawings. The weir box shall be mounted to the filter basin interior using Type 316 stainless steel wedge anchors and hardware. The basin wall must be smooth and plumb to facilitate a quality installation.

F. Backwash/sludge discharge assembly:

1. General:

a. The backwash function shall incorporate a pump that draws filter effluent through the cloth, thereby removing accumulated solids from the cloth surface. Because of the frequency of the backwash and misting associated with spray systems, designs that utilize high-pressure spray as the sole means of solids removal will not be acceptable.

b. Each backwash/sludge discharge assembly shall include a backwash system assembly, an external piping assembly, and 2 backwash pumps with variable frequency drive.

2. Backwash system assembly:

a. Number: 1 assembly per filter.

b. Each assembly includes:

1) Type 316 stainless steel backwash collection manifolds.
2) Type 316 stainless steel threaded unions.
3) PVC sludge collection manifolds.
4) Nylon combination nipples.
5) 1-1/2-inch wire reinforced flexible hose.
6) Stainless steel hose clamps.

3. External piping assembly:

a. Number: 1 assembly per filter.

b. The external piping assembly shall include:

1) PVC combination nipples.
2) 2-inch wire reinforced flexible hose.
3) 0 to 30 inches mercury vacuum gauges.
4) 0 to 15 pounds per square inch pressure gauges.
5) 3 inch circulation ball valves (2 per filter).
6) 8 backwash valves (for each filter).

7) 2 solids waste valves (for each filter).
8) 2 gate valves (for each filter).

4. Backwash pumps:
   a. Manufacturers: The following or equal:
      1) Gorman Rupp, model 12B20-BI.
   b. Type: Externally mounted centrifugal pump.
   c. Number: 2 per filter.
   d. Tag numbers:
      1) Filter No. 6 – pump 6A: 06-PMP-6640 and pump 6B: 06-PMP-6645.
      2) Filter No. 7 – pump 7A: 06-PMP -6740 and pump 7B: 06-PMP-6745
   e. Pump shall be provided with a 3 horsepower, 460 volt, 3 phase, 60 Hertz TEFC motor and operate at 1,750 revolutions per minute.
   f. Pump shall be rated for 130 gpm at TBD feet total dynamic head with 13.3 feet allowable discharge head after losses in internal filter piping have been accounted for.

G. Backwash valves and sludge valve:
   1. Each filter shall include eight (8) 2 inch backwash valves, and two (2) 2 inch solids waste valve.
   2. Type 316 stainless steel ball valve manufacturer standard.
   3. Each valve shall have a 115 volt, 1 phase, 60-cycle OPEN/CLOSE service electric actuator. Valve actuator shall include a compartment heater and thermostat, with limit switch feedback to the microprocessor in both the OPEN and CLOSE positions. Valve/actuator combination shall be TCI/RCI (RCI, a division of Rotork), Nibco, or equal.

H. Anchor bolts:
   1. Contractor shall provide anchor bolt calculations as specified in Section 01612 - Seismic Design Criteria.
   2. Contractor shall provide and install anchor bolts for the filters and backwash pumps. Anchor bolts shall be Type 316 stainless steel and as specified in Section 05120 - Structural Steel.

I. Piping:
   1. Contractor shall provide all piping, supports, bracing and fitting as required and as acceptable to the Engineer.

J. Finishes:
   1. Contractor shall provide field finishes as specified in Section 09960 - High-Performance Coatings.

2.05 CONTROLS AND INSTRUMENTATION:

A. General:
   1. Furnish a Vendor Control Panel as specified in Sections 16050 - Common Work Results for Electrical, 17050 - Common Work Results for Process Control and Instrumentation Systems, 17710 - Control Systems: Panels, Enclosures, and Panel Components, 17720 - Control Systems: Programmable Logic Controllers, 17733 - Control Systems: Network Materials and Equipment, and 17950 - Commissioning for Instrumentation and Controls, and

as recommended by equipment manufacturer to provide a complete operational system.

2. One control panel shall be supplied by vendor and installed by Installation Contractor to control each filter and shall be integrated into the plant control system.

B. Vendor Control panel:
   1. The design, and manufacture requirements for control panels are specified in Section 17710 - Control Systems: Panels, Enclosures, and Panel Components. Each panel shall be fed with a 480 VAC feeder from the MCC shown on the plans. Each of the panels shall have its own PLC, starters, and ancillary control components. Each control panel shall contain all ancillary components required for the operation of the filter, including but not limited to following:
      a. Wall-mounted NEMA Type 4X Type 304 stainless steel control panel with air conditioner.
      b. Dedicated PLC manufactured by Modicon and fiber optic Ethernet switch. All PLC circuit boards shall be conformally coated.
      c. The Control Panel shall communicate with the plant SCADA PLC. The Contractor shall coordinate the communications between the 2 systems.
      d. Main circuit breaker.
      e. Step down 480 volt to 120 volt transformer.
      f. Provide surge protection for the PLC.
      g. All motor starters, overload protection, and disconnecting means.
      h. Pilot devices, pushbuttons, selector switches for all pumps and valves.
      i. Air conditioner: A thermostat-controlled air conditioner shall be supplied to protect control components mounted inside the enclosure from high temperatures, humidity, and ambient air contaminants. It shall be constructed of Type 304 stainless steel material and provide NEMA Type 4X type protection. It shall use CFC - free or environmentally safe refrigerant:
         1) Manufacturers: The following or equal:
            a) Hoffman.
         2) All instruments and equipment including the control panel shall be shipped loose for field mounting and wiring by the Contractor. The mounting hardware and the field wiring and electrical conduit between all of the instruments/equipment and the control panel shall be provided by the Contractor.
   2. Uninterruptible power supplies (UPS):
      a. Provide double conversion true online UPS system.
      b. Include derating for temperature and elevation as necessary.
      c. UPS sizing calculation:
         1) Apply 1.5 safety factor.
         2) Provide itemized list of critical loads, including individual VA and watt ratings.
      d. Battery time calculation based on specified runtime for total load with the safety factor multiplied to it.
      e. Load calculation shall include power for all equipment shown in the power distribution drawing.
      f. Total battery recharge time as a function of capacity utilized.

g. Manufacturers: One of the following or equal:
1) Vertiv, Liebert GXT5 Series.
2) Eaton, 9PX Series.

3. Manual maintenance bypass switch:
a. Provides isolation of the UPS for maintenance purposes.
b. Standalone UL-listed.
c. 700 to 3,000 VA units: One of the following or equal:
1) Vertiv, Liebert Micropod 2U.
2) Eaton Corp., Powerware HotSwap.
d. Above 3,000 VA units: By manufacturer of UPS, with connections matched for operation with UPS.

C. Any Packaged Process System that is equipped with Programmable Logic Controllers PLC(s) shall provide the resources for communicating over the plant control network to the plant's SCADA system. Packaged Process System controllers shall include all necessary hardware modules, software drivers, documentation of software address codes, and documentation of communication parameters:
1. As specified in Sections 17720 - Control Systems: Programmable Logic Controllers and 17733 - Control Systems: Network Materials and Equipment.
2. These documents shall be adequately complete to allow the Owners programmer to set up communications for the status and control signals identified in the P&ID Drawings.
3. Each package PLC control system shall furnish to the Owners programmer for his programming application, a list of all identified signals, with signal identification tags and PLC internal memory address, to be interfaced to the SCADA system.
4. Furnish field support to the Owners programmer in the testing, loop checking, and interfacing of its Packaged Process System to the plant's SCADA system during the construction phase.

D. Instrumentation:
1. Manufacturer shall furnish the following components as a part of the filtration system:
a. Pressure transducer (1 per filter): Manufacturer standard supply.
b. Pressure and vacuum gauges (2 each per filter): Manufacturer standard supply.
c. High-level float (1 per filter): Manufacturer standard supply.
d. Vacuum sensor (1 per filter): Manufacturer standard supply.
2. Provide all I/O, setpoints, and alarms to the Plant SCADA PLC. SCADA shall be able to command the units on and off and adjust all setpoints.
3. Provide at least 4 spare analog inputs (4-20 mA) to be used for turbidity.

E. Workshops:
1. The Contractor shall schedule, prepare agendas, conduct, and prepare minutes for a teleconference workshop. Allow 2 hours for the workshop. The workshop shall be attended by:
a. The General Contractor.
b. The Manufacturer/Supplier.
c. The Owner's programmer.

d. The Design Engineer.
e. The Owner.

2. Workshop shall include review of control strategies, sequence of operations and normal/abnormal conditions and shutdowns, signal interfaces (hardwired and networked), communications standards, and general review and coordination of how each package works and is integrated with the Plant's SCADA system.

2.06 SPARE PARTS AND SPECIAL TOOLS

A. Spare parts: Provide the following:
   1. 16 filter frame and cloth segments.
   2. 1 Viton V-ring effluent port/center tube seal.
   3. 1 Backwash/Sludge valve actuator.

B. Special tools: Provide special tools if required for normal operation and maintenance.

PART 3 EXECUTION

3.01 INSTALLATION

A. The cloth media filter systems shall be installed under the direction of the system supplier in strict conformance with the manufacturer's installation instructions and approved shop drawings. An authorized representative of the Manufacturer shall perform final installation inspection, start-up, calibration, and instruction of operating personnel.

B. The Manufacturer shall inspect the installation of all equipment in this Section before start-up in order to verify that the equipment has been properly installed and operated adequately as a system and individually. The Contractor shall coordinate the scheduling of this activity with the Manufacturer.

C. Upon acceptance by the Engineer, alignment of equipment, piping, and accessories may vary from that indicated on the Drawings to suit the equipment furnished, without additional cost to the Owner.

D. Make up piping with a sufficient number of unions to permit ready breaking of lines for maintenance.

E. Support and brace plastic pipe to prevent sagging or overstressing of pipe and connections, and, furthermore, support piping so that no item of piping system transfers load or strain to equipment.

F. Adequately support piping so that operation of valves will not cause pipe to show appreciable movement.

G. Perform an end-to-end test with the aid of the electrical contractor.

H. Perform functional test with the aid of the Contractor.

I. Verify networking communication between the Owner's control system and the filter network.

3.02 FIELD COATING

A. Field coat as specified in Section 09960 - High-Performance Coatings.

3.03 PROGRAMMING WORKSHOP ASSISTANCE

A. The Supplier shall provide assistance and participate in three (3) half day programming workshops. Workshop attendance can be in person or virtual.

3.04 SUPPLIER/MANUFACTURER FIELD SERVICES

A. The Manufacturer shall furnish the services of a factory trained representative for a minimum of three (3) trips and ten (10), eight-hour days at the jobsite, during and after installation, to instruct and thoroughly inspect the equipment installation, supervise the initial operation of the equipment, instruct the plant operating personnel in proper operation and maintenance, and provide process assistance.

B. The services required of the representative shall include installation assistance, safety inspection, preventive maintenance and calibration check.

C. The Manufacturer’s representative shall have 5-years’ experience in the installation of similar systems and provide a list of 10 facilities at which he/she has inspected the installation and testing of similar cloth disk filter units.

D. Coordinate with Manufacturer’s field representative to ensure proper installation, testing, and start-up of the cloth disk filter units. The Contractor shall coordinate with Manufacturer the scheduling of all Field Services activities.

3.05 SUPPLIER/MANUFACTURER’S FIELD QUALITY CONTROL SERVICES

A. A qualified representative of both the Manufacturer and Contractor shall perform preliminary field-testing, inspection, and checkout of the furnished equipment, following installation. Tests shall be conducted to demonstrate to the Engineer that all system components furnished by the Manufacturer are fully operational, that all connecting piping is leak proof and properly anchored, and that the entire system furnished by the Manufacturer is ready for continuous safe operation. The purpose of the checkout shall be to ensure that each individual system component has been correctly installed, shall operate fully in the manner intended, and is ready to perform its function as part of an integrated system when placed in continuous operation.

B. Field Services:
   1. Manufacturer shall provide the services necessary to start-up, test, and operate the system as follows:
      a. Contractor assistance and inspection:
         1) Advice during installation.
         2) Equipment check-up and initial testing.
         3) Loop tests with assistance of the Contractor.

4) End-to-End test.
5) Control system network test.
6) PLC coordination.

b. Start-up and operator training:
1) Start-up assistance.
2) Supervision of equipment operation at start-up.
3) Operator training.

2. Fees, costs, and/or expenses resulting from Manufacturer assistance, as required or requested by the Contractor, that is in excess of the scheduled field services, as presented in Article 3.05, shall not be incurred by the Owner and is the sole responsibility of the Contractor.

C. Inspection and Testing:
1. Upon completion of equipment installation by the Contractor, and prior to equipment testing and start-up, the Manufacturer shall inspect the equipment installation and provide the Owner a letter of certification stating that the equipment has been installed in accordance with Manufacturer instruction and recommendations.
2. After all equipment has been completely installed by the installation Contractor, each unit shall be tested by the Manufacturer and equipment Manufacturer as follows:
a. Proper operation of the furnished equipment.
b. Operation of programmable controls, electrical panels, indicating lights, pushbuttons, etc., if applicable.
c. All other related equipment.

D. Guaranteed Performance Tests:
1. Contractor in cooperation with Manufacturer (Aqua-Aerobics) shall perform Guaranteed Performance tests to demonstrate filters performance per Article 1.03.D. The sampling information and results shall include the influent characteristics (TSS and NTU) and effluent characteristics (TSS and NTU) to demonstrate that the equipment meets the required performance. The performance test shall be performed when the filters are online and operational. Under supervision of Manufacturer, the Contractor shall conduct the performance tests and shall provide labor, equipment, material, power, electricity, instrumentation, lab service, and incidentals necessary to conduct the guaranteed performance tests.
2. The performance test period shall be run for a minimum of 5 continuous days each and must meet the performance requirements on a 24-hour average daily basis. The performance test shall be conducted within the first month after the disc filters are completely installed and operational, and after the plant systems have stabilized and the plant is operating normally. In the event that the performance tests fail, the Contractor and Manufacturer shall have an opportunity to make any necessary adjustments and the 5-day tests shall be performed again. If for any reason during the performance tests the effluent requirements are not met, the test shall be stopped, and the testing period shall begin again for the entire duration of the test period. Repeating the performance tests shall be Contractor’s and Manufacturer's responsibility and they shall bear all additional costs associated with retesting of the disc filters at no cost to the Owner.

3. The Contractor and Manufacturer shall notify the Owner and Engineer at least one week in advance of beginning any performance tests.
4. If the Contractor and Manufacturer are not able to meet the performance test requirements and achieve the required effluent quality during the performance tests, then the Manufacturer shall pay for additional modifications to correct any defects until the filters achieve successful effluent quality. The maximum cumulative liability to the Manufacturer for modifications to or supply of additional filter equipment shall not exceed 100 percent of the original price of the equipment specified in this Section.

3.06 COMMISSIONING

A. As specified in Section 01756 - Commissioning, 15958 - Mechanical Equipment Testing, and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Source Testing.
      b. Manufacturer's Certificate of Installation and Functionality Compliance.
   2. Manufacturer's Representative onsite requirements:
      a. Installation: 3 trips, 3-day minimum (as outlined above in Part 3.04).
      b. Functional Testing: 2 trips, 3-day minimum each.
   3. Training:
      a. Maintenance: 4 hours per session, 2 sessions.
      b. Operation: 2 hours per session, 2 sessions.
   4. Process operational period:
      a. As required by Owner or Contractor.

C. Source testing:
   1. Electrical and Controls:
      a. Conduct testing as specified in Section 17950 - Commissioning for Instrumentation and Controls.

D. Functional testing:
   1. Equipment:
      a. Test witnessing: Witnessed.
      b. Conduct Level 2 General Equipment Performance Test:
         1) Ensure that each individual system component has been correctly installed, shall operate fully in the manner intended, and is ready to perform its function as part of an integrated system when placed in continuous operation:
            a) Verify connecting piping is leak-proof and properly anchored.
         2) Demonstrate that the equipment is capable of performing its specified function in a satisfactory manner without mechanical or electrical defects, binding, or operational difficulties.
         3) Repair visible leaks.
         4) Test and calibrate controls, switches, automatic valves, and other instrumentation and control equipment associated with the cloth media filter units as specified in this Section, in accordance with the Manufacturer's printed instruction over the full operating range of the equipment.

c. Conduct Level 2 Vibration Test.
d. Conduct Level 2 Noise Test.

2. Electrical and Controls:
   a. Test witnessing: Witnessed.
   b. Conduct testing as specified in Section 17950 - Commissioning for Instrumentation and Controls.
3. System:
   a. Test witnessing: Witnessed.
   b. Conduct Level 2 General Equipment Performance Test.
   c. Conduct Level 2 Vibration Test.
   d. Conduct Level 2 Noise Test.
   e. Process test:
      1) Guaranteed performance testing:
         a) Demonstrate filters performance per Performance Design Criteria:
            (1) The sampling information and results shall include the influent characteristics (TSS and NTU) and effluent characteristics (TSS and NTU) to demonstrate that the equipment meets the required performance.
         b) Scheduling:
            (1) Perform first performance test when the initial 2 filters are online and operational.
            (2) Perform second performance test within the first month after the disc filters are completely installed and operational.
            (3) Duration: Run performance tests for a minimum of 5 continuous days each and must meet the performance requirements on a 24-hour average daily basis.

END OF SECTION

SECTION 13122

METAL BUILDING SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Prefabricated metal building systems.

1.02 REFERENCES

A. American Concrete Institute (ACI):
   1. 318 - Building Code Requirements for Structural Concrete and Commentary.

B. American Institute of Steel Construction (AISC):
   1. 303 - Code of Standard Practice for Steel Buildings and Bridges.
   2. 360 - Specification for Structural Steel Buildings.

C. American Iron and Steel Institute (AISI):
   1. SG02 - North American Specification for the Design of Cold-Formed Steel Structural Members.

D. ASTM International (ASTM):
   1. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   3. A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process.
   4. A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
   5. A792 - Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
   6. B187 - Standard Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes.
   7. B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   8. D1494 - Standard Test Method for Diffuse Light Transmission Factor of Reinforced Plastics Panels.
   9. F959 - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
   10. F436 - Standard Specification for Hardened Steel Washers.
   11. F3125 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength.

E. American Welding Society (AWS):
   1. D1.1 - Structural Welding Code - Steel.
   2. D1.3 - Structural Welding Code - Sheet Steel.

F. California Building Code (CBC), with local amendments.

G. International Accreditation Service (IAS):
   1. AC472 - Accreditation Criteria for Inspection Programs for Manufacturers of Metal Building Systems.

H. Metal Building Manufacturing Association (MBMA):
   1. Metal Building Systems Manual.

I. California Occupational Safety and Health Administration (CalOSHA):
   1. Occupational Safety and Health Standards:
      a. 1910.23 - Guarding floor and wall openings and holes.

J. Research Council on Structural Connections (RCSC):
   1. Specification for Structural Joints Using High Strength Bolts.

K. Society for Protective Coatings (SSPC):
   1. SSPC-SP2 - Hand Tool Cleaning.

L. Steel Door Institute (SDI):
   1. A250.8 - Recommended Specifications for Standard Steel Doors and Frames.

M. Underwriters' Laboratories, Inc. (UL):
   1. 580 - Tests for Uplift Resistance of Roof Assemblies.

1.03 DEFINITIONS

A. Primary framing: An assemblage of beams and columns that support the secondary framing members, and that collects loads to transfer to the building foundation.

B. Secondary framing: Members which directly support roof, wall, or floor surfaces and convey loads to the primary framing.

1.04 SYSTEM DESCRIPTION

A. System:
   1. Design: Furnish metal building with vertical walls, gable roof, and with column layout as indicated on the Drawings.
   2. Size:
      a. Furnish metal building of the size and configuration indicated on the Drawings.
      b. Coordinate manufacturer's design dimensions for metal building system components, including columns, with equipment foundations, and details indicated on the Drawings.
   3. Roof slope: Use a roof slope of 1 inch vertical in 12 inches horizontal or steeper where indicated on the Drawings.
   4. Provide building with horizontal and vertical bracing where indicated on the Drawings.
   5. Column reactions shall be vertical and horizontal only:
      a. No bending moments shall be transferred at column bases.

6. Building indicated on the Drawings is a roof canopy only:
    a. Wall framing and wall panels will not be provided under this contract; however, design the structural framing and report frame reactions to accommodate both the present condition, and the possibility of adding wall panels to enclose the structure at a future date.
7. The building roofing system will be listed for a UL 580, Class 90 designation.
8. Openings: Frame openings for doors, louvers, equipment with structural framing to replace panels and secondary framing cut for opening.

B. Performance requirements:
    1. General:
        a. Design of the metal building structure and its appurtenances shall conform to the requirements of the CBC, the Metal Building Systems Manual, and the requirements of this Section:
            1) Where the Metal Building Systems Manual conflicts with the requirements of this Section, the more restrictive requirements will govern.
        b. Do not include collateral or auxiliary loads in load combinations where dead loads offset other load effects (for example, uplift due to wind loads).
        c. Hot-rolled structural steel sections or welded-up plate sections: Design in accordance with AISC 360.
        d. Cold-formed steel structural members: Design in accordance with the AISI North American Specification for the Design of Cold-Formed Steel Structural Members.
        e. Anchor bolts:
            1) Design anchor bolts to resist column reactions reported from analysis.
            2) Design anchor bolts in accordance with ACI 318 Chapter 17 for cracked concrete to fail in a ductile manner, yielding the steel section before fracturing the surrounding concrete.
            3) Assume concrete foundation strength, f'c = 4,000 pound per square inch at 28-days.
    2. Loading:
        a. General:
            1) Design building for dead load, live loads, and combinations of loads including unbalanced loads in accordance with the IBC and the MBMA Metal Building Systems Manual, except as modified in this Section.
            2) Reduction in wind, live, or snow loads based on tributary loaded area will not be permitted.
        b . Roof loading requirements:
            1) Live load: Minimum 20 pounds per square foot assumed to act vertically on horizontal projected area of roof.

        c. Collateral loading: Uniform roof load of 10 pounds per square foot assumed to act vertically on horizontal projected area of roof to account for miscellaneous accessories supported from the structure:
            1) Collateral loading shall be considered a live load.

2) Design primary and secondary framing to support the additional weight of mechanical equipment such as fans, air conditioners, etc., shown on plans:
a) Mechanical equipment weights are in addition to collateral loading.

d. Auxiliary loading:
1) Structural members: Any single point along the secondary roof framing members shall be designed to carry a concentrated load of 200 pounds in addition to the roof live load.
2) Roof panels: Design panels to support a 200 pound load uniformly distributed over a 2 square foot area centered between supporting framing members, without exceeding a panel deflection to span ratio of 1/180 in a 2-span condition.
3) Auxiliary loading shall be considered a live load.
4) Auxiliary is to be considered concurrently with collateral loading.

e. Wind loading requirements: As specified in Section 01614 - Wind Design Criteria:
1) Design roof purlins and structural frames for loads specified, but not less than 20 pounds per square foot uplift on horizontally projected roof area.

f. Seismic loading requirements: As specified in Section 01612 - Seismic Design Criteria:
1) Bolted joints subject to seismic loading shall be designated pretensioned joints.

3. Deflection limitations:
a. Primary frames:
1) Gravity deflection:
a) Live load deflection: L/240.
b) Total load deflection: L/180.
2) Horizontal drift of rigid frames measured at eave:
a) Seismic drift limitation: H/100 unless indicated on the Drawings.
b) Wind drift limitation: H/500.

b. Secondary framing:
1) Gravity deflection:
a) Live load deflection: L/180.
b) Total load deflection: L/150.
2) Horizontal deflection: L/120.

c. Deflection of roof and wall panels: Span/180.
d. Deflection calculations should be based on the unreduced wind loads required in the CBC (50-year reoccurrence intervals).

4. Climatic conditions:
a. Gutters and downspouts: Design for a rainfall rate of 1.32 inches per hour.
b. Temperature: Provide for movement (expansion or contraction) caused by a range of ambient temperature of 120 degrees Fahrenheit without detrimental effects.

1.05 SUBMITTALS

A. Product Data:
1. Manufacturer’s installation instructions.
2. Manufacturer’s standard color charts and profiles:
a. Exterior wall and roof panels.

b. Interior wall and roof liner panels.
c. Gutters and downspout trim.

3. Manufacturer’s list of approved clamps that may be used to hang suspended items from roof purlins and details of acceptable methods of attachment to purlins.

B. Shop drawings:
1. Shop drawings: Catalog cuts; design and erection drawings; and other data needed to clearly describe design, materials, construction details, fasteners, and erection:
a. Erection drawings shall include building dimensions, required foundation footprint, anchor bolt and base plate settings, bracing, main and secondary framing, and sections and details required to fully describe construction of building.
b. Indicate quantity, size, grade, embedment, and projection, and location of anchor bolts.
2. Calculations: Submit engineering design calculations for the complete structural system, sealed and signed by a Civil or Structural Engineer licensed in the state where the project is located:
a. Clearly indicate foundation reactions at all columns. Identify all applied unfactored loads, load factors, and load combinations used to develop the reactions.
b. Calculations will be submitted for record information only:
1) Engineer’s review of calculations will be for general conformance to the loading requirements of this Section.
2) The building manufacturer shall remain fully responsible for the structural design and adequacy of the metal building system.
3. Descriptive data: Submit data for the following items either on the shop drawings or separately: Accessories, each type of flashing, trim closures, caps and similar items, fasteners, doors, roof openings, gutters, and downspouts.

C. Quality control submittals:
1. Building manufacturer:
a. If requested by the Engineer, submit a record of manufacturer's metal building systems of similar design manufactured and erected in the 5-year period preceding the bid date for this project:
1) Include date of installation, location of metal building, and name and address of Owner.
b. Submit evidence of manufacturer’s certification under IAS AC472 Accreditation:
1) Certification must be valid for the facility at which the metal building will be fabricated.
c. Confirmation of UL 580 wind uplift rating.
2. Erector:
a. Submit welder qualification certificates.

D. Record documents:
1. 1 set of reproducible “Record Drawings” for the erected structure:
a. Drawings shall bear the seal and signature of a Civil or Structural Engineer, registered in the state where the work is constructed and who provided responsible charge for the design.

E. Closeout submittals: Submit Contract Closeout Submittals as specified in Section 01770 - Closeout Procedures:
   1. Operating and Maintenance Information.
   2. Warranty.
   3. Certificate of Compliance: At the completion of the metal building manufacture, the manufacturer will furnish a letter to the Engineer stating that the work was performed in accordance with the approved construction documents.

1.06 QUALITY ASSURANCE

A. Manufacturer qualifications: Manufacturer shall have been engaged in the design, manufacture, and erection of metal building systems of the type specified for at least 5 years preceding the Bid Date of this Contract:
   1. Building manufacturer shall be certified by IAS AC472 Accreditation.
   2. The manufacturer’s Engineer of Record shall hold current license as a Civil or Structural Engineer in the state where the work will be constructed.

B. Erector qualifications: Erectors shall be trained, approved, and certified by the manufacturer prior to Bidding of the Project. Erectors shall demonstrate at least 3 years of experience in successfully erecting metal building systems of the type specified in Section 01610 - Project Design Criteria.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping: Deliver materials and fabrications to the job site in manufacturer's original containers with seals unbroken and labeled with manufacturer's identification and number.

B. Delivery:
   1. Deliver materials dry and undamaged, and store out of contact with ground.
   2. Cover materials with weathertight coverings and keep dry.
   3. Provide good air circulation and protection from surface staining for roof and wall covering sheets.

C. Storage and protection: Store materials in original, unopened containers in compliance with manufacturer's printed instructions.

1.08 WARRANTY

A. Provide Owner with warranty that exterior finish system for metal panels shall be guaranteed against blister, peeling, cracking, chipping, or material rust-through for a period of 1 year from the date of Substantial Completion.

B. Provide Owner with warranty stating that the metal building system shall be guaranteed against water leaks arising out of or caused by ordinary wear and tear by the elements for a period of 1 year from the date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Buildings: One of the following or equal:
   1. American Buildings Co.
   2. Behlen Building Systems.
   3. Butler Manufacturing Co.

2.02 MATERIALS

A. Primary framing (rigid frames):
   1. Welded plates or hot-rolled steel columns and roof beams, complete with necessary splice or connector plates for bolted field assembly:
      a. Minimum nominal thickness of structural shapes or their elements shall be 1/4-inch.
   2. Welding procedures, welder qualifications, and welding quality standards shall be in accordance with AWS D1.1 and AWS D1.3.
   3. Base, cap, compression plates, and stiffener plates shall be factory-welded in place, and shall have shop-fabricated connection holes:
      a. Provide minimum 4 anchor bolts per column base.
   4. Columns and roof beams shall be fabricated complete with holes in webs and flanges for attaching bracing and roof and sidewall framing.
   5. Shop finishing:
      a. Shop galvanized - electroplated:
         1) Prepare members in accordance with ASTM B187 prior to electroplating.
         2) Galvanize members by electroplating in accordance with ASTM B633.
         3) Provide a minimum zinc coating thickness of not less than 25 µm.
      b. Shop primed and field-coated high solids epoxy coating system:
         1) Apply 1 coat of shop primer in accordance with SSPC Paint Specification No. 15 for temporary corrosion protection:
            a) Remove shop primer as specified in Section 09960 - High-Performance Coatings prior to field coating.
         2) Prepare surfaces and apply finishes as specified in Section 09960 - High-Performance Coatings**.**

B. Secondary framing (purlins, girts, framing at endwalls and openings, eave struts, bracing):
   1. Hot rolled structural steel or cold-formed members.
   2. Minimum thickness: 16-gauge.
   3. Bracing elements constructed of wire rope, stranded tendons, or other similar material is not permitted:
      a. Rolled angle sections or solid steel bar is permitted.
   4. Provide factory-punched holes for panel connections.
   5. Shop finishing - hot rolled sections:
      a. Galvanized - electroplated:
         1) Prepare members in accordance with ASTM B187 prior to electroplating.

2) Galvanize members by electroplating in accordance with ASTM B633.
3) Provide a minimum zinc coating thickness of not less than 25 µm.

b. Shop primed and field-coated high solids epoxy coating system:
1) Apply 1 coat of shop primer in accordance with SSPC Paint Specification No. 15 for temporary corrosion protection. Remove shop primer as specified in Section 09960 - High-Performance Coatings prior to field coating.
2) Prepare surfaces and apply finishes as specified in Section 09960 - High-Performance Coatings.

6. Shop finishing (cold-formed sections):
a. Galvanized - hot-dipped:
1) Hot-dip galvanize members in accordance with ASTM A653 to G90 designation.

b. Shop-primed and field-coated high solids epoxy system:
1) Apply 1 coat of shop primer in accordance with SSPC Paint Specification No. 15 for temporary corrosion protection:
a) Remove shop primer as specified in Section 09960 - High-Performance Coatings prior to field coating.
2) Prepare surfaces and apply coating as specified in Section 09960 - High-Performance Coatings.

C. Roof and wall panels:
1. Roll-formed minimum 24-gauge steel, factory-finished each side.
2. Panels shall have interlocking side seams and shall be the manufacturer's maximum standard width Factory cut to maximum possible length to minimize end laps.
3. Factory pre-punched for fastening.
4. Panel finish:
a. Factory pre-painted, pre-finished coating consisting of a UV light-resistant polyvinylidene diflouride (PVDF) resin based paint and primer system having a total thickness not less than 1.0 mil on an approximately 55 percent aluminum-43 percent zinc-1 percent silicone galvanized coating complying with ASTM A792.
b. The galvanized coating shall be deposited at a minimum rate of 0.50 ounces/square foot.
c. Furnish manufacturer's standard color chart for Owner's selection.
5. Ridge panel: 1-piece, factory-formed to match roof slope at each side, of same material as roof panels, and capable of completely sealing roof ridge.

D. Bolted joint components: High-strength steel bolts used for steel-to-steel structural connections:
1. Bolts: ASTM F3125, Grade A325, Type 1 or ASTM F3125, Grade A490, Type 1.
2. Nuts: ASTM A563, heavy hex. Grade and finish to match bolts as specified in RCSC Specification for Structural Joints Using High Strength Bolts.
3. Washers: ASTM F436; flat unless otherwise noted.

4. Load indicator devices:
    a. Twist-off type tension-control bolt assemblies: ASTM F3125, Grade A1852, or ASTM F3125, Grade F2280.
    b. Compressible washer direct tension indicators: ASTM F959, Type 325-1 for ASTM F3125, Grade A325 bolts, or ASTM F959, Type 490-1 for ASTM F3125, Grade A490 bolts.
5. Bolts furnished for the project shall be a single size and grade.

E. Anchor bolts or anchor rods: As specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry except that material shall be Type 316 stainless steel unless otherwise indicated on the Drawings.

F. Fasteners and washers:
1. Fasteners and washers used for attachment of wall and roof panels.
2. Fasteners: Vinyl-coated steel or stainless steel.
3. Washers: Neoprene or other accepted type washer capable of being used to ensure watertightness at fastening locations.

G. Gutters and downspouts:
1. 24-gauge steel.
2. Galvanized in accordance with ASTM A653 to G60 designation.
3. Field painted. Color to be selected by Owner to complement wall panels.

H. Doors and frames:
1. Aluminum Door and Frames:
    a. Manufacturers: the following or equal:
    b. Model: SL-16 aluminum flush doors with aluminum frames.
    c. Door opening size: As indicated on the Drawings.
    d. Construction:
        1) Door thickness: 1-3/4 inches.
        2) Stiles and rails: Aluminum extrusions made from prime-equivalent billet that is produced from 100 percent reprocessed 6063-T6 alloy recovered from industrial processes, minimum of 2-5/16-inch depth.
        3) Corners: Mitered.
        4) Provide joinery of 3/8-inch diameter full-width tie rods through extruded splines top and bottom integral to standard tubular shaped stiles and rails reinforced to accept hardware as specified.
        5) Securing internal door extrusions:
            a) 3/16-inch angle blocks and locking hex nuts for joinery.
            b) Welds, glue, or other methods are not acceptable.
        6) Furnish extruded stiles and rails with integral reglets to accept face sheets. Lock face sheets into place to permit flush appearance.
        7) Rail caps or other face sheet capture methods are not acceptable.
        8) Extrude top and bottom rail legs for interlocking continuous weather bar.
        9) Meeting stiles:
            a) Pile brush weather seals.
            b) Extrude meeting stile to include integral pocket to accept pile brush weather seals.
        10) Bottom of door: Install bottom weather bar with nylon brush weatherstripping into extruded interlocking edge of bottom rail.

11) Glue: Use of glue to bond sheet to core or extrusions is not acceptable.
12) Face Sheet:
    a) Material: 0.125-inch thick aluminum.
    b) Texture: Smooth.
13) Core:
    a) Material: Poured-in-place polyurethane foam.
    b) Density: Minimum of 5 pounds per cubic foot.
    c) R-Value: Minimum of 9.
    d) ASTM E84: Class A.
14) Cutouts:
    a) Manufacture doors with cutouts for required vision lites, louvers, and panels.
    b) Factory install vision lites, louvers, and panels.
15) Hardware:
    a) Pre-machine doors in accordance with templates from specified hardware manufacturers and hardware schedule.
    b) Factory installed hardware.

2. Aluminum Entrance Door:
   a. Manufacturers: One of the following or equal:
      1) Kawneer Co., Model 190, Narrow Stile Doors.
      2) Amarlite Architectural Products, equivalent product.
      3) PPG Industries, Inc., equivalent product.
      4) VistaWall Architectural products, equivalent product.
   b. Framing materials: Extruded 6063-T5 alloy and temper in accordance with ASTM B221 alloy G.S. 10A-T5, minimum 0.125 inches thick.
   c. Stile and rail face dimensions:
      1) Vertical stiles: Maximum 2-1/8 inches.
      2) To rail: Maximum 2-1/4 inches.
      3) Bottom rail: Minimum 10 inches.
   d. Bottom rail of door: Manufacturer's standard channel section which closes bottom of door.
   e. Glass:
      1) Tinted monolithic, tempered, 1/4 inches thick, as specified in Section 08800 - Glazing.
      2) Glazing gaskets: EPDM elastomeric extrusions, manufacturer's standard sizes and shapes.
      3) Glazing moldings: Minimum 0.050-inch thick, hook-in type.
   f. Fasteners:
      1) Exposed fasteners: Aluminum, stainless steel or plated steel in accordance with ASTM B633.
      2) Perimeter anchors: Aluminum or steel.
   g. Hardware:
      1) Hinges: Entrance door manufacturer's standard, minimum 4-1/2 by 4 inch, 5 knuckle, ball bearing, non-removable pin, number per door as specified in Section 08710 - Door Hardware, finish as selected by Engineer.
      2) Cylinders: As required by Owner.
      3) Overhead concealed type with hydraulic spring control with rack and pinion operation, adjustable controls for closing, latching speed, back

check, and hold open; concealed arm and track mounted in door top rail:
a) Manufacturers: The following or equal:
(1) LCN Closers Division, Schlage Lock Co., 2030.
4) Push bar and pull handle: US32D brushed stainless steel:
a) Manufacturers: One of the following or equal:
(1) Kawneer Co., Style CPII and CO-09.
(2) Amarlite Architectural Products, equivalent products.
(3) PPG Industries, Inc., equivalent products.
(4) VistaWall Architectural products, equivalent products.
5) Thresholds: Entrance door manufacturer's standard 1/2-inch by 4-inch aluminum, mill finish.
6) Weatherstripping: Entrance door manufacturer's standard as follows:
a) For jambs and heads: Thermoplastic elastomer in tubular shape with semi-rigid polymeric backing.
b) For bottom door rail: EPDM blade gasket

3. Storefront:
a. Manufacturers: One of the following or equal:
1) Kawneer Co., Trifab VG 451.
2) AmarliteArchitecutral Products, equivalent product.
3) PPG Industries, Inc., equivalent product.
4) VistaWall Architectural Products, equivalent product.
b. Framing material: Extruded 6063-T5 allow and temper in accordance with ASTM B221 alloy G.S. 10A-T5, minimum 0.125 inches thick.
c. Dimensions: 2-inch face by 4-1/2 inch overall depth.
d. Insulated aluminum panels:
1) As recommended by the manufacturer as shown on the drawings.
4. Overhead Coiling Doors:
a. Manufacturers: One of the following or equal:
1) Overhead Door Corp.
2) Wayne-Dalton Corp.
3) The Cookson Co., Inc.
b. Aluminum overhead coiling door:
1) Mounting: Face of wall. Location as indicated on the Drawings.
c. Operation: As indicated on the Drawings.
d. Curtain:
1) Exterior Slats: Minimum 18-gauge B and S or heavier aluminum alloy manufacturer's standard, interlocking flat-faced slats with ends of alternate slats fitted with metal end locks to hold curtain in alignment.
2) Bottom bar: Fitted with 2 equal-sized aluminum angles minimum 1/8-inch thick, with lift handle and slide bolt at either end.
e. Weatherstripping:
1) Bottom bar: Manufacturer's standard, provided with a flexible PVC bulb type astragal to ensure a consistent seal along the floor. Extrusion designed to interlock with door curtain.
2) Door jambs: Manufacturer's standard, wool or nylon pile, vinyl extrusion seals.
3) Hood: Manufacturer's standard neoprene baffle.
f. Guides: Steel galvanized in accordance with ASTM A123, formed of roll formed steel channels and angles or structural angles of sufficient depth to provide a groove of adequate depth on each jamb to hold curtain firmly in guides under design wind pressure.

g. Brackets: Steel galvanized in accordance with ASTM A123, steel plate with permanently sealed ball bearings designed to enclose ends of coil and provide support for counterbalance pipe at each end.
h. Barrel and counterbalance mechanism: Steel pipe of sufficient size to carry door load with maximum deflection of 0.03 inch per foot of opening width and counterbalanced by helical springs, oil tempered torsion type designed with minimum safety factor of 1.25, and having cast iron barrel plugs that anchor springs to tension shaft and pipe.
i. Hood: Fabricated minimum 0.050-inch thick aluminum, designed to enclose curtain coil and counterbalance mechanism.
j. Insulation:
    1) Interior slats: Material to match exterior slats as specified in previous article, interlocking flat-faced slats, manufacturer's standard size with ends of alternate slats fitted with metal end locks to hold curtain in alignment.
    2) Insulation: CFC-free Polyethylene foam yielding a minimum R-value of 6.20.
k. Door operators:
    1) Chain operator: Provide a continuous hand chain and gearing on coil side of door.
    2) Motor operator: Provide a heavy-duty type motor operator:
        a) High starting torque type motor having sufficient power to operate the load at an average speed of 1 foot per second.
        b) Totally enclosed, fan cooled, continuous-duty motor, sized to suit door size (1 horsepower minimum), with Class B insulation.
        c) 480 volt, 3-phase operation.
        d) Controlled by momentary contact 3-button station marked OPEN, CLOSE, and STOP. As indicated on the Drawings.
        e) Provide automatic screw-type limit switch to break circuit at termination of travel.
    3) Provide gear reducer consisting of high efficiency worm gearing running in an oil bath and a spring set, solenoid-operated brake designed to hold the load when power is off.
    4) Provide emergency hand chain operator which does not affect the time of the limit switch, to operate the load in case of power failure.
    5) Operator to have reversing NEMA Size 1 starter having mechanical and electrical interlocks, properly sized 24-volt control transformer, and other controls necessary for proper operation, completely assembled and wired to a terminal strip to facilitate field wiring of the power source, pushbutton stations, and/or other remote devices.
    6) Unless otherwise indicated on the Drawings, all electrical material supplied shall be in NEMA Type 12 enclosures for interior locations and in NEMA Type 4X enclosure or NEMA Type 4 enclosures for exterior or wet locations.
    7) Provide electronic safety edge to reverse direction of door if obstruction is encountered.
    8) Where no safety edge is specified, 2-button constant pressure type pushbutton stations marked OPEN and CLOSE shall be provided in lieu of 3-button station previously indicated.
l. Slats, hood and bottom bar:
    1) Aluminum: As selected from manufacturer's standard anodized finish.

m. Guides and bracket plates:
1) Galvanized steel: manufacturer's standard rust inhibitive prime coat in a flat black finish.

I. Touch-up painting materials:
1. For structural elements:
a. Shop primer: Manufacturer’s standard primer.
b. Touch-up paint: Same as shop primer.
2. For sheet metal skin:
a. Exterior finish paint: Match specified coating.
1) Color: Color as selected by the Engineer.

J. Insulation:
1. Thermal value:
a. Roof insulation: R-19.
b. Wall insulation: R-13.

K. Caulking material: Elastomer type, manufacturer's standard.

L. Vent materials:
1. Steel: Minimum 20 gauge galvanized.
2. Screens: 1/8-inch mesh aluminum screen.

M. Ventilator accessories:
1. Bird Screen.
2. Flashing.

2.03 FABRICATION

A. Shop fabrication:
1. Structural elements:
a. Fabricate rigid frame of hot-rolled sections or continuously welded plate sections.
b. Field connections shall be bolted unless otherwise accepted by the Engineer.
2. Wall panels:
a. Provide panels that are 1 piece from base to eave and have fasteners located on inside of panels.
b. Provide top and bottom closures and bottom supports.
3. Roof panels:
a. Panel splicing: Panels may be spliced with minimum end overlap of 9 inches at purlins.
b. Ridge panel: Provide 1 piece ridge panel, factory formed to match roof slope, of same material as roof panel, and capable of completely sealing roof ridge.
c. Expansion of roof panels: Provide means to allow expansion of roof panels.
4. Fasteners for roof and wall panels:
a. Fasteners: Secure with fasteners that ensure maximum weathertightness, proper bearing surface, and permanent seal at point of fastening.
b. Washers: Use washers capable of assuring watertightness at fastening locations.

5. Accessories:
    a. Gutters, downspouts, and hangers:
        1) Provide 4-inch gutters, downspouts, and hangers as indicated on the Drawings.
    b. Vents:
        1) Provide vents of size and location indicated on the Drawings.
        2) Provide louvers that are operable and that have screens.
    c. Ventilators:
        1) Provide buildings with gravity vertical turbine ventilators with 12-inch throats where indicated on the Drawings.
        2) Provide ventilators that are gravity operated with damper.
        3) Accessories: Provide hardware and accessories including bird screen and flashing, as required to properly install ventilators in roof openings.

B. Tolerances:
    1. Hot-rolled sections: In accordance with AISC 303.
    2. Cold-formed and Built-up sections: In accordance with MBMA Metal Building Systems Manual.

2.04 SOURCE QUALITY CONTROL

A. General:
    1. Components of the metal building system fabricated in the manufacturer's shop will not be subject to special inspection, as specified in this Section.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of conditions:
    1. Verify site conditions prior to start of work. Unacceptable conditions shall be reported to Engineer.
    2. Starting of erection of metal building system work shall indicate acceptance of existing conditions.
        a . Manufacturer or manufacturer's trained erector shall review and examine existing site conditions, foundation, and surface preparation, and adequacy of site-prepared components prior to commencing erection of the building.

3.02 ERECTION

A. General:
    1. Erect in accordance with the MBMA, Metal Building Systems Manual and manufacturer's instruction, except as modified in this Section.
    2. Separate dissimilar materials with gaskets or suitable insulating coatings.
    3. Keep exposed surfaces clean and free from sealant, metal cuttings, and other foreign materials.

B. Framing and structural members:
   1. Set anchor rods by template and securely tie into formwork before concrete placement.
   2. Provide uniform bearing under baseplates and sills by filling using a nonshrinking grout as specified in Section 03600 - Grouting.

C. Walls and roof:
   1. Erect a structure that will be free from water leaks and meet design requirements.
   2. Direct side lap edges away from the prevailing winds at the site.
   3. Do not exceed the maximum fastener spacings specified:
      a. Space fasteners uniformly not to exceed: 8 inches on center at ends of covering, 12 inches on center at intermediate supports and at roof covering side laps, and 18 inches on center at wall covering side laps.
   4. Install fasteners in straight lines within a tolerance of 1/2-inch per bay.
   5. Seal side laps, ends of roof, wall coverings, and joints at accessories:
      a. Drive fasteners to the surface and seat gasketed heads and washers.
   6. Fasten accessories to framing members, except as otherwise accepted by the Engineer.
   7. Wall panels shall be isolated from concrete floor slab and/or foundation.
   8. Flashing shall be provided at the base of wall panels to prevent wind-driven rain from entering the building envelope.

D. Gutters and downspouts:
   1. Attach securely to the building.
   2. Install gutters sloped to drain with adequate provisions for expansion and contraction.

E. Doors and roof openings:
   1. Anchor securely to the supporting construction.
   2. Install doors plumb and true and adjust to provide operation.

3.03 FIELD QUALITY CONTROL

A. General:
   1. Installation of metal building system will be subject to special inspection and evaluation during construction, as specified in this Section.

B. Site inspection:
   1. Special inspection of the metal building system components will be performed at the time and frequency outlined in Schedule 13-1.
   2. The elements of the metal building system construction that will be subject to special inspection are as indicated in Attachment 13-1.

3.04 ADJUSTING

A. Field painting:
   1. Prepare and touch up abraded or corroded spots on shop-primed surfaces immediately after erection:
      a. Use the same material as was used for the shop coat.
   2. Paint shop-primed ferrous surfaces as specified in Section 09960 - High-Performance Coatings.

B. Field coated:
   1. Prepare and apply coating as specified in Section 09960 - High-Performance Coatings.

C. Paint primed surfaces of doors:
   1. Prepare and apply coating as specified in Section 09960 - High-Performance Coatings.

D. Touch-up factory finished surfaces of roof and wall panels with the manufacturers recommended paint where damaged or abraded.

E. Where shop processes such as shearing or punching leave edges of galvanized steel unprotected by galvanization, touch up unprotected edges as specified in this Section.

F. Galvanized surfaces: Repair damaged galvanized surfaces in accordance with ASTM A780.

3.05 CLEANING

A. Remove excess materials, equipment, and debris incidental to this work upon completion.

3.06 PROTECTION

A. During erection, the erector shall be responsible for the protection of this and all adjacent work from damage.

END OF SECTION

SECTION 13446

MANUAL ACTUATORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Valve and gate actuators.
   2. Handwheel actuators.
   3. Hand-cranked geared actuators.
   4. Floor boxes.
   5. Floor stands.
   6. Key operated valves.
   7. Bench stands.
   8. Accessory equipment and floor boxes.

1.02 REFERENCES

A. Aluminum Association (AA):
   1. DAF-45 - Designation System for Aluminum Finishes.

B. American Water Works Association (AWWA).

C. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

D. National Electrical Code (NEC).

1.03 DEFINITIONS

A. NEMA:
   1. Type 4X enclosure in accordance with NEMA 250.
   2. Type 7 enclosure in accordance with NEMA 250.

1.04 SUBMITTALS

A. Shop drawings: Include shop drawings and product data with associated gate or valve as an integrated unit.

1.05 QUALITY ASSURANCE

A. Provide valve actuators integral with valve or gate, except for valve actuators utilizing T-wrenches or keys, and portable gate actuators intended to operate more than 1 valve.

B. Provide similar actuators by 1 manufacturer.

C. Provide gates and hand operating lifts by 1 manufacturer.

D. Provide hydraulic gate lifts by 1 manufacturer.

E. Provide hydraulic valve actuators and motorized actuators by 1 manufacturer.

1.06 MAINTENANCE

A. Extra materials:
   1. Key operated valve keys or wrenches: Furnish a minimum 4 keys with 4-foot shafts and 3-foot pipe handles or wrenches with 4-foot shafts and 3-foot handles for operating key operated valves.

PART 2 PRODUCTS

2.01 VALVE AND GATE ACTUATORS

A. Valve actuators:
   1. Cylinder actuators, motorized actuators, and portable gate actuators are specified in Sections 13447 - Electric Motorized Actuators.
   2. Manual actuators:
      a. Material: Type 316 stainless steel.
      b. Design: Hand lever.
      c. Spring release handle: 12-inch.
      d. Notch plate: 10 position.
      e. Secure with mounting bolts.
      f. Locking device so that valve can be locked in any position with a wing nut.
   3. Stem and cover:
      a. For submerged valves, provide extension stem as indicated on the Drawings.
   4. Limit switches: Provide limit switches on manually actuated valves where indicated on the Drawings:
      a. Limit switches: Heavy-duty, industrial grade, oiltight, with not less than 2 auxiliary contacts.
      b. Rating: Rated for 10 amps, 120 volts alternating current.
      c. Enclosure: NEMA Type 4X enclosure and with stainless steel levers and arms. Provide switch with NEMA Type 7 enclosure when switch is located within areas with NEC Class 1, Division 1 or Class 1, Division 2 designations as indicated on the Drawings.

B. Stem covers:
   1. Aluminum pipe:
      a. Threaded cap on top.
      b. Bolted aluminum flange on bottom.
      c. Slots cut 1- by 12-inch at 18 inches on center in front and back of pipe.
      d. Capable of covering threaded portion of greased stems that project above actuators when gates or valves are opened or closed.
   2. Ultraviolet light resistant, clear butyrate plastic or polycarbonate pipe:
      a. Capped on the upper end.
      b. Either threaded into the top of the gate operators or held in place by bolt-down aluminum brackets.
      c. Capable of covering threaded portion of greased stems that project above actuators when gates or valves are opened or closed.

3. Staff gauges:
    a. Adhesive-backed mylar, suitable for outdoor service.
    b. Calibrated in hundredths of feet.
    c. Read the weir crest elevations directly.
    d. Gauge range: 1.5 feet minimum.
    e. Indicate the following elevations on each staff gauge:
        1) -0.75, -0.50, -0.25, 0.0, 0.25, 0.50, 0.75.
    f. Supplement with a stem-mounted pointer or indicator that permits direct observation of the weir gate crest elevation.
    g. Apply staff gauges to each stem cover after installation of the cover and after calibration and testing of the weir gates.
    h. Set gauges precisely by a survey crew using instruments acceptable to the Engineer.

C. Stem cover flanges, pipes and caps:
1. After fabrication, etch and anodize to produce the following chemical finishes in accordance with AA publication DAF-45:
    a. A 41 - Clear Anodic Coating.
    b. C 22 - Medium Matte Finish.

D. Gate stem covers: Concentric with stem.

E. Position indicators:
1. For all aboveground worm gear or traveling nut manual actuators, provide position indication on the actuator enclosure.
2. Tail rods on hydraulic cylinders, or dial indicators with clear full-open and closed position indicators, calibrated in number of turns or percentage of opening.

F. Manual or power actuator size:
1. Sized to deliver maximum force required under most severe specified operating condition, including static and dynamic forces, seat and wedge friction, and seating and unseating forces with safety factor of 5, unless otherwise specified.

G. Actuator size: Capable of supporting weight of suspended shafting unless carried by bottom thrust bearings; shaft guides with wall mounting brackets.

H. Provisions for alternate operation: Where specified or indicated on the Drawings, position and equip crank or handwheel operated geared valve actuators or lifts for alternate operation with tripod mounted portable gate actuators.

I. Operation: Counterclockwise to open with suitable and adequate stops, capable of resisting at least twice normal operating force to prevent overrun of valve or gate in open or closed position.

J. Open direction indicator: Cast arrow and legend indicating direction to rotate actuator on handwheel, chain wheel rim, crank, or other prominent place.

K. Buried actuator housing: Oil and watertight, specifically designed for buried service, factory packed with suitable grease, completely enclosed space between actuator housing and valve body so that no moving parts are exposed to soil; provide actuators with 2-inch square AWWA operating nut.

L. Worm gear actuators: Provide gearing on worm gear actuators that is self-locking with gear ratio such that torque in excess of 160 foot-pounds will not need to be applied to operate valve at most adverse conditions for which valve is designed.

M. Traveling nut actuators: Capable of requiring maximum 100 foot-pounds of torque when operating valve under most adverse condition; limit stops on input shaft of manual actuators for fully open and closed positions; non-moving vertical axis of operating nut when opening or closing valve.

2.02 HANDWHEEL ACTUATORS

A. Manufacturers: One of the following or equal:
   1. Rodney Hunt Co.
   2. Waterman Industries, Inc.

B. Coating: Handwheel as specified in Section 09960 - High-Performance Coatings.

C. Mounting: Floor stand or bench stand. Unless otherwise indicated on the Drawings position actuator 36 inches (nominal) above top of walkway surface.

D. Bearings above and below finished threaded bronze operating nut: Ball or roller.

E. Wheel diameter: Minimum 24 inches.

F. Indicator: Counterclockwise opening with arrow, and word OPEN cast on top of handwheel indicating direction for opening.

G. Pull to operate: Maximum 40 pounds pull at most adverse design condition.

H. Stem travel limiting device: Setscrew locked stop nuts above and below lift nut.

I. Grease fittings: Suitable for lubrication of bearings.

2.03 HAND-CRANKED GEARED ACTUATORS

A. Type: Single removable crank; fully enclosed.

B. Mounting: Floor and bench stand. Unless otherwise indicated on the Drawings position actuator 36 inches (nominal) above top of walkway surface.

C. Operating nut: When scheduled for portable gate actuators.

D. Geared lifts: 2-speed with minimum ratio of 4 to 1.

E. Teeth on gears, spur pinions, bevel gears, and bevel pinions: Cut.

F. Lift nuts: Cast manganese bronze.

G. Exterior surfaces on cast-iron lift parts: Smooth.

H. Bearings above and below flange on lift nuts: Ball or roller; capable of taking thrust developed by opening and closing of gates under maximum operating head; with bronze sleeve bearings and sufficient grease fittings for lubrication of moving parts, including bearings and gears.

I. Crank rotation indicator: Cast arrow with word OPEN in prominent location readily visible indicating correct rotation of crank to open gate.

J. Hand cranks: 15-inch radius; requiring maximum 25 pounds pull to operate gate at maximum operating head; with:
   1. Revolving brass sleeves.
   2. Gears, spur pinions, bevel gears, and bevel pinions with cut teeth.
   3. Cast manganese bronze lift nuts.
   4. Cast-iron lift parts with smooth exterior surfaces.

K. Indicator: Dial position type mounted on gear actuator; enclosed in cast-iron or aluminum housing with clear plastic cover; marked with fully open, 3/4, 1/2, 1/4, and closed positions.

2.04 FLOOR BOXES

A. Manufacturers: The following or equal:
   1. Waterman Industries, Inc.

B. Floor boxes: Cast-iron; with:
   1. Counter type indicator.
   2. Hinged, lockable lid with directional arrow.
   3. 2-inch square AWWA operating nut.
   4. Packing gland providing drip-tight seal around valve shaft.

2.05 FLOOR STAND

A. Manufacturers: One of the following or equal:
   1. Rodney Hunt Co.
   2. Waterman Industries, Inc.

B. Floor stand assemblies: Heavy-duty cast-iron, suitable for mounting specified actuator.

2.06 BENCH STANDS

A. Manufacturers: One of the following or equal:
   1. Rodney Hunt Co.
   2. Waterman Industries, Inc.

B. Bench stands: Handwheel actuators or hand crank, geared actuators conforming to hand-cranked geared actuator requirements, except capacity to be mounted on haunch, wall bracket, or self-contained gate yoke.

2.07 ACCESSORY EQUIPMENT

A. Wall brackets or haunches: As indicated on the Drawings.

B. Stems: Stainless steel; sized to match output of actuator; minimum gate or valve operating stem diameter; maximum 200 slenderness ratio.

C. Stem couplings: Stainless steel; internally threaded to match stem; lockable to stem by set screw.

D. Stem guides: Cast-iron with silicon bronze bushing; maximum 200 slenderness ratio; capable of being mounted with wall bracket; adjustable in 2 directions.

E. Wall brackets: Cast-iron, capable of withstanding output of actuator, adjustable in 2 directions.

F. Stem stuffing boxes: Cast-iron, with adjustable gland and packing.

G. Fasteners: Type 316 stainless steel.

H. Anchor bolts: As specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry except that the material shall be Type 316 stainless steel.

I. Geared valve actuators: Provided with cut gears, either spur or worm; sized to operate valves at most adverse design condition; with maximum 40-pound pull at handwheel or chain wheel rim.

J. Geared valve traveling nut actuators: Acceptable only where specified or indicated on the Drawings.

K. Accessory equipment for valves and gates requiring remote actuators: Operating stems, stem couplings, stem guides, wall brackets, and stem stuffing boxes.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install floor boxes in concrete floor with lid flush with floor.

B. After installation of gate and stem covers, mark stem covers at point where top of stems are at full-open position and at closed position.

C. Attach floor stand to structure with anchor bolts.

D. Install stem stuffing boxes where operating stems pass through intermediate concrete floor slabs.

3.02 SCHEDULES

A. Geared actuators: Provide geared actuators for following valves:
   1. Butterfly valves larger than 6 inches, nominal size, on liquid service.
   2. Butterfly valves larger than 10 inches, nominal size, on gas and air service.
   3. Plug valves 6 inches, nominal size, and larger.

B. Handwheel actuators: Provide handwheel actuators for valves mounted 6 feet or less above floors.

C. Chain wheel actuators: Provide chain wheel actuators for valves mounted more than 6 feet to centerline above floors.

END OF SECTION

SECTION 13447

ELECTRIC ACTUATORS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Electric motor-driven actuators for valves and gates as identified in the valves and gates actuator schedule as EAM, EDM, or EDR.

B. Section does not include: Electric motor-driven actuators for valves to be supplied as part of an equipment package listed in Section 11366B Cloth Media Disk Filter Equipment.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. C504 - Standard for Rubber-Seated Butterfly Valves.
   2. C542 - Standard for Electric Motor Actuators for Valves and Slide Gates.

B. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

1.03 DEFINITIONS

A. NEMA:
   1. Type 4X enclosure in accordance with NEMA 250.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures and Section 15050 - Common Work Results for Mechanical Equipment.

B. Provide a complete list/schedule of all actuators being provided with their associated tag names as indicated on the design drawings and/or specifications, service process area and the size of the valve they are actuating.

C. Product data:
   1. Electrical ratings:
      a. Voltage and number of phases.
      b. Starting and running current.
      c. Voltage levels and source for control and status.
   2. Description of integral control interface.
   3. Environmental ratings, including NEMA enclosure rating and submergence capabilities.
   4. Gear ratios for both manual and motorized actuation.
   5. Opening and closing directions.
   6. Allowable starts per hour.

7. List of all included options and accessories.
8. Full travel times.
9. Gearbox data including gear ratio, and gearbox efficiency.

D. Shop drawings:
   1. Wiring diagrams:
      a. Include all options and expansion cards furnished with each actuator.
   2. Dimensioned drawings of each valve and actuator combination.
   3. Dimensioned drawings of each valve gearbox.
   4. Electric motor data.

E. Calculations:
   1. Operating torque.
   2. Maximum torque calculations for seating and unseating.
   3. Maximum operating torque at starting and normal operation.
   4. Signed by Professional Engineer.

F. Provide draft vendor operation and maintenance manual as specified in Section 01782 - Operation and Maintenance Data:
   1. Include a list of all configurable parameters, and the final values for each.
   2. Include a troubleshooting chart covering the complete valve and controls/electrical power systems, showing description of trouble, probable cause, and suggested remedy.

G. Commissioning submittals:
   1. Provide Manufacturer's Certificate of Source Testing as specified in Section 01756 - Commissioning.
      a. Affidavit in accordance with AWWA C542.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

H. Project closeout documents:
   1. Provide final vendor operation and maintenance manual as specified in Section 01782 - Operation and Maintenance Data.

1.05 WARRANTY

A. Provide warranty as specified in General Conditions.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers for lines 4 inch and larger:
   1. One of following or equal:
      a. Rotork Controls Inc. IQ3 Range:
         1) IQ for multi-turn applications.
         2) IQT for quarter-turn applications.
      b. Limitorque Corp.:
         1) Accutronix MX for multi-turn applications.
         2) Accutronix QX quarter-turn applications.

c. Auma:
    1) SA (multi-turn) with Aumatic AC controls.
    2) SQ (quarter-turn) with Aumatic AC controls.

2.02 CHARACTERISTICS FOR ACTUATORS ON LINES 4 INCHES AND LARGER

A. Provide actuators complete and operable with all components and accessories required for operation.

B. Power supply:
    1. Voltage and phases as indicated in the Motorized Actuator Schedule.
    2. Valve or gate motion independent of power supply phase rotation.
    3. Provide an internal backup power source or mechanical indicator to maintain settings and track valve position when main power is off.
    4. The actuators shall incorporate all major components such as the motor, starter, local controls, terminals, etc. housed within a self-contained, sealed enclosure.

C. Size actuator to move gates or valves from full open to closed position within the time indicated in the Motorized Actuator Schedule:
    1. If an operating time is not indicated on the Motorized Actuator Schedule, size the actuator to move gates or valves at minimum 12 inches per minute under maximum load. Measure rate of closure for valves at maximum diameter of disc, plug, or ball.
    2. Size actuators so that gear boxes are not required where possible.

D. Control interface:
    1. Configuration:
        a. Provide a non-intrusive, non-contacting interface for configuring all input and output settings, control values, ranges, torque switch settings, valve positions switch settings, and options:
            1) Configurable from a handheld configuring tool or input devices on the actuator.
    2. Local interface, integral to actuator:
        a. Non-intrusive, non-contacting selector switches:
            1) LOCAL-STOP-REMOTE:
                a) Motor actuator operation is prevented with the switch in STOP.
            2) OPEN-CLOSE:
                a) Controls the valve when LOCAL-STOP-REMOTE is in LOCAL.
                b) Spring return to center.
                c) Configurable between maintained (actuator runs until end of travel, high torque, or a LOCAL-STOP-REMOTE is switched to STOP) and momentary (actuator stops when lever is released).
        b. Local display:
            1) Valve fully open and fully closed indicators.
            2) Numerical display showing actual valve or gate position in percent of travel.
    3. Control inputs:
        a. Capable of using 120 VAC or 24 VDC inputs.
        b. Controls the valve when LOCAL-STOP-REMOTE is in REMOTE.

c. Isolated inputs capable of operating from external control voltage source or internal power supply:
1) Furnish 120 VAC or 24 VDC control power supplies within the actuator.
d. Provide the following inputs:
1) OPEN.
2) CLOSE.
e. OPEN and CLOSE inputs configurable between maintained (actuator runs until end of travel, high torque, or a STOP input) and momentary (actuator stops when command is removed).

4. Status outputs:
a. Dry contact outputs configured for the functions indicated on the Drawings. Provide the following outputs for all actuators:
1) Fully closed.
2) Fully open.
3) LOCAL-STOP-REMOTE in REMOTE position.
b. All output contacts rated for 5 amps, 120 VAC, and 24 VDC.

5. Analog input:
a. Provide a 4-20 milliampere analog input for analog modulating valves when indicated on the Drawings.
b. Modulate valve to maintain position based on analog input value.
c. Maximum input impedance 250 ohms.

6. Analog output:
a. Provide an isolated 4-20 milliampere analog output when indicated on the Drawings:
1) Loop power sourced from the actuator power supply.
2) Capable of driving into a load up to 500 ohms.
3) Output proportional to process value(s) indicated on the Drawings.
4) Valve or gate position.
5) Operating torque.

E. Features:
1. Time delay on reversal: Incorporate time delay between stopping actuator and starting in opposite direction to limit excessive current, torque, and heating from instantaneous reversal.
2. Data logging:
a. Store diagnostic data and reference data.
b. Time-stamped historical operating data, including number of operations and most recent operations.
c. Starting torque, maximum running torque, and end of travel torque:
1) Store reference data (recorded during commissioning) and data from last operation.
3. Provide display of logged data on the actuator, or provisions to download to a personal computer.

F. Materials:
1. Construct motorized actuators of materials suitable for the environment in which the valve or gate is to be installed.

G. Components:
    1. Motors.
    2. Specifically designed for valve actuator service with high starting torque, totally enclosed non-ventilated construction.
    3. Torque ratings equal to or greater than that required for valve seating and dynamic torques with a 25 percent factor of safety:
        a. Design requirements for rubber-seated AWWA butterfly valves:
            1) Design actuators for maximum gate or valve operating torque, in accordance with and using safety factors required in AWWA C504 and AWWA C542:
                a) Valve actuator torque requirement for open-close service: Not less than the required valve-seating and dynamic torques under design operating conditions in accordance with AWWA C504.
                b) Valve actuator torque requirement for modulating service: Not less than twice the required valve dynamic torque under design operating conditions in accordance with AWWA C504.
        b. Design requirements for slide gates, gate valves, knife gate valves, globe valves, and diaphragm valves:
            1) Design valves and actuators for maximum operating torque, in accordance with and using safety factors required in AWWA C542.
            2) Design for the maximum torque and thrust running load over the full cycle.
            3) Maximum torque or thrust rating: The actuator stall torque or maximum thrust output shall not exceed the torque or thrust capability of the valve or gate, as determined by the valve or gate manufacturer.
    4. Capable of being removed and replaced without draining the actuator gear case.
    5. Motor bearings shall be amply proportioned of the anti-friction type and permanently lubricated.
    6. Rated for operating under the following conditions without exceeding temperature limits with ambient temperature of 40 degrees Celsius:
        a. Continuous operation for 15 minutes or twice the open-to-close operating time (whichever is greater) at normal operating torque or 33 percent of maximum torque (whichever is greater).
        b. 60 starts per hour for open/close service or 1,200 starts per hour for modulating service.
    7. Provide the following motor protection features:
        a. Jammed valve (no valve motion detected through a time delay).
        b. High motor temperature (sensed by an embedded thermostats).
        c. High torque.
        d. Single phasing protection.

H. Enclosures:
    1. Actuator housing ratings as indicated in the Motorized Actuator Schedule.
    2. Stainless steel external fasteners.
    3. Provide o-ring seals for each of the following areas:
        a. Between the terminal compartment and the internal electrical elements.
        b. Between the mechanical and electrical portions to protect from the ingress of oil, and to protect the mechanical components of oil from dust and moisture when the electrical terminal is open.

4. Provide the following minimum enclosure ratings:
    a. NEMA Type 4X enclosure for general applications.

I. Position sensing:
1. Electronic and adjustable using a solid-state encoder wheel.
    a. Mechanical limit switches and potentiometers are not acceptable.
2. Capable of retaining position and monitoring valve or gate motion when valve is manually actuated and when main power is not present.
3. Valve range and position switch outputs field adjustable.

J. Torque sensing:
1. Torque shutdown setting: 40 percent to 100 percent rated torque:
    a. Adjustable in 1 percent increments.
2. Capable of interrupting control circuit during both opening and closing and when valve torque overload occurs.
3. Electrical or electronic torque sensing:
4. Independent of variations in frequency, voltage, or temperature.
5. Provide a temporary inhibit of the torque sensing system during unseating or during starting in mid-travel against high inertia loads.
6. Provide visible verification of torque switch status without any housing disassembly.

K. Manual actuators:
1. Hand wheel for manual operation.
    a. Maximum 80-pound pull on rim when operating gate or valve under maximum load.
    b. Provide pull chain when motorized actuator is located more than 6 feet above floor surface:
        1) Chain shall be of sufficient length to reach approximately 4 feet above the operating level.
        2) Where the chain obstructs an aisle or walkway, provide holdback or other means to ensure chain does not create a nuisance or hazard to operating personnel.
2. Declutch lever: Padlockable, capable of mechanically disengaging motor and related gearing and freeing hand wheel for manual operation.

L. Gearing: Hardened alloy steel spur or helical gears and self-locking, alloy bronze worm gear set:
1. Accurately cut to ensure minimum backlash.

M. Bearings:
1. Anti-friction bearing with caged balls or rollers throughout.
2. Sealed-for-life type thrust bearings housed in a separate thrust base.

N. Drive bushing:
1. Easily detachable for machining to suit the valve stem or gearbox input shaft.
2. Positioned in a detachable base of the actuator.

O. Lubrication:
1. Provide totally enclosed actuator gearing with oil or grease filled gear case suitable for operation at any angle.
2. Actuators requiring special or exotic lubricants are not acceptable.

2.03 ACCESSORIES

A. Software:
   1. Furnish PC-based diagnostic and configuration software to display diagnostic data.

B. Termination module cover:
   1. For actuators on a valve network, provide a means to keep the valve network in service, in the event where the actuator must be removed.
   2. Provide sunshades for all outdoor installations of remote control stations that use an LCD or similar screen. Regular pushbutton, sector switches, and pilot light control stations will not require a sunshade.

2.04 SPARE PARTS AND SPECIAL TOOLS

A. As specified in Section 01600 - Product Requirements.

B. Spare parts:
   1. Provide the following (minimum 10 percent of total number of actuators of each model type furnished, but not less than 1 for each model of actuator furnished):
      a. Stem nut.
      b. Worm shaft subassembly.
      c. Drive sleeve subassembly.
      d. Complete actuator seal kit.
      e. Actuator gearbox oil (sufficient quantity to fill 4 gearboxes).
      f. Encoder.
      g. Control module.
   2. Provide 1 spare motor for each size motor furnished.

C. Setting tool:
   1. If required for setting or configuring the actuator, provide a handheld setting tool:
      a. Furnish 1 setting tool for every 10 actuators.

PART 3 EXECUTION

3.01 GENERAL

A. As specified in Section 15050 - Common Work Results for Mechanical Equipment.

B. Position visual indicators so that they are most easily visible.

3.02 COMMISSIONING

A. As specified in Section 01756 - Commissioning, Section 15958 - Mechanical Equipment Testing, and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Source Testing:
         1) Proof-of-Design and Performance Test Reports in accordance with AWWA C542.
      b. Manufacturer's Certificate of Installation and Functionality Compliance.
   2. Manufacturer's Representative on-site requirements:
      a. Installation: 2 trips, 2-day minimum each.
      b. Functional testing: 2 trips, 2-day minimum each.
   3. Training:
      a. Maintenance: 4 hours per session, 2 sessions.
      b. Operation: 2 hours per session, 2 sessions.

C. Source testing:
   1. Design and Performance Test Reports in accordance with AWWA C542.
   2. Test each actuator with a simulated load:
      a. Simulate a typical valve load.
   3. Electrical Instrumentation and Controls:
      a. Test witnessing: not witnessed.
      b. Conduct testing as specified in Section 17950 - Commissioning for Instrumentation and Controls.

D. Functional testing:
   1. Installed actuator:
      a. Test witnessing: Witnessed.
      b. Conduct Level 2 General Equipment Performance Tests.
      c. Conduct Level 2 Vibration Tests.
      d. Conduct Level 2 Noise Tests.
   2. Electrical Instrumentation and Controls:
      a. Test witnessing: Witnessed.
      b. Conduct testing as specified in Section 17950 - Commissioning for Instrumentation and Controls.

3.03 MOTORIZED ACTUATOR SCHEDULE

A. Provide all actuators indicated on the Drawings:
   1. Major process actuators are listed in the Intelligent Actuator Schedule in this Section.
   2. The Motorized Actuator Schedule does not include all number and types of actuators required for the Project.

B. Abbreviations relating to type:
   1. BFV = Butterfly Valve.
   2. BV = Ball Valve.
   3. PV = Plug Valve.
   4. SG = Slide Gate.

C. Abbreviations relating to actuator type:
   1. O/C = Open and Close Service.
   2. MOD = Modulating Service.

D. Abbreviations relating to controls:
   1. PA = Profibus PA.
   2. DP = Profibus DP.
   3. DN = DeviceNet.
   4. FF = Foundation Fieldbus H1.
   5. MB = Modbus RTU (RS-485).
   6. NET = Manufacturer's proprietary network.
   7. A = Analog (4-20 mA) control, modulating duty.
   8. D = Discrete Jog Open/Close, variable percent open.
   9. D-O/C = Discrete Open/Close.

END OF SECTION

INTELLIGENT ACTUATOR SCHEDULE									
Item	**Reference DWG**	**Type**	**Size**	**Actuator Type**	**NEMA Rating**	**Voltage/ Phase/ Hz**	**Notes**	**Open Time**	**Controls**
Filter Cell 6 Inlet Valve 06-EDR-6601	06N03	BFV	12”	O/C	4X	480/3/60		30 s	D
Filter Cell 6 Outlet Valve 06-EDR-6602	06N03	BFV	18”	O/C	4X	480/3/60		30 s	D-O/C
Filter Cell 6 FTW Valve 06-EDR-6603	06N03	BFV	18”	O/C	4X	480/3/60		30 s	D-O/C
Filter Cell 7 Inlet Valve 06-EDR-6701	06N06	BFV	12”	O/C	4X	480/3/60		30 s	D
Filter Cell 7 Outlet Valve 06-EDR-6702	06N06	BFV	18”	O/C	4X	480/3/60		30 s	D-O/C
Filter Cell 7 FTW Valve 06-EDR-6703	06N06	BFV	18”	O/C	4X	480/3/60		30 s	D-O/C
Filter Cell 1 Inlet Valve 06-EDR-631(1)	06N09	BFV	12”	O/C	4X	480/3/60		30 s	D
Filter Cell 2 Inlet Valve 06-EDR-635(1)	06N09	BFV	12”	O/C	4X	480/3/60		30 s	D
Filter Cell 3 Inlet Valve 06-EDR-651(1)	06N09	BFV	12”	O/C	4X	480/3/60		30 s	D
Filter Cell 4 Inlet Valve 06-EDR-655(1)	06N09	BFV	12”	O/C	4X	480/3/60		30 s	D
Filter Cell 5 Inlet Valve 06-EDR-660(1)	06N09	BFV	12”	O/C	4X	480/3/60		30 s	D

Notes:
(1) New motorized actuator to be installed on existing equipment. Field verify characteristics prior to sizing motor actuator.

SECTION 15050

COMMON WORK RESULTS FOR MECHANICAL EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Basic design and performance requirements for building mechanical equipment and process mechanical equipment.

1.02 REFERENCES

A. American Gear Manufacturer's Association (AGMA) Standards:
   1. 6001-E08 - Design and Selection of Components for Enclosed Gear Drives.

B. American Bearing Manufactures Association (ABMA) Standards:
   1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

C. American Petroleum Institute (API):
   1. 682 - Shaft Sealing Systems for Centrifugal and Rotary Pumps.

D. ASTM International (ASTM):
   1. A36 - Standard Specification for Carbon Structural Steel.
   2. A48 - Standard Specification for Gray Iron Castings.
   3. A125 - Standard Specification for Steel Springs, Helical, Heat-Treated.
   4. A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   5. A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   6. A320 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service.
   7. A536 - Standard Specification for Ductile Iron Castings.
   8. A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   9. B61 - Standard Specification for Steam or Valve Bronze Castings.
   10. B62 - Standard specification for Composition Bronze or Ounce Metal Castings.
   11. B505 - Standard Specification for Copper Alloy Continuous Castings.
   12. B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
   13. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   14. F594 - Standard Specification for Stainless Steel Nuts.

E. Hydraulic Institute (HI).

F. Occupational Safety and Health Administration (OSHA).

G. Unified Numbering System (UNS).

1.03 DEFINITIONS

A. Resonant frequency: That frequency at which a small driving force produces an ever-larger vibration if no dampening exists.

B. Rotational frequency: The revolutions per unit of time usually expressed as revolutions per minute.

C. Critical frequency: Same as resonant frequency for the rotating elements or the installed machine and base.

D. Peak vibration velocity: The root mean square average of the peak velocity of the vibrational movement times the square root of 2 in inches per second.

E. Rotational speed: Same as rotational frequency.

F. Maximum excitation frequency: The excitation frequency with the highest vibration velocity of several excitation frequencies that are a function of the design of a particular machine.

G. Critical speed: Same as critical frequency.

H. Free field noise level: Noise measured without any reflective surfaces (an idealized situation); sound pressure levels at 3 feet from the source unless specified otherwise.

I. Operating weight: The weight of unit plus weight of fluids or solids normally contained in unit during operation.

1.04 DESIGN REQUIREMENTS

A. General:
   1. Product requirements as specified in Section 01600 - Product Requirements.
   2. Project conditions as specified in Section 01610 - Project Design Criteria.
   3. Provisions specified under each technical equipment specification prevail over and supersede conflicting provisions specified in this Section.
   4. Equipment manufacturer's responsibility extends to selection and mounting of gear drive units, motors or other prime movers, accessories, and auxiliaries required for proper operation.
   5. Vibration considerations:
      a. Resonant frequency:
         1) For single-speed equipment, ensure there are no natural resonant frequencies within 25 percent above or below the operating rotational frequencies or multiples of the operating rotational frequencies that may be excited by the equipment design.
         2) For variable-speed equipment, ensure there are no natural resonant frequencies within 25 percent above or below the range of operating frequencies.
      b. Design, balance, and align equipment to meet the vibration criteria specified in Section 15958 - Mechanical Equipment Testing.
   6. Equipment units weighing 50 pounds or more: Provide with lifting lugs or eyes to allow removal with hoist or other lifting device.

B. Power transmission systems:
   1. V-belts, sheaves, shaft couplings, chains, sprockets, mechanical variable-speed drives, variable frequency drives, gear reducers, open and enclosed gearing, clutches, brakes, intermediate shafting, intermediate bearings, and U-joints are to be rated for 24 hour-a-day continuous service or frequent stops-and-starts intermittent service, whichever is most severe, and sized with a service factor of 1.5 or greater in accordance with manufacturer recommendations:
      a. Apply service factor to nameplate horsepower and torque of prime source of power and not to actual equipment loading.
      b. Apply service factors in accordance with AGMA 6001-E08, other applicable AGMA standards, or other applicable referenced standards.

C. Equipment mounting and anchoring:
   1. Mount equipment on cast-iron or welded-steel bases with structural steel support frames:
      a. Utilize continuous welds to seal seams and contact edges between steel members.
      b. Grind welds smooth.
   2. Provide bases and supports with machined support pads, dowels for alignment of mating of adjacent items, adequate openings to facilitate grouting, and openings for electrical conduits.
   3. Provide jacking screws in bases and supports for equipment weighing over 1,000 pounds.
   4. Design equipment anchorage, supports, and connections for dead load, running loads, loads during start-up, seismic load specified in Section 01612 - Seismic Design Criteria, and other loads as required for proper operation of equipment:
      a. For equipment with an operating weight of 400 pounds or greater and all equipment that is supported higher than 4 feet above the floor, provide calculations for:
         1) The operating weight and location of the centroid of mass for the equipment.
         2) Forces and overturning moments.
         3) Shear and tension forces in equipment anchorages, supports, and connections.
         4) The design of equipment anchorage, supports, and connections based on calculated shear and tension forces.
   5. Anchorage of equipment to concrete or masonry:
      a. Perform calculations and determine number, size, type, strength, and location of anchor bolts or other connections.
      b. Unless otherwise indicated on the Drawings, select and provide anchors from the types specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
      c. Provide bolt sleeves around cast-in anchor bolts for 400 pounds or greater equipment:
         1) Adjust bolts to final location and secure the sleeve.
   6. Anchorage of equipment to metal supports:
      a. Perform calculations and determine number, size, type, strength, and location of bolts used to connect equipment to metal supports.
   7. Unless otherwise indicated on the Drawings, install equipment supported on concrete over non-shrink grout pads as specified in this Section.

1.05 SUBMITTALS

A. As specified in Section 01600 - Product Requirements.

B. Product data:
   1. For each item of equipment:
      a. Design features.
      b. Load capacities.
      c. Efficiency ratings.
      d. Material designations by UNS alloy number or ASTM Specification and Grade.
      e. Data needed to verify compliance with the Specifications.
      f. Catalog data.
      g. Nameplate data.
      h. Clearly mark submittal information to show specific items, materials, and accessories or options being furnished.
   2. Gear reduction units:
      a. Engineering information in accordance with applicable AGMA standards.
      b. Gear mesh frequencies.

C. Shop drawings:
   1. Drawings for equipment:
      a. Drawings that include cut-away drawings, parts lists, material specification lists, and other information required to substantiate that proposed equipment complies with specified requirements.
   2. Outline drawings showing equipment, driver, driven equipment, pumps, seal, motor(s) or other specified drivers, variable frequency drive, shafting, U-joints, couplings, drive arrangement, gears, base plate or support dimensions, anchor bolt sizes and locations, bearings, and other furnished components.
   3. Installation instructions including leveling and alignment tolerances, grouting, lubrication requirements, and initial Installation Testing procedures.
   4. Wiring, control schematics, control logic diagrams and ladder logic or similar for computer-based controls.
   5. Recommended or normal operating parameters such as temperatures and pressures.
   6. Alarm and shutdown setpoints for all controls furnished.

D. Calculations:
   1. Structural:
      a. Substantiate equipment base plates, supports, bolts, anchor bolts, and other connections meet minimum design requirements specified and seismic design criteria as specified in Section 01612 - Seismic Design Criteria.
   2. Mechanical:
      a. ABMA 9 or ABMA 11 L10 life for bearings calculation methods for drivers, pumps, gears, shafts, motors, and other driveline components with bearings.
      b. Substantiate that operating rotational frequencies meet the requirements of this Section.

c. Torsional analysis of power transmission systems: When torsional analysis specified in the equipment sections, provide:
1) Sketch of system components identifying physical characteristics including mass, diameter, thickness, and stiffness.
2) Results of analysis including first and second critical frequencies of system components and complete system.
d. Calculations shall be signed and stamped by a licensed engineer.

3. Drinking water:
a. If applicable, conform to the requirements of Section 01600 - Product Requirements for materials in contact with drinking water.

E. Operation and maintenance manuals:
1. As specified in Section 01782 - Operating and Maintenance Data.
2. Equipment with bearings:
a. Include manufacturer and model number of every bearing.
b. Include calculated ball pass frequencies of the installed equipment for both the inner and outer raceways.

F. Commissioning submittals: As specified in Section 01756 - Commissioning.

G. Project closeout documents: As specified in Section 01770 - Closeout Procedures.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials as specified in Section 01600 - Product Requirements including special requirements for materials in contact with drinking water.

B. Ferrous materials:
1. Steel for members used in fabrication of assemblies: ASTM A36.
2. Iron castings: ASTM A48, tough, close-grained gray iron, free from blowholes, flaws, and other imperfections.
3. Ductile iron castings: ASTM A536, Grade 65-45-12, free from flaws and imperfections.
4. Galvanized steel sheet: ASTM A653, minimum 0.0635-inch (16-gauge).
5. Expanded metal: ASTM A36, 13-gauge, 1/2-inch flat pattern expanded metal.
6. Stainless steel:
a. As specified in Section 05120 - Structural Steel.
b. In contact or within 36 inches of water: Type 316 or 316L.
c. In sea air environment: Type 316 or 316L.
d. Other locations: Type 304 or 304L.
e. Source cleaning and passivation as specified in Section 05120 - Structural Steel.

C. Non-ferrous materials:
1. Bronze in contact with wastewater: Composition of not more than 2 percent aluminum nor more than 6 percent zinc; UNS Alloy C83600, C89833, C89520, C92200, or C93700 in accordance with ASTM B61, B62, B505, or B584, when not specified otherwise.
2. Aluminum: As specified in Section 05140 - Structural Aluminum.

D. Dielectric materials for separation of dissimilar metals:
   1. Neoprene, bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other materials as specified.

E. Non-shrink grout and epoxy non-shrink grout: As specified in Section 03600 - Grouting.

2.02 ANCHORS AND FASTENERS

A. Mechanical anchoring to concrete and masonry:
   1. As specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry:
      a. Type 316 stainless steel.
   2. Design as specified in Section 01612 - Seismic Design Criteria.

B. High-strength fasteners:
   1. As specified in Section 05120 - Structural Steel.

C. Flange bolts:
   1. As specified in Section 15052 - Common Work Results for General Piping.

D. Mechanical assembly fasteners:
   1. Stainless steel:
      a. High-temperature service or high-pressure service:
         1) Bolts: ASTM A193, Grade B8 (Type 304) or Grade B8M (Type 316), Class 1, heavy hex.
         2) Nuts: ASTM A194, Grade 8, heavy hex.
         3) Washers: Alloy group matching bolts and nuts.
      b. Low-temperature service:
         1) Bolts: ASTM A320, Grade B8 (Type 304) or Grade B8M (Type 316), Class 1, heavy hex.
         2) Nuts: ASTM A194, Grade 8 (Type 304) or Grade B8M (Type 316), heavy hex.
         3) Washers: Alloy group matching bolts and nuts.
      c. General service:
         1) Bolts: ASTM F593, Alloy Group 1 (Type 304) or Alloy Group 2 (Type 316).
         2) Nuts: ASTM F594, Alloy Group 1 (Type 304) or Alloy Group 2 (Type 316).
         3) Washers: Alloy group matching bolts and nuts.

2.03 SHAFT COUPLINGS

A. General:
   1. Type and ratings: Provide non-lubricated type, designed for not less than 50,000 hours of operating life.
   2. Sizes: Provide as recommended by manufacturer for specific application, considering horsepower, speed of rotation, and type of service.

B. Shaft couplings for close-coupled electric-motor-driven equipment:
   1. Use for:
      a. Equipment 1/2 horsepower or larger.
      b. Reversing equipment.

c. Equipment subject to sudden torque reversals or shock loading:
d. Examples:
1) Reciprocating pumps, blowers, and compressors.
2) Conveyor belts.

2. Manufacturers: One of the following or equal:
a. Lovejoy.
b. T.B. Woods.
3. Provide flexible couplings designed to accommodate angular misalignment, parallel misalignment, and end float.
4. Manufacture flexible component of coupling from synthetic rubber or urethane.
5. Provide service factor of 2.5 for electric motor drives and 3.5 for engine drives.
6. Do not allow metal-to-metal contact between driver and driven equipment.

C. Shaft couplings for direct-connected electric-motor-driven equipment:
1. Use for 1/2 horsepower or larger and subject to normal torque, non-reversing applications.
2. Manufacturers: One of the following or equal:
a. Rexnord.
b. T.B. Woods.
3. Provide flexible couplings designed to accommodate shock loading, vibration, and shaft misalignment or offset.
4. Provide flexible connecting element of rubber and reinforcement fibers.
5. Provide service factor of 2.0.
6. Connect stub shafts through collars or round flanges, firmly keyed to their shafts with neoprene cylinders held to individual flanges by through pins.

D. Spacer couplings: Where cartridge-type mechanical seals or non-split seals are specified, provide a spacer-type coupling of sufficient length to remove the seal without disturbing the driver or driven equipment unless noted otherwise in the individual equipment specifications.

E. Specialized couplings: Where requirements of equipment dictate specialized features, supply coupling recommended for service by manufacturer:
1. Includes any engine-driven equipment.

2.04 STUFFING BOX, SEAL CHAMBER, AND SHAFT SEALS

A. General:
1. Unless otherwise noted in the equipment section, provide cartridge-type, double mechanical shaft seals for pumps.
2. Provide a stuffing box large enough for a double mechanical seal.
3. Where packing is specified, provide stuffing box large enough to receive a double mechanical seal.
4. Provide seal or packing flush connections, (3/4-inch size unless another size is indicated on the Drawings).
5. Provide and route leakage drain line to nearest equipment floor drain indicated on the Drawings.
6. For pumps with packing, design packing gland to allow adjustment and repacking without dismantling pump except to open up packing box.
7. Seal or packing flush requirements shall be in accordance with API Standard 682 requirements. Unless otherwise indicated, specified or required

by the equipment and seal manufacturers, the following API flushing Plan arrangements shall be utilized as appropriate for the application:

a. Single seal, clean water applications: Plan 11 (Discharge bypass to seal).
b. Single seal, vertical pump applications: Plan 13 (Seal bypass to suction).
c. Single seal, clean hot water (greater than 180 degrees Fahrenheit) applications: Plan 23 (Seal cooler and pumping ring).
d. Single seal, solids, or contaminants containing water applications: Plan 32 (External seal water).
e. Double seal applications: Plan 54 (External seal water).

B. Packing: When specified in the equipment section of the specifications, provide the following type of packing:
   1. Wastewater, water, and sludge applications:
      a. Asbestos free.
      b. PTFE (Teflon) free.
      c. Braided graphite.
      d. Manufacturers: One of the following or equal:
         1) Chesterton, 1400.
         2) John Crane, equivalent product.
   2. Drinking water service:
      a. Asbestos free.
      b. Material: Braided PTFE (Teflon).
      c. Manufacturers: One of the following or equal:
         1) Chesterton, 1725.
         2) John Crane, equivalent product.

C. Mechanical seals: Provide seal types specified in the equipment sections and as specified.
   1. Provide seal types meeting the following requirements:
      a. Balanced hydraulically.
      b. Spring: Stationary, out of pumping fluid, Hastelloy C; Type Elgiloy or 17-7 PH stainless steel for split seals.
      c. O-ring: Viton 747.
      d. Gland: Type 316L stainless steel.
      e. Set screws: Type 316L stainless steel.
      f. Faces: Reaction bonded, silicon carbide.
      g. Seal designed to withstand 300 pounds per square inch gauge minimum differential pressures in either direction; no requirement for seal buffer pressure to be maintained when pump is not operational even though process suction head may be present in pump.
   2. Cartridge-type single mechanical:
      a. Manufacturers: One of the following or equal:
         1) Chesterton, S10.
         2) John Crane, 5610 Series.
   3. Cartridge-type double mechanical: Manufacturers:
      a. One of the following or equal:
         1) Chesterton, S20.
         2) John Crane, 5620 Series.
   4. Split-face single mechanical: Manufacturers:
      a. One of the following or equal:
         1) Chesterton, 442.
         2) John Crane, 3740.

5. Cartridge-type flushless mechanical:
    a. Manufacturers: One of the following or equal:
        1) Chesterton, 156.
        2) John Crane, 5870.

2.05 GEAR REDUCTION UNITS

A. Type: Helical or herringbone, unless otherwise specified.

B. Design:
1. Made of alloys treated for hardness and for severe service.
2. AGMA Class II service:
    a. Use more severe service condition when such is recommended by unit's manufacturer.
3. Cast-iron housing with gears running in oil.
4. Anti-friction bearings.
5. Thermal horsepower rating based on maximum horsepower rating of prime mover, not actual load.
6. Manufactured in accordance with applicable AGMA standards.

C. Planetary gear units are not to be used.

2.06 BELT DRIVES

A. Sheaves:
1. Separately mounted on bushings by means of at least 3 pull-up bolts or cap tightening screws.
2. When 2 sheave sizes are specified, provide separate belts sized for each set of sheaves.
3. Statically balanced for all; dynamically balanced for sheaves that operate at a peripheral speed of more than 5,500 feet per minute.
4. Key bushings to drive shaft.

B. Belts: Anti-static type when explosion-proof equipment or environment is specified.
1. When spare belts are specified, furnish 1 spare belt for every different type and size of belt-driven unit:
    a. Where 2 or more belts are involved, furnish matched sets.
    b. Identify as to equipment, design, horsepower, speed, length, sheave size, and use.
    c. Package in boxes labeled with identification of contents.

C. Manufacturers: One of the following or equal:
1. Dodge, Dyna-V belts with matching Dyna-V sheaves and Taper-Lock bushings.
2. T.B. Woods, Ultra-V belts with matching Sure-Grip sheaves and Sure-Grip bushings.

2.07 BEARINGS

A. Type: Oil or grease lubricated, ball or roller antifriction type, of standard manufacture.

B. Oil-lubricated bearings: Provide either pressure lubricating system or separate oil reservoir splash-type system:
   1. Size oil-lubrication systems to safely absorb heat energy generated in bearings when equipment is operating under normal conditions and with the temperature 15 degrees Fahrenheit above the maximum design temperature as specified in Section 01610 - Project Design Criteria.
   2. Provide an external oil cooler when required to satisfy the specified operating conditions:
      a. Provide air-cooled system if a water-cooling source is not indicated on the Drawings.
      b. Equip oil cooler with a filler pipe and external level gauge.

C. Grease lubricated bearings, except those specified to be factory sealed: Fit with easily accessible grease supply, flush, drain, and relief fittings.
   1. Lubrication lines and fittings:
      a. Lines: Minimum 1/4-inch diameter stainless steel tubing.
      b. Multiple fitting assemblies: Mount fittings together in easily accessible location.
      c. Use standard hydraulic-type grease supply fittings:
         1) Manufacturers: One of the following or equal:
            a) Alemite.
            b) Zerk.

D. Ratings: Rated in accordance with ABMA 9 or ABMA 11 L10 life for bearings rating life of not less than 50,000 hours.

2.08 MOTORS

A. As specified in Section 16222 - Low Voltage Motors Up to 500 Horsepower.

2.09 GEAR MOTORS

A. Motors as specified in Section 16222 - Low Voltage Motors Up to 500 Horsepower.

B. Helical gearing for parallel shaft drives and worm gearing for right-angle drives.

C. Manufactures: One of the following or equal:
   1. Baldor Electric Company.
   2. Bodine Electric Company.

2.10 VENDOR CONTROL PANELS

A. As specified in Sections 17710 - Control Systems: Panels, Enclosures, and Panel Comments and 17720 - Control Systems: Programmable Logic Controllers.

2.11 EQUIPMENT SUPPORT FRAMES

A. Bolt holes shall not exceed bolt diameter by more than 25 percent, up to a limiting maximum diameter oversize of 1/4-inch.

2.12 PIPING AND VALVES

A. Piping as specified in Section 15052 - Common Work Results for General Piping.

B. Valves as specified in Section 15110 - Common Work Results for Valves.

2.13 SAFETY EQUIPMENT

A. Safety guards:
   1. Provide guards that protect personnel from rotating shafts or components within 7.5 feet of floors or operating platforms.
   2. Requirements:
      a. Allow visual inspection of moving parts without removal.
      b. Allow access to lubrication fittings.
      c. Prevent entrance of rain or dripping water for outdoor locations.
      d. Size belt and sheave guards to allow for installation of sheaves 15 percent larger and addition of 1 belt.
   3. Materials:
      a. Sheet metal: Carbon steel, 12-gauge minimum thickness, hot-dip galvanized after fabrication.
      b. Fasteners: Type 304 stainless steel.

2.14 SPRING VIBRATION ISOLATORS

A. Design requirements:
   1. Telescopic top and bottom housing with vertical stabilizers to resist lateral and vertical forces.
   2. Use steel coil springs.
   3. Design vibration isolators in accordance with seismic design criteria as specified in Section 01612 - Seismic Design Criteria.

B. Performance requirements: Minimum spring deflection of 1-inch under static load and capable of limiting transmissibility to 10 percent maximum at design operating load.

C. Manufacturers: One of the following or equal:
   1. California Dynamics Corporation, Type RJSD.
   2. Mason Industries, equivalent product.

D. Materials:
   1. Fabricate isolators using welded-steel or shatterproof ductile iron in accordance with ASTM A536 Grade CS-45-12.
   2. Spring steel: ASTM A125.

2.15 NAMEPLATES

A. Fastened to equipment at factory in an accessible and visible location.

B. Stainless steel sheet engraved or stamped with text, holes drilled or punched for fasteners.

C. Fasteners: Number 4 or larger oval head stainless steel screws or drive pins.

D. Text:
   1. Manufacturer’s name, equipment model number and serial number, motor horsepower when appropriate, and identification tag number.
   2. Indicate the following additional information as applicable:
      a. Maximum and normal rotating speed.
      b. Service class per applicable standards.
   3. Include for pumps:
      a. Rated total dynamic head in feet of fluid.
      b. Rated flow in gallons per minute.
      c. Impeller, gear, screw, diaphragm, or piston size.
   4. Include for gear reduction units:
      a. AGMA class of service.
      b. Service factor.
      c. Input and output speeds.

2.16 SHOP FINISHES

A. Provide appropriate factory coatings as specified in Section 09960 - High-Performance Coatings.
   1. Motors and gear reducers: Shop finish paint with manufacturer's standard coating, unless otherwise specified in the individual equipment specification.

2.17 SPECIAL TOOLS

A. Supply 1 set of special tools as specified in Section 01600 - Product Requirements.

2.18 SOURCE TESTING

A. Testing requirements unless specified otherwise in the individual equipment specifications:
   1. Mechanical equipment: Level 1 General Equipment Performance Test as specified in Section 15958 - Mechanical Equipment Testing.
   2. Motors: As specified in Section 16222 - Low Voltage Motors Up to 500 Horsepower.
   3. Vendor control panels: As specified in Section 17950 - Commissioning for Instrumentation and Controls.

2.19 SHIPPING

A. As specified in Section 01600 - Product Requirements.

B. Prior to shipment of equipment:
   1. Bearings (and similar items):
      a. Pack separately or provide other protection during transport.
      b. Greased and lubricated.
   2. Gear boxes:
      a. Oil filled or sprayed with rust preventive protective coating.
   3. Fasteners:
      a. Inspect for proper torques and tightness.

PART 3 EXECUTION

3.01 DELIVERY, HANDLING, STORAGE, AND PROTECTION

A. As specified in Section 01600 - Product Requirements.

B. Inspect fasteners for proper torques and tightness.

C. Storage:
   1. Bearings:
      a. Rotate units at least once per month or more often as recommended by the manufacturer to protect rotating elements and bearings.
   2. Gear boxes:
      a. Inspect to verify integrity of protection from rust.

D. Protection:
   1. Equipment Log shall include description of rotation performed as part of maintenance activities.

3.02 INSTALLATION

A. Field measurements:
   1. Prior to shop drawings preparation, take measurements and verify dimensions indicated on the Drawings.
   2. Ensure equipment and ancillary appurtenances fit within available space.

B. Sequencing and scheduling:
   1. Equipment anchoring: Obtain anchoring material and templates or setting drawings from equipment manufacturers in adequate time for anchors to be cast-in-place.
   2. Coordinate details of equipment with other related parts of the Work, including verification that structures, piping, wiring, and equipment components are compatible.

C. Metal work embedded in concrete:
   1. Accurately place and hold in correct position while concrete is being placed.
   2. Clean surface of metal in contact with concrete immediately before concrete is placed.

D. Concrete surfaces designated to receive non-shrink grout:
   1. Heavy sandblast concrete surface in contact with non-shrink grout.
   2. Clean concrete surfaces of sandblasting sand, grease, oil, dirt, and other foreign material that may reduce bond to non-shrink grout.
   3. Saturate concrete with water. Concrete shall be saturated surface damp at time non-shrink grout is placed.

E. Install equipment in accordance with manufacturer's installation instructions and recommendations.

F. Lubrication lines and fittings:
   1. Support and protect lines from source to point of use.
   2. Fittings:
      a. Bring fittings to outside of equipment in manner such that they are readily accessible from outside without necessity of removing covers, plates, housings, or guards.
      b. Mount fittings together wherever possible using factory-mounted multiple fitting assemblies securely mounted, parallel with equipment lines, and protected from damage.
      c. Fittings for underwater bearings: Bring fittings above water surface and mount on edge of structure above.

G. Alignment of drivers and equipment:
   1. Where drive motors or other drivers are connected to driven equipment by flexible coupling, disconnect coupling halves and align driver and equipment after complete unit has been leveled on its foundation.
   2. Comply with procedures of appropriate HI, AGMA Standards, alignment tolerances of equipment manufacturers and the following requirements to bring components into angular and parallel alignment:
      a. Maximum total coupling offset (not the per-plane offset): Not to exceed 0.5 mils per inch of coupling length for spacer couplings based on coupling length (not dial separation).
      b. Utilize jacking screws, wedges, or shims as recommended by the equipment manufacturer and as specified in the equipment sections.
   3. Use reverse-indicator arrangement dial-type or laser-type alignment indicators: Mount indicators on the driver/coupling flange and equipment/coupling flange. Alignment instrumentation accuracy shall be sufficient to read angular and radial misalignment at 10 percent or less of the manufacturer's recommended acceptable misalignment.
   4. Alignment and calculations shall include measurement and allowance for thermal growth, spacer coupling length, indicator separation, and axial spacing tolerances of the coupling.
   5. When alignment satisfies most stringent tolerance of system components, grout between base and foundation.
      a. Allow minimum 48 hours for grout to harden.
      b. After grout hardens, remove jacking screws, tighten anchor bolts and other connections, and recheck alignment.
      c. Correct alignment as required.
   6. After functional testing is complete, dowel motor or drivers and driven equipment:
      a. Comply with manufacturer's instructions.

H. Grouting under equipment bases, baseplates, soleplates, and skids:
   1. Unless otherwise indicated on the Drawings, grout with non-shrink grout as specified in Section 03600 – Grouting:
      a. Non-shrink epoxy grout required only when indicated on the Drawings.
   2. Comply with equipment manufacturer's installation instructions for grouting spaces, and tolerances for level and vertical and horizontal alignment.
   3. Install grout only after:
      a. Equipment is leveled and in proper alignment.
      b. Piping connections are complete and in alignment with no strain transmitted to equipment.

4. Do not use leveling nuts on equipment anchors for supporting and leveling equipment bases, baseplates, soleplates, and skids for grouting.
5. Use jack screws for supporting and leveling equipment bases, baseplates, soleplates, and skids for grouting following the procedure defined below:
    a. Drill and tap equipment base plates, sole plates, and skids for jack screws.
    b. Use suitable number and size of jack screws.
    c. End of jack screws shall bear on circular steel plates epoxy bonded to equipment foundation.
    d. Jack screw threads that will be in contact with grout: Wrap with multiple layers of tape or other material, acceptable to Engineer, to prevent grout from bonding to threads.
    e. Place and cure grout as specified in Section 03600 - Grouting.
    f. After grout is cured, remove jack screws and material used to prevent bonding to grout:
        1) Provide jack screws to Owner for future use.
    g. Tighten equipment anchors in accordance with equipment manufacturer requirements.
    h. Fill holes where jack screws have been removed with grout.
    i. Cure as specified in Section 03600 - Grouting.
6. For equipment bases, baseplates, soleplates, and skids where it is not practical to use jack screws, use steel wedges and shims.
    a. Wrap wedges and shims that contact grout with multiple layers of tape or other material, acceptable to Engineer, to prevent grout from bonding.
    b. Place and cure grout as specified in Section 03600 - Grouting.
    c. Remove wedges or shims.
    d. Tighten equipment anchors to in accordance with equipment manufacturer requirements.
    e. Fill voids where wedges and shims have been removed with grout.
    f. Cure as specified in Section 03600 - Grouting.
7. Preparation of equipment bases, baseplates, soleplates, and skids for grouting:
    a. Metal in contact with grout: Grit blast to white metal finish.
    b. Clean surfaces of equipment bases, baseplates, soleplates, and skids in contact with grout of dirt, dust, oil, grease, paint, and other material that will reduce bond.
8. Preparation of concrete equipment foundation for grouting:
    a. Rough concrete surfaces in contact with grout.
    b. Concrete contact surface shall be free of dirt, dust, laitance, particles, loose concrete, or other material or coatings that will reduce bond.
    c. Saturate concrete contact surface area with water for minimum of 24 hours prior to grouting.
    d. Remove standing water just prior to grout placement, using clean rags or oil-free compressed air.

9. Forms and header boxes:
    a. Build forms for grouting of material with adequate strength to withstand placement of grouts.
    b. Use forms that are rigid and liquid tight. Caulk cracks and joints with an elastomeric sealant.
    c. Line forms with polyethylene film for easy grout release. Forms carefully waxed with 2 coats of heavy-duty paste wax will also be acceptable.

10. Grout placement requirements:
    a. Minimum ambient and substrate temperature: 45 degrees Fahrenheit and rising:
        1) Conform to grout manufacturer's temperature requirements.
    b. Pour grout using header box.
    c. Keep level of grout in header box above bottom of equipment bases, baseplates, soleplates, and skids at all times to prevent air entrapment.
    d. Grout shall flow continuously from header box to other side of forms without trapping air or forming voids.
    e. Vibrate, rod, or chain grout to facilitate grout flow, consolidate grout, and remove entrapped air.
    f. After grout sets, remove forms and trim grout at 45-degree angle from bottom edge of equipment bases, baseplates, soleplates, and skids.
    g. Cure as specified in Section 03600 - Grouting.

I. Field welding:
1. Use welding procedures, welders, and welding operators qualified and certified in accordance with AWS D1.1.
2. Shielded arc welding.

J. Field finishes:
1. Protect motors.
2. Clean equipment.
3. Apply primer and coating systems as specified in Section 09960 - High-Performance Coatings requirements.

K. Special techniques:
1. Use applicable special tools and equipment, including precision machinist levels, dial indicators, and gauges as required in equipment installations.

L. Tolerances:
1. Completed equipment installations: Comply with requirements for intended use and specified vibration and noise tolerances.

M. Warning signs:
1. Mount securely with stainless fasteners at equipment that can be started automatically or from remote locations.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Functional testing requirements unless specified otherwise in the individual equipment specifications:
1. Mechanical equipment: Level 1 tests as specified in Section 15958 - Mechanical Equipment Testing.
2. Motors: As specified in Sections 16222 - Low Voltage Motors Up to 500 Horsepower and 16950 - Field Electrical Acceptance Tests.
3. Vendor control panels: As specified in Section 17950 - Commissioning for Instrumentation and Controls.

END OF SECTION

SECTION 15052

COMMON WORK RESULTS FOR GENERAL PIPING - PLANT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Basic materials and methods for metallic and plastic piping systems.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 Through 24.
   2. B16.47 - Large Diameter Steel Flanges: NPS 26 Through NPS 60 Metric/Inch Standard.

B. American Water Work Association (AWWA):
   1. C105 - Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
   2. C207 - Standard for Steel Pipe Flanges for Waterworks Services-Size 4 In. Through 144 In.

C. ASTM International (ASTM):
   1. A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   2. A194 - Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   3. A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
   4. A563 - Standard Specification for Carbon and Alloy Steel Nuts.
   5. F37 - Standard Test Methods for Sealability of Gasket Materials.
   6. F2329 - Standard Specification for Zinc Coating, Hot-Dip, Requirements of Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

D. California Health and Safety Code.

E. NSF International (NSF).

1.03 DEFINITIONS

A. Buried pipes: Pipes that are buried in the soil with or without a concrete pipe encasement.

B. Exposed pipe: Pipes that are located above ground, or located inside a structure, supported by a structure, or cast into a concrete structure.

C. Underground pipes: Buried pipes - see “A.” above.

D. Underwater pipes: Pipes below the top of walls in basins or tanks containing water.

E. Wet wall: A wall with water on at least 1 side.

PART 2 PRODUCTS

2.01 GENERAL

A. Materials as specified in Section 01600 - Product Requirements including special requirements for materials in contact with drinking water.

2.02 ESCUTCHEONS

A. Material: Chrome-plated steel plate.

B. Manufacturers: One of the following or equal:
   1. Dearborn Brass Co., Model Number 5358.
   2. Keeney Manufacturing Co., Model Number 102 or Number 105.

2.03 LINK TYPE SEALS

A. Characteristics:
   1. Modular mechanical type, consisting of interlocking neoprene or synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening.
   2. Links to form a continuous rubber belt around the pipe.
   3. Provide a nylon polymer pressure plate with Type 316 stainless steel hardware. Isolate pressure plate from contact with wall sleeve.
   4. Hardware to be Type 316 stainless steel:
      a. Provide anti-galling lubricant for threads.

B. One of the following or equal:
   1. Link-Seal.
   2. Pipe Linx.

2.04 FLANGE BOLTS AND NUTS

A. General:
   1. Washer:
      a. Provide a washer for each nut.
      b. Washer shall be of the same material as the nut.
   2. Nuts: Heavy hex-head.
   3. Cut and finish flange bolts to project a maximum of 1/4-inch beyond outside face of nut after assembly.
   4. Tap holes for cap screws or stud bolts when used.
   5. Lubricant for stainless steel bolts and nuts:
      a. Chloride-free.
      b. Manufacturers: One of the following or equal:
         1) Huskey FG-1800 Anti-Seize.
         2) Weicon Anti-Seize High-Tech.

B. For ductile iron pipe:
   1. On exposed pipes with pressures equal to or less than 150 pounds per square inch gauge (psig):
      a. Bolts: ASTM A307, Grade B.
      b. Nuts: ASTM A563, Grade A.
      c. Bolts and Nuts: Hot-dip galvanized in accordance with ASTM F2329.
   2. On exposed pipes with pressures greater than 150 psig:
      a. Bolts: ASTM A193, Grade B.
      b. Nuts: ASTM A194, Grade 2H.
      c. Bolts and nuts: Hot-dip galvanized in accordance with ASTM F2329.
   3. On underwater pipes and pipes adjacent to wet walls:
      a. Bolts: ASTM A193, Grade B8M.
      b. Nuts: ASTM A194, Grade 8M.
   4. On buried pipes:
      a. Bolts: ASTM A193, Grade B7.
      b. Nuts: ASTM A194, Grade 2H.
      c. Coat with high solids epoxy and encase in 2 layers of loose polyethylene wrap in accordance with AWWA C105.

C. Plastic pipe:
   1. On exposed pipes:
      a. Bolts: ASTM A307, Grade B.
      b. Nuts: ASTM A563, Grade A.
      c. Bolts and Nuts: Hot-dip galvanized in accordance with ASTM F2329.
   2. On underwater pipes and pipes adjacent to wet walls:
      a. Bolts: ASTM A193, Grade B8M.
      b. Nuts: ASTM A194, Grade 8M.

D. Steel pipe:
   1. On exposed pipes:
      a. For ASME B16.5 Class 150 flanges and AWWA C207 Class D flanges:
         1) Bolts: ASTM A307, Grade B.
         2) Nuts: ASTM A563, Grade A.
         3) Bolts and Nuts: Hot-dip galvanized in accordance with ASTM F2329.
      b. For ASME B16.5 and B16.47 Class 300 flanges and AWWA C207 Class E and F flanges:
         1) Bolts: ASTM A193, Grade B7.
         2) Nuts: ASTM A194, Grade 2H.
   2. On underwater pipes and pipes adjacent to wet walls:
      a. Bolts: ASTM A193, Grade B8M.
      b. Nuts: ASTM A194, Grade 8M.

2.05 GASKETS

A. General.
   1. Gaskets shall be suitable for the specific fluids, pressure, and temperature conditions.
   2. Capable of being applied on surface of piping with cavities to provide for an improved seal with the internal piping pressure.

B. Gaskets for flanged joints in ductile iron and steel piping for sewage service:
   1. Suitable for pressures equal and less than 150 pounds per square inch gauge, temperatures equal and less than 250 degrees Fahrenheit, and raw sewage service.
   2. Gasket material:
      a. Neoprene elastomer with minimum Shore A hardness value of 70.
      b. Reinforcement: Cloth or synthetic fiber.
      c. Thickness: Minimum 3/32-inch thick for less than 10-inch pipe; minimum 1/8 inch thick for 10-inch and larger pipe.
   3. Manufacturers: One of the following or equal:
      a. Pipe less than 48 inches in diameter:
         1) Garlock, Style 7797.
         2) John Crane, similar product.
      b. Pipe 48 inches in diameter and larger:
         1) Garlock, Style 3760.
         2) John Crane, similar product.

C. Gaskets for steam cleaned non glass-lined ductile iron and steel piping:
   1. Suitable for pressures equal to and less than 150 pounds per square inch gauge, temperatures equal to and less than 360 degrees Fahrenheit, and raw sewage service.
   2. Material:
      a. Neoprene elastomer, compressed, non-asbestos fiber reinforcement.
   3. Manufacturers: One of the following or equal:
      a. Garlock, Bluegard 3300.
      b. John Crane, similar product.

D. Gaskets for steam cleaned glass lined ductile iron piping:
   1. Suitable for pressures equal to and less than 150 pounds per square inch gauge, temperatures equal to and less than 360 degrees Fahrenheit, and sludge service.
   2. Material:
      a. Teflon gasketing with 1/16-inch sheet thickness each side (1/8-inch total sheet thickness), filled with corrugated or perforated Type 316 stainless steel ring and non-asbestos filler material with minimum 5/16-inch overall thickness.
   3. Manufacturers: One of the following or equal:
      a. Garlock, Style HP3561.
      b. John Crane, similar product.

E. Gaskets for flanged joints in polyvinyl chloride and polyethylene piping:
   1. Suitable for pressures equal to and less than 150 pounds per square inch gauge, with low flange bolt loadings, temperatures equal to and less than 120 degrees Fahrenheit, and polymer, chlorine, caustic solutions, and other chemicals, except chemicals which liberate free fluorine including fluorochemicals and gaseous fluorine.
   2. Material: 0.125-inch thick Viton rubber.
   3. Manufacturers: One of the following or equal:
      a. Garlock.
      b. John Crane, similar product.

F. Gaskets for flanged joints in low pressure air piping:
   1. Suitable for pressures equal to and less than 150 pounds per square inch gauge, temperatures equal to and less than 300 degrees Fahrenheit, and compressed air service.
   2. Material: EPDM elastomer, 1/8-inch thick, 60 Shore hardness, smooth surface.
   3. Manufacturers: One of the following or equal:
      a. Garlock, Style 8314.
      b. John Crane, similar product.

G. Gaskets for flanged joints in ductile iron or steel water piping:
   1. Suitable for hot or cold water, pressures equal to and less than 150 pounds per square inch gauge, and temperatures equal to and less than 160 degrees Fahrenheit.
   2. Material:
      a. Neoprene elastomer, compressed, with non-asbestos fiber reinforcement.
      b. Teflon ring; or Teflon envelope with non-asbestos filler.
   3. Manufacturers: One of the following or equal:
      a. Garlock, Bluegard 3300.
      b. John Crane, similar product.

H. Gaskets for grooved joints in ductile iron:
   1. Material to be used for following services unless otherwise specified:
      a. FlushSeal® type or equal:
         1) For liquid service:
            a) Nitrile: Grade S; for temperatures to 180 degrees Fahrenheit**.**

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Piping drawings:
      a. Except in details, piping is indicated diagrammatically. Not every offset and fitting, or structural difficulty that may be encountered has been indicated on the Drawings. Sizes and locations are indicated on the Drawings.
      b. Perform minor modifications to piping alignment where necessary to avoid structural, mechanical, or other type of obstructions that cannot be removed or changed.
         1) Modifications are intended to be of minor scope, not involving a change to the design concept or a change to the Contract Price or Contract Times.
   2. Piping alternatives:
      a. Provide piping as specified in this Section, unless indicated on the Drawings or specified otherwise.
      b. Alternative pipe ratings:
         1) Piping with greater pressure rating than specified may be substituted in lieu of specified piping without changes to the Contract Price.
         2) Piping of different material may not be substituted in lieu of specified piping.

c. Valves in piping sections: Capable of withstanding specified test pressures for piping sections and fabricated with ends to fit piping.
d. Grooved joints: Use couplings, flange adapters, and fittings of the same manufacturer:
    1) Manufacturer's factory trained representative:
        a) Provide on-site training for Contractor's field personnel.
        b) Periodically visit the jobsite to verify Contractor is following best recommended practices.
    2) Distributor's representative is not considered qualified to conduct the training or jobsite visits.
e. Flanged joints: where 1 of the joining flanges is raised face type, provide a matching raised face type flange for the other joining flange.

3. Unless otherwise indicated on the Drawings, piping at pipe joints, fittings, couplings, and equipment shall be installed without rotation, angular deflection, vertical offset, or horizontal offset.

B. Wall and slab penetrations:
1. Provide sleeves for piping penetrations through aboveground masonry and concrete walls, floors, ceilings, roofs, unless specified or otherwise indicated on the Drawings.
2. For piping 1 inch in nominal diameter and larger, provide sleeves with minimum inside diameters of 1 inch plus outside diameter of piping. For piping smaller than 1 inch in nominal diameter, provide sleeve of minimum twice the outside diameter of piping:
    a. Arrange sleeves and adjacent joints so piping can be pulled out of sleeves and replaced without disturbing the structure.
    b. Cut ends of sleeves flush with surfaces of concrete, masonry, or plaster.
    c. Conceal ends of sleeves with escutcheons where piping runs through floors, walls, or ceilings of finished spaces within buildings.
    d. Seal spaces between pipes and sleeves with link-type seals when not otherwise specified or indicated on the Drawings.
3. Provide flexibility in piping connecting to structures to accommodate movement due to soil settlement and earthquakes. Provide flexibility using details indicated on the Drawings.
4. Core drilled openings:
    a. Do not damage or cut existing reinforcing bars, electrical conduits, or other items embedded in the existing concrete without acceptance by Engineer.
    b. Determine location of reinforcing bars or other obstructions with a non-destructive indicator device.
    c. Remove dust and debris from hole using compressed air.

C. Exposed piping:
1. Install exposed piping in straight runs parallel to the axes of structures, unless otherwise indicated on the Drawings:
    a. Install piping runs plumb and level, unless otherwise indicated on the Drawings:
        1) Slope plumbing drain piping with a minimum of 1/4-inch per foot downward in the direction of flow.
2. Install exposed piping after installing equipment and after piping and fitting locations have been determined.

3. Support piping: As specified in Sections 15061 - Pipe Supports, 15062 - Preformed Channel Pipe Support System:
    a. Do not transfer pipe loads and strain to equipment.
4. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, flanged coupling adapters, and other types of joints or means which are compatible with and suitable for the piping system, and necessary to allow ready assembly and disassembly of the piping.
5. Assemble piping without distortion or stresses caused by misalignment:
    a. Match and properly orient flanges, unions, flexible couplings, and other connections.
    b. Do not subject piping to bending or other undue stresses when fitting piping.
    c. Do not correct defective orientation or alignment by distorting flanged joints or subjecting flange bolts to bending or other undue stresses.
    d. Flange bolts, union halves, flexible connectors, and other connection elements shall slip freely into place.
    e. Alter piping assembly to fit, when proper fit is not obtained.
    f. Install eccentric reducers or increasers with the top horizontal for pump suction piping.

D. Buried piping:
1. Bury piping with minimum 3-foot cover without air traps, unless otherwise indicated on the Drawings.
2. Where 2 similar services run parallel to each other, piping for such services may be laid in the same trench:
    a. Lay piping with sufficient room for assembly and disassembly of joints, for thrust blocks, for other structures, and to meet separation requirements of public health authorities having jurisdiction.
3. Laying piping:
    a. Lay piping in finished trenches free from water or debris. Begin at the lowest point with bell ends up slope.
    b. Place piping with top or bottom markings with markings in proper position.
    c. Lay piping on an unyielding foundation with uniform bearing under the full length of barrels.
    d. Where joints require external grouting, banding, or pointing, provide space under and immediately in front of the bell end of each section laid with sufficient shape and size for grouting, banding, or pointing of joints.
    e. At the end of each day's construction, plug open ends of piping temporarily to prevent entrance of debris or animals.
4. Concrete encase buried pipe installed under concrete slabs or structures.

E. Venting piping under pressure:
1. Lay piping under pressure flat or at a continuous slope without air traps, unless otherwise indicated on the Drawings.
2. Install plug valves as air bleeder cocks at high points in piping:
    a. Provide 1-inch plug valves for water lines, and 2-inch plug valves for sewage and sludge lines, unless otherwise indicated on the Drawings.
3. Provide additional pipe taps with plug cocks and riser pipes along piping as required for venting during initial filling, disinfecting, and sampling.
4. Before piping is placed into service, close plug valves and install plugs. Protect plugs and plug valves from corrosion in as specified in Section 09960 - High-Performance Coatings.

F. Restraining buried piping:
   1. Restrain piping at valves and at fittings where piping changes direction, changes sizes, and at ends:
      a. When piping is underground, use concrete thrust blocks, mechanical restraints, or push-on restraints.
      b. Determine thrust forces by multiplying the nominal cross-sectional area of the piping by design test pressure of the piping**.**
   2. Provide restraints with ample size to withstand thrust forces resulting from test pressures:
      a. During testing, provide suitable temporary restraints where piping does not require permanent restraints.
   3. Place concrete thrust blocks against undisturbed soil.
   4. Place concrete so piping joints, fittings, and other appurtenances are accessible for assembly and disassembly.
   5. Provide underground mechanical restraints where specified in the Piping Schedule.

G. Restraining above ground piping:
   1. Restrain piping at valves and at fittings where piping changes direction, changes sizes, and at ends:
      a. When piping is aboveground or underwater, use mechanical or structural restraints.
      b. Determine thrust forces by multiplying the nominal cross-sectional area of the piping by design test pressure of the piping.
   2. Provide restraints with ample size to withstand thrust forces resulting from test pressures:
      a. During testing, provide suitable temporary restraints where piping does not require permanent restraints.

H. Connections to existing piping:
   1. Expose existing piping to which connections are to be made with sufficient time to permit, where necessary, field adjustments in line, grade, or fittings:
      a. Protect domestic water/potable water supplies from contamination:
         1) Make connections between domestic water supply and other water systems in accordance with requirements of public health authorities.
         2) Provide devices approved by Owner of domestic water supply system to prevent flow from other sources into the domestic supply system.
   2. Make connections to existing piping and valves after sections of new piping to be connected have been tested and found satisfactory.
   3. Provide sleeves, flanges, nipples, couplings, adapters, and other fittings needed to install or attach new fittings to existing piping and to make connections to existing piping.
   4. For flanged connections, provide stainless steel bolts with isolation bushings and washers, and full-face flange gaskets.

I. Connections to in-service piping:
   1. As specified in Section 01140 - Work Restrictions.

J. Connections between ferrous and nonferrous metals:
   1. Connect ferrous and nonferrous metal piping, tubing, and fittings with dielectric couplings especially designed for the prevention of chemical reactions between dissimilar metals.
   2. Nonferrous metals include aluminum, copper, and copper alloys.

K. Flanged connections between dissimilar metals such as ductile iron pipe and steel pipe:
   1. Provide stainless steel bolts with isolation bushings and washers, and full-face flange gaskets.

3.02 CLEANING

A. Piping cleaning:
   1. Upon completion of installation, clean piping interior of foreign matter and debris.
   2. Perform special cleaning when required by the Contract Documents.

B. Cleaning potable water piping:
   1. Flush and disinfect potable water piping.

C. Cleaning air piping:
   1. Perform special cleaning of filtered air piping from the intake clean air plenums to the discharge points and high-pressure air piping:
      a. Protect surfaces from contamination.
   2. Special cleaning shall include wire brushing, power tool cleaning, wiping down with lint-free cloths, brooming, and vacuuming to remove rust, scale, weld spatter, dust, dirt, oil, and other matter deleterious to operation of the air system:
      a. Do not sandblast installed piping.
   3. To the greatest extent possible, clean piping immediately prior to final closure of piping systems:
      a. Enter piping, clean and wipe down surfaces, and vacuum out residue.
      b. Clean surfaces not accessible to this cleaning operation after installation within 6 hours preceding installation.
   4. Subsequent to cleaning, protect surfaces from contamination by dust, dirt, construction debris, and moisture, including atmospheric moisture:
      a. Whether or not pipe upstream has been cleaned, temporarily seal openings in partially completed work except when installation is actively in progress.
      b. When installation is actively in progress, seal openings at the end of each day's construction or when construction is temporarily stopped.
   5. Suspend cleaning and seal openings when inclement weather, including dust storms, is imminent.
   6. Use clean, dry air for testing the piping and other elements of the system.
   7. Prior to introduction of air to the system, blow piping clean:
      a. Blow with maximum discharge rate possible for minimum 4 hours, using new blowers or compressors and filters.
   8. Clean surfaces that become contaminated prior to acceptance.

D. Conduct pressure and leak test, as specified.

3.03 PIPING SCHEDULE

PIPING SCHEDULE											
Process Abbrev.	**Service**	**Nominal Diameter (inches)**	**Material**	**Pressure Class Special Thickness Class Schedule Wall Thickness**	**Pipe Spec. Section**	**Joints/ Fittings**	**Test Pressure/ Method**	**Lining**	**Coating**	**Service Conditions**	**Comments**
3W	Utility Water										
	Aboveground	1/2 - 3/4	GSP, ASTM A53 Grade B	SCH 40	15270	SCRD	100 psig/HH	None	EPP per 09960		
	Aboveground	1 - 3 1/2	PVC, ASTM D1785	SCH 80	15249	SW or FL	100 psig/HH	None	Waterborne Acrylic Emulsion		
	Aboveground	4 - 24	DIP, AWWA C151	Class 53	15211	FL or GE	100 psig/HH	CM	EPP per 09960		
	Underground	1/2 - 3 1/2	PVC, ASTM D1785	SCH 80	15249	SW	100 psig/HH	None	None		
	Underground	4 - 24	DIP, AWWA C151	Class 51	15211	Mech Rest. MJ	180 psig/AM	CM	PEE (2 layers)		

PIPING SCHEDULE											
Process Abbrev.	**Service**	**Nominal Diameter (inches)**	**Material**	**Pressure Class Special Thickness Class Schedule Wall Thickness**	**Pipe Spec. Section**	**Joints/ Fittings**	**Test Pressure/ Method**	**Lining**	**Coating**	**Service Conditions**	**Comments**
CD	Chemical Drain										
	Underground	1-6	PVC	SCH 80	15230	SW	50 psig/HH	None	None		
	Aboveground	1-6	PVC	SCH 80	15230	SW	50 psig/HH	None	EPP		
D	Plant Drain										
	Underground	2 - 6	PVC	SCH 80	15230	B&SP	22.5 feet/LH	Coal tar pitch	EPP per 09960		
	Underground	4-24	DIP, AWWA C151, Push-On	Class 53	15211	Mechanical -joint (restrained)	22.5 feet/LH	CM	PEE (2 layers)		

PIPING SCHEDULE											
Process Abbrev.	**Service**	**Nominal Diameter (inches)**	**Material**	**Pressure Class Special Thickness Class Schedule Wall Thickness**	**Pipe Spec. Section**	**Joints/ Fittings**	**Test Pressure/ Method**	**Lining**	**Coating**	**Service Conditions**	**Comments**
FEF	Filter Effluent										
	Aboveground	4 - 12	Black Steel, ASTM A53 Grade B	SCH 40	15270	SCRD	60 FT/HH	CM	PEE		
	Aboveground	14 - 36	Steel, AWWA C200	Per Spec	15278	WLD or GE	60 FT /HH	CM	EPP per 09960		
	Underground	4 - 36	DIP, AWWA C151	Class 53	15211	Mechanical -joint (restrained)	60 FT/HH	CM	PEE (2 layers)		
FI	Filter Influent								EPP per 09960		
	Aboveground	4 - 12	Black Steel, ASTM A53 Grade B	SCH 40	15270	WLD or FL	105 FT/HH	CM	EPP per 09960		
	Aboveground	14 - 36	Steel, AWWA C200	Per Spec	15278	WLD or GE	105 FT/HH	CM	EPP per 09960		

PIPING SCHEDULE											
Process Abbrev.	**Service**	**Nominal Diameter (inches)**	**Material**	**Pressure Class Special Thickness Class Schedule Wall Thickness**	**Pipe Spec. Section**	**Joints/ Fittings**	**Test Pressure/ Method**	**Lining**	**Coating**	**Service Conditions**	**Comments**
FRW (BW)	Filter Reject Water (Backwash Water)										
	Aboveground	1/2 - 3 1/2	GSP, ASTM A53 Grade B	SCH 40	15270	SCRD	60 feet/HH	CM	EPP per 09960		
	Aboveground	14 - 36	Steel, AWWA C200	Per Spec	15278	WLD, FL or GE	60 FT/HH	CM	EPP per 09960		
	Underground	3 - 36	DIP, AWWA C151	Class 51	15211	Mech Rest. MJ	60 FT/HH	CM	PEE (2 layers)		
FTW	Filter To Waste										
	Aboveground	4 - 12	Black Steel, ASTM A53 Grade B	SCH 40	15270	WLD or FL	60 FT/HH	CM	EPP per 09960		
	Aboveground	14 - 36	Steel, AWWA C200	Per Spec	15278	WLD, GE or FL	60 FT/HH	CM	EPP per 09960		
	Underground	3 - 36	DIP, AWWA C151	Class 51	15211	Mech Rest. MJ	60 FT/HH	CM	PEE (2 layers)		
TPE	Tertiary Plant Effluent										
	Underground	3 - 36	DIP, AWWA C151	Class 51	15211	Mech Rest. MJ	60 FT/HH	CM	PEE (2 layers)		

PIPING SCHEDULE

Process Abbrev.	Service	Nominal Diameter (inches)	Material	Pressure Class Special Thickness Class Schedule Wall Thickness	Pipe Spec. Section	Joints/ Fittings	Test Pressure/ Method	Lining	Coating	Service Conditions	Comments
SA	Sample										
	Aboveground	1/2 - 6	Steel, AWWA C200	Per Spec	15278	WLD	120 psig/HH	CM	Waterborne Acrylic Emulsion		
	Underground	1/2 - 6	PVC, ASTM D1785	SCH 80	15270	SW or FL	120 psig/HH	None	None		

Abbreviations:

1. The following abbreviations used in the column of test method refer to the respective methods as specified in Section 15956 - Piping Systems Testing.
   - AM Air method
   - GR Gravity method
   - HH High head method
   - LH Low head method
   - SC Special case
2. Abbreviations to designate piping include the following:
   - B&SP Bell and spigot
   - CI Cast iron
   - CISP Cast iron soil pipe
   - CL Class, followed by the designation
   - CM Cement mortar
   - CTP Coal tar pitch
   - DIP Ductile iron piping
   - EPP Epoxy polyurethane coating
   - FL Flange
   - GA Gauge, preceded by the designation
   - GE Grooved end joint
   - GL Glass lined
   - GSP Galvanized steel pipe
   - MJ Mechanical joint
   - NPS Nominal pipe size, followed by the number in inches
   - psi pounds per square inch
   - psig pounds per square inch gauge
   - PE Polyethylene
   - PEE Polyethylene encasement
   - PTW Polyethylene tape wrap
   - PVC Polyvinyl Chloride
   - SCH Schedule, followed by the designation
   - SCRD Screwed-On
   - SST Stainless steel
   - SW Solvent welded
   - VCP Vitrified clay piping
   - WLD Weld

END OF SECTION

SECTION 15061

PIPE SUPPORTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Supports for pipe, fittings, valves, and appurtenances.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   3. A967 - Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.

B. Manufacturer's Standardization Society (MSS):
   1. SP-58 - Pipe Hangers and Supports - Materials, Design, and Manufacture.

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. Design features.
   2. Load capacities.
   3. Material designations by UNS alloy number or ASTM Specification and Grade.
   4. Data needed to verify compliance with the Specifications.
   5. Catalog data.
   6. Clearly mark submittal information to show specific items, materials, and accessories or options being furnished.

1.04 WARRANTY

A. Provide warranty as specified in General Conditions.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 01600 - Product Requirements.

2.02 MATERIALS

A. General:
   1. Hot dip galvanized:
      a. Fabricate as specified in Section 05120 - Structural Steel.
      b. Hot dip after fabrication of support in accordance with ASTM A123.
      c. Repair galvanized surface as specified in Section 05120 - Structural Steel.
   2. Stainless steel.
      a. Fabricate as specified in Section 05120 - Structural Steel.
      b. Finish requirements: Remove free iron, heat tint oxides, weld scale, and other impurities, and obtain a passive finished surface.
      c. At the shop, perform pickling and passivation on all surfaces inside and out in accordance with ASTM A380 or A967:
         1) Passivation treatments using citric acid are not allowed.
      d. Field welding is prohibited unless specifically allowed by the Owner. All field welds shall be passivated.

B. Outdoor areas: Areas exposed to the natural outdoor environment:
   1. Hot Dip Galvanized.

C. Indoor areas: Areas exposed to an indoor environment including galleries and tunnels:
   1. Hot Dip Galvanized.

D. Submerged, 3 feet or less above water level in a structure, or inside a water bearing structure:
   1. Type 316 Stainless Steel.

E. Stainless steel piping system:
   1. Type 316 Stainless Steel.

F. Chemical containment areas and chemical piping:
   1. Type 316 Stainless Steel.

G. Fasteners:
   1. As specified in Section 05120 - Structural Steel.

2.03 PIPE SUPPORTS

A. Hanger rods: Sized to match suspended pipe hanger, or as indicated on the Drawings:
   1. Manufacturers: One of following or equal:
      a. For stainless steel piping:
         1) Nibco-Tolco, Figure 103.
         2) FM Stainless Fasteners
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 140.
         2) Bergen-Power, Figure 133.
         3) Cooper B-Line Systems, Inc., Figure B3205.

B. Hanger rods, continuously threaded: Sized to match suspended pipe hanger, or as indicated on the Drawings:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Bergen-Power, Figure 94.
         2) FM Stainless Fasteners.
      b. For steel and ductile iron piping:
         1) Anvil International, Figure 146.
         2) Bergen-Power, Figure 94.

C. Eye bolts:
   1. For stainless steel piping:
      a. Type 316 stainless steel, welded and rated equal to full load capacity of rod.
   2. For all other piping, unless indicated on the Drawings:
      a. Welded and rated equal to full load capacity of rod.

D. Welded eyebolt rod:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Nibco-Tolco, Figure 101.
         2) FM Stainless Fasteners.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 278.
         2) Bergen-Power, Figure 93.
         3) Cooper B-Line Systems, Inc., Figure B3210.

E. Adjustable ring hangers: MSS SP-58, Type 7 or Type 9 (system dependent):
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Nibco-Tolco, Figure 1C.I.
         2) Bergen-Power, Figure 100SS.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 97.
         2) Cooper B-Line Systems, Inc., Figure B3172.

F. Adjustable clevis hangers: MSS SP-58, Type 1:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Cooper B-Line Systems, Inc., Figure B3100 or B3102.
         2) FM Stainless Fasteners, Figure 60.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 260 or Figure 590.
         2) Bergen-Power, Figure 100.
         3) Cooper B-Line Systems, Inc., Figure B3100 or B3102.

G. Adjustable clevis hangers for insulated pipe: Oversize:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Nibco-Tolco, Figure 1A.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 300.

2) Bergen-Power, Figure 100EL.
3) Cooper B-Line Systems, Inc. Figure B3108.

H. Brackets: MSS SP-58, Type 32 with back plate; rated for 1,500 pounds:
1. Manufacturers: One of the following or equal:
a. For stainless steel piping:
1) Nibco-Tolco, Figure 30M.
2) Cooper B-Line Systems, Inc., Figure B3066.
3) FM Stainless Fasteners, Figure 98.
b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 195.
2) Cooper B-Line Systems, Inc., Figure B3066.

I. Brackets, heavy duty: MSS SP-58, Type 33 with back plate; rated for 3,000 pounds:
1. Manufacturers: One of following or equal:
a. Anvil International, Figure 199.
b. Cooper B-Line Systems, Inc., Figure B3067.

J. Standard U-bolt: MSS SP-58, Type 24:
1. Manufacturers: One of the following or equal:
a. For stainless steel piping:
1) Nibco-Tolco, Figure 110.
2) Cooper B-Line Systems, Inc., Figure B3188.
3) FM Stainless Fasteners, Figure 37.
b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 137.
2) Bergen-Power, Figure 283.
3) Cooper B-Line Systems, Inc., Figure B3188.

K. Riser clamps: MSS SP-58, Type 8:
1. Manufacturers: One of the following or equal:
a. For stainless steel piping:
1) Cooper B-Line Systems, Inc., Figure B3373.
2) FM Stainless Fasteners, Figure 61.
b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 261.
2) Bergen-Power, Figure 126.
3) Cooper B-Line Systems, Inc., Figure B3373.

L. Pipe clamps: MSS SP-58, Type 4:
1. Manufacturers: One of the following or equal:
a. For stainless steel piping:
1) Nibco-Tolco, Figure 4.
2) Cooper B-Line Systems, Inc., Figure 3140.
b. For all other piping, unless indicated on the Drawings:
1) Anvil International, Figure 212.
2) Bergen-Power, Figure 175.
3) Cooper B-Line Systems, Inc., Figure B3140.

M. Adjustable offset pipe clamp:
    1. Manufacturers: One of the following or equal:
        a. For stainless steel piping:
            1) Nibco-Tolco, Figure 4.
            2) Cooper B-Line Systems, Inc., Figure B3149.
            3) FM Stainless Fasteners, Figure 63.
        b. For all other piping, unless indicated on the Drawings:
            1) Anvil International, Figure 100.
            2) Cooper B-Line Systems, Inc., Figure B3149.

N. Offset pipe clamp:
    1. Manufacturers: One of the following or equal:
        a. For stainless steel piping:
            1) Nibco-Tolco, Figure 8.
            2) Cooper B-Line Systems, Inc., Figure 3148.
        b. For all other piping, unless indicated on the Drawings:
            1) Anvil International, Figure 103.
            2) Cooper B-Line Systems, Inc., Figure B3148.

O. Floor stand or stanchion saddles: MSS SP-58, Type 37. Provided with U-bolt hold down yokes:
    1. Manufacturers: One of the following or equal:
        a. For stainless steel piping:
            1) Nibco-Tolco, Figure 318.
            2) FM Stainless Fasteners, Figure 59.
        b. For all other piping, unless indicated on the Drawings:
            1) Anvil International, Figure 259.
            2) Bergen-Power, Figure 125.
            3) Cooper B-Line Systems, Inc., Figure B3090.
        c. Threaded pipe stand support stanchion. Match pipe support material:
            1) Anvil International, Figure 63T.
            2) Bergen-Power, Figure 138.
            3) Cooper B-Line Systems Inc., Figure B3088ST.

P. Spring hangers:
    1. Manufacturers: One of the following or equal:
        a. For stainless steel piping:
            1) Bergen-Power, Figure 920.
        b. For all other piping, unless indicated on the Drawings:
            1) Anvil International, Figure B-268, Type G.
            2) Bergen-Power, Figure 920.

Q. One hole pipe clamps:
    1. Manufacturers: One of the following or equal:
        a. For stainless steel piping: Engineer knows of no product.
        b. For all other piping:
            1) Anvil International, Figure 126.
            2) Carpenter & Paterson, Figure 237S.

R. Welded beam attachment: MSS SP-58, Type 22:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Nibco-Tolco, Figure 304.
         2) Cooper B-Line Systems, Inc., Figure 3083.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 66.
         2) Bergen-Power, Figure 113A or 113B.
         3) Cooper B-Line Systems, Inc., Figure B3083.

S. Heavy pipe clamp: MSS SP-58, Type 4:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Nibco-Tolco, Figure 4H.
      b. For all other piping, unless called out otherwise on the drawings:
         1) Anvil International, Figure 216.
         2) Bergen-Power, Figure 298.

T. PTFE pipe slide assembly: MSS SP-58, Type 35 with lateral and vertical restraint:
   1. Manufacturers: One of the following or equal:
      a. For stainless steel piping:
         1) Nibco-Tolco, Figure 426.
      b. For all other piping, unless indicated on the Drawings:
         1) Anvil International, Figure 257, Type 3.
         2) Cooper B-Line Systems, Inc., Figure B3893.

U. Anchor bolts, concrete anchors, concrete inserts, powder-actuated fasteners, and sleeve anchors: As specified in Section 05120 - Structural Steel.

PART 3 EXECUTION

3.01 INSTALLATION

A. Support, suspend, or anchor exposed pipe, fittings, valves, and appurtenances to prevent sagging, overstressing, or movement of piping; and to prevent thrusts or loads on or against connected pumps, blowers, and other equipment.

B. Field verify support location, orientation, and configuration to eliminate interferences prior to fabrication of supports.

C. Carefully determine locations of inserts. Anchor to formwork prior to placing concrete.

D. Use flush shells only where indicated on the Drawings.

E. Do not use anchors relying on deformation of lead alloy.

F. Do not use powder-actuated fasteners for securing metallic conduit or steel pipe larger than 1-inch to concrete, masonry, or wood.

G. Suspend pipe hangers from hanger rods and secure with double nuts.

H. Install continuously threaded hanger rods only where indicated on the Drawings.

I. Use adjustable ring hangers or adjustable clevis hangers for 4-inch and smaller diameter pipe.

J. Use adjustable clevis hangers for pipe larger than 4 inches in diameter.

K. Secure pipes with double nutted U-bolts or suspend pipes from hanger rods and hangers:
   1. For stainless steel piping, use stainless steel U-bolts.
   2. For all other piping, use galvanized U-bolts.

L. Support spacing:
   1. Support 2-inch and smaller piping on horizontal and vertical runs at maximum 5 feet on center, unless otherwise specified.
   2. Support larger than 2-inch piping on horizontal and vertical runs at maximum 10 feet on center, unless otherwise specified.
   3. Support exposed polyvinyl chloride and other plastic pipes at maximum 5 feet on center, regardless of size.
   4. Support tubing, PVC pipe 1-inch and smaller, copper pipe and tubing, fiber-reinforced plastic pipe or duct, and rubber hose and tubing at intervals close enough to prevent sagging greater than 1/4-inch between supports.
   5. Do not suspend or support valves, pipe and fittings from another pipe or conduit.

M. Install supports at:
   1. Any change in direction.
   2. Both sides of flexible pipe connections.
   3. Base of risers.
   4. Floor penetrations.
   5. Connections to pumps, blowers, and other equipment.
   6. Valves and appurtenances.

N. Securely anchor plastic pipe, valves, and headers to prevent movement during operation of valves.

O. Anchor plastic pipe between expansion loops and direction changes to prevent axial movement through anchors.

P. Provide elbows or tees supported from floors with base fittings where indicated on the Drawings.

Q. Support base fittings with metal supports or when indicated on the Drawings support on concrete piers.

R. Do not use chains, plumbers' straps, wire, or similar devices for permanently suspending, supporting, or restraining pipes.

S. Support plumbing drainage and vents in accordance with plumbing code as specified in Section 01410 - Regulatory Requirements.

T. Supports, clamps, brackets, and portions of support system bearing against copper pipe: Copper plated, copper throughout, or isolated with neoprene or polyvinyl chloride tape.

U. Where pipe is insulated, install over-sized supports and hangers.

V. Install insulation shield in accordance with MSS SP-58, Type 40. Shield shall be galvanized steel unless otherwise specified or indicated on the Drawings.

W. Install riser clamps at floor penetrations and where indicated on the Drawings.

X. Coat support system components as specified in Section 09960 - High-Performance Coatings.

END OF SECTION

SECTION 15062

PREFORMED CHANNEL PIPE SUPPORT SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Preformed channel pipe support system consisting of preformed channels, fittings, straps, and fasteners engineered to support piping.

1.02 REFERENCES

A. American Institute of Steel Construction (AISC).

B. American Iron and Steel Institute (AISI).

C. Manufacturer's Standardization Society (MSS):
   1. SP-58 - Pipe Hangers and Supports - Materials, Design, and Manufacture.

1.03 SYSTEM DESCRIPTION

A. Design responsibility:
   1. The manufacturer of the preformed channel pipe support system is responsible for the design of the support system.
   2. Prepare design calculations utilizing the design criteria included in these Specifications.
   3. Prepare detailed shop drawings illustrating the layout of the support system and identifying the components of the support system.

B. Design criteria:
   1. Include live, dead, and seismic loads associated with piping, valves, and appurtenances. Consider the content of the pipes in load calculations.
   2. Minimum gauge thickness: 12-gauge.
   3. Allowable stress of channels:
      a. Steel channels: The lesser of 25,000 pounds per square inch, or 0.66 times yield stress of steel.
      b. Stainless steel channels: 0.66 times the yield stress of the stainless steel alloy.
   4. Maximum deflection: 1/240 of span.
   5. Allowable column loads: As recommended by manufacturer in published instruction for column's unsupported height and "K" value for calculating effective column length of not less than 1.0.
   6. Future loads:
      a. Support systems indicated on the Drawings may include spaces intended to accommodate future pipes.
      b. Assume such spaces are occupied by 6-inch diameter ductile iron pipes. Only the number of pipes that would physically fit into the space need be considered.
      c. Include the weight of the pipe contents in determining future loads. Assume pipe contents are water.

7. Seismic design criteria: As specified in Section 01612 - Seismic Design Criteria as specified for mechanical equipment.
8. Spacing of supports: As required to comply with design requirements but not more than 5 feet.

C. Supports below the top of walls of water bearing structures: Use Type 316 stainless steel for support system components:
1. Supports in other locations: Use hot-dipped galvanized components unless other materials are specifically indicated on the Drawings.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data.

1.05 QUALITY ASSURANCE

A. Design preformed channel pipe support system for loads in accordance with applicable provisions of:
1. AISC Manual of Steel Construction.
2. AISI Cold-Formed Steel Design Manual.

B. Product standards:
1. Pipe support materials: In accordance with MSS SP-58.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fabricate preformed channel pipe support system using, as a minimum, parts specified below and meeting the requirements specified under Design Criteria:
1. Manufacturers: One of the following or equal:
a. Unistrut, Series P1000 or P1001; P5500 or P5501.
b. Allied Support Systems, Power Strut, Figure PS-200 or PS-200 2TS; PS-150 or PS-150 2TS.
c. Cooper Ind., B-Line, Channel Type B22 or B22A; B12 or B12A.

2.02 ACCESSORIES

A. Preformed channel concrete inserts: Minimum 12 inches long:
1. Manufacturers: One of the following or equal:
a. Unistrut, Series P-3200.
b. Allied Support Systems, Figure 282.
c. Cooper Ind., B-Line Series B32I.

B. 90-degree angle fittings:
1. Manufacturers: One of the following or equal:
a. Unistrut, P1026.
b. Allied Support Systems, Power Strut, P603.

C. Pipe straps:
   1. For pipes 8 inches in diameter and smaller: Use 2-piece universal strap with slotted hex head screw and nut.
      a. Manufacturers: One of the following or equal:
         1) Unistrut, Series P1109 through P1126.
         2) Allied Support Systems, PS1100.
         3) Cooper Ind., B-Line Series B2000.
   2. For pipes greater than 8 inches in diameter: Unless different material is otherwise indicated on the Drawings use 1-piece 1-inch wide by 1/8-inch thick steel strap, hot-dip galvanized after fabrication.
   3. For stainless steel pipes: Use type of strap required for the pipe sizes specified above, but use Type 316 stainless steel materials.

D. Prefabricated double channel bracket:
   1. Manufacturers: One of the following or equal:
      a. Unistrut, P2542-P2546.
      b. Cooper Ind., B-Line Series B297.

E. Touch-up paint for galvanized surfaces:
   1. Manufacturers: The following or equal:
      a. Galvinox, Galvo-Weld.

F. Touch-up paint for painted surfaces: Same formulation as factory paint.

2.03 FABRICATION

A. Hot-dip galvanize support system components after fabrication to required length and shape.

B. Do not galvanize or paint stainless steel components.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install preformed channel concrete inserts for vertical support, quantity based on manufacturer's structural design calculations.

B. Fasten preformed channel pipe supports to existing walls using Z-fittings and concrete anchors as indicated on the Drawings.

C. Fasten preformed channel pipe supports to preformed channel concrete inserts embedded in ceiling using U-shaped fittings.

D. Suspend threaded rods from concrete inserts embedded in ceiling. Support preformed channel pipe supports with threaded rods.

E. Touchup cut or damaged galvanized surfaces.

F. Prevent contact between pipes and support components of dissimilar metals. Utilize rubber coated, plastic coated, or vinyl coated components, stainless steel components, or wrap pipe with PVC or polyethylene tape.

G. Install support as near as possible to concentrated loads.

H. Install support within 2 feet of horizontal and vertical changes in pipe alignment.

I. Adjust supports or install shims to obtain specified slope or elevation.

END OF SECTION

SECTION 15075

EQUIPMENT IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Equipment nameplates.
   2. Special items.

1.02 SUBMITTAL

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Shop drawings:
   1. Product data.
   2. Installation instructions.

C. Samples.

1.03 QUALITY ASSURANCE

A. Regulatory requirements: Comply with OSHA.

PART 2 PRODUCTS

2.01 EQUIPMENT NAMEPLATES

A. Material and fabrication:
   1. Stainless steel sheet engraved or stamped with text, holes drilled, or punch for fasteners.

B. Fasteners:
   1. Number 4 or larger oval head stainless steel screws or drive pins.

C. Text:
   1. Manufacturer’s name, equipment model number and serial number, identification tag number; and when appropriate, drive speed, motor horsepower with rated capacity, pump rated total dynamic head, and impeller size.

2.02 SPECIAL ITEMS

A. In addition, special coating of following items will be required:

Item	Color
Valve handwheels and levers	Red
Hoist hooks and blocks	Yellow and black stripes
Steel guard posts	In accordance with standard details

B. Paint minimum 2 inches high numbers on or adjacent to accessible valves, pumps, flowmeters, and other items of equipment which are indicated on the Drawings or in Specifications by number.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify satisfactory conditions of substrate for applying identification.

B. Verify that conditions are satisfactory for installation and application of products as specified in Section 01600 - Product Requirements.

3.02 PREPARATION

A. Prepare and coat surfaces of special items as specified in Section 09960 - High-Performance Coatings.

B. Prepare surface in accordance with product manufacturer's instructions.

END OF SECTION

SECTION 15076

PIPE IDENTIFICATION - PLANT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Pipe identification including the following:
   1. Pipe identification by color and legend.
   2. Underground warning tape.
   3. Tracer wire.
   4. Witness markers.
   5. Valve identification.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. A13.1 - Scheme for the Identification of Piping Systems.

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Submit following:
   1. Product data.
   2. Samples.
   3. Manufacturer's installation instructions.
   4. Submit following as specified in Section 01770 - Closeout Procedures:
      a. Operation and Maintenance Data.
      b. Warranty.

PART 2 PRODUCTS

2.01 ABOVE GROUND AND IN-CHASE PIPE IDENTIFICATION

A. Manufacturers:
   1. One of the following or equal:
      a. Seton, Opti Code Pipe Markers.
      b. Lab Safety Supply.
      c. Marking Services, Inc.

B. Materials:
1. Pipe markers: Self-adhesive vinyl, suitable for outdoor application from -40 degrees to 180 degrees Fahrenheit; in accordance with ASME A13.1 requirements:
a. Lettering:

Nominal Pipe Diameter	Lettering Size
Less than 1.5 inches	1/2-inch
1.5 inches to 2 inches	3/4-inch
2.5 inches to 6 inches	1-1/4 inches
8 inches to 10 inches	2-1/2 inches
Over 10 inches	3-1/2 inches

b. Marker colors:

Service	Lettering	Background
Flammables, chemicals, toxics	Black	Yellow
Water, nontoxic solutions or low hazard liquids	White	Green
Nonflammable or nontoxic gases	White	Blue
Fire quenching fluids (foam, fire water, CO_2 Halon)	White	Red

2. Coating: As specified in Section 09960 - High-Performance Coatings.
3. Pipe identification tags: Aluminum or stainless steel with stamped-in 1/4-inch high identifying lettering.
4. Pipe identification tag chains: Aluminum or stainless steel.
5. Snap-on markers: Markers with 3/4-inch high letters for 3/4 to 4-inch pipe or covering, or 5-inch high letters for 5-inch or larger pipe or cover:
a. Manufacturers: One of following or equal:
1) Brady BradySnap-On B-915.
2) Seton Setmark.

2.02 BURIED PIPELINE IDENTIFICATION

A. Underground warning tape:
1. Manufacturer: One of the following or equal:
a. Seton Name Plate Co.
b. T. Christy Enterprises, Inc.
c. Marking Services, Inc.
2. Material:
a. Polyethylene tape for prolonged underground use.
b. Minimum tape thickness: 4 mils.
c. Overall tape width: 6 inches.
d. Message: “CAUTION” with the name of the service followed by “LINE BURIED BELOW.” in black lettering on colored background in accordance with approved APWA colors:
1) Water: Blue.
2) Sewer: Green.

3) Telephone: Orange.
4) Gas and other services: Yellow.

B. Tracer wire:
1. Manufacturers: One of the following or equal:
a. Kris-Tech Wire.
b. Corrpro.
2. Materials: One of the following or equal:
a. Solid copper conductor
b. Thickness minimum: 10 gauge.
c. Insulation:
1) Match insulation color to the color of the pipe being installed.
3. Splicing Kit:
a. Manufacturers: One of the following or equal:
1) Ryall Electric Co., 3M Kit No. 82-A1.
4. Station Box:
a. Lid and collar materials: Cast iron.
b. Able to withstand heavy traffic loading.
c. Manufacturers: One of the following or equal:
1) Farwest Corrosion Control Co, Glenn 4 Test Station.

C. Witness markers:
1. Manufacturers: One of the following or equal:
a. Carsonite Composites, Utility Marker.
b. Hampton Technical Associates, Inc.
2. Materials:
a. Glass fiber and resin reinforced thermosetting composite material.
b. UV resistant.
3. Constructed as a single piece.
4. Pointed at the bottom end.
5. Information to be included on the marker:
a. “Caution” (type of service) “Pipeline”.
b. Phone number for Underground Service Alert.
c. Phone number for Owner in case of emergency.
d. Station number.
e. Offset:
1) Only provide offset if marker is not directly over the pipe.
f. Name of appurtenance or fitting (e.g. 45, BO, ARV, etc.)

2.03 VALVE AND GATE IDENTIFICATION

A. Provide valve and gate schedule for each valve and gate in the Work with the following information:
1. Identification number.
2. Location.
3. Type.
4. Function.
5. Normal operating position.

B. Identification tag requirements:
   1. Diameter: 2-inches.
   2. Material:
      a. Buried applications: Stainless steel or brass.
      b. Buried applications with concrete marker: Brass.
      c. Above ground and in-chase applications: 19 gauge aluminum or PVC.
   3. Stamp tags in 1/4-inch high letter.
   4. Provide non-corrosive metal wire suitable for attaching the tag to the operator base.
   5. Secure tags to valve or gate:
      a. Attach tags in such a way as to allow free and full operation of the valve or gate.
   6. Buried applications with concrete marker: Secure tags to concrete marker.

C. Submittal requirements:
   1. Submit 2 samples of the type of tag proposed and the manufacturer’s standard color chart and letter styles to the Engineer for review.

D. Manufacturer: The following or equal:
   1. Seton Name Plate Co.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify satisfactory conditions of substrate for applying identification.

B. Verify that conditions are satisfactory for installation and application of products as specified in Section 01600 - Product Requirements.

3.02 PREPARATION

A. Prepare and coat surfaces as specified in Section 09960 - High-Performance Coatings.

B. Prepare surface in accordance with product manufacturer's instructions.

3.03 ABOVE GROUND AND IN-CHASE PIPING IDENTIFICATION

A. Identify exposed piping, valves, and accessories in accessible chases with lettering or tags designating service of each piping system with flow directional arrows and color code.

B. Color code:
   1. Paint piping with colors as scheduled in Piping Color Code and Marker Schedule.

C. Lettering and flow direction arrows:
   1. Stencil lettering on painted bands or use snap-on markers on pipe to identify pipe. When stenciling, stencil 3/4-inch high letters on 3/4 through 4-inch pipe or coverings, or 5-inch high letters on 5-inch and larger pipe or coverings.
   2. Provide lettering and flow direction arrows near equipment served, adjacent to valves, both sides of walls and floors where pipe passes through, at each branch or tee, and at intervals of not more than 50 feet in straight runs of pipe.

D. Where scheduled, space 6-inch wide bands along stainless steel pipe at 10-foot intervals and other pipe at 5-foot intervals.

E. Label chemical tank fill pipelines at locations which are visible from chemical fill stations.

F. Metal tags:
   1. Where outside diameter of pipe or pipe covering is 5/8-inch or smaller, provide metal pipe identification tags instead of lettering.
   2. Fasten pipe identification tags to pipe with chain.
   3. Where tags are used, color code pipe as scheduled.

3.04 BURIED PIPING IDENTIFICATION

A. Underground warning tape:
   1. Place continuous run of warning tape in pipe trench, 12 inches above the pipe.

B. Tracer wire:
   1. Install on all non-metallic pipe.
   2. Install an electrically continuous run of tracer wire along the entire length of the pipe with wire terminations in valve boxes, vaults, or structures.
   3. Install tracer wire on top of the pipe and secure to pipe with tape a minimum of every 10 feet.
   4. Where approved by the Engineer, splice sections of wire together using approved direct bury wire nuts:
      a. Twisting the wires together is not acceptable.

C. Witness markers:
   1. Install over pipe in unpaved open-space areas at intervals not greater than 200 feet.
   2. Place markers at appurtenances located in unpaved areas.
   3. Embed markers at least 18 inches into the soil.

3.05 APPLICATION

A. Identify piping with legend markers, directional arrow markers, and number markers; use self-adhesive arrow roll tape to secure ends of piping markers and indicate flow direction.

B. Provide legend markers, directional arrow markers, and number markers where piping passes through walls or floors, at piping intersections and at maximum 15-foot spacing on piping runs.

C. Provide piping marker letters and colors as scheduled.

D. Place markers on piping so they are visible from operator's position in walkway or working platform near piping. Locate markers along horizontal centerline of pipe, unless better visibility is achieved elsewhere.

3.06 PIPING COLOR CODE AND MARKER SCHEDULE

Service Fluid	Pipe Color	Marker Legend
Drain	Charcoal	DRAIN
Pumped Drain	Charcoal	PUMPED DRAIN
Process Water	Dark Blue	PROCESS WATER
Return Water	Silver/Grey	RETURN WATER
Sample	Green	FLUID BEING SAMPLED
Sanitary Drain	Charcoal	SANITARY DRAIN
Service Air	Green	SERVICE AIR

Letters	Color of Pipe	Color of Bands	Color of Letters
Non-potable or Raw	Light Blue	Dark Gray	Black
Distilled or Demineralized	Light Blue	Black	Black
Service Water (lines downstream from backflow prevention unit)	Dark Blue	White	Red
Sample	Dark Blue	Black	White
Filter-to-Waste	Light Brown	None	Black
Wash Water Drain	Light Gray	None	Black
Drain	Dark Gray	None	White
Sump Pump Pipe Line	Dark Gray	Red	White

END OF SECTION

SECTION 15110

COMMON WORK RESULTS FOR VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Basic requirements for valves.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. C111/A21.11 - Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe Fittings.

B. ASTM International (ASTM):
   1. A126 - Standard Specification for Gray Iron Casting for Valves, Flanges, and Pipe Fittings.
   2. A480 - Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
   3. A536 - Standard Specification for Ductile Iron Castings.

C. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

D. Society for Protective Coatings (SSPC):
   1. SP7 - Brush-Off Blast Cleaning.
   2. SP10 - Near-White Blast Cleaning.

1.03 DESIGN REQUIREMENTS

A. Pressure rating:
   1. Suitable for service under minimum working pressures of 150 pounds per square inch gauge.
   2. When a piping system is specified in the Piping Schedule to be tested at a pressure greater than 150 pounds per square inch gauge, provide valves for that piping system with design working pressure which is sufficient to withstand the test pressure.

B. Valve to piping connections:
   1. Valves 3 inches nominal size and larger: Flanged ends.
   2. Valves less than 3 inches nominal size: Screwed ends.
   3. Plastic valves in plastic piping:
      a. Up to 2.5 inches: Provide solvent or heat welded unions.
      b. 3 inches and above: Provide solvent or heat-welded flanges.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data:
    1. Submit the following information for each valve:
        a. Valve type, size, pressure rating, Cv factor.
        b. Coatings.
        c. Power valve actuators:
            1) Information on valve actuator including size, manufacturer, model number, limit switches, mounting; and motor enclosure, seating and unseating torque coefficient, dynamic torque, and bearing friction for calculation of maximum operating torque.
            2) Complete wiring diagrams and control system schematics.
        d. Manual valve actuators:
            1) Information on valve actuator including size, manufacturer, model number.
        e. Certified drawings with description of component parts, dimensions, weights, and materials of construction.
        f. Certifications of reference standard compliance:
            1) Submit certification that the valves and coatings are suitable in potable water applications in accordance with NSF 61.
        g. Clearly mark submittal information to show specific items, materials, and accessories or options being furnished.
        h. Factory test data.

C. Provide vendor operation and maintenance manual as specified in Section 01782 - Operation and Maintenance Data:
    1. Furnish bound sets of installation, operation, and maintenance instructions for each type of manual valve 4 inches in nominal size and larger, and all non-manual valves. Include information on valve operators.

D. Provide Manufacturer’s Certificate of Source Testing as specified in Section 01756 - Commissioning.

E. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.05 QUALITY ASSURANCE

A. Manufacturer qualifications:
    1. Valves manufactured by manufacturers whose valves have had successful operational experience in comparable service.

1.06 DELIVERY STORAGE AND HANDLING

A. Protect valves and protective coatings from damage during handling and installation; repair coating where damaged.

PART 2 PRODUCTS

2.01 MATERIALS

A. Stainless steel: In accordance with ASTM A480, Type 316, or Type 304, UNS Alloy S31600 or S30400.

B. Valve and operator bolts and nuts:
   1. Fabricated of stainless steel for the following installation conditions:
      a. Submerged in sewage or water.
      b. In an enclosed space above sewage or water.
      c. In structures containing sewage or water, below top of walls.
      d. At openings in concrete or metal decks.
   2. Where dissimilar metals are being bolted, use stainless steel bolts with isolation bushings and washers.
   3. Underground bolts: Low-alloy steel in accordance with AWWA C111/A21.11.

C. Bronze and brass alloys: Use bronze and brass alloys with not more than 6 percent zinc and not more than 2 percent aluminum in the manufacture of valve parts; UNS Alloy C83600 or C92200 unless specified otherwise.

D. Valve bodies: Cast iron in accordance with ASTM A126, Class 30 minimum or ductile iron in accordance with ASTM A536, Grade 65-45-12 minimum unless specified otherwise.

2.02 INTERIOR PROTECTIVE LINING

A. When specified in the particular valve specification, provide valves with type of protective lining specified in the particular valve Specification.

B. Apply protective lining to interior, non-working surfaces, except stainless steel surfaces.

C. Lining types:
   1. Fusion bonded epoxy:
      a. Manufacturers: The following or equal:
         1) 3-M Company, ScotchKote 134; certified to NSF 61 for drinking water use.
      b. Clean surfaces in accordance with SSPC SP 7 or SP 10, as recommended by epoxy manufacturer.
      c. Apply in accordance with manufacturer's published instructions.
      d. Lining thickness: 0.010 to 0.012-inch, except that:
         1) Lining thickness in grooves for gaskets: 0.005-inch.
         2) Do not coat seat grooves in valves with bonded seat.
      e. Quality control:
         1) Lining thickness: Measured with a non-destructive magnetic type thickness gauge.
         2) Verify lining integrity with a wet sponge-testing unit operating at approximately 60 volts, or as recommended by the lining manufacturer.
         3) Consider tests successful when lining thickness meets specified requirements and when no pinholes are found.
         4) Correct defective lining disclosed by unsuccessful tests, and repeat test.
         5) Repair pinholes with liquid epoxy recommended by manufacturer of the epoxy used for lining.

2. High solids epoxy:
    a. Product equivalent to high solids epoxy specified in Section 09960 - High-Performance Coatings:
        1) Certified in accordance with NSF 61 for drinking water use.
        2) Interior: Coat valve interior with manufacturer's equivalent high performance high solids epoxy coating system with a certifiable performance history for the service conditions and as approved by the Engineer. Manufacturer shall provide for approval, coating information sufficient to allow Engineer to assess equivalence to the specified high solids epoxy coating specified in Section 09960 - High-Performance Coatings.
    b. Clean surfaces to meet SP-7 or SP-10, or as recommended by coating manufacturer.
    c. Quality control: After coating is cured, check coated surface for porosity with a holiday detector set at 1,800 volts, or as recommended by coating manufacturer:
        1) Repair holidays and other irregularities and retest coating.
        2) Repeat procedure until holidays and other irregularities are corrected.

2.03 UNDERGROUND VALVES

A. Provide underground valves with flanged, mechanical, or other type of joint required for the type of pipe to which the valve is to be connected.

B. Coating and wrapping:
    1. After installation, encase valves in 2 layers of polyethylene wrap as specified for ductile iron piping in Section 15211 - Ductile Iron Pipe: AWWA C151.
        a. Ascertain that polyethylene wrapping does not affect operation of valve.

2.04 STEAM VALVES

A. Valves in steam or steam condensate piping: Ductile iron body in accordance with ASTM A536, Grade 65-45-12 minimum or cast steel or forged steel.

2.05 VALVE BOXES

A. Provide cast-iron valve boxes at each buried valve to access valve and valve operators.

B. Do not support boxes on valve, valve operator, or pipe.

C. Boxes:
    1. 2-piece, fabricated of cast iron; provide cover, with asphalt varnish or enamel protective coating.
    2. Adjustable to grade, install centered around the upper portions of the valve and valve operator.

D. Manufacturers: One of the following or equal:
    1. Tyler Pipe Industries, Inc.
    2. Neenah Foundry Co.

2.06 VALVE OPERATORS

A. Valve operator "Open" direction: Open counterclockwise.

B. Provide valves located below operating level or deck with extensions for key operation or floor stands and handwheels.

C. Provide manually operated valves located not more than 6 feet above the operating level with tee handles, wrenches, or handwheels:
   1. Make the valve operator more conveniently accessible by rolling valves, located more than 5 feet but less than 6 feet above the operating level, toward the operating side.
   2. Secure tee handles and wrenches to the valve head or stem, except where a handle or wrench so secured constitutes a hazard to personnel; in which case, stow handle or wrench immediately adjacent to the valve on or in a suitable hanger, bracket, or receptacle.

D. Fit valves located more than 6 feet above operating level with chain operated handles or valve wheels:
   1. Chains: Sufficient length to reach approximately 4 feet above the operating level.
   2. Where chains constitute a nuisance or hazard to operating personnel, provide holdbacks or other means for keeping the chains out of the way.

E. Provide an operator shaft extension from valve or valve operator to finished grade or deck level when buried valves, and other valves located below the operating deck or level, are specified or indicated on the Drawings to be key operated; provide 2 inches square AWWA operating nut, and box and cover as specified, or a cover where a box is not required.

PART 3 EXECUTION

3.01 EXAMINATION

A. Preparation prior to installation:
   1. Install valves after the required submittal on installation has been accepted.
   2. Determine after flanged valves and flanged check valves are selected, the face-to-face dimensions of flanged valves and flanged check valves.

B. Fabricate piping to lengths taking into account the dimensions of flanged valves and flanged check valves.

3.02 INSTALLATION

A. Provide incidental work and materials necessary for installation of valves including flange gaskets, flange bolts and nuts, valve boxes and covers, concrete bases, blocking, and protective coating.

B. Where needed, furnish and install additional valves for proper operation and maintenance of equipment and plant facilities under the following circumstances:
   1. Where such additional valves are required for operation and maintenance of the particular equipment furnished by Contractor.
   2. Where such additional valves are required as a result of a substitution or change initiated by Contractor.

C. Install valves with their stems in vertical position above the pipe, except as follows:
   1. Butterfly valves, gate valves aboveground, globe valves, ball valves, and angle valves may be installed with their stems in the horizontal position.
   2. Install buried plug valves with geared operators with their stems in a horizontal position.

D. Install valves so that handles clear obstructions when the valves are operated from fully open to fully closed.

E. Place top of valve boxes flush with finished grade or as otherwise indicated on the Drawings.

F. Valves with threaded connections:
   1. Install valves by applying wrench on end of valve nearest the joint to prevent distortion of the valve body.
   2. Apply pipe joint compound or Teflon tape on external (male) threads to prevent forcing compound into valve seat area.

G. Valves with flanged connections:
   1. Align flanges and gasket carefully before tightening flange bolts.
   2. When flanges are aligned, install bolts and hand tighten.
   3. Tighten nuts opposite each other with equal tension before moving to next pair of nuts.

H. Valves with soldered connections:
   1. Do not overheat connection to prevent damage to resilient seats and metal seat rings.
   2. Position valves in full open position before starting soldering procedure.
   3. Apply heat to piping rather than to valve body.

3.03 FIELD APPLIED COATING OF VALVE EXTERIOR

A. Match color and be compatible with manufacturer’s coating system and as specified in Section 09960 - High-Performance Coatings:
   1. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
   2. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services from each manufacturer for all valves supplied:
   1. Provide Manufacturer's Certificate of Source Testing.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance.

C. As specified elsewhere for specific valve types, sizes or actuators:
   1. Source testing.
   2. Manufacturers on site services for Owner Training, Installation Testing, Functional Testing, and during the Process Operational Period.

END OF SECTION

SECTION 15111

BALL VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Ball valves.

B. As specified in Section 15110 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 24.

B. American Water Works Association (AWWA):
   1. C507 - Standard for Ball Valves 6 Inch Through 48 Inch.

C. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. A216 - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
   3. A351 - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.

1.03 SYSTEM DESCRIPTION

A. General: Unless otherwise indicated on the Drawings use:
   1. Metal body ball valves on metallic pipelines.
   2. Plastic body ball valves on plastic pipelines.

B. Do not use metal body ball valves in sodium hypochlorite or sodium bisulfite systems.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: As specified in Section 15110 - Common Work Results for Valves:
   1. Metal body ball valves: 6 inches and larger only: Submit affidavit of compliance in accordance with AWWA C507.
   2. Operation and maintenance manual.

C. Commissioning submittals:
   1. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.05 WARRANTY

A. Provide warranty as specified in General Conditions.

PART 2 PRODUCTS

2.01 METAL BODY BALL VALVES, 6-INCH SIZE AND LARGER

A. Manufacturers: One of the following or equal:
   1. Crane ChemPharma Energy, Resilient seated valve.
   2. DeZURIK/APCO, Metal seated valve.
   3. Henry Pratt Company, Resilient seated valve.

B. General:
   1. Type: Non-lubricated, resilient seated or metal seated and capable of sealing in either flow direction.
   2. In accordance with AWWA C507.
   3. Stem packing: Manually adjustable while valve is under pressure.
   4. ASME B16.1, Class 125 flanged ends.

C. Materials:
   1. Body: ASTM A48 cast iron with 400 series Monel seats (metal seated valves only) and integrally cast bronze bushed trunnions.
   2. Ball: Type 304 or 316 stainless steel.
   3. Seats: PTFE resilient seated valves.
   4. Stem seals: PTFE or Viton™.

D. Valve actuator:
   1. Manually operated valves: Self-locking worm gear type actuator with position indicator. Permanently lubricate gearing. Provide adjustable screws to stop travel at both open and closed positions.
   2. Electric motor operated valves: Provide electric motor operator as specified in Section 13447 - Electric Actuators.

2.02 METAL BODY BALL VALVES, LESS THAN 6-INCH SIZE

A. Manufacturers: One of the following, or equal:
   1. Conbraco Industries, Inc., Apollo Valves.
   2. Flow-Tek, Inc.
   3. Metso Automation/Jamesbury.
   4. NIBCO, Inc.

B. General:
   1. Type: Non-lubricated, full port and capable of sealing in either direction.
   2. End connections:
      a. Threaded or solder ends for sizes 3-inch and smaller.
      b. Class 150 flanged for sizes larger than 3 inches:
         1) Flanges: In accordance with ASME B16.1 standards.
   3. Stem packing: Manually adjustable while valve is under pressure.

4. Shafts:
    a. Rigidly connected to the ball by a positive means:
        1) Design connection to transmit torque equivalent to at least 75 percent of the torsional strength of the shaft.
5. Handles: Stainless steel latch lock handle with vinyl grip and stainless steel nut designed to open and close the valve under operating conditions.
6. Temperature limits: Suitable for operation between minus 20 and 350 degrees Fahrenheit.

C. Materials:
1. Valves in copper lines: Bronze body.
2. Valves in steel and ductile iron piping: Ductile iron or cast steel body.
3. Valves in stainless steel piping: Stainless steel body, material type to match piping material as specified in Section 15052 - Common Work Results for General Piping.
4. Ball: Type 304 or 316 stainless steel, Type 316 in digester gas applications.
5. Seats: PTFE.
6. Stem seals: PTFE or Viton™.
7. Bearings: Self-lubricated, corrosion resistant material that will not contaminate potable water.
8. Valves for combustible fluid applications (digester gas, natural gas, fuel oil, etc.) must be of fire safe design.

2.03 PLASTIC BODY BALL VALVES

A. Manufacturers: One of the following or equal:
1. Asahi America.
2. Chemtrol Division, NIBCO, Inc.
3. Georg Fischer Piping Systems.
4. Hayward Flow Control.
5. Plast-O-Matic Valves, Inc.

B. General:
1. Type: Non-lubricated and capable of sealing in either flow direction.
2. End connections: True union; solvent or heat welded to piping.
3. Operator handle: Lever.

C. Materials:
1. Body: Polyvinyl chloride (PVC).
2. Ball: Polyvinyl chloride (PVC).
3. Seats: PTFE (Teflon™).
4. O-rings: EPDM.

D. Venting requirements:
1. PVC and CPVC ball valves for hypochlorite service:
    a. Provide valve with factory drilled 0.125-inch hole in the upstream side of the ball.
    b. Provide an engraved plastic tag permanently attached to the valve stem stating, "One side of ball drilled for hypochlorite service".
    c. Provide an arrow inscribed on the valve body to indicate direction of flow.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install each type of valve in accordance with manufacturers' printed instructions.

B. Special techniques:
   1. PVC ball valves for hypochlorite service:
      a. Provide valve with factory drilled 0.125-inch hole in the upstream side of the ball.
      b. Provide an engraved plastic tag permanently attached to the valve stem stating "One side of ball drilled for hypochlorite service."

3.02 FIELD APPLIED COATING OF VALVE EXTERIOR

A. Match color and be compatible with manufacturer’s coating system and as specified in Section 09960 - High-Performance Coatings:
   1. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
   2. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Installation and Functionality Compliance.

C. Source testing:
   1. Shell test: With valve in the open position, conduct hydrostatic test of the valve body at 1.5 times the maximum rated pressure for 7 minutes.
   2. Seat test: With valve in the closed position, conduct hydrostatic test of the valve seat seals at 1.1 times the maximum rated pressure for 7 minutes. Test each seat independently.

D. Functional testing:
   1. Valves:
      a. Test witnessing: Witnessed.
      b. Conduct pressure and leak test, as specified in Section 15956 - Piping Systems Testing.

END OF SECTION

SECTION 15112

BUTTERFLY VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Butterfly valves:
   1. As specified in Section 15110 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Classes 25, 125 and 250.
   2. B16.5 - Pipe Flanges and Flanged Fittings, NPS 1/2 through NPS 24.

B. American Water Works Association (AWWA):
   1. C110 - Standard for Ductile-Iron and Gray-Iron Fittings.
   2. C504 - Rubber-Seated Butterfly Valves.
   3. C540 - Standard for Power-Actuating Devices for Valves and Sluice Gates.
   4. C550 - Protective Interior Coatings for Valves & Hydrants.
   5. C606 - Standard for Grooved and Shouldered Joints.

C. ASTM International (ASTM):
   1. A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. A216 - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for Higher-Temperature Service.
   3. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   4. A351 - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
   5. A395 - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
   6. A479 - Standard Specification for Stainless Steel Bars and Shapes for Use in Boilers and Other Pressure Vessels.
   7. A515 - Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate - and Higher-Temperature Service.
   8. A516 - Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate - and Lower-Temperature Service.
   9. A536 - Standard Specification for Ductile Iron Castings.
   10. A564 - Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.

11. A743 - Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
12. A890 - Standard Specification for Castings, Iron-Chromium-Nickel-Molybdenum Corrosion-Resistant, Duplex (Austenitic/Ferritic) for General Application.
13. B462 - Standard Specification for Forged or Rolled UNS N06030, UNS N06022, UNS N06035, UNS N06200, UNS N06059, UNS N10362, UNS N06686, UNS N08020, UNS N08024, UNS N08026, UNS N08367, UNS N10276, UNS N10665, UNS N10675, UNS N10629, UNS N08031, UNS N06045, UNS N06025, UNS R20033 Alloy Pipe Flanges, Forged Fittings, and Valves and Parts for Corrosive High-Temperature Service.
14. B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
15. B691 - Standard Specification for Iron-Nickel-Chromium-Molybdenum Alloys (UNS N08366 and UNS N08367) Rod, Bar, and Wire.
16. D429 - Standard Test Methods for Rubber Property-Adhesion to Rigid Substrate.

D. Compressed Gas Association (CGA):
   1. Standard G-4.1 - Cleaning Equipment for Oxygen Service.

E. NSF International (NSF):
   1. Standard 61 - Drinking Water System Components - Health Effects.

F. United States Code of Federal Regulations (CFR):
   1. 21 - Food and Drugs.

1.03 SYSTEM DESCRIPTION

A. Design requirements:
   1. General purpose AWWA butterfly valves:
      a. Design standard: Provide valves designed and manufactured in accordance with AWWA C504.
      b. Class:
         1) Provide butterfly valves in accordance with AWWA Class 150B, unless otherwise specified.
         2) Provide butterfly valves in accordance with AWWA Class 250B in piping systems with test pressure greater than 150 pounds per square inch and less than 250 pounds per square inch.
   2. High pressure butterfly valves:
      a. Piping systems designed for operating pressures greater than 250 pounds per square inch and less than 450 pounds per square inch: Provide ASME B16.5, Class 300 high pressure valves.
   3. Industrial class butterfly valves:
      a. Industrial class butterfly valves capable of 150 pounds per square inch leak tight shut off.
   4. Stainless steel butterfly valves:
      a. Stainless steel butterfly valves capable of a minimum of 100 pounds per square inch leak tight shut off and with special cleaning, packaging, and handling.

B. Usage:
   1. Provide and install butterfly valve types as outlined in the Butterfly Valve Application Schedule at the end of this Section.

C. Design requirements for all butterfly valves with power actuating devices:
   1. Design valves and actuators for maximum operating torque, in accordance with and using safety factors required in AWWA C540, using the following values:
      a. Maximum water velocity: 16 feet per second with valve fully open.
      b. Maximum pressure differential across the closed valve equal to the pressure class designation.
      c. Coefficient for seating and unseating torque, dynamic torque, and bearing friction in accordance with valve manufacturer's published recommendations.
   2. Valve disc: Seat in an angular position of 90 degrees to the pipe axis and rotate an angle of 90 degrees between fully open and fully closed positions:
      a. Do not supply valves with stops or lugs cast with or mechanically secured to the body of the valve for limiting the disc travel.
   3. Unacceptable thrust bearings: Do not provide valves with thrust bearings exposed to the fluid in the line and consisting of a metal bearing surface in rubbing contact with an opposing metal bearing surface.

D. Performance requirements:
   1. Tight shutoff at the pressure rating of the valve with pressure applied in either direction.
   2. Suitable for the following service conditions:
      a. Throttling.
      b. Frequent operation.
      c. Operation after long periods of inactivity.
      d. Installation in any position and flow in either direction.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: 15110 - Common Work Results for Valves:
   1. For general purpose AWWA butterfly valves, include description of the method of attachment of the disc edge to the valve disc.
   2. Interior epoxy coatings: Affidavit of compliance attesting that epoxy coatings applied to interior surfaces of butterfly valves comply with all provisions in accordance with AWWA C550.
   3. Certification, for valves and coatings in contact with potable water, that the products used are suitable for contact with drinking water in accordance with NSF Standard 61.

C. Commissioning submittals:
   1. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.05 WARRANTY

A. Provide warranty as specified in General Conditions.

PART 2 PRODUCTS

2.01 GENERAL PURPOSE AWWA BUTTERFLY VALVES

A. Manufacturers: One of the following or equal:
   1. DeZURIK/Sartell Model BAW.
   2. Henry Pratt Co.

B. Valve body:
   1. Material: Cast iron, ASTM A126, Grade B, or ductile iron, ASTM A536, Grade 65-45-12.
   2. Body design:
      a. Flanged body valves:
         1) Usage: Comply with limitations specified in the Butterfly Valve Application Schedule.
         2) Flanges: In accordance with ASME B16.1 Class 125 flanges for Class 150B valves, in accordance with ASME B16.1 Class 250 flanges for Class 250B valves.
      b. Mechanical joint body valves:
         1) Usage: Comply with limitations specified in the Butterfly Valve Application Schedule.
         2) Mechanical joint design: In accordance with AWWA C110.
         3) When mechanical joint body valves are used, incorporate valve into thrust restraint analysis as specified in Section 15211 - Ductile Iron Pipe: AWWA C151. Utilize test pressure on one side of valve and zero pressure on the opposite side of the valve. Restrain pipe joints on both sides of valve as determined by thrust analysis calculations.
      c. Grooved end body valves:
         1) Usage: Butterfly valves with grooved ends may be used in piping systems specified in the Piping Schedule to have grooved end joints. Comply with additional limitations specified in the Butterfly Valve Application Schedule.
         2) Grooved end joint design: In accordance with AWWA C606.

C. Disc:
   1. Material: Cast iron or ductile iron with Type 316 stainless steel edge that matches seat in valve body.
   2. Secure valve disc to shaft by means of smooth-sided, taper or dowel pins, Type 316 stainless steel, or Monel.
   3. Extend pins through shaft and mechanically secure in place.

D. Shaft and bearings:
   1. Shaft design:
      a. Valves 20-inches and less: 1-piece, through disc design.
      b. Valves greater than 20-inch size: 2-piece, stub shaft design.
   2. Shaft seal: Vee type, chevron design.
   3. Shaft material for Class 150B valves: Type 316 stainless steel, ASTM A276.
   4. Shaft material for Class 250B valves: Type 17-4 pH stainless steel, ASTM A564.

5. Shaft bearings: Self-lubricating sleeve type:
    a. Valves 20 inches and less: Nylatron.
    b. Valves greater than 20-inch size: Teflon with stainless steel or fiberglass backing.

E. Seats:
1. Seat materials:
    a. In low-pressure air applications: EPDM.
    b. In all other applications: EPDM.
2. For valves 20 inches in nominal size and smaller, bond or vulcanize seat into the valve body.
3. For valves 24 inches in nominal size and larger, retain seats mechanically or by adhesive:
    a. Mechanical retainage: Retain seat by a clamping ring with segmented clamping ring locks with adjusting locking screws:
        1) Clamping ring, ring locks, and adjusting locking screws: Type 316 stainless steel.
        2) Provide means to prevent ring locks and screws used to retain seats from loosening due to vibration or cavitation.
    b. Adhesive retainage: Inset the seat within a groove in the valve body and retain in place with epoxy injected behind the seat so that the seat expands into the body.
    c. Do not provide valves with seats retained by snap rings or spring-loaded retainer rings.
4. Resilient seat: Withstand 75 pound per inch pull when tested in accordance with ASTM D429, Method B.

F. Valve packing:
1. Valves 4 inches to 48 inches nominal size: Self-adjusting V-type packing or chevron-type packing. NBR or EPDM to match seat material.
2. Valves 54 inches nominal size and larger: Adjustable V-type packing with bronze packing gland or self-adjusting V-type packing. NBR or EPDM to match seat material.

2.02 COATING

A. Shop coat interior and exterior metal surfaces of valves, except as follows:
1. Interior machined surfaces.
2. Surfaces of gaskets and elastomeric seats and stem seals.
3. Bearing surfaces.
4. Stainless steel surfaces and components.

B. Coating material for potable water applications:
1. Formulate interior coating material from materials in accordance with CFR 21, AWWA C550, and NSF 61.
2. Submit affidavit of compliance attesting that epoxy coatings applied to interior surfaces of butterfly valves in accordance with CFR 21, AWWA C550, and NSF 61.

C. Interior surfaces:
   1. Interior surfaces, except for valves used in low-pressure air service: High solids epoxy.
   2. Interior surfaces of valves used in low-pressure air service: High temperature coating for range of 150 to 350 degrees Fahrenheit.

D. Exterior surfaces:
   1. Exterior surfaces of valves, actuators, and accessories coating in accordance with Section 09960 - High-Performance Coatings with the following coating types:
      a. Submerged valves: High solids epoxy.
      b. Buried valves: Coal tar epoxy.
      c. Other valves: High solids epoxy with polyurethane topcoat.
   2. Polished and machined surfaces: Apply rust-preventive compound:
      a. Manufacturers: One of the following or equal:
         1) Houghton, Rust Veto 344.
         2) Rust-Oleum, R-9.

E. Coating materials:
   1. High solids epoxy and coal tar epoxy:
      a. Products: As specified in Section 09960 - High-Performance Coatings:
         1) Coating product in contact with potable water must be in accordance with AWWA C550 and NSF 61.
   2. High temperature coating: As specified in Section 09960 - High-Performance Coatings and in accordance with AWWA C550.
   3. Rust-preventive compound:
      a. Manufacturers: One of the following or equal:
         1) Houghton, Rust Veto 344.
         2) Rust-Oleum, R-9.

F. Field applied coatings of valve exterior:
   1. Match color and be compatible with manufacturer's coating system and as specified in Section 09960 - High-Performance Coatings:
      a. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
      b. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install valves with valve shafts horizontal, unless a vertical shaft is required to suit a particular installation, and unless a vertical shaft is indicated on the Drawings.

B. Install pipe spools or valve spacers in locations where butterfly valve disc travel may be impaired by adjacent pipe lining, pipe fittings, valves, or other equipment.

3.02 BUTTERFLY VALVE APPLICATION SCHEDULE

A. Acceptable butterfly valve types and body styles are listed in the Butterfly Valve Application Schedule provided at the end of this Section. Furnish and install butterfly valves in accordance with this Schedule.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Installation and Functionality Compliance.

C. Functional testing:
   1. Valves:
      a. Test witnessing: Witnessed.
      b. Conduct pressure and leak test, as specified in Section 15110 - Common Work Results for Valves.

BUTTERFLY VALVE APPLICATION SCHEDULE	
Valve Type and Style	**Acceptable Applications**
General Purpose AWWA Butterfly Valves - Flanged Body Design.	Aboveground or submerged in the following service applications only: - Acceptable in all service applications except oxygen and ozone service and high-pressure service. - May be used in buried applications when required by the specified piping system.
General Purpose AWWA Butterfly Valves - Mechanical Joint Body Design.	Buried in the following service applications only: - Acceptable in all service applications except oxygen and ozone service and high-pressure service.
General Purpose AWWA Butterfly Valves - Lugged Body Design.	Aboveground in the following service applications only: - Aeration Air Systems.
General Purpose AWWA Butterfly Valves - Wafer (not lugged) Body Design.	Not allowed.
General Purpose AWWA Butterfly Valves - Grooved End Body Design.	Aboveground, in sizes 20 inches and less, with piping system test pressure less than 100 psi, and in the following service applications only: - Acceptable in all service applications, except oxygen and ozone service, where piping for that service is specified in the Piping Schedule to have grooved end joints.
Stainless Steel Butterfly Valves - Lugged Body Design.	Aboveground in the following service applications only: - Oxygen Systems. - Ozone Systems.
Stainless Steel Butterfly Valves - Wafer (not lugged) Body Design.	Not allowed.

END OF SECTION

SECTION 15114

CHECK VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Check valves.

B. As specified in Section 15110 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Inch Standard.

B. American Water Works Association (AWWA):
   1. C508 - Standard for Swing-Check Valves for Waterworks Service 2 Inch Through 24 Inch NPS.

C. ASTM International (ASTM):
   1. A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. A313 - Standard Specification for Stainless Steel Spring Wire.
   3. A536 - Standard Specification for Ductile Iron Castings.
   4. B582 - Standard Specification for Nickel-Chromium-Iron-Molybdenum-Copper Alloy Plate, Sheet, and Strip.
   5. B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

1.03 SYSTEM DESCRIPTION

A. Design requirements:
   1. Check valves: When not otherwise specified as indicated on the Drawings, provide check valves suitable for service as follows:
      a. In either horizontal or vertical position.
      b. Suitable for service working pressures up to 150 pounds per square inch gauge.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: As specified in Section 15110 - Common Work Results for Valves.

C. Commissioning submittals:
   1. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.05 WARRANTY

A. Provide warranty as specified in General Conditions.

PART 2 PRODUCTS

2.01 CENTER GUIDE (SILENT) CHECK VALVES

A. Manufacturers: One of the following or equal:
   1. APCO, Model Number 600.
   2. Crispin, Series GC.

B. Valve design:
   1. Center-guided, spring-loaded plug.
   2. Replaceable seat and plug.
   3. Shaft guide bushing.
   4. Non-slam, silent shutoff.
   5. Flanged body.

C. Materials:
   1. Body: Cast iron, ASTM A126 Grade B, or Type 316 stainless steel, ASTM A313.
   2. Plug and seat: Bronze, ASTM B584 C83600.
   3. Spring: Stainless steel, ASTM A313 Type 316.
   4. Shaft and bushing: Bronze, ASTM B584 C83600.
   5. Seat: Buna-N or EPDM.

2.02 SWING CHECK VALVES

A. Valves 1/4-inch through 3 inches:
   1. Manufacturers: One of the following or equal:
      a. Crane Valve Co., Number 36.
      b. Lunkenheimer Co., Figure 554Y.
   2. Valve design:
      a. Threaded joints.
      b. Y-pattern body with integral seat.
      c. Hinged disc.
      d. Access to valve seat for regrinding without disassembly of piping.
   3. Materials:
      a. Body, cap, hinge, and disc: Bronze.

B. Valves 4 inches through 24 inches:
   1. Manufacturers: One of the following or equal:
      a. Kennedy, Figure 106LW or M&H, Model 159.
      b. Mueller Co., Model A-2600.
      c. APCO Model 250.
      d. Crispin SWL Series.

2. Valve design:
    a. In accordance with AWWA C508.
    b. Constructed to permit top entry and removal of internal components without removing the valve.
    c. Equipped with outside lever and weight.
3. Materials:
    a. Body: Cast iron, ASTM A126 Class B or ASTM A536 Grade 65-45-12 Ductile Iron.
    b. Disc:
        1) Valve disc shall be ASTM A126 cast iron, ASTM A536 ductile iron, or ASTM B584 bronze.
        2) 4-inch valves: Bronze or stainless steel rings and seats.
        3) 6 inches and larger valves: Bronze-faced or stainless steel rings and seats.
        4) Rubber seat Buna-N or EPDM.
    c. Hinge pins: Stainless steel.

2.03 SLANTING DISC CHECK VALVES

A. Manufacturers: One of the following or equal:
1. APCO, Series 800-T.
2. ValMatic Series 9800-T.
3. Crispin, Series TD.

B. Valve design: 2-piece construction, bolted at the center, with disc at an angle of 55 angular degrees:
1. Minimum cross-sectional area throughout valve body: Equal to cross-sectional area of the pipe connected to the valve.
2. Control disc closing with top-mounted, oil-filled, cushion chamber.
3. Fit cylinder with a flow control valve.
4. Ends: Flanged, ASME B16.1.

C. Materials:
1. Body and disc: Cast iron, ASTM A126, Class B.
2. Seat ring and disc ring: Bronze, ASTM B584, Alloy C 92200, Alloy C 83600, Alloy C 94700, or Alloy C 93700.
3. Pivot pins: Stainless steel, ASTM A582.
4. Bushings: Stainless steel.
5. Oil reservoirs: Stainless steel.

2.04 PLASTIC BALL CHECK VALVES

A. Manufacturers: One of the following or equal:
1. Chemtrol Division of Nibco.
2. Georg Fischer Piping Systems.
3. Plast-O-Matic Valves, Inc.
4. Hayward Flow Control.

B. Valves: Ball type:
1. Material: Polyvinyl chloride.
2. End connection: Double-or single-union-type.
3. Seals: Viton.

C. Valve body material:
   1. Polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), Polypropylene (PP) or polyvinylidene fluoride (PVDF), as best suited for each individual service condition.

D. Union connections material:
   1. NPT or socket ends conforming to ASME B16.5 pipe flanges and flange fittings, Class 150.

E. Seats and seals material:
   1. EPDM, Buna-N, or Viton.

F. Maximum inlet pressure rating:
   1. PVC, CPVC, or PVDF: 150 pound per square inch at 77 degrees Fahrenheit.
   2. PP: 100 pounds per square inch at 77 degrees Fahrenheit.

PART 3 EXECUTION

3.01 INSTALLATION

A. Flapper-type check valves:
   1. Install with proper orientation of flow direction arrow on valve body.
   2. When installed in horizontal pipelines, mount with shaft on vertical locations.
   3. When mounted in a vertical pipeline, directly downstream of an elbow, mount with the shaft perpendicular to the outermost portion of the elbow.
   4. Mount on downstream side of discharge silencer when used on positive displacement and centrifugal blowers.

3.02 FIELD APPLIED COATING OF VALVE EXTERIOR

A. Match color and be compatible with manufacturer’s coating system and as specified in Section 09960 - High-Performance Coatings:
   1. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
   2. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Installation and Functionality Compliance.

C. Functional testing:
    1. Valves:
        a. Test witnessing: Witnessed.
        b. Conduct pressure and leak test, as specified in Section 15956 - Piping Systems Testing.

END OF SECTION

SECTION 15116

PLUG VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Non-lubricated plug valves.
   2. Lubricated plug valves.
   3. Multi-port plug valves.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. C517 - Resilient-Seated Cast Iron Eccentric Plug Valves.
   2. C606 - Grooved and Shouldered Joints.

B. ASTM International (ASTM):
   1. A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. A536 - Standard Specification for Ductile Iron Castings.

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures and 15110 - Common Work Results for Valves.

B. Product data.

C. Shop drawings.

D. Calculations.

E. Vendor operation and maintenance manual as specified in Section 01782 - Operation and Maintenance Data.

F. Commissioning submittals:
   1. Provide Manufacturer’s Certificate of Source Testing as specified in Section 01756 - Commissioning:
      a. Interior coating.
   2. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.04 WARRANTY

A. Provide warranty as specified in General Conditions.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 15110 - Common Work Results for Valves.

2.02 NON-LUBRICATED PLUG VALVES

A. Manufacturers: Sole-sourced to the following:
   1. DeZurik, "PEC".

B. Design:
   1. Type: Non-lubricated eccentric type, in accordance with AWWA C517.
   2. Plug face: Resilient material that operates satisfactorily at a temperature of 180 degrees Fahrenheit continuous and 215 degrees Fahrenheit intermittent, except for valves in compressed air or digester gas service:
      a. Valves in compressed air service: Resilient material suitable for continuous duty at 250 degrees Fahrenheit.
      b. Valves in digester gas service: Resilient material suitable for petroleum or digester gas at continuous duty at 180 degrees Fahrenheit.
   3. Compression washer: Provide flat compression washer made of Teflon, or of a material having equal physical characteristics on valve stem between plug and bonnet.
   4. Stem seals: Provide stem seals serviceable without unbolting the valve bonnet assembly.
   5. Grit excluders: Provide PTFE grit excluders at upper plug journals to prevent entry of foreign solids in bearing area.
   6. Clearly mark valves to indicate their open and closed positions.
   7. Provide valves with ends as required by piping details indicated on the Drawings:
      a. Grooved end body valves:
         1) Usage: Plug valves with grooved ends may be used in piping systems specified in the Piping Schedule to have grooved end joints and as indicated on the Drawings.
         2) Grooved end joint design: In accordance with AWWA C606.

C. Materials:
   1. Body and plug: ASTM A126, Class B, cast-iron, with plug face of neoprene, Buna N, or material suitable for the intended service as specified under paragraph "Design" above.
   2. Body seats in valves 3 inch size and larger: Provide with overlay of not less than 90-percent nickel and minimum thickness of 1/8-inch on surfaces contacting the plug face.
   3. Stem bearing and bottom bearing: Type 316 stainless steel.
   4. Internal parts, except the body and plug: Type 316 stainless steel or Nickel.
   5. Exposed nuts, bolts, and washers: Zinc plated. Exception: Exposed nuts, bolts, and washers for buried service: Stainless steel.

2.03 LUBRICATED PLUG VALVES

A. Manufacturers: One of the following or equal:
   1. Nordstrom.
   2. Walworth.

B. Type: Semi-steel tapered plug valves.

C. Design:
   1. Plug removable through top of valve.
   2. Combined lubricant screw and grease gun fitting, of the type where the pressure of the grease can be used to raise the plug slightly off its seat.

D. Where indicated on the Drawings or specified, provide plug valves with high head extension and floor stand with indicator. Provide worm gear-operated valves with worm shaft extension and floor stand, and with indicator supplied by manufacturer of plug valve:
   1. Equip floor stands serving plug valves with individual operating wrenches.

2.04 VALVE OPERATORS

A. Furnish valves with an operating wrench or worm gear operator:
   1. Equip valves 4 inch nominal size and smaller with a lever operator.
   2. Equip valves 6 inch nominal size and larger with a worm gear operator.

2.05 COATING

A. Coat and test interior metal surfaces as specified in Section 15110 - Common Work Results for Valves.

B. Field applied coating of valve exterior:
   1. Match color and be compatible with manufacturer’s coating system and as specified in Section 09960 - High-Performance Coatings:
      a. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
      b. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

2.06 SHIPMENT, SPARE PARTS, MAINTENANCE PRODUCTS, AND SPECIAL TOOLS

A. As specified in Section 01600 - Product Requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install valves as specified in Section 15110 - Common Work Results for Valves and the manufacturer's instructions:
   1. Unless differently indicated on the Drawings install valves so that in the closed position the pressure in the pipeline applies a seating head on the valves.
   2. Install valves so that in the open position the plug is located in the top half of the valve body.

B. For valves requiring lubrication: Lubricate and fill extended lubricant pipes with lubricant suitable for service intended.

3.02 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Installation and Functionality Compliance.

C. Functional testing:
   1. Valves:
      a. Test witnessing: Witnessed.
      b. Conduct pressure and leak test as specified in Section 15110 - Common Work Results for Valves.

END OF SECTION

SECTION 15117

SPECIALTY VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Specialty valves.

B. As specified in Section 15110 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Civil Engineers (ASCE):
   1. 25 - Earthquake-Actuated Automatic Gas Shutoff Devices.

B. American Society of Mechanical Engineers (ASME):
   1. B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

C. American Water Works Association (AWWA):
   1. C511 - Standard for Reduced Pressure-Principle Backflow-Prevention Assembly.
   2. C800 - Underground Service Line Valves & Fittings (Also Included: Collected Standards For Service Line Materials).

D. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. A126 - Standard Specification for Gray Iron Casting for Valves, Flanges, and Pipe Fittings.
   3. A276 - Standard Specification for Stainless Steel Bars and Shapes.
   4. A536 - Standard Specification for Ductile Iron Castings.
   5. B584 - Standard Specification for Copper Alloy Sand Castings for General Application.
   6. D2000 - Standard Classification System for Rubber Products in Automotive Applications.

E. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

1.03 DEFINITIONS

A. NEMA Type 4 enclosure in accordance with NEMA 250.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: As specified in Section 15110 - Common Work Results for Valves.

C. Commissioning submittals:
   1. Backflow preventer certification.
   2. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.05 WARRANTY

A. Provide warranty as specified in General Conditions.

PART 2 PRODUCTS

2.01 SOLENOID VALVES

A. 2-way solenoid valves:
   1. Manufacturers: One of the following or equal:
      a. Automatic Switch Co., Series 8210.
      b. Skinner Electric Valve Division, Series C.

B. 3-way solenoid valves:
   1. Manufacturers: One of the following or equal:
      a. Automatic Switch Co., Series 8320.
      b. Skinner Electric Valve Division, Type A4.

C. 4-way solenoid valves:
   1. Manufacturers: One of the following or equal:
      a. Automatic Switch Co., Bulletin 8344.
      b. Skinner Electric Valve Division, Series V9.

D. Design:
   1. Valves: Suitable for service under the following conditions:
      a. Fluid: 3W.
      b. Temperature of fluid: 70 degrees Fahrenheit.
      c. Piping test pressure: 180 pounds per square inch gauge.
   2. Unless otherwise indicated on the Drawings, provide valves that meet the following requirements:
      a. Minimum NEMA Type 4 enclosure.
      b. 120 VAC operation.
      c. Suitable for use as indicated on the Drawings.
      d. Minimum Class F coil insulation.
   3. 2-way valves: Furnish with openings of size equal to or larger than the nominal size designation of the valve.
   4. Furnish with manual/bypass operators.

E. Materials:
   1. Body: Brass or bronze.
   2. Seats: Resilient material.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install as specified in Section 15110 - Common Work Results for Valves in accordance with manufacturer's published instructions.

B. Install with a minimum clearance of 12 inches and with maximum clearance of 30 inches between the relief port and the floor or finished grade or top of containment wall.

C. Plastic body diaphragm valves for sodium hypochlorite service:
   1. When valves are installed horizontally, install valves with valve stem position rotated as necessary such that no internal valve obstruction prevents the passage of vapors traveling along the top of adjacent piping from traveling through the valve.

D. Backflow preventers:
   1. Install with a minimum clearance of 12 inches and with maximum clearance of 30 inches between the relief port and the floor or finished grade or top of containment wall.
   2. Install with sufficient side clearance for access for testing and maintenance.

3.02 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer’s Certificate of Installation and Functionality Compliance.
      b. Manufacturer’s Representative onsite requirements as specified in Section 15110 - Common Work Results for Valves.

END OF SECTION

SECTION 15118

PRESSURE REDUCING AND PRESSURE RELIEF VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Pressure reducing and pressure relief valves for water, air, sludge and chemical service.

B. As specified in Section 15110 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.42 - Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.

B. ASTM International (ASTM):
   1. A48 - Standard Specification for Gray Iron Castings.
   2. A536 - Standard Specification for Ductile Iron Castings.

C. Underwriters Laboratories, Inc. (UL).

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: As specified in Section 15110 - Common Work Results for Valves.

C. Commissioning submittals:
   1. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.04 WARRANTY

A. Provide warranty as specified in General Conditions.

PART 2 PRODUCTS

2.01 WATER PRESSURE REDUCING VALVES

A. Water pressure reducing valves, 2 1/2 inches and smaller:
   1. Manufacturers: One of the following or equal:
      a. Watts Regulator, Series LF223.
      b. Wilkins, 500 Series.
   2. Direct operated, single seat type pressure reducing valve.
   3. Materials:
      a. Body and spring cover: Bronze.
      b. Valve seat: Series 300 stainless steel.

c. Diaphragm: Reinforced Buna Nitrile.
d. Disk: Buna Nitrile.

B. Water pressure reducing valves, 3 inches and larger:
1. Manufacturers: One of the following, or equal:
a. Watts ACV Series 115.
b. Cla-Val Model 90-01.
2. Design:
a. Pilot controlled, hydraulically operated, diaphragm actuated, globe patterned valve.
b. Rated for 125 pounds per square inch gauge.
c. Pilot line: Equipped with a strainer.
d. Flanges: 150 pound rating, in accordance with ASME B16.42.
3. Materials:
a. Body and cover: Cast iron ASTM A48 or Ductile Iron ASTM A536.
b. Valve trim: Bronze.
c. Pilot control: Cast bronze with Series 303 stainless steel trim.
d. Diaphragm: Nylon reinforced Buna N.

2.02 WATER PRESSURE RELIEF VALVES

A. Water pressure relief valves:
1. Manufacturers: One of the following, or equal:
a. Watts ACV Series 116.
b. Cla-Val Model 50-01.
2. Design:
a. Pilot controlled, hydraulically operated, diaphragm actuated, globe patterned valve.
b. Rated for 125 pounds per square inch gauge.
c. Pilot line: Equipped with a strainer.
d. End connections:
1) 2 1/2 inch and smaller: Screwed.
2) 3 inch and larger: 150 pound rated flanges in accordance with ASME B16.42.
3. Materials:
a. Body and cover: Cast iron ASTM A48 or Ductile Iron ASTM A536.
b. Valve trim: Bronze.
c. Pilot control: Cast bronze with Series 303 stainless steel trim.
d. Diaphragm: Nylon reinforced Buna N.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install as specified in Section 15110 - Common Work Results for Valves.

3.02 FIELD APPLIED COATING OF VALVE EXTERIOR

A. Match color and be compatible with manufacturer’s coating system and as specified in Section 09960 - High-Performance Coatings:
   1. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the paint manufacturer.
   2. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, blast clean valve surfaces or utilize other surface preparation recommended by the manufacturer of the coating material and apply the coating system used for coating adjacent piping.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Installation and Functionality Compliance.

C. Functional testing:
   1. Valves:
      a. Test witnessing: Witnessed.
      b. Conduct pressure and leak test as specified in Section 15110 - Common Work Results for Valves.

END OF SECTION

SECTION 15119

AUTOMATIC AIR AND VACUUM VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Air release valves, air/vacuum valves, and combination air valves.

B. As specified in Section 15110 - Common Work Results for Valves.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. B16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through 24.

B. American Water Works Association (AWWA).

C. ASTM International (ASTM):
   1. A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   3. A270 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Sanitary Tubing.
   4. B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: As specified in Section 15110 - Common Work Results for Valves.

C. Commissioning submittals:
   1. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.04 WARRANTY

A. Provide warranty as specified in General Conditions.

PART 2 PRODUCTS

2.01 AIR RELEASE VALVES, WATER SERVICE

A. Manufacturers: One of the following or equal:
   1. ARI.

B. Design:
   1. Pressure rating: 150 pounds per square inch gauge.
   2. Inlet: Screwed, 2-inch.
   3. Orifice size: 1/4-inch diameter.

C. Materials:
   1. Valve body: Cast iron.
   2. Float and internal trim: Type 316 stainless steel.
   3. Seat or valve plunger: Buna-N.

2.02 AIR RELEASE VALVES, SEWAGE SERVICE

A. Manufacturers: One of the following or equal:
   1. APCO, Series 400 and 450.
   2. Crispin Series S.

B. Design:
   1. Elongated body using a needle on a compound lever to operate release valve.
   2. Release air under pressure without spilling liquid.
   3. Pressure rating: 150 pounds per square inch.
   4. Orifice size: 1/4-inch diameter.
   5. Connections: Threaded, 2-inch diameter inlet and threaded, 1/2-inch diameter outlet.

C. Accessories:
   1. Inlet eccentric plug shutoff valve.
   2. Blowoff valve.
   3. Backflushing shutoff valve.
   4. Backflush hose with quick disconnect couplings - 10 feet.

D. Materials:
   1. Body: Ductile or cast iron.
   2. Float: Type 316 stainless steel.
   3. Needle: Buna-N.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install as specified in Section 15110 - Common Work Results for Valves and manufacturer’s instructions.

B. Install air release valves and air and vacuum valves with suitable discharge lines to nearest equipment drain.

3.02 FIELD APPLIED COATING OF VALVE EXTERIOR

A. Match color and be compatible with manufacturer's coating system and as specified in Section 09960 - High-Performance Coating:
   1. When shop applied finish coating matches field applied coating on adjacent piping, touch up shop coating in damaged areas in accordance with instructions recommended by the manufacturer.
   2. When shop applied coating does not match field coating on adjacent piping, or when damage has occurred to the shop applied coating that requires more than touchup, remove existing coating by abrasive blast cleaning and apply the coating system used for coating adjacent piping in accordance with Section 09960 - High-Performance Coating:
      a. Submerged valves: SP-5 White Metal Blast cleaning.
      b. Other valves: SP-10 Near-white blast cleaning.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Manufacturer services:
   1. Provide certificates:
      a. Manufacturer's Certificate of Installation and Functionality Compliance.

C. Functional testing:
   1. Valves:
      a. Test witnessing: Witnessed.
      b. Conduct pressure and leak test as specified in Section 15110 - Common Work Results for Valves.

END OF SECTION

SECTION 15120

PIPING SPECIALTIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Piping specialties including:
   1. Spray nozzles.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24.

B. American Water Works Association (AWWA):
   1. C110 - Standard for Ductile-Iron and Gray-Iron Fittings.
   2. C151 - Standard for Ductile-Iron Pipe, Centrifugally Cast.

C. ASTM International (ASTM):
   1. A148 - Standard Specification for Steel Castings, High-Strength, for Structural Purposes.
   2. A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   3. A194 - Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   4. A536 - Standard Specification for Ductile Iron Castings.

D. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects, Includes Errata.
   2. 372 - Drinking Water System Components - Lead Content.

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. For each piping product in this Section as applicable:
      a. Design features.
      b. Load capacities.
      c. Material designations by UNS alloy number or ASTM Specification and Grade.
      d. Data needed to verify compliance with the Specifications.
      e. Catalog data.
      f. Clearly mark submittal information to show specific items, materials, and accessories or options being furnished.

C. Calculations:
   1. Provide calculations in accordance with NSF 372 for materials in contact with drinking water.

D. Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning:
   1. Provide as specified in this Section.

1.04 WARRANTY

A. Provide warranty as specified in General Conditions.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 01600 - Product Requirements.

B. Materials in contact with drinking waters: In accordance with NSF 61 and NSF 372.

2.02 SPRAY NOZZLES

A. Design:
   1. Operating pressure 10 pounds per square inch gauge, at which pressure each nozzle discharges not less than 3.5 gallons per minute, nor more than 5.0 gallons per minute:
      a. Spray: Flat, heavy sheet, fan with uniform distribution.
      b. Fan width at the water surface not less than 6.5 feet at 10 pounds per square inch gauge.
      c. Spray deflection with a replaceable deflector insert free to rotate away from the orifice opening and mechanically locked in place and counterweighted.
   2. Spray nozzles structurally suitable for pressure up to 200 pounds per square inch gauge.
   3. Nozzles, easy flush type.

B. Materials:
   1. Spray nozzles: Leaded bronze.
   2. Nozzles provided with 1/4-inch national pipe thread, and the orifice diameter not less than 1/4-inch.
   3. Replaceable spray deflector: Neoprene rubber.

PART 3 EXECUTION

3.01 GENERAL

A. As specified in Section 01600 - Product Requirements.

B. Drawings supersede conflicts with this Section.

C. Bellows type expansion joints and vibration control joints:
   1. Protect joints against damage during pressure test.

3.02 INSTALLATION

A. Spray nozzles:
   1. Install spray nozzles so that elevation of the nozzles is 18 inches above the water surface.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Field testing:
   1. As specified in Section 15052 - Common Work Results for General Piping.
   2. Protect bellows type expansion joints and vibration control joints.

END OF SECTION

SECTION 15121

PIPE COUPLINGS - PLANT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Pipe couplings for ductile iron piping.
   2. Pipe couplings for carbon steel piping.
   3. Pipe couplings for stainless steel piping.

1.02 REFERENCES

A. American National Standards Institute (ANSI).

B. American Society of Mechanical Engineers (ASME):
   1. B31.1 - Power Piping.
   2. B31.9 - Building Services Piping.

C. American Water Works Association (AWWA):
   1. C111 - Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   2. C207 - Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In.
   3. C606 - Standard for Grooved and Shouldered Joints.

D. ASTM International (ASTM):
   1. A36 - Standard Specification for Carbon Structural Steel.
   2. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   3. A193 - Standard Specification for Alloy Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
   4. A351 - Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
   5. A449 - Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/9 ksi Minimum Tensile Strength, General Use.
   6. A536 - Standard Specification for Ductile Iron Castings.
   7. A576 - Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
   8. D2000 - Standard Classification System for Rubber Products in Automotive Applications.
   9. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.

E. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.
   2. 372 - Drinking Water System Components - Lead Content.

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data:
   1. For each product in this Section as applicable:
      a. Design features.
      b. Load capacities.
      c. Material designations by UNS alloy number or ASTM Specification and Grade.
      d. Data needed to verify compliance with the Specifications.
      e. Catalog data.
      f. Clearly mark submittal information to show specific items, materials, and accessories or options being furnished.

C. Calculations:
   1. Provide calculations in accordance with NSF 372 for materials in contact with drinking water.

1.04 WARRANTY

A. Provide warranty as specified in General Conditions.

PART 2 PRODUCTS

2.01 GENERAL

A. As specified in Section 01600 - Product Requirements:
   1. Materials in contact with drinking waters: In accordance with NSF 61 and NSF 372.

B. Known acceptable manufacturers are listed by specific products.

C. Provide references as specified in this Section by specific product.

D. Manufacturer's representatives' requirements as specified in Section 01756 - Commissioning and this Section by specific product.

E. Gaskets for flexible couplings and flanged coupling adapters:
   1. Provide gasket materials for piping applications as follows:
      a. Low-pressure and high-pressure air, steam, hot water: EPDM.
      b. All other piping applications: Neoprene rubber or Buna-N.

F. Exterior coatings for underground and submerged applications:
   1. Manufacturers: One of the following or equal:
      a. Tapecoat Co., Inc., T.C. Mastic.
      b. Kop-Coat Co., Inc., Bitumastic Number 50.
   2. Thickness: Minimum 0.040 inch.

2.02 PIPE COUPLINGS FOR DUCTILE IRON PIPING

A. Dismantling joints:
   1. Manufacturers: Sole source to match existing:
      a. Romac Ind., Inc., Style DJ400.
   2. Materials:
      a. Flanged spool: AWWA C207 steel pipe:
         1) ASTM A53 for sizes 3 inches to 12 inches.
         2) ASTM A36 for sizes 14 inches to 72 inches.
      b. End ring and body:
         1) For sizes 3 inches to 12 inches, ductile iron in accordance with ASTM A536.
         2) For sizes 14 inches to 72 inches, steel in accordance with ASTM A36 or A53.
      c. Follower ring: Ductile iron in accordance with ASTM A536.
      d. Bolts and hex nuts:
         1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
         2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
      e. Tie rods: High tensile steel in accordance with ASTM A193 Grade B7.
   3. Flange design: Class D steel ring flange in accordance with AWWA C207, compatible with ANSI Class 125 and 150 bolt circles.
   4. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.

B. Flanged coupling adapters: 12-inch size and smaller:
   1. Manufacturers: Sole source to match existing:
      a. Romac Ind., Inc., Style FCA501.
   2. Materials:
      a. Flanged body: Ductile iron in accordance with ASTM A536.
      b. Follower ring: Ductile iron in accordance with ASTM A536.
      c. Bolts and hex nuts:
         1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
         2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
   3. Flange design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
   4. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.

C. Flanged coupling adapters: Greater than 12-inch size:
   1. Manufacturers: Sole source to match existing:
      a. Romac Ind., Inc., Style FC400.
   2. Materials:
      a. Flange and flanged body: Ductile iron or low carbon steel having a minimum yield strength of 30,000 pounds per square inch.
      b. Follower ring: Low carbon steel having a minimum yield strength of 30,000 pounds per square inch.

c. Bolts and hex nuts:
1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.

3. Flange design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
4. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.

D. Flexible couplings:
1. Manufacturers: Sole source to match existing:
a. Romac Ind., Inc., Style 501.
2. Materials:
a. Center rings: Ductile iron in accordance with ASTM A536.
b. Follower rings: Ductile iron in accordance with ASTM A536.
c. Bolts and hex nuts:
1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
2) Buried and underwater: Type 316 stainless steel in accordance with ASTM F593.
3. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.
4. Center sleeve dimensions: Provide center sleeves with lengths in accordance with following table:

Nominal Pipe Size	Sleeve Length
3 inch and smaller	Manufacturer's standard
4 inch through 8 inch	7 inches
10 inch through 14 inch	12 inches
Greater than 16 inch	Use steel flexible coupling per Pipe Couplings for Steel Piping

E. Restrained flange coupling adapter:
1. Manufacturers: Sole source to match existing:
a. Romac Ind., Inc., Style RFCA.
2. Materials:
a. Flange and flanged body: Ductile iron in accordance with ASTM A536.
b. Follower ring: Lug type restraint system:
1) Follower ring: Ductile iron in accordance with ASTM A536.
2) Restraining lugs: Ductile iron in accordance with ASTM A536:
a) Designed to contact the pipe and apply forces evenly.
3) Restraining bolts:
a) Ductile iron in accordance with ASTM A536.
b) Bolt heads shall be designed to twist off when the proper torque has been applied.
c. Bolts and hex nuts:
1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.

3. Flange design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
4. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.
5. Angular deflection: Restrained flange coupling adapter must allow angular deflection after assembly.

F. Grooved joint couplings:
1. Manufacturers:
   a. Victaulic Co., Series 31 or equal.
2. Materials:
   a. Housings: Ductile iron in accordance with ASTM A536.
   b. Gasket:
      1) FlushSeal® type, or equal. Elastomer in accordance with ASTM D2000.
      2) Viton.
   c. Bolts and nuts: Electroplated steel in accordance with ASTM A449.
   d. Coating: As specified in Section 09960 - High-Performance Coatings.
3. For use with rigid or flexible radius grooved components in accordance with AWWA C606.
4. For connection to IPS steel pipe sizes, Victaulic Style 307.

2.03 PIPE COUPLINGS FOR CARBON STEEL PIPING

B. Dismantling joints:
1. Manufacturers: Sole source to match existing:
   a. Romac Ind., Inc., Style DJ400.
2. Materials:
   a. Flanged spool:
      1) C207 Schedule 40 pipe in accordance with ASTM A53 for sizes 3 inches to 12 inches.
      2) Steel for pipe in accordance with ASTM A36 or A53 for sizes 14 inches to 72 inches.
   b. End ring and body:
      1) For sizes 3 inches to 12 inches, ductile iron in accordance with ASTM A536.
      2) For sizes 14 inches to 72 inches, steel in accordance with ASTM A36.
   c. Follower ring: Ductile iron in accordance with ASTM A536 or steel in accordance with ASTM A36 or A576.
   d. Bolts and hex nuts:
      1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
      2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
   e. Tie rods: High tensile steel in accordance with ASTM A193 grade B7.
3. Flange design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
4. Coating and lining: Fusion bonded epoxy certified in accordance with NSF 61.

C. Flanged coupling adapters:
   1. Manufacturers: Sole source to match existing:
      a. Romac Ind., Inc., Style FCA501 (10 inch and smaller) or Style FC400 (12 inch and larger).
   2. Materials:
      a. Flange and flanged body: Ductile iron or low carbon steel having a minimum yield strength of 30,000 pounds per square inch.
      b. Follower ring: Low carbon steel having a minimum yield strength of 30,000 pounds per square inch.
      c. Bolts and hex nuts:
         1) Aboveground: High-strength, low-alloy steel in accordance with AWWA C111.
         2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
   3. Flange design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
   4. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.

D. Flexible couplings:
   1. Manufacturers: Sole source to match existing:
      a. Smith-Blair, Inc., Series 411.
   2. Materials:
      a. Center sleeve and follower flanges: Ductile iron or low carbon steel having a minimum yield strength of 30,000 pounds per square inch.
      b. Bolts and hex nuts:
         1) Aboveground: High strength, low alloy steel in accordance with AWWA C111.
         2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.
   3. Coating and lining: Manufacturer's standard fusion bonded epoxy, NSF 61 certified.
   4. Center sleeve dimensions: Provide center sleeves with lengths in accordance with following table:

Nominal Pipe Diameter	Sleeve Length
2-1/2 inch and smaller	Manufacturer's standard
3 inch through 6 inch	7 inch
8 inch through 14 inch	7 inch
Greater than 14 inches	10 inch

E. Restrained flange coupling adapters:
   1. Manufacturers: Sole source to match existing:
      a. Romac Ind., Inc., Style RFCA.
   2. Materials:
      a. Flange and flanged body: Ductile iron in accordance with ASTM A536.
      b. Follower ring: Lug type restraint system:
         1) Follower ring: Ductile iron in accordance with ASTM A536.

2) Restraining lugs: Ductile iron in accordance with ASTM A536:
a) Designed to contact the pipe an apply forces evenly.
3) Restraining bolts: Ductile iron in accordance with ASTM A536. Bolt heads shall be designed to twist off when the proper torque has been applied.

c. Bolts and hex nuts:
1) Aboveground: High-strength, low-alloy steel in accordance with AWWA C111.
2) Buried and underwater: Type 316 stainless steel bolts in accordance with ASTM F593.

3. Flange design: Class D steel ring flange in accordance with AWWA C207 compatible with ANSI Class 125 and 150 bolt circles.
4. Coating and lining: Manufacturer's standard fusion bonded epoxy certified in accordance with NSF 61.

F. Grooved joint couplings:
1. Model numbers from one manufacturer are shown to indicate type only. Equivalent products of other manufacturers may be submitted for approval.
2. Coating: As specified in Section 09960 - High-Performance Coatings.
3. Sizes through 12 inch:
a. Rigid type:
1) Housings shall be cast with offsetting angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with ASME B31.1 and B31.9.
2) 2 inch through 6 inch: Installation-ready, for direct stab installation without field disassembly, with grade EHP gasket rated to plus 250 degrees Fahrenheit.
3) Manufacturers: One of the following or equal:
a) Victaulic Style 107.
b) Victaulic Zero-Flex Style 07.

b. Flexible type:
1) For use in locations where vibration attenuation and stress relief are required.
2) Three flexible couplings may be used in lieu of a flexible connector.
3) The couplings shall be placed in close proximity to the source of the vibration.
4) Manufacturers: The following or equal:
a) Victaulic Style 77.

c. Flange adapter:
1) Flat face, ductile iron housings with elastomer pressure responsive gasket, for direct connection to ANSI Class 125 or 150 flanged components.
2) Manufacturers: The following or equal:
a) Victaulic Style 741.

4. Sizes 14 inch through 24 inch:
a. Victaulic AGS series with lead-in chamfer on housing key and wide width FlushSeal® gasket.
b. Rigid type:
1) Housing key shall fill the wedge shaped AGS groove and provide rigidity and system support and hanging in accordance with ASME B31.1 and B31.9.

2) Manufacturers: The following or equal:
a) Victaulic Style W07.
c. Flexible type:
1) Housing key shall fit into the wedge shaped AGS groove and allow for linear and angular pipe movement.
2) Manufacturers: The following or equal:
a) Victaulic Style W77.
d. Flange adapter:
1) Flat face, ductile iron housings with elastomer pressure responsive gasket, for direct connection to ANSI Class 125 or 150 flanged components.
2) Manufacturers: The following or equal:
a) Victaulic Style W741.
5. For sizes 30 inch and larger:
a. Manufacturers: The following or equal:
1) Victaulic Style AGS multiple-segment housing may be used.

2.04 PIPE COUPLINGS FOR STAINLESS STEEL PIPING

A. Flexible couplings:
1. Manufacturers: The following or equal:
a. Dresser, Inc., Style 38.

B. Grooved joint couplings:
1. Manufacturers: The following or equal:
a. Victaulic Co.
2. Materials:
a. Housings:
1) Ductile iron in accordance with ASTM A536.
2) Stainless steel in accordance with ASTM A351.
b. Gasket: Elastomer in accordance with ASTM D2000.
c. Bolts and nuts:
1) Electroplated steel in accordance with ASTM A449.
2) Stainless steel in accordance with ASTM F593.
3. Rigid type:
a. Victaulic Style 89 and W89 (ductile iron housings).
b. Victaulic Style 489 (stainless steel housings).
4. Flexible type: Victaulic Style 77S.

PART 3 EXECUTION

3.01 INSTALLATION

A. In underground and underwater installations, coat the exterior of coupling with a protective coating in accordance with manufacturer's instructions.

B. Joints and flexible connections shall be installed centered with no angular deflection unless otherwise indicated on the Drawings.

C. Flexible couplings and flange coupling adapters: Install with gap between pipe ends in accordance with the following table unless a greater gap is indicated on the Drawings. Maximum gap tolerance shall be within 1/8 inch:
   1. Install flexible coupling with pipe gap located in middle of center sleeve.
   2. Install flanged coupling adapter with end of plain end pipe in middle of flanged coupling body.

Center Ring Length	Gap Dimension and Tolerance
4 inch through 6 inch	3/8 inch
7 inch	5/8 inch
10 inch and greater	7/8 inch

D. Provide harnesses (tie-downs) for flexible couplings unless otherwise indicated on the Drawings with a written note:
   1. Design harnesses (tie-downs) for the test pressures as specified in the Piping Schedule in Section 15052 - Common Work Results for General Piping.

E. Grooved joint couplings:
   1. Grooved ends: Clean and free from indentations, projections, and roll marks in the area from pipe end to groove.
   2. Gaskets: Elastomer grade suitable for the intended service, and molded and produced by the coupling manufacturer.

END OF SECTION

SECTION 15211

DUCTILE IRON PIPE: AWWA C151 - PLANT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Ductile iron pipe, joints, connections, and fittings.

B. As specified in Section 15052 - Common Work Results for Pipelines.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

B. American Water Works Association (AWWA):
   1. C110 - Standard for Ductile-Iron and Gray-Iron Fittings.
   2. C111 - Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   3. C115 - Flanged Ductile Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
   4. C150 - Standard for Thickness Design of Ductile-Iron Pipe.
   5. C151 - Standard for Ductile-Iron Pipe, Centrifugally Cast.
   6. C600 - Installation of Ductile Iron Water Mains and Their Appurtenances.
   7. C606 - Standard for Grooved and Shouldered Joints.

C. American Welding Society (AWS):
   1. D11.2 - Guide for Welding Iron Castings.

D. ASTM International (ASTM):
   1. A47 - Standard Specifications for Ferritic Malleable Iron Castings.
   2. A536 - Standard Specifications for Ductile Iron Castings.

E. Ductile Iron Pipe Research Association (DIPRA):
   1. Thrust Restraint Design Manual.

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: As specified in Section 15052 - Common Work Results for General Piping.

C. Shop drawings:
   1. Detailed layout drawings showing alignment of pipes, location of valves, fittings, and appurtenances, types of joints, and connections to pipelines or structures.
   2. Thrust restraint systems.

3. Photographs, drawings, and descriptions of fittings, gaskets, couplings, grooving of pipe and fittings.
4. Pipe coatings and linings as specified in Section 09997 - Pipeline Coatings and Linings.

D. Calculations:
1. Calculations for thrust restraint system design.

E. Manufacturer's source testing.

1.04 QUALITY ASSURANCE

A. Ductile iron pipe shall be supplied by a single manufacturer.

B. Hydrostatically test each joint of ductile iron pipe in accordance with AWWA C151.

C. Pre-installation meeting:
1. Arrange for Coating Manufacturer's Technical Representative to attend preconstruction conferences, and to make periodic visits to factory or shop to inspect surface preparation of pipe, fittings, and accessories; and to inspect application of linings to interior and coatings to exterior pipe, fittings, and accessories.

PART 2 PRODUCTS

2.01 MANUFACTURED UNITS

A. Ductile iron piping:
1. Manufacturers:
a. American Cast Iron Pipe Co.
b. Pacific States Cast Iron Pipe Co.
c. SIP Industries.
d. U.S. Pipe.

2.02 THRUST RESTRAINT SYSTEM DESIGN

A. The length of pipe that must be restrained on each side of the focus of a thrust load as specified in the Pipe Schedule.

B. Design pressure: as specified in the Pipe Schedule.

C. Laying condition: Type 3 in accordance with AWWA C150.

D. Soil type: Silt 1.

E. Unit friction resistance for polyethylene encasement of pipe: DIPRA factor multiplied by a safety factor of 1.5.

2.03 CONCRETE THRUST BLOCK RESTRAINT

A. Joint thrust restraint system designed by Contractor:
1. Concrete thrust blocks will not be permitted for DIP restraint.

2.04 DUCTILE IRON JOINTS AND CONNECTIONS

A. General:
   1. Pressure class or special thickness class as indicated in the Piping Schedule provided in Section 15052 - Common Work Results for General Piping.
   2. In accordance with AWWA C150 and AWWA C151.
   3. Joints:
      a. Flanged.
      b. Grooved.
      c. Mechanical.
      d. Push-on Rubber Gasket.
      e. Integrally Restrained Mechanical.
      f. Mechanical Wedge Action.
      g. Integrally Restrained Push-On.
      h. Push-On Joint Restraint Harness.
   4. Connections:
      a. Tapping saddle.
      b. Tapping sleeve.
      c. Welded outlet.
   5. Fittings.

B. Joints:
   1. Flanged joints:
      a. Screw-on flanges: Comply with the diameter, thickness, drilling, and other characteristics in accordance with ASME B16.1. In addition, comply with the following requirements:
         1) Ductile iron.
         2) Long hub, threaded, and specially designed for ductile iron pipe.
         3) After attaching to pipe, machine flange face to make pipe end and flange even and perpendicular to the axis of the pipe.
      b. Bolt holes on flanges: 2-holed and aligned at both ends of pipe.
      c. Cap screw or stud bolt holes: Tapped.
      d. Bolts and nuts: As specified in Section 15052 - Common Work Results for General Piping.
      e. Gaskets: Standard styrene butadiene copolymer (SBR) unless specified otherwise in Section 15052 - Common Work Results for General Piping.
   2. Grooved joints: In accordance with AWWA C606, as complemented and modified below, radius-cut type, with following components:
      a. Couplings: Rigid type, cast from ductile iron in accordance with ASTM A536, Grade 65-45-12, or malleable iron in accordance with ASTM A47, Grade 32510.
      b. Bolts and nuts: As specified in Section 15052 - Common Work Results for General Piping.
      c. Gaskets: As specified in Section 15052 - Common Work Results for General Piping.
      d. Fittings: In accordance with AWWA C606, rigid radius-cut groove:
         1) Center-to-center dimensions: In accordance with AWWA C110.
         2) Wall thickness and other characteristics: In accordance with AWWA C606.
      e. Flanged unit connections: Flanged to grooved joint adapters or a long enough spool with one end flanged and the other end grooved to prevent interference with the operation of adjacent valves, pumps, or other items.

3. Mechanical joints: In accordance with AWWA C111:
    a. Gaskets: As specified in Section 15052 - Common Work Results for General Piping.
    b. Bolts and nuts, including T-bolts: As specified in Section 15052 - Common Work Results for General Piping.
4. Push-on rubber gasket joints: In accordance with AWWA C111:
    a. Gaskets: As specified in Section 15052 - Common Work Results for General Piping.
5. Integrally restrained mechanical joints:
    a. Application:
        1) Where designated mechanical restraint.
        2) Mechanical joint is specified in the Piping Schedule provided in Section 15052 - Common Work Results for General Piping is indicated on the Drawings, supply a restrained mechanical joint piping system, which includes restrained mechanical joints where necessary based upon thrust calculations.
        3) Standard mechanical joints as specified above can be used where thrust calculations demonstrate restraint is not required.
    b. Design:
        1) Integral retainer weldment type or lugged type joint with Type 304 stainless steel rods and nuts.
        2) Restrained mechanical joints of the configuration which utilizes a gripping or friction force for restraint will not be acceptable.
    c. Gaskets: As specified in Section 15052 - Common Work Results for General Piping.
    d. Bolts and nuts, including T-bolts: As specified in Section 15052 - Common Work Results for General Piping.
    e. Manufacturers: Where restrained mechanical joints are required, use one of the following or equal:
        1) American Cast Iron Pipe Co., MJ Coupled Joint.
        2) Pacific States Cast Iron Pipe Co., Lock Mechanical Joint.
        3) U.S. Pipe, Bolt-Lok.
        4) U.S. Pipe, Mech-Lok.
6. Integrally restrained push-on joints:
    a. Application:
        1) Where designation restrained push-on is specified in the Piping Schedule provided in Section 15052 - Common Work Results for General Piping as indicated on the Drawings, supply a restrained push-on joint piping system, which includes restrained push-on joints where necessary based upon thrust calculations.
        2) Standard push-on rubber gasket joints as specified above can be used where thrust calculations demonstrate restraint is not required.
    b. Design:
        1) Restrained push-on joints of the configuration which utilizes a gripping or friction force for restraint will not be acceptable.
        2) Suitable for the following working pressures:
            a) For 4- through 24-inch pipe: 350 pounds per square inch gauge.
            b) For 30- through 54-inch pipe: 250 pounds per square inch gauge.
    c. Gaskets: As specified in Section 15052 - Common Work Results for General Piping.

d. Manufacturers: One of the following or equal:
    1) U.S. Pipe, TR Flex.
    2) McWane Ductile, TR Flex.
    3) American Cast Iron Pipe Co., Flex Ring or Lok-Ring.
e. Limit buried joints to half the manufacturer's published allowable angular joint deflection for purposes of pipeline alignment and elimination of fittings.

C. Connections:
1. Tapping saddle as specified in Owner standard specification**.**
2. Tapping sleeve as specified in Owner standard specification**.**

D. Fittings:
1. Ductile iron in accordance with AWWA C110.
2. Joint type: Same as that of the associated piping as specified in Section 15052 - Common Work Results for General Piping.
3. Plain end-to-flanged joint connectors using setscrews are not acceptable.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
1. Install ductile iron piping in accordance with AWWA C600, or as modified in Section 15052 - Common Work Results for General Piping.
2. For underground piping, the trenching, backfill, and compaction: As specified in Section 02318 - Trenching.

B. Joints:
1. Install types of joints as specified in the piping schedule provided in Section 15052 - Common Work Results for General Piping.
2. Mechanical joints are not acceptable in above ground applications.
3. Field closure for restrained push-on pipe:
    a. Locate field closures in areas where thrust calculations demonstrate restraint is not required.
4. Grooved joints:
    a. Install piping with grooved joints where specified in the piping schedule as specified in Section 15052 - Common Work Results for General Piping.
    b. Assemble grooved joints in accordance with manufacturer's published instructions.
    c. Support grooved-end pipe in accordance with manufacturer's published instructions:
        1) Install at least 1 support between consecutive couplings.

C. Connection:
1. Tapping ductile iron pipe:
a. Direct tapping of ductile iron pipe may be performed but is limited to the following conditions:
1) Maximum allowable tap diameter by pipe diameter and pressure class:

Pipe Size (inches)	Pressure Class				
	150	200	250	300	350
	Maximum Allowable Direct Tap Size (inches)				
3	-	-	-	-	3/4
4	-	-	-	-	3/4
6	-	-	-	-	1
8	-	-	-	-	1
10	-	-	-	-	1
12	-	-	-	-	1-1/4
14	-	-	1-1/4	1-1/2	1-1/2
16	-	-	1-1/2	2	2
18	-	-	2	2	2
20	-	-	2	2	2
24	-	2	2	2	2

b. The maximum allowable tap diameter for pipelines greater than 24 inches is 2 inches.
c. 2 layers of 3-mil thread sealant are required to minimize the torque required to effect a watertight connection.
2. Direct tapping of glass lined ductile iron pipe may be performed only when approved in writing by the Engineer. Direct tapping of glass lined pipe shall be performed in accordance with the above conditions for tapping ductile iron pipe in addition to the following conditions:
a. Drilling and tapping shall be performed using a hole saw:
1) Use of a large drill bit is not acceptable.
b. As the hole saw approaches the glass lining, lessen the inward pressure to avoid excess chipping or cracking of the lining:
c. Minor chipping or spalling of the glass lining shall be repaired using an epoxy resin “glass repair kit” provided by the fabricator:
1) Manufacturers: One of the following or equal:
a) Devoe - Devran 224 HS.
b) Sherwin-Williams Co. - Sher-Tile High Solids Epoxy.
2) Repair kit use is only allowed for areas of damage less than 1/2 inch in diameter:
a) Larger areas of damage will require replacement.
3) Surface shall be prepared and repair kit shall be applied in accordance with manufacturer and/or fabricator’s instructions.

3.02 FIELD QUALITY CONTROL

A. Testing ductile iron piping:
   1. Test as specified in Section 15052 - Common Work Results for General Piping and Section 15956 - Piping Systems Testing.

END OF SECTION

SECTION 15230

PLASTIC PIPING AND TUBING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Plastic pipe, tubing, and fittings.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.12 - Cast Iron Threaded Drainage Fittings.

B. ASTM International (ASTM):
   1. D1248 - Standard Specification for Polyethylene Plastics Extrusion Materials For Wire and Cable.
   2. D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
   3. D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
   4. D1869 - Standard Specification for Rubber Rings for Asbestos-Cement Pipe.
   5. D2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
   6. D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
   7. D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
   8. D2513 - Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings.
   9. D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
   10. D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
   11. D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.
   12. D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
   13. D3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
   14. D3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
   15. D3350 - Standard Specification for Polyethylene Plastic Pipes and Fittings Materials.
   16. D4101 - Standard Specification for Polypropylene Injection and Extrusion Materials.
   17. F438 - Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.

18. F439 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
19. F441 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
20. F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
21. F493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
22. F645 - Standard Guide for Selection, Design and Installation of Thermoplastic Water-Pressure Piping Systems.
23. F679 - Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
24. F714 - Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

C. American Water Works Association (AWWA):
   1. C900 - Standard for Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 Inches to 12 Inches, for Water Transmission Distribution.

D. NSF International (NSF).

E. Plastics Pipe Institute (PPI):
   1. TR 31 - Underground Installation of Polyolefin Piping.

1.03 ABBREVIATIONS

A. ABS: Acrylonitrile-butadiene-styrene.

B. CPVC: Chlorinated polyvinyl chloride.

C. DR: Dimension ratio.

D. DWV: Drain, waste, and vent.

E. ID: Inside diameter of piping or tubing.

F. NPS: Nominal pipe size followed by the size designation.

G. NS: Nominal size of piping or tubing.

H. PE: Polyethylene.

I. PP: Polypropylene.

J. PVC: Polyvinyl chloride.

K. SDR: Standard dimension ratio; the outside diameter divided by the pipe wall thickness.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: As specified in Section 15052 - Common Work Results for General Piping.

C. Shop Drawings:
   1. Describe materials, pipe, fittings, gaskets, and solvent cement.
   2. Installation instructions.

1.05 QUALITY ASSURANCE

A. Fusion machine technician qualifications: 1-year experience in the installation of similar PE piping systems from the same manufacturer.

B. Plastic pipe in potable water applications: Provide pipe and tubing bearing NSF seal.

C. Mark plastic pipe with nominal size, type, class, schedule, or pressure rating, manufacturer and all markings required in accordance with ASTM and AWWA standards.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect piping materials from sunlight, scoring, and distortion.

B. Do not allow surface temperatures on pipe and fittings to exceed 120 degrees Fahrenheit.

C. Store and handle PE pipe and fittings as recommended by manufacturer in published instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Extruding and molding material: Virgin material containing no scrap, regrind, or rework material except where permitted in the referenced standards.

B. Fittings: Same material as the pipe and of equal or greater pressure rating, except that fittings used in drain, waste, and vent piping systems need not be pressure rated.

C. Unions 2-1/2 inches and smaller: Socket end screwed unions. Make unions 3 inches and larger of socket flanges with 1/8-inch full-face soft EPDM gasket.

2.02 PVC GRAVITY SEWER PIPING

A. Materials:
   1. Polyvinyl chloride (PVC) gravity sewer pipe and fittings: In accordance with ASTM D3034 for piping NPS 15 and smaller diameter, and to ASTM F679 for piping NPS 18 and larger diameter:
      a. Referenced standards apply as complemented and modified in this Section.
      b. Fittings: Supplied by the pipe manufacturer.

2. PVC compounds: Class Number 12454, in accordance with ASTM D1784:
    a. Stabilizers, antioxidants, lubricants, colorants, and other additives and fillers: Not to exceed 10 parts by weight per 100 of PVC resin in the compound.
3. Pipe NPS 15 and smaller diameter: Wall thickness SDR 26:
    a. Joints: Push-on joints in accordance with ASTM D3212.
4. Pipe NPS 18 and larger diameter:
    a. PVC compound: Cell classification 12454 in accordance with ASTM D1784.
    b. Minimum wall thickness: Thickness T-1 in accordance with Table 1 in ASTM F679.
    c. Joints: Integral bell gasketed joints in accordance with ASTM F679.
    d. Bell: Fabricated from pipe sections, thickness of the wall of the bell equivalent to the pipe wall thickness.
    e. Gasket ring: Locked into the bell.
    f. Spigot end of the pipe: Marked by the manufacturer to identify the final in-place position of the spigot in the bell.
5. Fittings, including wyes, tees, elbow caps, plug adapters, and manhole waterstops: Same wall thickness as the pipe:
    a. Fittings: Factory molded with joints and gaskets equal to those of the pipe.
6. Gasket: EPDM in accordance with ASTM D3212 or ASTM F477:
    a. Keep rubber gasket in place during pipe joining.
7. Gasket for connection to manhole: Stainless steel clamp with gasket or similar device to seal the penetration.

2.03 PP PIPING

A. Materials:
    1. Pipe: Schedule 40 dimensions, extruded from Type I-19509 material in accordance with ASTM D4101.
    2. Fittings: Molded from the same material and same laying length in accordance with ASME B 16.12:
        a. Fittings: Manufactured by pipe manufacturer.

2.04 PE TUBING AND FITTINGS

A. Materials:
    1. Small bore PE tubing: Black flexible virgin PE tubing, OD copper tubing size.
        a. Plastic tubing ID as follows:
            1) For NS 1/4 inch, ID of 0.170 inch.
            2) For NS 5/16 inch, ID of 0.187 inch.
            3) For NS 3/8 inch, ID of 0.251 inch.
            4) For NS of 1/2 inch, an ID of 0.375 inch.
    2. Fittings: Compression fittings, Dekoron E-Z; or equal.
    3. Protective sheath:
        a. Manufacturers: One of the following or equal:
            1) Dekoron, "Poly-Cor."
            2) Parker Hannifin Corp./Fluid connector Products, Parflex Division, Multitube.
    4. Plug-in fittings for connection to instruments: Brass quick-connect fittings.

2.05 POLYETHYLENE PIPING FOR DRAIN, WASTE, AND VENT PIPING SYSTEMS

A. General:
   1. Pipe and fittings: High-density polyethylene.
   2. Dimensions of pipe and fittings: Based on controlled outside diameter in accordance with ASTM F714:
      a. SDR: Maximum of 11.

B. Manufacturers: One of the following or equal:
   1. DuPont, Sclairpipe.
   2. Polaris, Duratuff; or equal.

C. Pipe, fittings, and adapters: Furnished by the same manufacturer, and compatible with components in the same system and with components of other systems to which connected.

D. Materials:
   1. Polyethylene: In accordance with ASTM D1248, Type III, Class C, Category 5, Grade P34; listed by the Plastic Pipe Institute under the designation PE 3408; and have a minimum cell classification, in accordance with ASTM D3350.
   2. Pipe and fittings: Manufactured from material with the same cell classification.

2.06 SOURCE QUALITY CONTROL

A. PVC gravity sewer piping:
   1. Mark pipe and fittings in accordance with ASTM D3034. Also mark the production control code on pipe and fittings.

B. PP piping:
   1. Test samples and testing: Cut test samples of pipe, 6 inches long, from full length sections and test by the method outlined in accordance with ASTM D2412:
      a. Deflect pipe at least 35 percent without failure. Stiffness at 5 percent deflection equals or exceeds 55 pounds per square inch after the test samples have been immersed in a 5 percent solution by weight of sulfuric acid and n-Heptain for a period of 24 hours prior to testing.
      b. Failure is defined as rupture of the pipe wall.
      c. Stiffness factor may be computed by the method outlined in accordance with ASTM D2412 or by dividing the load in pounds per linear inch by the deflection in inches and 5 percent deflection.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Where not otherwise specified, install piping in accordance with ASTM F645, or manufacturer's published instructions for installation of piping, as applicable to the particular type of piping.
   2. Provide molded transition fittings for transitions from plastic to metal or IPS pipe. Do not thread plastic pipe.

3. Locate unions where indicated on the Drawings, and elsewhere where required for adequate access and assembly of the piping system.
4. Provide serrated nipples for transition from plastic pipe to rubber hose.

B. Installation of PVC gravity sewer piping:
1. Install piping in accordance with manufacturer's published instructions, as modified and complemented in this Section.
2. Install pipe and fittings not later than 4 months after their manufacture.
3. Provide for contraction and expansion at joints with a gasket ring.
4. Provide plugs or caps for stubs and branch pipes left unconnected to laterals.
5. Lubricate and assemble joints in accordance with the pipe manufacturer's published instructions.
6. Make connections to manholes with a manhole gasket that prevents infiltration and exfiltration through the penetrations:
   a. Provide opening for connection large enough to allow subsequent grouting around the manhole gasket.
   b. Grout around the manhole gasket and seal the opening.

C. Installation of PP piping:
1. Install piping in accordance with manufacturer's published instructions.

D. Installation of polyethylene (PE) tubing and fittings:
1. Install small bore PE tubing in accordance with manufacturer's printed instructions, in neat straight lines, supported at close enough intervals to avoid sagging, and in continuous runs wherever possible.
2. Bundle tubing in groups of parallel tubes within protective sheath.
3. Tubes within protective sheath may be color coded, but protect tubing other than black outside the sheath by wrapping with black plastic electrician's tape.
4. Grade tubing connected to meters in one direction.

E. Installation of PE piping for drain, waste, and vent:
1. Install piping as recommended in manufacturer's published instructions.

3.02 FIELD QUALITY CONTROL

A. Leakage test for PVC piping, Class Type:
1. Polyvinyl chloride (PVC) piping, Class Type: Subject to visible leaks test and to pressure test with maximum leakage allowance, as specified in Section 15956 - Piping Systems Testing.
2. Pressure test with maximum leakage allowance: Perform test after backfilling:
   a. Pressure: 125 pounds per square inch, gauge.
   b. Maximum leakage allowance as follows, wherein the value for leakage is in gallons per 100 joints per hour:

NPS, Inches	1-1/2	2	2-1/2	3	4	6	8	10	12
Leakage	0.41	0.52	0.63	0.76	0.98	1.45	1.88	2.35	2.80

B. Mandrel tests for PVC gravity sewer and HDPE piping:
1. Perform initial mandrel test:
   a. After cleaning and completion of other tests.
   b. After placement and compaction of backfill.
   c. Before construction of pavement or surfacing.

d. Not sooner than 30 days after pipe installation.
e. Not later than 60 days after installation.

2. Utilize a 9 rod mandrel with minimum length equal to NPS and diameter as follows:

Nominal Pipe Size (NPS)	Mandrel Diameter, inches
6	5.50
8	7.37
10	9.21
12	10.96
15	13.56

3. Test procedure: Pull the mandrel through the line under test by 1 person, by hand, with reasonable effort, without the aid of mechanical equipment.
4. Failing test: Where the mandrel test is not successful, remove and replace the section of piping with the obstruction; test the piping again, including visible leaks test, pressure test with maximum leakage allowance, mandrel tests, and other specified tests:
   a. Correction of excessive deflection or obstructions by methods other than removal of the affected piping and replacement of the removed piping with new piping will not be accepted.

END OF SECTION

SECTION 15249

POLYVINYL CHLORIDE (PVC) PIPE: SCHEDULE TYPE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Schedule type PVC pipe and fittings.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. D1784 - Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
   2. D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
   3. D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
   4. D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
   5. D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
   6. D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.
   7. F645 - Standard Guide for Selection, Design and Installation of Thermoplastic Water-Pressure Piping Systems.

B. NSF International (NSF):
   1. 61 - Drinking Water System Components - Health Effects.

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: As specified in Section 15052 - Common Work Results for General Piping.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect from sunlight, scoring, and distortion.

B. Do not allow surface temperatures to exceed 120 degrees Fahrenheit.

C. Store and handle as recommended by manufacturer in published instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Extruding and molding material: Virgin material containing no scrap, regrind, or rework material except where permitted in the referenced standards:
   1. Pipe: Designation PVC 1120 in accordance with ASTM D1785 and appendices:
      a. Extruded from Type I, Grade 1, Class 12454 material in accordance with ASTM D1784.
      b. Schedule 80, 40 unless otherwise indicated on the Drawings or specified in the Piping Schedule in Section 15052 - Common Work Results for General Piping.
   2. Fittings: In accordance with ASTM D2467:
      a. Same material as the pipe and of equal or greater pressure rating.
      b. Supplied by pipe manufacturer.
      c. Unions 2-1/2 inches and smaller:
         1) Use socket end screwed unions.
      d. Unions 3 inches and larger:
         1) Use socket flanges with 1/8-inch full-face soft neoprene gasket.
   3. Solvent cement:
      a. In accordance with ASTM D2564.
      b. Manufacturers: The following or equal:
         1) IPS Corp.
      c. Certified by the manufacturer for the service of the pipe.
      d. In potable water applications: Provide solvent cement listed by NSF for potable water applications.
      e. Primer: As recommended by the solvent cement manufacturer.

2.02 SOURCE QUALITY CONTROL

A. Meets or exceeds all quality assurance test requirements stated in ASTM D1785.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install piping in accordance with ASTM F645, or manufacturer's published instructions for installation of piping, as applicable.

B. Provide molded transition fittings for transitions from plastic to metal pipe:
   1. Do not thread pipe.

C. Locate unions where indicated on the Drawings, and elsewhere where required for adequate access and assembly of the piping system.

D. Provide serrated nipples for transition from pipe to rubber hose.

E. Solvent weld joints in accordance with ASTM D2855.

3.02 FIELD QUALITY CONTROL

A. Test pipe as specified in Section 15052 - Common Work Results for General Piping and Section 15956 - Piping Systems Testing.

END OF SECTION

SECTION 15270

STEEL PIPE: GALVANIZED AND BLACK, ASTM A53

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Steel pipe: Galvanized and black, ASTM A53.

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME):
   1. B16.3 - Malleable-Iron Threaded Fittings: Classes 150 and 300.
   2. B16.5 - Pipe Flanges and Flanged Fittings.
   3. B16.9 - Factory-Made Wrought Buttwelding Fittings.

B. American Water Works Association (AWWA):
   1. C110 - Ductile-Iron and Gray-Iron Fittings.
   2. C203 - Coal-Tar Protective Coatings and Linings for Steel Water Pipelines-Enamel and Tape-Hot Applied.
   3. C205 - Standard for Cement-Mortar Protective Lining and Coating for Steel Water Pipe-4 Inches and Larger-Shop Applied.
   4. C206 - Field Welding of Steel Water Pipe.
   5. C602 - Standard for Cement-Mortar Lining of Water Pipelines in Place - 4 inches and Larger.
   6. C606 - Standard for Grooved and Shouldered Joints.

C. ASTM International (ASTM):
   1. A47 - Standard Specification for Ferritic Malleable Iron Casting.
   2. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   3. A105 - Standard Specification for Carbon Steel Forgings for Piping Applications.
   4. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   5. A183 - Standard Specification for Carbon Steel Track Bolts and Nuts.
   6. A536 - Standard Specification for Ductile Iron Castings.
   7. C150 - Standard Specification for Portland Cement.
   8. D2000 - Standard Classification System for Rubber Products in Automotive Applications.

1.03 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: As specified in Section 15052 - Common Work Results for General Piping.

PART 2 PRODUCTS

2.01 MATERIALS

A. Portland cement: In accordance with ASTM C150, Type II, low alkali.

2.02 MANUFACTURED UNITS

A. Steel pipe:
   1. General:
      a. In accordance with ASTM A53:
         1) Type: Type E - electric-resistance welded or Type S - seamless.
         2) Grade: Grade A or B.
      b. Schedule:
         1) As indicated on the Drawings or as specified in Section 15052 - Common Work Results for General Piping pipe schedule.
         2) Minimum Schedule unless otherwise indicated on the Drawings or as specified in Section 15052 - Common Work Results for General Piping pipe schedule:
            a) Pipe 6 inches and smaller: Schedule 40.
            b) Pipe greater than 6 inch to 12 inch: Schedule 20.
            c) Pipe greater than 12 inch: 0.25 inches.

B. Pipe fittings:
   1. Flanged and welding fittings:
      a. Butt-weld fittings in accordance with ASME B16.9.
      b. Schedule of fittings: Same class or thickness as the pipe to which it connects.
   2. Screwed fittings:
      a. Malleable iron:
         1) Class 150 or Class 300 in accordance with ASME B16.3, as specified in Section 15052 - Common Work Results for General Piping pipe schedule.
         2) Galvanized in accordance with ASTM A153 where used with galvanized pipe.
   3. Grooved joint fittings:
      a. Fittings for grooved joint steel piping: Rigid-grooved type.
      b. Fittings for grooved joint piping:
         1) Manufacturers: One of the following or equal:
            a) Victaulic Co. of America.
         2) Ductile iron fittings:
            a) Larger than 4 inches in diameter: In accordance with ASTM A536, Grade 65-45-12, long radius, per AWWA C110.
            b) Less than 4 inches in diameter: Malleable iron conforming to ASTM A47, Grade 32510.
         3) Where cast fittings are not made, forged steel in accordance with ASME B 16.9, ASTM A105, Grade B with 0.375 inch minimum wall thickness:
            a) Bends: Long radius.

4) Fittings for grooved joint piping shall be furnished by the manufacturer of the grooved joint coupling.
5) Fittings for grooved joint piping shall be for rigid-grooved type joints. Connection to flanged units shall be by means of a spool with one end flanged and the other grooved, long enough to prevent interference with adjacent valves, pumps, or other items, minimum length, 4 inches.

C. Pipe joints:
1. General:
a. Use type of pipe joints as indicated on the Drawings or as specified in Section 15052 - Common Work Results for General Piping pipe schedule.
b. In addition to the type of pipe joints indicated on the Drawings or as specified in Section 15052 - Common Work Results for General Piping pipe schedule, use flexible couplings, unions or flanged joints to allow ready assembly and disassembly of the piping.
2. Flanged joints:
a. In accordance with ASME B16.5, steel, 150 pounds, slip-on or weld neck, galvanized in accordance with ASTM A153 where used with galvanized pipe.
b. Companion flanges:
1) In accordance with ASME B16.5, steel.
2) Class 150 pounds, slip-on or welding neck.
c. Weld flanges to pipe or fittings before applying lining.
d. Machine flanges or provide tapered filler for changes in grade or to slope lines for drainage.
e. Match pipe flanges to the valve flanges.
f. Flange bolts: As specified in Section 15052 - Common Work Results for General Piping.
g. Gaskets: As specified in Section 15052 - Common Work Results for General Piping.
3. Grooved joints:
a. Grooves: Cut grooves. Rolled grooves are not acceptable.
b. Couplings housing: Cast in 2 or more segments of ductile iron in accordance with ASTM A536, Grade 65-45-12 or malleable iron in accordance with ASTM A47, Grade 32510.
c. Bolts and nuts: In accordance with ASTM A183, Grade 2.
d. Gaskets: Composition water sealing designed so that the internal piping pressure serves to increase the seal's watertightness:
1) Gaskets for water service and oil-free air systems at temperatures less than 230 degrees Fahrenheit shall be made of ethylene propylene diene monomers (EPDM) in accordance with ASTM D2000 Line Call Out 2CA615A25B24.
2) Gaskets for use with cement-mortar lined steel piping shall be captured between the ends of the pipe to protect exposed metal from corrosion, and shall be made of nitrile in accordance with ASTM D2000.
e. Perform grooving of the pipe wall only on standard or heavier schedule weight pipe:
1) For pipe with wall thickness less than standard weight, weld a shouldered end on the pipe in accordance with AWWA C606.
2) Shoulder: Type B or D in accordance with AWWA C606.

f. Couplings and grooving:
1) Manufacturers: One of the following or equal:
a) Victaulic Co.
g. Grooved joint piping shall not be used in the following installations:
1) In underground and underwater installations.
2) In piping subject to test pressures of 150 pounds per square inch gauge, or more.
3) In steam and gas piping.
4) In sludge and scum piping designed to be steam cleaned.
4. Welded joints: Butt welds, 2 pass, full depth with beveled ends and no backing rings.

D. Pipe lining and coating:
1. General:
a. Lining and coating shall be as indicated on the Drawings or as specified in Section 15052 - Common Work Results for General Piping.
2. Pipe coating:
a. Extend pipe coating for underground piping 6 inches above finish grade or finish floor, and neatly terminate.
b. Field paint aboveground steel pipe as specified in Execution of this Section.
c. Coat exposed piping as specified in Section 09960 - High-Performance Coatings.
d. Coat submerged piping as specified in Section 15052 - Common Work Results for General Piping pipe schedule and Section 09960 - High-Performance Coatings.
e. Cement-mortar coating:
1) Cement-mortar coating: In accordance with AWWA C205, modified as follows:
a) Sand: In accordance with AWWA C205 except that the total percentage of deleterious material shall not exceed 3 percent.
3. Pipe lining:
a. Cement-mortar lining:
1) Shop apply cement-mortar lining in accordance with AWWA C205. At the option of Contractor, field apply with a pipe lining machine.
b. Coal-tar enamel lining:
1) Coal-tar enamel lining for interior of steel pipe: In accordance with AWWA C203.
c. Coal-tar epoxy lining:
1) Coal-tar epoxy lining: Epoxy bituminous coating as specified for submerged metal in Section 09960 - High-Performance Coatings.
d. High solids epoxy:
1) High solids epoxy as specified for submerged metal or exposed metal in Section 09960 - High-Performance Coatings.
e. Polyurethane lining:
1) Polyurethane as specified for submerged metal in Section 09960 - High-Performance Coatings.

2.03 FABRICATION

A. Shop coat of primer:
   1. Flanges and portions of pipe not covered with cement-mortar shall be given a shop coating of primer.
   2. Primer compatible with finish coating system.

PART 3 EXECUTION

3.01 INSTALLATION

A. Pipe joints:
   1. General:
      a. Steel pipe joints shall be screwed, welded, flanged, grooved, or made with flexible joints. The type of joint for piping is as specified in Section 15052 - Common Work Results for General Piping pipe schedule or as indicated on the Drawings.
      b. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, and other types of joints or means necessary to allow ready assembly and disassembly of the piping.
      c. Unless otherwise indicated on the Drawings or as specified in Section 15052 - Common Work Results for General Piping pipe schedule, pipe joints shall be as follows:
         1) Pipe smaller than 2 inches in nominal diameter shall have screwed joints, welded joints, unions, or flexible couplings.
         2) Pipe 2 inches to 4 inches in nominal diameter shall have screwed joints, flanged joints, welded joints, or joints made with flexible couplings.
         3) Pipe larger than 4 inches in nominal diameter shall have flanged joints, welded joints, or joints made with flexible couplings.
   2. Flanged joints:
      a. Flanges shall come together at the proper orientation with no air gaps between the flanges after the gaskets are in place.
      b. Secure welding neck flanges with full penetration butt welds without backing rings.
      c. Secure slip-on flanges with both internal and external welds.
      d. After welding in place, the faces of flanges shall be perpendicular to the axis of the pipe, or, in the case of fittings, at the proper angle to each other, and bolt holes shall be in proper alignment.
   3. Grooved joints:
      a. Assemble in accordance with manufacturer's published instructions.
      b. Support grooved joint pipe in accordance with manufacturer's recommendations. In addition, provide at least 1 support between consecutive couplings.
   4. Screwed joints:
      a. Perform threading with clean, sharp dies:
         1) Wavy, rough, or otherwise defective pipe threads are not acceptable.
      b. Make screwed joints tight and clean with an application of Teflon tape or paste compound applied to the male threads only, except as follows:
         1) Make up liquid and liquefied petroleum gas lines, with litharge and glycerin.

c. Provide railroad type unions with bronze-to-iron seat. Galvanized where used with galvanized pipe:
1) Flanged joints may be used instead of unions.

5. Welded joints:
a. Field welded joints: Electric arc welded in accordance with AWWA C206.
b. Welder’s qualification: Qualified in accordance with AWWA C206:
1) Welders' testing shall be at the Contractor's expense, including cost of test nipples, welding rods, and equipment.
c. Do not weld galvanized pipe.

B. Pipe lining and coating:
1. Pipe lining:
a. Field applied cement-mortar lining shall be of the same density, smoothness, and thickness as shop applied lining, and in accordance with AWWA C602.
2. Pipe Coating:
a. Plastic tape wrap application:
1) Wrap fittings, valves, and other odd shaped components in the pipeline with first and finish wrapping over the prime coat.
2) Wrap joints, fittings, valves, and other irregular shapes of piping with extruded coatings with tape as specified in this subparagraph.
b. Field coat aboveground steel pipe as specified in Section 09960 - High-Performance Coatings.

3.02 FIELD QUALITY CONTROL

A. Field test fabricated steel manifolds with the pipe to which they connect.

END OF SECTION

SECTION 15278

STEEL PIPE - BURIED AND EXPOSED

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Steel piping, joints, fittings, and fabricated steel piping fittings and specials.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

B. American Society of Mechanical Engineers (ASME):
   1. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. B16.3 - Malleable-Iron Threaded Fittings: Classes 150 and 300.
   3. B16.5 - Pipe Flanges and Flanged Fittings.
   4. B16.9 - Factory-Made Wrought Buttwelding Fittings.
   5. B16.12 - Cast Iron Threaded Drainage Fittings.

C. American Water Works Association (AWWA):
   1. C200 - Steel Water Pipe 6 Inches and Larger.
   2. C205 - Cement-Mortar Protective Lining and Coating for Steel Water Pipe: 4 inches and Larger-Shop Applied.
   3. C206 - Field Welding of Steel Water Pipe.
   4. C207 - Standard for Steel Pipe Flanges for Waterworks Service-Sizes 4 inches Through 144 inches.
   5. C208 - Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
   6. C606 - Standard for Grooved and Shouldered Joints.
   7. M11 - Steel Pipe: A Guide for Design and Installation.

D. ASTM International (ASTM):
   1. A47 - Standard Specification for Ferritic Malleable Iron Casting.
   2. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   3. A105 - Standard Specification for Carbon Steel Forgings for Piping Applications.
   4. A106 - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   5. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   6. A183 - Standard Specification for Carbon Steel Track Bolts and Nuts.
   7. A536 - Standard Specification for Ductile Iron Castings.
   8. D297 - Standard Test Methods for Rubber Products-Chemical Analysis.
   9. D395 - Standard Test Methods for Rubber Property-Compression Set.
   10. D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.

11. D471 - Standard Test Methods for Rubber Property-Effect of Liquids.
12. D573 - Standard Test Methods for Rubber -Deterioration in an Air Oven.
13. D2000 - Standard Classification System for Rubber Products in Automotive Applications.
14. D2240 - Standard Test Method for Rubber Property-Durometer Hardness.
15. E165 - Standard Practice for Liquid Penetrant Testing for General Industry.

1.03 SYSTEM DESCRIPTION

A. Design requirements:
   1. Design criteria for pipe and pipe fittings: In accordance with AWWA M11 with the following modifications:
      a. Wall thickness: Thicker of the thickness specified in Section 15052 - Common Work Results for General Piping Pipe Schedule, and the following thickness:
         1) For pipes smaller than 26 inches in diameter: Minimum 1/4 inch.
         2) For pipes 26 inches and larger but less than 38 inches in diameter: Minimum 5/16 inch.
         3) For pipes 38 inches and larger in diameter and including 72 inches in diameter: Minimum 3/8 inch.
      b. Inside diameter of unlined pipe: Nominal.
      c. Inside diameter of lined pipe: As measured from face to face of liner, but not less than nominal.
      d. Deflection of underground pipe inside diameter: Maximum 2 percent under trench load of H-20 live load in accordance with AASHTO specifications.
      e. Working stress of steel: Maximum 50 percent of yield stress.
      f. Contractor shall develop and submit calculations to determine the steel pipe and fitting wall thickness and design requirements according to the requirements of this specification.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: As specified in Section 15052 - Common Work Results for General Piping.

C. Shop drawings:
   1. Details of fittings and specials showing thickness and dimensions of plates.
   2. Details of welds and materials.
   3. Listing of proposed services and locations for use of grooved joint type piping.
   4. Tabulated layout schedules for cement-mortar lined and coated steel pipe.
   5. Grooved joint piping fittings, gaskets, and couplings.
   6. Grooving of pipe and fittings.

D. Calculations:
   1. Submit calculations prepared and stamped by a professional engineer licensed in the State of California. The calculations shall be based on the requirements defined in this Section.
   2. Design calculations: Wall thicknesses for external loading, special loading, internal pressure, and other necessary design cases.

E. Certificates of Compliance: Cement-mortar lined and coated steel pipe.

F. Mill certificates.

G. Test reports: Rubber gaskets.

1.05 QUALITY ASSURANCE

A. Applicable standards:
   1. Steel pipe larger than 12 inches diameter shall conform to the following standards, as complemented and modified in this Section:
      a. Steel pipe: AWWA C200.
      b. Fittings and specials: AWWA C208.
      c. Reinforcement of fittings and specials: AWWA M11.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel pipe:
   1. Type, pipe 6 inches and smaller: ASTM A53, black or galvanized, seamless or straight seam electric resistance welded. Minimum Schedule 40.
   2. Type, from 6 to 12 inches: ASTM A53, black or galvanized pipe, seamless or straight seam electric resistance welded. Minimum Schedule 20.
   3. Type, larger than 12 inches: AWWA C200, without butt strap, riveted, or swaged joints; wall thickness as specified.
   4. Type, 24 inches and larger, with grooved type couplings and wall thickness less than 1/2-inch: Provided with stub ends, sized as follows, for grooves:
      a. Thickness: As recommended by coupling manufacturer, but not less than 1/2-inch.
      b. Length: Width of coupling plus 1 inch, but not less than 6 inches.
   5. Type for liquid or gaseous dry chlorine: ASTM A106, Grade A, Schedule 80, assembled with 300 pounds per square inch malleable iron fittings and ammonia type flanges.

B. Steel pipe fittings:
   1. Screwed fittings:
      a. Malleable iron: ASME B16.3, 150 pounds; galvanized in accordance with ASTM A153 where used with galvanized pipe.
      b. Cast iron drainage: ASME B16.12, galvanized in accordance with ASTM A153 where used with galvanized pipe.
   2. Flanged fittings:
      a. Type for 12-inch and smaller pipe: ASME B16.1, cast iron or ductile iron, 125 pounds; or ASME B16.5, steel, 150 pounds, galvanized in accordance with ASTM A153 where used with galvanized pipe.
      b. Type for larger than 12-inch pipe: ASME B16.5, steel, 150 pounds; galvanized in accordance with ASTM A153 where used with galvanized pipe; or AWWA C207 and AWWA C208, fabricated from flanges and steel pipe, respectively.
      c. Companion flanges for 4 inches and smaller pipe: ASME B16.1, cast iron or ductile iron, 125 pounds; ASME B16.5, steel, 150 pounds, slip-on or welding neck; or ammonia type for use on chlorine liquid or gas piping.

d. Companion flanges for larger than 4 inch to and including 12-inch pipe: ASME B16.5, slip-on or welding neck type.
e. Companion flanges for larger than 12-inch pipe: ASME B16.5, steel, 150 pounds; galvanized in accordance with ASTM A153 where used with galvanized pipe; or AWWA C207, steel plate or raised hub type.
f. Weld flanges to pipe or fittings before applying lining.
g. Machine flanges or provide tapered filler for changes in grade or to slope lines for drainage.
h. Flange bolts: As specified in Section 15052 - Common Work Results for General Piping.
i. Gaskets: As specified in Section 15052 - Common Work Results for General Piping.

3. Welding fittings:
   a. Welding fittings for piping 8 inches and less in nominal diameter: Butt-welding fittings in accordance with ASME B16.9, standard wall, or standard weight.
   b. Welding fittings for piping larger than 8 inches in nominal diameter: Butt-welding fittings in accordance with ASME B16.9, or, at the option of the Contractor, made up out of sections of pipe welded together, except where smooth bends are indicated for air lines.
   c. Fittings made up of sections of pipe welded together shall be made of pipe of at least the same wall thickness as the pipe with which used, and bends shall be miter bends, fabricated in accordance with AWWA C208 and as supplemented by AWWA M11. Welding of these made-up fittings shall be in accordance with AWWA C206:
      1) Design and fabricate outlets and 4 branch fittings in accordance with AWWA M11.
      2) Bends may be welded to adjacent pipe sections:
         a) Bends shall be manufactured of the following number of pieces:
            (1) Bends from 0 to 30 degrees angle, 2 pieces.
            (2) Bends from 30 to 45 degrees angle, 3 pieces.
            (3) Bends from 45 to 67-1/2 degrees angle, 4 pieces.
            (4) Bends from 67-1/2 to 90 degrees angle, 5 pieces.

4. Grooved joint fittings:
   a. Fittings for grooved joint steel piping: Rigid-grooved type, and as follows:
      1) Grooves: Cut; rolled grooves are not acceptable.
      2) Couplings: Cast in 2 or more segments of ductile iron in accordance with ASTM A536, Grade 65-45-12 or malleable iron in accordance with ASTM A47, Grade 32510.
      3) Bolts and nuts: As specified in Section 15052 - Common Work Results for General Piping.
      4) Gaskets: Composition water sealing designed so that the internal piping pressure serves to increase the seal's watertightness:
         a) Gaskets for water service and oil-free air systems at temperatures less than 230 degrees Fahrenheit shall be made of ethylene propylene diene monomers (EPDM) in accordance with ASTM D2000 Line Call Out 2CA615A25B24.
         b) Gaskets for use with cement-mortar lined steel piping shall be captured between the ends of the pipe to protect exposed metal from corrosion, and shall be made of nitrile in accordance with ASTM D2000, Line Call Out 2CA615A25B24.

5) Perform grooving of the pipe wall only on standard or heavier schedule weight pipe:
a) For pipe with wall thickness less than standard weight, weld a shouldered end on the pipe in accordance with AWWA C606.
b) Fabricated pipe, pipe in accordance with AWWA C200, shall have shouldered ends welded onto the pipe.
c) Shoulder: Type B or D in accordance with AWWA C606.
6) Couplings and grooving:
a) Manufacturers: One of the following or equal:
(1) Gustin-Bacon Piping Products.
(2) Victaulic Co.

b. Fittings for grooved joint piping: Ductile iron in accordance with ASTM A536, Grade 65-45-12, or malleable iron in accordance with ASTM A47, Grade 32510, and as follows:
1) Where cast fittings are not made, standard fittings including large diameter elbows shall be made of forged steel in accordance with ASTM A105, Grade B with 0.375 inch wall thickness, or shall be standard segmentally welded fittings fabricated of Schedule 40 carbon steel pipe:
a) Grooves:
(1) Manufacturers: One of the following or equal:
(a) Gustin-Bacon Piping Products.
(b) Victaulic Co.
2) Fittings for grooved joint piping shall be furnished by the manufacturer of the grooved joint material.
3) Fittings for grooved joint piping shall be for rigid-grooved type joints.
4) Connection to flanged units shall be by means of flange to grooved joint adapters:
a) Where the flanged to grooved joint adapters interfere with the operation of adjacent valves, pumps, or other items, the connection shall be by means of a spool with one end flanged and the other grooved, long enough to prevent interference with adjacent valves, pumps, or other items.

C. Steel pipe lining and coating:
1. General:
a. Except where otherwise specified in the Specifications or indicated on the Drawings, lining and coating for steel pipe shall be as specified in 15052 - Common Work Results for General Piping.
b. Refer to specification 09997 - Pipeline Coatings and Linings for lining and coating requirements.

D. Fabricated steel piping fittings and specials:
1. General: Specified herein are the design and fabrication of fabricated steel piping fittings and specials, which include elbows, branches, nozzles, manifolds, headers, heads, collars, stiffeners, reinforcements, and other steel fabrications relating to steel piping, but shall not include steel pipe.
2. Design:
a. Contractor shall design and detail fittings and specials:
1) Design: In accordance with the recommended procedures in AWWA Manual M11, as complemented and modified in this Section.

2) Nozzles: Reinforced in accordance with recommended practice in AWWA M11, Steel Pipe Manual.
3) Design reinforcing for fittings and specials for the specified test pressure.
4) Fittings shall conform in dimension to AWWA C208, complemented with the provisions specified in this Section.
5) The working stress for steel used for fabrication of pipe shall not exceed 50 percent of the yield stress.

b. The thickness of pipe, large elbows, and headers, except header nozzles, shall be the thicker of:
1) The thickness designed in accordance with the design methods specified in this Section.
2) The thickness indicated on the Drawings, or specified in Section 15052 - Common Work Results for General Piping Pipe Schedule, or as required by the Contractor's calculations.
3) The following thicknesses:
a) For pipes smaller than 26 inches in diameter: Minimum 1/4 inch.
b) For pipes 26 inches and larger but less than 38 inches in diameter: Minimum 5/16 inch.
c) For pipes 38 inches and larger in diameter and including 72 inches in diameter: Minimum 3/8 inch.

c. Elbows shall be of the number of pieces as specified in this Section, and thickness of material shall conform to thickness of pipe or manifold shells specified.
d. Ends of fittings to be welded to pipe shall be beveled for welding.

3. Fabrication:
a. Shop fabricate steel piping fittings and specials in units as long as practicable for safe hauling and installation. Minimize number of field welds.
b. Fabricate fittings and specials to uniform lengths with proper end clearance for the specified types of joint or attachment.
c. Fabricate fittings and specials to allow field assembly without cutting or special work.
d. Where specified in the Piping Schedule in Section 15052 - Common Work Results for General Piping or indicated on the Drawings, the inside of fabricated steel manifolds and other fittings and specials shall receive a cement-mortar lining in accordance with AWWA C205:
1) Reinforce lining for piping 24 inches in diameter and larger with wire fabric.
e. Do not weld flanges to nozzles until the nozzles and reinforcements are completely welded to the header:
1) Accurately space and align flanges so that when connections have been made there will be no stress on the header, piping, or equipment. Properly locate and align equipment.

4. Dished heads:
a. Dished heads on 84 inch diameter and smaller manifolds: 1 piece (seamless) spherically dished (torispherical) heads:
1) Larger heads may be seamed.
b. Dish radius: Same dimension as the outside diameter of the head measured at skirt.

c. Skirt face length: Not less than 3 inches.
d. Design heads in accordance with recommended practice in AWWA M11, Steel Pipe Manual.

5. Testing: No shop testing will be required for manifolds or piping connected thereto.

E. AWWA C200 steel pipe and fittings design and fabrication:
1. General:
a. Applicable standards: AWWA C200 steel pipe shall conform to the standards specified in General of this Section.
b. Identification marks: Provide identification marks in accordance with AWWA C200. These marks shall be stenciled or otherwise shown at the top of the piping items exterior, including the following information:
1) Name or trademark of the manufacturer.
2) Date of manufacture of the item.
3) Internal diameter in inches.
4) Number of the item, sequential from initial to end station.
c. Diameter designation: The pipe diameter specified in the Specifications and indicated on the Drawings shall be the clear inside diameter after application of the cement-mortar lining with a tolerance of plus 0 inch and minus 1/4 inch.
2. Design:
a. Pipe and fittings shall be designed by Contractor.
b. Design: In accordance with the recommended procedures in AWWA Manual M11, as complemented and modified in this Section.
c. Thicknesses of pipe, fittings and specials shall be the thicker of:
1) The thickness designed in accordance with the design methods specified in this Section
2) The thickness indicated on the Drawings or specified in Section 15052 - Common Work Results for General Piping Pipe Schedule.
3) The following thicknesses:
a) For pipes smaller than 26 inches in diameter: Minimum 1/4 inch.
b) For pipes 26 inches and larger but less than 38 inches in diameter: Minimum 5/16 inch.
c) For pipes 38 inches and larger in diameter and including 72 inches in diameter: Minimum 3/8 inch.
d. The working stress for steel used for fabrication of pipe shall not exceed 50 percent of the yield stress.
e. Break longitudinal and girth seams for straight seam pipe shall be no greater in number than would be required for the fabrication of pipe with 96-inch by 120-inch steel plates:
1) Break longitudinal seams at the girth seams.
f. Calculate earth loads using the following formula:

$$W = 192 \times H \times B$$

wherein the various terms shall have the following meaning:

W: Earth load, pounds per linear foot of pipe.
H: Height of fill over the pipe, feet.

B: Outside diameter of the pipe, feet.
x: Mathematical symbol for multiplication.

g. Add AASHTO's H-20 loading to earth loads.
h. Design pipe, fittings and specials for a deflection, under external loads, not to exceed 2 percent of the diameter:
   1) Stiffness computations shall not consider the effect of the cement-mortar lining and coating.
   2) Calculate deflection using the Spangler formula and the following values:
      a) Bedding constant K = 0.100.
      b) Modulus of soil reaction E' = 700 pounds per square inch.
      c) Deflection lag constant D_1 = 1.00.
i. Where piping is designated to be flanged or welded in order to restrain thrust, the design of the cylinder and flange or welded joint shall take into account the effect of stresses caused by thrust loads.
j. Steel cylinder shall be subject to no more than the lesser of 15,000 pounds per square inch or 50 percent of the steel yield stress.

3. Materials:
   a. Coatings and linings: As required in Section 15052 - Common Work Results for General Piping and Section 09997 - Pipeline Coatings and Linings.
   b. Gaskets shall be as specified in Section 15052 - Common Work Results for General Piping and meet the following requirements:
      1) Minimum tensile strength, tested in accordance with ASTM D 412, between 2,000 and 2,700 pounds per square inch.
      2) Minimum elongation, tested in accordance with ASTM D 412, between 350 and 400 percent.
      3) Shore A durometer hardness, tested in accordance with ASTM D 2240, between 50 and 65.
      4) Specific gravity, tested in accordance with ASTM D 297, between 0.90 and 1.50.
      5) Maximum compression set, tested in accordance with Method B of ASTM D 395, 20 percent.
      6) Maximum tension strength loss, tested in accordance with ASTM D 573 at 96 hours, 70 degrees Centigrade, in air, 20 percent.
      7) Maximum elongation loss, tested in accordance with ASTM D 573 at 96 hours, 70 degrees Centigrade, in air, 20 percent.
      8) Maximum absorption, tested in accordance with ASTM D 471 at 48 hours, 70 degrees Centigrade, in air, 5 percent.
4. Joints and connections:
   a. Joints:
      1) Except as otherwise specified or indicated on the Drawings, provide lap welded or bell and spigot type joints with rubber gaskets for pipelines 54 inches and smaller.
      2) Butt-strap joints shall be used only where required for closures or where indicated on the Drawings.
      3) The joints furnished shall have the same or higher-pressure rating as the abutting pipe.

b. Connections:
    1) Connections to existing systems shall be made using a flange isolation joint.
    2) If an existing pipeline or facility does not include a flange at or near the connection point:
        a) An isolation flange shall be placed in the first length of pipe.
        b) A butt-strap joint shall be used to connect the first length of pipe to the existing pipeline.
c. Bell and spigot joint rings: Rolled Carnegie shape M-3516.
d. Lap welded joints:
    1) Double fillet weld lap welded joints shall be welded on the inside and outside of the joint.
    2) Lap joints prepared for electric field welding shall be in accordance with AWWA C 206.
    3) Joint forming:
        a) Joint geometry and joint field weld will be such that no part of any field weld will be closer than 1 inch to the nearest point of tangency to the bell radius.
        b) Bell ends shall be formed by and expanding press or by being moved axially over a die in such a manner as to stretch the steel plate beyond its elastic limit to form a truly round bell of suitable diameter and shape.
    4) Faying surfaces of the bell and spigot shall be essentially parallel, but in no case shall the bell slope vary more than 2 degrees from the longitudinal axis of the pipe.
e. Butt-strap joints: Butt-strap joints where used or required, shall be:
    1) A minimum of 10 inches wide.
    2) The same thickness as the pipe wall.
    3) Provide for a minimum of 2-inch lap at each pipe joint.
    4) Double fillet weld each side of joint on the inside and outside of the joint.
f. Flanges: AWWA C207, Class D, steel ring, and as follows:
    1) Match pipe flanges to the valve flanges:
        a) At flanged joints connecting to valves, provide a steel pipe section without rod reinforcing and not less than 24 inches in length.
        b) Apply cement-mortar lining and coating to the steel pipe section.
    2) Flange bolts: As specified in Section 15052 - Common Work Results for General Piping.
    3) Gaskets: As specified in Section 15052 - Common Work Results for General Piping.

5. Fabrication:
    a. Shop coat of primer: Flanges and portions of pipe not covered with cement-mortar shall be given a shop coating of primer.
    b. Bend radii of fittings: Not less than 2.5 times the nominal diameter in accordance with AWWA C208.

PART 3 EXECUTION

3.01 INSTALLATION

A. Joints:
   1. Steel pipe joints shall be screwed, welded, flanged, grooved, or made with flexible joints. The type of joint for piping is specified in the Piping Schedule in Section 15052 - Common Work Results for General Piping.
   2. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, and other types of joints or means necessary to allow ready assembly and disassembly of the piping.
   3. Unless otherwise indicated on the Drawings or specified in the Piping Schedule in Section 15052 - Common Work Results for General Piping, pipe joints shall be as follows:
      a. Pipe smaller than 2 inches in nominal diameter shall have screwed joints or flexible couplings.
      b. Pipe 2 inches to 4 inches in nominal diameter shall have screwed joints, flanged joints, welded joints, or joints made with flexible couplings.
      c. Pipe larger than 4 inches in nominal diameter shall have flanged joints, welded joints, or joints made with flexible couplings.

B. Screwed joints:
   1. Perform threading with clean, sharp dies:
      a. Wavy, rough, or otherwise defective pipe threads are not acceptable.
   2. Make screwed joints tight and clean with an application of Teflon tape or approved paste compound applied to the male threads only, except as follows:
      a. Make up liquid and dry chlorine lines, and liquefied petroleum gas lines, with litharge and glycerin.
   3. Provide railroad type unions with bronze-to-iron seat, galvanized where used with galvanized pipe:
      a. Flanged joints may be used instead of unions.

C. Flanged joints:
   1. In flanged joints, flanges shall come together at the proper orientation with no air gaps between the flanges after the gaskets are in place.
   2. Attach slip-on flanges to pipe by 2 fillet welds, in accordance with AWWA C207.
   3. Secure welding neck flanges with full penetration butt welds without backing rings:
      a. After welding in place, the faces of flanges shall be perpendicular to the axis of the pipe, or, in the case of fittings, at the proper angle to each other, and bolt holes shall be in proper alignment.

D. Welded joints:
   1. Welded joints shall be electric welded in accordance with AWWA C206.
   2. Welders shall be qualified pursuant to the provisions of AWWA C206:
      a. Welders' testing shall be at the Contractor's expense, including cost of test nipples, welding rods, and equipment.
   3. Do not weld galvanized pipe.

E. Grooved joints:
   1. Piping with grooved joints shall be installed where indicated on the Drawings and may be installed in place of flanged piping and screwed piping, except that grooved joint piping shall not be used in the following installations:
      a. In underground and underwater installations.
      b. In piping subject to test pressures of 150 pounds per square inch gauge, or more.
      c. In steam and gas piping.
      d. In sludge and scum piping designed to be steam cleaned.
   2. Assemble in accordance with manufacturer's published instructions.
   3. Support grooved-end pipe in accordance with manufacturer's recommendations. In addition, provide at least 1 support between consecutive couplings.

3.02 FIELD QUALITY CONTROL

A. Testing: Fabricated steel manifolds shall be field tested with the pipe to which they connect.

B. Weld testing: Liquid penetrant testing: As soon as possible after welding of pipeline joints, all fillet welds shall be tested by the liquid penetrant inspection procedure in accordance with ASTM E165 under Method “B” and “Leak Testing”. All defects shall be chipped out, rebelled and retested. Upon retest, the repaired area shall show no leaks or other defects.

END OF SECTION

SECTION 15762

HEATING UNITS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Electric unit heaters (EUH).
   2. Thermostats for unit heater.

1.02 REFERENCES

A. Air Movement and Control Association International, Inc. (AMCA):
   1. 302 - Application of Sone Ratings for Non-Ducted Air Moving Devices.

B. American Gas Association (AGA).

C. California Code of Regulations (CCR):
   1. Title 24 - Building Standards Code.

D. National Electrical Code (NEC).

E. National Fire Protection Association (NFPA):
   1. 54 - National Fuel Gas Code.
   2. 70 - National Electrical Code (NEC).

F. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (100 V Maximum).

G. Underwriters' Laboratories, Inc. (UL).

1.03 DEFINITIONS

A. NEMA Type 3R enclosure in accordance with NEMA 250.

1.04 SYSTEM DESCRIPTION

A. Design requirements:
   1. Provide supports meeting the seismic design criteria as specified in Section 01610 - Project Design Criteria and wind design criteria for exterior units as specified in Section 01610 - Project Design Criteria.
   2. Electrical components: UL listed and meeting the design and installation requirements of the NEC.
   3. Hot water piping, gas piping, drains, venting, and other appurtenances of unit heaters: Install in accordance with building code, mechanical code, and plumbing code as specified in Section 01410 - Regulatory Requirements, and the NFPA.

4. Noise levels for unit heaters installed in offices, hallways, or entry areas: Not to exceed 10 Sones as measured in accordance with AMCA Publication 302.
5. Motors supplied with heating units: As specified in Section 16222 - Low Voltage Motors up to 500 Horsepower.
6. Heaters: For projects located in California, comply with efficiency requirements of CCR Title 24.

B. Performance requirements are included in the Heating Unit Schedules at the end of this Section.

C. Design and supply necessary electrical power and control systems, components, and wiring to make a complete functioning system:
1. Comply with referenced electrical Sections and design to perform system heating functions as specified in Section 15936 - Instrumentation and Control Devices for HVAC.

1.05 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures and Section 15050 - Common Work Results for Mechanical Equipment.

B. Product data:
1. Samples: Manufacturer's standard color chips for cabinets finish.
2. Certificates: Successful testing of burners used in gas unit heaters.
3. Provide heating units and controls that are listed by UL.

C. Shop drawings:
1. System layout, mechanical, electrical power, and control diagrams.
2. Materials.
3. Supports and seismic bracing calculations and details.
4. Cut sheets on primary and ancillary equipment.
5. Sound ratings of fans in Sones in accordance with AMCA Publication 302.
6. For projects located in California, certification of compliance with CCR Title 24 efficiency standards.

D. Commissioning submittals:
1. Provide Manufacturer’s Certificate of Source Testing as specified in Section 01756 - Commissioning.
2. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

E. Project closeout documents:
1. Provide vendor operation and maintenance manual as specified in Section 01782 - Operation and Maintenance Data.

F. Warranties.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect equipment from dust and atmospheric exposure as recommended by the unit manufacturer:
1. Provide temporary closures for equipment openings designed for airflow.

1.07 SITE CONDITIONS

A. As specified in Section 01610 - Project Design Criteria.

1.08 WARRANTY

A. As specified in General Conditions.

PART 2 PRODUCTS

2.01 ELECTRIC UNIT HEATER (EUH)

A. Manufacturers: One of the following or equal:
   1. Indeeco, Type TRIAD.
   2. Trane, similar models.
   3. Markel, similar models.
   4. Chromalox, similar models.

B. Fan type: Aluminum axial flow:
   1. Provide fan guards.
   2. Dynamically balance.
   3. Fan designed for quiet operation.
   4. Permanently lubricated ball bearings.
   5. Automatic reset thermal overload protection.

C. Heating element characteristics:
   1. Rated capacity at entering air temperature of 65 degrees Fahrenheit.
   2. Fin type, Type 316 stainless steel plated heater elements, with elements brazed to common fins, designed for maximum strength and maximum heat transfer.
   3. 3-phase designed for balanced phases.
   4. Over temperature cutout with automatic reset.

D. Features:
   1. Built-in magnetic contactors.
   2. Control transformer for 24 or 120-volt control as indicated in the Heating Unit Schedules.
   3. Required mounting brackets.
   4. Individually adjustable outlet louvers.
   5. Heavy 16 gauge stainless steel louvered outlet grille and plated rear grille.
   6. Cabinet formed of minimum thickness 18-gauge steel with steel stiffeners. Listed for corrosive areas and NEMA 4X hose down requirements.
   7. Controls:
      a. Provide thermostat as specified in this Section.
      b. Provide control transformer suitable for 24-volt or 120-volt control as indicated in the Heating Unit Schedules.

E. Finishes:
   1. Casing finish backed enamel in manufacturer's standard color.

2.02 THERMOSTATS FOR UNIT HEATERS

A. Type: Wall mounted, heat only with fan AUTO-ON selector switch when fan part of unit and separate system ON-OFF selector switch.

B. Dial or lever temperature setpoint adjustment with 45 to 90 degrees Fahrenheit setpoint range.

C. Setpoint and temperature indication.

D. Control voltage as indicated in the attached Heating Unit Schedules.

E. The use of mercury within the thermostat is not acceptable.

F. Bi-metallic contacts suitable for 1- or 2-stage unit heater control as specified for the heater size or as scheduled.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect all components for shipping damage, conformance to specifications, and proper torques and tightness of fasteners, as specified in Section 15050 - Common Work Results for Mechanical Equipment.

B. Examine and verify that Work is in condition to receive installation specified in this Section:
   1. Take measurements and verify dimensions to ascertain fit of installation.
   2. Verify structural sufficiency to support installation.
   3. Verify that chassis, shafts, and openings are correctly located:
      a. Otherwise cut new openings where required.
   4. Confirm specified thermostat and other controls are compatible with specified equipment.

C. Examine and verify structural details and sections indicated on the Drawings, ascertain adequacy, and determine possible conflicts in dimensions and clearances.

3.02 PREPARATION

A. Before installation, remove dust and debris from equipment and ducts.

B. During installation and until equipment is operated, protect equipment and ducts from dust and debris by covering openings with tape or plastic.

3.03 INSTALLATION

A. Install equipment as indicated on the Drawings and as specified in Section 15050 - Common Work Results for Mechanical Equipment and the manufacturer's written installation instructions:
   1. Provide disconnect switches at the unit heaters wherever indicated on the Drawings, specified in this Section, scheduled and wherever required by code.

B. Anchoring and support: Install anchoring for seismic and wind forces to meet the design criteria specified in Section 01610 - Project Design Criteria.

C. Alignment: Adjust ductwork alignment when necessary to resolve conflicts with architectural and structural features or to resolve conflicts with work of other trades.

D. Install and wire unit heaters and thermostats in accordance with manufacturer's recommendations.

E. Adjust heater units with louvers for optimum air circulation.

F. Provide gas unit heater venting in accordance with mechanical code and plumbing code as specified in Section 01410 - Regulatory Requirements and in accordance with NFPA 54.

3.04 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

3.05 FIELD QUALITY CONTROL

A. Test equipment and installation to verify operation is within manufacturer's standards and that noise levels do not exceed levels specified.

B. Test equipment performance and balance equipment as specified in Section 15954 - Testing, Adjusting, and Balancing for HVAC.

3.06 HEATING UNIT SCHEDULES

A. See drawings for Heater Schedule.

END OF SECTION

SECTION 15812

METAL DUCTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Aluminum ductwork.

1.02 REFERENCES

A. ASTM International (ASTM):
   1. B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

B. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   1. HVAC Systems-Duct Design.
   2. Seismic Restraint Manual Guidelines for Mechanical Systems.

C. Underwriters Laboratories, Inc. (UL):
   1. 181A - Closure Systems for Use with Rigid Air Ducts.

1.03 SYSTEM DESCRIPTION

A. Design requirements:
   1. Custom design and fabricate metal ductwork for the applications indicated on the Drawings and for the conditions specified.
   2. In accordance with SMACNA Manual for gauge of sheet metal, joint types, reinforcement, bracing, hangers and supports, fabrication, and installation:
      a. Sheet metal thicknesses: The greater of that thickness required to in accordance with SMACNA for the design pressure specified and the following minimum thicknesses:

Diameter or Largest Dimension of Rectangular Duct (Inches)	Minimum Sheet Thickness, Inches (B&S Gauge)
Up to 12	0.025 (22)
13 to 30	0.032 (20)
Larger than 31	0.040 (18)

      b. Spacing of hangers and supports:
         1) Provide supports as indicated on the Drawings.
         2) When supports are not shown, provide supports as required in accordance with SMACNA but no greater than the spacing indicated on the Drawings or the following requirements; whichever is less:
            a) Ducts 18 inches and smaller in largest dimension: 8 feet on center.
            b) Ducts over 18 inches in largest dimension: 4 feet on center.
      c. Support connections:
         1) Provide as indicated on the Drawings.

2) When not indicated on the Drawings, provide in accordance with SMACNA.
3) As a minimum, all support connections to metal or wood roofs shall be located at roof framing members only.
4) No penetrations through roof deck, roof membrane, or connections to roof membrane are acceptable.

3. Design pressure: 2 inches water column unless otherwise indicated on the Drawings or specified.
4. Seismic design criteria: As specified in Section 01612 - Seismic Design Criteria and in accordance with SMACNA Seismic Restraint Manual Guidelines for Mechanical Systems.
5. Hanger reinforcement:
   a. Ducts 18 inches and smaller in largest dimension: None.
   b. Ducts over 18 inches and under 30 inches in largest dimension: 1-1/2 inches by 1-1/2 inches by 1/8-inch angles, 8 feet on center.
   c. Ducts 30 inches and larger in largest dimension: 1-1/2 inches by 1-1/2 inches by 1/8-inch angles, 4 feet on center.
6. When ducts are specified with insulation on interior walls, size duct to provide clear inside dimensions indicated on the Drawings.

B. Miscellaneous design details:
1. Changes in duct size:
   a. Use uniformly tapering sections.
   b. Taper not more than 1 inch in 5 inches of run unless otherwise indicated on the Drawings.
2. Bends: With the exception of miter bends, design bends with inside radii equal to duct width or diameter:
   a. Install turning vanes at all 90 degree beds.
3. Duct sleeves: Install duct sleeve when ducts pass through concrete or masonry walls, slabs, or ceilings.
4. Access openings: Install in locations that allow access to dampers, fusible links, controllers, and similar devices.
5. Flexible connections: Install at connections to air handling equipment and at locations indicated on the Drawings.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data:
1. Duct and component material and details of construction.
2. System layout including floor and wall penetrations.
3. Supports and anchoring details.
4. Components used in the duct system including turning vanes, dampers, flexible connections, and access doors.

C. Design data: Seismic design calculations:
1. Design calculations for duct construction as specified in Section 01612 - Seismic Design Criteria and in accordance with SMACNA.

D. Provide Manufacturer’s Certificate of Source Testing as specified in Section 01756 - Commissioning.

PART 2 PRODUCTS

2.01 MATERIALS

A. Ducts: Aluminum alloy 3003 H14 in accordance with ASTM B209.

B. Flexible connectors: As specified in Section 15820.

C. Turning vanes: Match duct material.

D. Reinforcing: Formed or extruded aluminum angles.

2.02 COMPONENTS

A. Duct sleeves:
   1. Sleeve flanges: 4 inches wide.
   2. Size: 2 inches larger than the duct or duct with external insulation.

B. Access openings:
   1. Size: 2 inches less than duct size.
   2. Doors:
      a. Gauge not less than duct sheet.
      b. Provide continuous hinge and latch on outside.
   3. Gasket: Along door periphery.
   4. Visual panel: 1/8-inch thick, clear plexiglass.

C. Turning vanes:
   1. Material: Same as ductwork.
   2. Type:
      a. Single-blade vanes for duct widths less than 36 inches.
      b. Airfoil type vanes for duct widths of 36 inches and greater:
         1) No trailing edge.
   3. Mounted in side rails.
   4. Provide turning vanes for square-turn elbows, smooth radius elbows, and splitters.
   5. Size: 2-inch blades for ducts up to 18 inches, 4-1/2 inch blades for larger ducts.

D. Splitter dampers: Provide at branch take-offs where necessary for balancing system.

E. Extractors:
   1. Components:
      a. Synchronized steel curved blades.
      b. Heavy side rails.
      c. Screw operator.
   2. Provide extractors at take-off from main supply duct adjacent to diffusers, registers, or grilles where splitter is not used.

2.03 FABRICATION

A. Fabricate ductwork to the configuration and dimensions indicated on the Drawings.

B. Dimensions indicate net free area. Increase duct dimensions by thickness of insulation when internal insulation is specified.

C. Do not utilize S clips, duct tape, or externally applied mastic on medium pressure duct systems.

D. Do not use snap lock seams.

E. Provide flexible duct connectors at all connections to fans and other air movement equipment.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine and verify that Work is in condition to receive metallic ductwork as specified in this Section:
   1. Take measurements and verify dimensions on shop drawings to verify fit of installation.
   2. Verify that supports and openings are correctly located.

B. Examine and verify structural details and determine conflicts in dimensions and clearances.

3.02 INSTALLATION

A. Cover ductwork openings with tape, plastic, or sheet metal to reduce the amount of dust or debris which may collect in the system at each of the following times:
   1. At the time of rough installation.
   2. During storage on the construction site.
   3. Until final start-up of the heating and cooling equipment.

B. Before installation remove dust and debris from ducts.

C. Adjust duct alignment where necessary to resolve conflicts with architectural features or to resolve conflicts with the work of other trades.

D. Install ductwork to provide a system free of buckling, warping, or vibration.

E. Hangers:
   1. Install hangers as indicated on the Drawings.
   2. When hangers are not detailed, conform to SMACNA HVAC System Duct Design and Seismic Restraint Manual standards and the following requirements:
      a. Rectangular ducts concealed in ceiling spaces:
         1) Use metal strap hangers.
         2) Fasten to sides of duct with 2 screws.
         3) Fasten to bottom of duct with 1 screw.

b. Rectangular ducts in exposed areas:
   1) Install shelf angle trapeze hangers or Unistrut type hangers.
   2) Install sway bracing as required by seismic calculations, minimum 1 brace at right angle to each duct run.
c. Round ducts in exposed areas:
   1) Install 2 half-round bands with rods bolted to panels.
   2) Install sway bracing as required by seismic calculations, minimum 1 brace at right angle to each duct run.

3. Flexible connections: As specified in Section 15820 - Ductwork Accessories.

F. Provide closed-cell neoprene gaskets at flanged joints.

G. Tapes and mastics used to seal ductwork shall be listed and labeled in accordance with UL 181A and shall be marked.

3.03 FIELD QUALITY CONTROL

A. Inspect ductwork under operating conditions.
   1. Correct audible leaks and leaks that can be felt with the hand.

B. Test and balance ducting systems as specified in Section 15954 - Testing, Adjusting, and Balancing for HVAC.

END OF SECTION

SECTION 15820

DUCTWORK ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Dampers and damper operators.
   2. Diffusers, grilles, and registers.
   3. Screens.
   4. Flexible duct connectors.
   5. Other ductwork accessories.

1.02 REFERENCES

A. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

B. National Fire Protection Association (NFPA):
   1. 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
   2. 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

C. Uniform Building Code (UBC).

D. Underwriters Laboratories, Inc. (UL):
   1. 555 - Fire Dampers.
   2. 555S - Smoke Dampers.

1.03 DEFINITIONS

A. Dampers, diffusers, grilles, and registers specified are indicated on the Drawings by the abbreviations listed below. Each abbreviation is followed by a hyphen and a number to designate the required style of unit:
   1. BD: Balancing Damper.
   2. BDD: Backdraft Damper.
   3. DG: Door Grille.
   4. FD: Fire Damper.
   5. FL: Flexible Duct Connector.
   6. RR: Return Register or Grille.
   7. SD: Smoke Damper.
   8. SFD: Smoke and Fire Damper combination.
   9. SR: Supply Register, Grille, or Diffuser.

B. NEMA Type 1 enclosure in accordance with NEMA 250.

C. Return registers:
   1. RR designation includes wall, ceiling, and duct mounted air exhaust or return devices including diffusers and grilles with or without control dampers.
   2. When no return register style is indicated on the Drawings, provide Style RR-3; provide 4 inch flanged drop frame when duct mounting indicated.

D. Supply registers:
   1. SR designation includes wall, ceiling, and duct mounted air supply devices including diffusers and grilles with or without control dampers.
   2. When no supply register style is indicated on the Drawings, provide Style SR-3; provide 4 inch flanged drop frame when duct mounting indicated.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

PART 2 PRODUCTS

2.01 DAMPERS

A. Manufacturers:
   1. Provide dampers manufactured by the same manufacturer.
   2. Dampers:
      a. Manufacturers: One of the following or equal:
         1) One manufacturer's model is listed with each style, similar models from other listed vendors are acceptable:
            a) Ruskin Manufacturing.
            b) American Warming and Ventilating.
            c) Swartwout.

B. Materials:
   1. Metallic ductwork:
      a. Aluminum for aluminum duct work; aluminum or galvanized steel for galvanized steel ductwork unless specified otherwise with styles.
   2. Fiberglass reinforced plastic ductwork:
      a. Fiberglass reinforced plastic where not otherwise specified.

C. Components:
   1. Include specified damper type with frame actuators, clips, connectors, and other accessories necessary for mounting; provide locking quadrant manual actuator or electric actuator as indicated on the Drawings.

D. Backdraft dampers (BDD):
   1. BDD-3, Style 3 Backdraft Damper, Heavy Duty Counterbalanced Backdraft Damper:
      a. Service: Low pressure opening at 0.01 inches water column in rectangular ducts or wall mounting for spot air velocities up to 2,500 feet per minute; weather resistant for exhaust applications.

b. Size and installation: Size as indicated on the Drawings and suitable for mounting as indicated.
c. Frame: 2.25 inches deep, 0.125-inch minimum thickness 6063T5 aluminum with insect screen and water stop.
d. Blades: 0.070-inch minimum thickness 6063T5 aluminum with Zytel bearings, elastomer edge seals, and aluminum tie-bar; blades require no more than 4.25 inches clearance beyond frame when fully open.
e. Counterbalance: Zinc plated bar on blades; adjustable down to 0.01 inch water column opening.
f. Finish: Kynar in manufacturer's standard colors to be selected by the Engineer.
g. Manufacturers: The following or equal:
1) Ruskin, Model CBD6.

2.02 DIFFUSERS, GRILLES, AND REGISTERS

A. Manufacturers:
1. Provide diffusers, grilles, and registers manufactured by the same manufacturer.
2. Diffusers, grilles, and registers: One of the following or equal. One manufacturer's model is listed with each style, similar models from other listed vendors are acceptable:
a. Titus Manufacturing Corp.
b. Tuttle and Bailey.
c. Kees, Inc.
d. Metal Industries, Inc., (MetalAire).
e. Krueger.

B. Materials:
1. For metallic ductwork: Aluminum for aluminum duct work; aluminum or galvanized steel for galvanized steel ductwork unless specified otherwise with styles.

C. Components: Include specified style with frame, clips, connectors, and other accessories necessary for mounting.

D. Appearance: Similar for units in same room or space.

E. Return diffuser, grille, and register styles:
1. RR-3, Return Register Style 3:
a. Size and installation: Rectangular grille with size as indicated on the Drawings framed for surface mounting on gypsum or directly mounted on exposed ducting; provide 4 inch flanged drop frame when duct mounted.
b. Faceplate: Removable grille with fixed blades spaced at 3/4 inch; front blades parallel to long dimension with 35 degree deflection; provide gasket at frame for sealing.
c. Core: When connected to ducting, provide suitable rectangular or round neck to match ducting; when filter indicated on the Drawings, provide 1-inch deep filter frame and hinged face with 1/4-turn fasteners.
d. Damper: When connected to ducting, provide opposed blade volume control damper suitable for use with ducting type; damper to be adjustable through the face of the unit.

e. Materials: Aluminum frame, core, damper, and faceplate.
f. Manufacturers: The following or equal:
1) Titus, Model 350FL or Model 350FF1.

2.03 SCREENS

A. Characteristics and features:
1. Bird screen: 1/2-inch mesh by 14 gauges.
2. Insect screens: 18 by 14 mesh.
3. Screens and frames, same material as ductwork, hood, louver, fan, or equipment connected to screen.
4. Screens secured in frames.

2.04 FLEXIBLE CONNECTIONS

A. Provide flexible duct connectors at all connections to fans and other air movement equipment as indicated on the Drawings.

B. FL-2, Duct to Duct Flexible Connection, Corrosive Environment:
1. Fabric for flexible connections exposed to chemicals shall be glass fabric coated with Teflon and suitable for a temperature range of -10 degrees Fahrenheit to 500 degrees Fahrenheit and shall have a weight of at least 14 ounces per square yard and a thickness of 0.014-inch.
2. Manufacturers: The following or equal:
a. Ventfabrics, “Ventel”.

PART 3 EXECUTION

3.01 PREPARATION

A. Before installation, remove dust and debris from ducts and accessories.

3.02 INSTALLATION

A. Install items in accordance with manufacturer’s instructions.

B. FL-2, Flexible Connections:
1. Install at building expansion joints and as indicated on the Drawings.
2. Install with collar and metal band to form airtight joints.
3. Install with minimum 4 inches of slack in fabric.
4. Exterior locations: Install sheet metal weather cover over fabric.
5. Duct alignment shall be a maximum of 1/2-inch offset.
6. The minimum/maximum gap shall be 2-inches and 6-inches.
7. Lap longitudinal joints and glue per manufacturer’s recommendations.

3.03 FIELD QUALITY CONTROL

A. Set grilles, dampers, and diffusers to achieve flows and flow patterns indicated on the Drawings and test finished system as specified in Section 15954 - Testing, Adjusting, and Balancing for HVAC.

B. Mark final balance positions on all manual damper actuators with paint pen in a distinctive color.

END OF SECTION

SECTION 15830

FANS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Fans, including:
   1. Type 14 - Centrifugal sidewall exhaust fans.

1.02 REFERENCES

A. American Bearing Manufacturers Association (ABMA):
   1. 9, Load Ratings and Fatigue Life for Ball Bearings.
   2. 11, Load Ratings and Fatigue Life for Roller Bearings.

B. Air Movement and Control Association International, Inc. (AMCA):
   1. 210, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating.
   2. 211, Certified Rating Program- Product Rating Manual for Fan Air Performance.
   3. 300, Reverberant Room Method for Sound Testing of Fan.
   4. 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

C. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
   1. 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
   2. 68 - Laboratory Methods of Testing to Determine Sound Power in a Duct.

D. ASTM International (ASTM):
   1. A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
   2. D4167 - Standard Specification for Fiber Reinforced Plastic Fans and Blowers.
   3. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

E. National Electrical Code (NEC).

F. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

G. National Fire Protection Association (NFPA):
   1. 90A - Standard for Installation of Air Conditioning and Ventilating Systems.
   2. 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

H. National Roofing Contractors Association (NRCA).

I. Occupational Safety and Health Administration (OSHA).

J. Underwriters' Laboratories, Inc. (UL).

1.03 DEFINITIONS

A. As used in this Section and on the drawings, abbreviations and Fan Schedule headings have the following meaning:
   1. SF or SPF: Supply Fan.
   2. EF or EXF: Exhaust Fan.
   3. Type: Fan type as specified in this Section.
   4. SP or ESP: Fan External Static Pressure in inches water column.
   5. Size: Nominal fan blade or wheel diameter in inches.
   6. Hp: Fan motor horsepower.
   7. V/Ph: Fan motor voltage and power phases.

B. NEMA:
   1. Type 1 enclosure in accordance with NEMA 250.
   2. Type 3R enclosure in accordance with NEMA 250.

1.04 SYSTEM DESCRIPTION

A. Design requirements:
   1. Provide fans that have sharply rising pressure characteristics which extend throughout the operating range and continue to rise beyond the efficiency peak.
   2. Provide fans that peak as close as possible to the maximum efficiency and whose operating range is within the normal fan selection range.
   3. When scheduled, provide guided vibration isolator for fans, so that not more than 10 percent of the vibration amplitude of the fan and motor is transmitted to the supporting structure.
   4. Design fan inner scroll and air stream surfaces to maintain smoothness for entire fan service life.
   5. Seismic supports: Seismic design criteria as specified in Section 01612 - Seismic Design Criteria.
   6. Wind supports for exterior units: Wind design criteria as specified in Section 01614 - Wind Design Criteria.
   7. Electrical components: UL listed and meeting the design and installation requirements of the NEC.
   8. Applicable portions as specified in Section 15050 - Common Work Results for Mechanical Equipment.
   9. Motors supplied with fans: TEFC, IEEE 841 Compliant, NEMA premium efficiency, Class F insulation, Class B temperature rise, 1.15 service factor; provide motor voltage phases and speed as scheduled; non-overloading on any point of the fan curve including belt losses.
   10. Roof curbs: Designed in accordance with NRCA standards.
   11. Insulation and adhesives: Meet NFPA 90A requirements for flame spread and smoke generation.
   12. Belt drive systems: Adjustable for minimum within 5 percent speed change, rated for 1.5 times maximum horsepower motor available for the scheduled fan size or model.

13. Screens: Provide bird or insect screen as specified with the fan type or as listed on the Fan Schedule:
    a. Bird screen: Stainless steel; 0.5-inch mesh 18-gauge.
    b. Insect screen: Stainless steel mesh and frame.
14. Finishes: When not specified with fan type, coat ferrous metals as specified in Section 09960 - High-Performance Coatings.
15. Accessories: Provide accessories specified and those scheduled.
16. Provide fans with fire/smoke control system as specified under paragraph Fire/Smoke Control System Design Requirements.

B. Performance requirements:
    1. Performance requirements are included in the Fan Schedule located at the end of this Section.
    2. Fan performance: Rated and licensed to bear the AMCA label in accordance with AMCA 210 and AMCA 211.
    3. Total sound power levels in the 8 octave band range as measured in accordance with ASHRAE 68, AMCA 301, or AMCA 300 as appropriate for each fan: Not to exceed the lesser of the following or the Sones levels on the Fan Schedule.

Sound Power Level, decibel levels referenced to 10-12 watts								
Frequency, Hz	63	125	250	500	1,000	2,000	4,000	8,000
General	100	98	94	88	84	84	78	75

    4. Air filters supplied with fans: 25 to 30 percent dust spot efficiency when rated per ASHRAE Testing Standard 52.2.
    5. Bearings: Rated per ABMA 9 or 11 for a L10 life rating of not less than 50,000 hours; provide greater life when specified with each fan type.

C. Electrical and control system design:
    1. Design and supply necessary electrical power and control systems, components, and wiring to make a complete functioning system. Design to perform the system ventilating functions with the control systems as specified in Section 15936 - Instrumentation and Control Devices for HVAC or as indicated on the Drawings and as specified in the following Sections:
        a. Section 16050 - Common Work Results for Electrical.
        b. Section 16060 - Grounding and Bonding.
        c. Section 16075 - Identification for Electrical Systems.
        d. Section 16123 - 600-Volt or Less Wires and Cables.
        e. Section 16130 - Conduits.
        f. Section 16222 - Low Voltage Motors up to 500 Horsepower.

D. Fire control system design requirements:
    1. Provide all supply, exhaust, and odor control fans greater than or equal to 2,000 cubic feet per minute with smoke control system including the following minimum components:
        a. Duct or fan mounted smoke detector as specified in Section 15936 - Instrumentation and Control Devices for HVAC.
        b. Fan interlock to shut down fan upon smoke detection.

c. Signals for fans and smoke detectors to and from local fire alarm control panel if a fire alarm control panel is part of project design.
d. Provide all wire, conduit, end of line resistors, and other electrical equipment for complete functioning smoke control system. Provide in conformance with the electrical, mechanical, and instrumentation Drawings. When no electrical design for smoke control system is indicated, Contractor shall provide design and installation of the smoke control system.

1.05 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data:
1. Materials.
2. Primary and ancillary equipment.
3. Sound Power Level in each of 8 octave bands and overall Sones.
4. Fan system layout, mechanical, electrical power, and control diagrams.
5. Supports, vibration isolators, and seismic bracing calculations and details.
6. Calculated fan vibration levels and field-testing method.
7. Bearing life.
8. Fan performance curves showing specified operating condition.

C. Provide vendor operation and maintenance manual as specified in Section 01782 - Operation and Maintenance Data:
1. Furnish bound sets of installation, operation, and maintenance instructions for each type fan.

D. Provide Manufacturer’s Certificate of Source Testing as specified in Section 01756 - Commissioning.

1.06 QUALITY ASSURANCE

A. Provide fans:
1. Listed by UL.
2. Rated in accordance with AMCA.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver units in 1 piece, factory assembled, internally wired, and lubricated.

B. Protect equipment from dust and atmospheric exposure as recommended by the unit manufacturer:
1. As a minimum provide temporary closures for equipment openings designed for airflow.

1.08 EXTRA MATERIALS

A. Provide 1 extra set of belts per installed fan for fans specified with belt drives.

PART 2 PRODUCTS

2.01 TYPE 14, CENTRIFUGAL SIDEWALL EXHAUST FANS

A. Manufacturers: One of the following or equal:
   1. Greenheck, Model CUBE - Wall Mounted.
   2. Loren Cook, Model ACWB.
   3. Penn Ventilator.

B. Characteristics:
   1. Wall-mounted, upblast circular exhaust fan unit.
   2. Backward inclined centrifugal fan wheel with Venturi inlet; performance as scheduled.
   3. Materials: Aluminum fan, housing, and accessories.
   4. Fan bearings: Permanently lubricated ball bearing type.
   5. Adjustable belt drive rated for 150 percent of motor horsepower.
   6. Motor characteristics: As scheduled.
   7. Finishes: Polyester finish on fan and all accessories equal to Greenheck Hi-Pro Polyester or equal.
   8. Provide duct adapter.
   9. Provide other accessories as scheduled.

C. Accessories:
   1. Mounting brackets: Necessary for installation.
   2. Bird screen: Provide bird screen if no screen is listed on the Fan Schedule.

2.02 SOURCE QUALITY CONTROL

A. Factory test fans listed on the Fan Schedule for proper operation, performance, and electrical controls.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine and verify that Work is in condition to receive installation specified in this Section.

B. Take measurements and verify dimensions to ascertain fit of installation.

C. Ascertain support and openings are correctly located.

3.02 PREPARATION

A. Before installation, remove dust and debris from equipment and ducts.

B. During installation and until equipment is operated, protect equipment and ducts from dust and debris by covering openings with tape or plastic.

3.03 INSTALLATION

A. Observe applicable installation requirements as specified in Section 15050 - Common Work Results for Mechanical Equipment.

B. Anchoring and support:
   1. Provide anchoring and support for fans and appurtenances.
   2. Provide anchoring to sustain seismic and wind forces as specified in Sections 01612 - Seismic Design Criteria and 01614 - Wind Design Criteria.

C. Adjust alignment of ducts where necessary to resolve conflicts with architectural features or to resolve conflicts with the work of other trades.

D. Install and wire unit fans and controls in accordance with manufacturer's recommendations.

E. Install flexible connections to fans.

F. Install roof curb and fan as recommended by fan manufacturer.

G. For fan housings with threaded water trap drain, provide drain piped from fan housing to the nearest drain channel, floor drain, or sump.

3.04 FIELD QUALITY CONTROL

A. Test equipment and installation to verify tightness, operation, and unit vibration is within manufacturer's submitted maximum.

B. Test equipment performance and balance equipment as specified in Section 15954 - Testing, Adjusting, and Balancing for HVAC.

3.05 COMMISSIONING

A. As specified in Section 01756 - Commissioning, 15958 - Mechanical Equipment Testing, and this Section.

3.06 SCHEDULES

A. Refer to Drawings for Fan Schedule.

END OF SECTION

SECTION 15852

LOUVERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Stationary weather louvers.

1.02 REFERENCES

A. Air Movement and Control Association International, Inc. (AMCA):
   1. 500-L - Laboratory Methods of Testing Louvers for Rating.
   2. 500-D - Laboratory Methods of Testing Dampers for Rating.
   3. 511 - Certified Ratings Program - Product Rating Manual for Air Control Devices.

B. ASTM International (ASTM):
   1. D2584 - Standard Test Method for Ignition Loss of Cured Reinforced Resins.

C. Underwriters Laboratories, Inc. (UL).

1.03 PERFORMANCE REQUIREMENTS

A. Performance: In accordance with AMCA 511 when tested in accordance with AMCA 500.

B. Designed for 20 pounds per square foot wind load.

1.04 SUBMITTALS

A. Shop drawings: Include dimensions, anchorage details, and relationships to adjacent materials.

B. Product data.

1.05 QUALITY ASSURANCE

A. Provide louvers with the following, unless otherwise specified:
   1. AMCA certification and rating in accordance with AMCA 511 for air performance and water penetration.

PART 2 PRODUCTS

2.01 GENERAL

A. Louver types: Louvers are marked on the drawings with a letter L followed by a number referring to a louver type in this Section. Individual louver size and airflow rates are as indicated on the Drawings.

B. Accessories:
   1. Provide installation clips and flanged or jamb-mounting styles suitable for the mounting locations as indicated on the Drawings.
   2. Provide extended sills for louvers indicated as installed recessed from the exterior wall surface.
   3. Provide stainless steel fasteners unless noted otherwise.
   4. Corrosion protection.
   5. Provide gravity damper for all outside air intake and exhaust louvers unless noted otherwise.

C. Protective coatings for aluminum in contact with concrete or masonry:
   1. Manufacturers: One of the following or equal:
      a. Koppers Co., Inc.
      b. Tarmastic 100.
      c. Porter Coatings.

2.02 STATIONARY WEATHER LOUVERS, TYPE L-1

A. Manufacturers: One of the following or equal:
   1. Greenheck, Model ESD-603.
   2. Ruskin, Model ELF 6375DXH.
   3. Airolite Co., equivalent product.

B. Requirements:
   1. Type: Stationary louver with drainable blades.
   2. Frame: 6 inches deep, minimum 0.125-inch thick, Type 6063-T5 aluminum with downspouts and caulking channel provided.
   3. Blades: Minimum 0.125-inch thick, Type 6063-T5 aluminum drainable blades spaced at 6-inch centers, stationary mounted at 37.5 degrees.
   4. Screens: Removable aluminum frame with aluminum wire; insect screens on intakes and bird screens on exhausts.
   5. Pressure drop (without screen): Maximum 0.15-inch water column for exhaust service and 0.15-inch water column for intake service at 1,000 feet per minute free area velocity.
   6. Water penetration: Maximum 0.01-ounce water per square foot at 1,027 feet per minute free area velocity.
   7. Mullions: Hidden.
   8. Finish: Kynar finish**;** color as selected by Owner or Architect.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install louvers in accordance with manufacturer's instructions; caulk all frames to make weathertight.

B. Install louvers for machinery, engines, and similar equipment to allow easy louver removal for machinery or engine removal through the louver opening space without louver projections on floors or walls.

C. Anchor louvers to concrete or masonry with concrete anchors through jambs.

D. Corrosion protection:
   1. Aluminum in contact with concrete or masonry: Apply 2 coats bitumastic black solution.
   2. Aluminum in contact with dissimilar metal, except stainless steel: Isolate from dissimilar metal with neoprene gaskets, sleeves, or washers. Utilize stainless steel fasteners.
   3. Field-testing: As specified in Section 15954 - Testing, Adjusting, and Balancing for HVAC.

END OF SECTION

SECTION 15936

INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Controls for Heating, Ventilating, and Air Conditioning (HVAC) Systems:
   1. Thermostats.
   2. Airflow switches.
   3. HVAC control descriptions.

1.02 REFERENCES

A. CSA International (CSA).

B. National Electrical Code (NEC).

C. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 Volts Maximum).

D. National Fire Protection Association (NFPA):
   1. 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

E. Underwriters' Laboratories, Inc. (UL):
   1. 268A - Standard for Smoke Detectors for Duct Application.
   2. 1479 - Fire Tests of Through-Penetration Firestops.

F. California Code of Regulations (CCR):
   1. Title 24 - Building Standard Code.

1.03 SYSTEM DESCRIPTION

A. General requirements:
   1. All electrical components shall be UL-listed and meet the design and installation requirements of the NEC.
   2. Complete, functional system: Provide all necessary electrical power and control systems, components, and wiring to make a complete functioning system.
   3. Comply with electrical Sections for electrical power and control systems.
   4. System control functions to perform as described in Products.
   5. Materials: New, free from defects, and of the quality specified.
   6. Common manufacturer: Provide components, component accessories, and devices, as much as possible, by the same manufacturer throughout the work.
   7. Mounting: Mount control components and devices in accessible locations for maintenance and as recommended by the manufacturer; provide necessary

manufacturer-approved mounting and configuration hardware for mounting and operation of control components and devices.

8. Components and systems must in accordance with CCR Title 24 energy conservation regulations and be listed with the California Energy Commission as approved for sale in California.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Product data: As specified in Section 15050 - Common Work Results for Mechanical Equipment.

C. Shop drawings:
   1. Manufacturer's information including:
      a. Catalog information clearly marked to show specific products, models, and sizes being furnished.
      b. Component cut sheets.
   2. Provide certification that components and systems meet CCR Title 24 and are approved by the California Energy Commission.

1.05 QUALITY ASSURANCE

A. The control system shall be designed in accordance with UL and CSA standards.

B. Regulatory requirements: In accordance with CCR Title 24.

1.06 DELIVERY, STORAGE, AND HANDLING

A. The system control products shall be stored and handled per manufacturer's recommendations.

1.07 SITE CONDITIONS

A. Elevation and ambient conditions as specified in Section 01610 - Project Design Criteria.

1.08 WARRANTY

A. Special warranties: Warranty period begins at date of Project Acceptance or first date of Beneficial Use by the Owner:
   1. 1 year: Parts and on-site labor for components, systems, and programming.

PART 2 PRODUCTS

2.01 THERMOSTATS

A. General:
   1. Thermostat types: Thermostat types are called out on the drawings by the letter T followed by a number; this designation refers to the specified thermostat types specified in this Section; where no type is called out, provide

1 of the specified types that will match the controlled equipment requirements and provide a functioning system.
2. Manufacturers: One of the following or equal:
   a. Johnson Controls, model as specified with each type.
   b. Honeywell, Tradeline, equivalent models.

B. T-2, Type 2 Thermostat, Cooling Only, Line Voltage:
1. Johnson Controls Model:
   a. Dry locations (no hose bibs or open water processes in room): Model A19BBC-2 in NEMA 1 enclosure.
   b. Wet locations (hose bibs or open water processes in room): Model A19KNC-1 in rain and dusttight enclosure.
2. Switch action: Single-pole double-throw, close on rising temperature.
3. Sensing element: Coiled bulb and capillary.
4. Setpoint: 30 to 110 degrees Fahrenheit with knob adjuster and visible scale.
5. Electrical ratings: 16 amps alternating current at 120 volts, 9.2 amps alternating current at 208 volts.
6. Differential range: For dry locations, 3 to 12 degrees Fahrenheit adjustable; for wet locations, 5 degrees Fahrenheit fixed.

2.02 HVAC CONTROL DESCRIPTIONS

A. General: Provide control systems that will maintain room or area comfort under changing ambient conditions and varying use; descriptions in this Section are general in nature and do not cover every mode of operation.

B. Storage Building HVAC Control Description (Area 22):
1. The storage building will be ventilated by a wall mounted exhaust fan, 22-EF-2201, and intake louvers. The building will be heated by wall mounted electric unit heaters, 22-EUH-2202 and 22-EUH-2203.
2. The exhaust fan will be provided with an H-O-A switch and in “auto” mode will be controlled by a Type 2 thermostat. The thermostat setpoint will be 85 degrees Fahrenheit so that when the room temperature rises above the setpoint, the exhaust fan will energize and ventilate the area.
3. The electric unit heaters will each be controlled by their own thermostat. The thermostat setpoint will be 55 deg F so that when the room temperature drops below the setpoint, the heaters will energize and heat the area.

C. Filter Support Building - Compressor Room HVAC Control Description (Area 7):
1. The compressor room in the filter support building will be provided with a new wall mount exhaust fan, 07-EF-002, to directly ventilate and remove heat off of the existing air compressors.
2. The exhaust fan will be provided with an H-O-A switch and in “auto” mode will be controlled by the Plant PLC to interlock the fan with the compressors as follows:
   a. The Plant PLC receives a running status from each of the two compressors.
   b. When one or both of the compressors are running, the Plant PLC will send a signal to energize the exhaust fan.
   c. When none of the compressors are running, the exhaust fan shall not be energized (unless in “hand” mode).

PART 3 EXECUTION

3.01 PREPARATION

A. Before installation remove dust and debris from equipment and accessories.

B. During installation and until equipment is operated, protect equipment and accessories from dust and debris.

3.02 INSTALLATION

A. Install as indicated on the Drawings, in accordance with NFPA 90A, and per the manufacturer's written instructions.

B. Coordinate installation of HVAC control systems with other trades:
   1. Prior to installation, coordinate wiring and conduit requirements with electrical subcontractor.

C. Mount remote annunciator and test station on wall near smoke detector:
   1. Devices shall be easily accessible from floor level.
   2. Label annunciator and test station.

D. Provide all electrical work to support smoke detector:
   1. Coordinate with electrical subcontractor.

E. Sensor and control station mounting:
   1. Where not otherwise indicated, mount 5 feet above floor or walking level.
   2. Provide insulating back plates when mounting is on an exterior wall or a wall adjoining an unconditioned space.
   3. Shield outside thermostats or sensors from the sun; provide thermostats with remote bulb and compensated capillary.
   4. Install locking covers where indicated on the Drawings.

3.03 COMMISSIONING

A. As specified in Section 01756 - Commissioning and this Section.

B. Functional testing:
   1. HVAC Instrumentation and Controls:
      a. Test witnessing: Witnessed.
      b. Test each control component and system as part of HVAC system testing, adjusting, and balancing as specified in Section 15954 - Testing, Adjusting, and Balancing for HVAC.

END OF SECTION

SECTION 15954

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Heating, ventilation, and air conditioning systems testing, adjusting, and balancing.

1.02 REFERENCES

A. Associated Air Balance Council (AABC):
   1. National Standards for Field Measurements and Instrumentation, Total System Balance, Air Distribution Systems.

B. National Environmental Balancing Bureau (NEBB):
   1. Procedural Standards for Testing, Adjusting, and Balancing Environmental Systems.

C. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   1. Heating, Ventilating, and Air Conditioning Systems - Testing, Adjusting, and Balancing.

D. Testing, Adjusting, and Balancing Bureau (TABB):
   1. International Standards for Environmental Systems Balance.

1.03 TESTING, ADJUSTING, AND BALANCING WORK REQUIREMENTS

A. Procure the services of an independent air balance and testing agency belonging to and in good standing with the AABC, NEBB, or the TABB to perform air balancing, testing, and adjustment of building and process air conditioning, heating, and ventilating air systems.

B. The Work includes: Balancing new air systems installed as part of this contract and existing air systems affected by the installation of new equipment.

C. Perform testing of heating, ventilating, and air conditioning equipment, balancing of distribution systems, and adjusting of air terminal units and ductwork accessories to ensure compliance with Specifications and Drawings. Perform tests for following:
   1. Heating units.
   2. Fans.
   3. Ductwork accessories.
   4. Ducting.
   5. HVAC controls.
   6. Other specified HVAC equipment.

D. Test each mode of operation of thermostats, electronic controllers, and pneumatic, electric or electronic heating, ventilating, and air conditioning instruments to ensure operation as specified.

E. Test and adjust room distribution patterns at air outlets.

F. Provide instruments required for testing, adjusting, and balancing operations; retain possession of instruments; remove instruments from site at completion of services.

G. Make instruments available to the Engineer to facilitate spot checks during testing.

H. Provide test holes for pressure and pitot flow measurements; provide plugs for all test holes after testing.

1.04 QUALITY ASSURANCE

A. Test, balance, and adjust environmental systems in accordance with either:
   1. AABC: National Standards for Field Measurements and Instrumentation, Total Systems Balance, Air Distribution-Hydronic System.
   2. NEBB: Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
   3. TABB: International Standards for Environmental Systems Balance.

B. Perform services under direction of AABC, NEBB, or TABB certified supervisor.

C. Calibrate and maintain instruments in accordance with requirements of standards. Make calibration histories of instruments available for examination.

D. Make measurements in accordance with accuracy requirements of standards.

E. Testing, adjusting, and balancing performance requirements:
   1. Comply with procedural standards of certifying association.
   2. Execute each step of prescribed testing, balancing, and adjusting procedures without omission.
   3. Accurately record required data.
   4. Make measurements in accordance with recognized procedures and practices of certifying association.
   5. Measure air volume discharged at each outlet and adjust air outlets to design air volumes within 5 percent over.

1.05 SUBMITTALS

A. Resumes of proposed supervisor and personnel showing training and qualifications.

B. Interim reports: At least 30 days prior to starting field work, submit the following:
   1. Set of report forms filled out as to design flow values and installed equipment pressure drops, and required cubic feet per minute for air terminals.
   2. Develop heating, ventilating, and air conditioning system schematic similar to Figure 6-1 in SMACNA Testing, Adjusting, and Balancing.
   3. Complete list of instruments proposed to be used, organized in appropriate categories, with data sheets for each showing:
      a. Manufacturer and model number.
      b. Description and use when needed to further identify instrument.

c. Size or capacity range.
d. Latest calibration date.

C. Final report: At least 15 days prior to Contractor's request for final inspection, submit 3 copies of final reports, on applicable reporting forms. Include:
1. Identify instruments which were used and last date of calibration of each.
2. Procedures followed to perform testing, adjusting, and balancing.
3. Identification and succinct description of systems included in report.
4. Initial balance test results made with all dampers and air control devices in full open positions.
5. Description of final locations and sizes, including opening area and dimensioned configuration of orifices and other restrictions used to achieve final balanced flows.
6. Description of final location and opening positions of dampers, registers, louvers, and valves.
7. Schematics of systems included in report; use schematics as part of testing, adjusting, and balancing report to summarize design and final balanced flows.
8. Testing, adjusting, and balancing report forms.
9. Final field results established for system balancing including airflow, fan speeds, and fan static pressures at the fan inlet and outlet.
10. Appendices.
11. Include appendices for:
a. Raw field data taken during testing.
b. Sample calculation sheet for each type of calculation made to convert raw field data to final results.
c. Initial air balance results with dampers and registers in full open position; include airflow at all inlets and outlet, initial fan speed and fan suction and discharge pressures.

D. Proposed schedule for testing and balancing.

E. Provide Manufacturer’s Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

1.06 SITE CONDITIONS

A. Prior to start of testing, adjusting, and balancing, verify that:
1. Systems installation is complete and in full operation.
2. Outside conditions are within reasonable range relative to design conditions.
3. Lighting fixtures are energized.
4. Special equipment such as computers, laboratory equipment, and electronic equipment are in full operation.
5. Requirements for preparation for testing and balancing have been met for elements of each system which require testing.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

A. Perform Functional Tests as specified in Section 01756 - Commissioning.

B. Testing, adjusting, and balancing acceptance criteria: Consider testing, adjusting, and balancing procedures successful and complete when heating, ventilating, and air conditioning systems and components are functioning properly and system air flows are within specified tolerances of design flows.

3.02 TESTING, ADJUSTING, AND BALANCING

A. Test, adjust, and balance separate complete heating, ventilating, and air conditioning systems.

B. Include in testing, adjusting, and balancing related existing heating, ventilating, and air conditioning components.

C. Perform testing, adjusting, and balancing cycles until airflows meet acceptance criteria:
   1. Ascertain airflow balance between overall requirements and flow in individual supply and exhaust grilles.

D. Initial testing, adjusting, and balancing: Perform first test on each system with dampers, grilles, orifices, and other variable airflow devices in their full open position; measure and report initial airflows, fan speed, and fan static pressures at fan inlet and outlet:
   1. Adjust total system flow downward or upward by adjusting fan speed until 1 inlet or outlet is at indicated flow and all other flows exceed indicated flows.
   2. Adjust fan speed by changing fan drives or sheaves as necessary.

E. Subsequent testing, adjusting, and balancing: Perform adjustments in subsequent testing, adjusting, and balancing by adjusting dampers, louvers, or size of orifices or plates:
   1. Measure and record air volume discharged at each inlet and outlet and adjust air inlets and outlets to design air volumes within 0 to 5 percent over design rates.
   2. Adjust fan speeds and motor drives within drive limitations, for required air volume.
   3. Measure cubic feet per minute and static pressures and adjust air supply and exhaust fan units to deliver at least 100 to 105 percent of the design air volume.
   4. Measure and record static air pressure conditions on fans, including filter and coil pressure drops, and total pressure across the fan.
   5. Evaluate building and room pressure conditions to determine adequate supply and return air conditions.
   6. Evaluate space and zone temperature of conditions to determine adequate performance of the systems to maintain temperatures without draft.
   7. Permanently mark final balance positions of balancing dampers.

F. Develop heating, ventilating, and air conditioning system schematics similar to Figure 6-1 in SMACNA Testing, Adjusting, and Balancing.

G. Accurately record the required data on AABC, NEBB, or TABB test and balance report forms.

H. Measure amperage draw of fan and pump motors for final balance.

I. Test primary source equipment in accordance with AABC, NEBB, or TABB procedures:
   1. Primary source equipment includes items listed in this Section not previously tested as part of this testing, adjusting, and balancing work.
   2. Complete appropriate AABC, NEBB, or TABB equipment test forms for each piece of equipment.
   3. Calculate cooling and heating capacities to show conformance with specified capacities.
   4. Adjust equipment as needed to deliver specified cooling and heating loads.
   5. Record final equipment performing characteristics and adjustment settings in the final design report.

END OF SECTION

SECTION 15956

PIPING SYSTEMS TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Test requirements for piping systems.

1.02 REFERENCES

A. National Fuel Gas Code (NFGC).

B. American Society of Mechanical Engineers (ASME):
   1. B31.1 - Power Piping.
   2. B31.3 - Process Piping.
   3. B31.8 - Gas Transmission and Distribution Piping Systems.

C. Underwriters Laboratories Inc. (UL).

1.03 TESTING REQUIREMENTS

A. General requirements:
   1. Testing requirements are stipulated in Laws and Regulations; are included in the Piping Schedule in Section 15052 - Common Work Results for General Piping; are specified in the specifications covering the various types of piping; and are specified in this Section.
   2. Requirements in Laws and Regulations supersede other requirements of Contract Documents, except where requirements of Contract Documents are more stringent, including higher test pressures, longer test times, and lower leakage allowances.
   3. Test plumbing piping in accordance with Laws and Regulations, the plumbing code, as specified in Section 01410 - Regulatory Requirements, and UL requirements.
   4. Test natural gas or digester gas piping:
      a. For less than 125 pounds per square inch gauge working pressure, test in accordance with mechanical code, as specified in Section 01410 - Regulatory Requirements, or the National Fuel Gas Code, whichever is more stringent.
      b. For 125 pounds per square inch gauge or greater working pressure, test per ASME B31.3 or ASME B31.8, whichever is more stringent.
   5. When testing with water, the specified test pressure is considered to be the pressure at the lowest point of the piping section under test.
      a. Lower test pressure as necessary (based on elevation) if testing is performed at higher point of the pipe section.

B. Furnish necessary personnel, materials, and equipment, including bulkheads, restraints, anchors, temporary connections, pumps, water, pressure gauges, and other means and facilities required to perform tests.

C. Water for testing, cleaning, and disinfecting:
   1. Water for testing, cleaning, and disinfecting will be provided as specified in Section 01500 - Temporary Facilities and Controls.

D. Pipes to be tested: Test only those portions of pipes that have been installed as part of this Contract. Test new pipe sections prior to making final connections to existing piping. Furnish and install test plugs, bulkheads, and restraints required to isolate new pipe sections. Do not use existing valves as test plug or bulkhead.

E. Unsuccessful tests:
   1. Where tests are not successful, correct defects or remove defective piping and appurtenances and install piping and appurtenances that comply with the specified requirements.
   2. Repeat testing until tests are successful.

F. Test completion: Drain and leave piping clean after successful testing.

G. Test water disposal: Dispose of testing water using filter to waste, or effluent bypass to the storm drain system and the Stormwater Pump Station in accordance with requirements of federal, state, county, and city regulations governing disposal of wastes in the location of the Project and disposal site.

1.04 SUBMITTALS

A. Submit as specified in Section 01330 - Submittal Procedures.

B. Schedule and notification of tests:
   1. Submit a list of scheduled piping tests by noon of the working day preceding the date of the scheduled tests.
   2. Notification of readiness to test: Immediately before testing, notify Engineer in writing of readiness, not just intention, to test piping.
   3. Have personnel, materials, and equipment specified in place before submitting notification of readiness.

1.05 SEQUENCE

A. Clean piping before pressure or leak tests.

B. Test gravity piping underground, including sanitary sewers, for visible leaks before backfilling and compacting.

C. Underground pressure piping may be tested before or after backfilling when not indicated or specified otherwise.

D. Backfill and compact trench, or provide blocking that prevents pipe movement before testing underground piping with a maximum leakage allowance.

E. Test underground piping before encasing piping in concrete or covering piping with slab, structure, or permanent improvement.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 TESTING ALIGNMENT, GRADE, AND DEFLECTION

A. Alignment and grade:
   1. Visually inspect the interior of gravity piping with artificial light, reflected light, or laser beam.
   2. Consider inspection complete when no broken or collapsed piping, no open or poorly made joints, no grade changes that affect the piping capacity, or no other defects are observed.

B. Deflection test:
   1. Pull a mandrel through the clean piping section under test.
   2. Perform the test not sooner than 30 days after installation and not later than 60 days after installation.
   3. Use a 9-rod mandrel with a contact length of not less than the nominal diameter of the pipe within 1 percent plus or minus.
   4. Consider test complete when the mandrel can be pulled through the piping with reasonable effort by 1 person, without the aid of mechanical equipment.

3.02 AIR TESTING METHOD FOR PRESSURE PIPING

A. Air test piping, indicated with "AM" in the Piping Schedule, with air or another nonflammable or inert gas.

B. Test gas, air, liquefied petroleum gas, liquid chlorine, and chlorine gas piping by the air test method:
   1. Test chlorine piping with dry air or nitrogen having a dew point of minus 40 degrees Fahrenheit or less. Supply temporary air dryers as necessary.

C. Test at pressure as specified in Piping Schedule in Section 15052 - Common Work Results for General Piping:
   1. Provide temporary pressure relief valve for piping under test:
      a. Set at the lesser of 110 percent of the test pressure or 50 pounds per square inch gauge over the test pressure.
   2. Air method test pressures shall not exceed 110 percent of the piping maximum allowable working pressure calculated in accordance with the most stringent of ASME B31.1, ASME B31.3, ASE B31.8, or the pipe manufacturer's stated maximum working pressure.
   3. Gradually increase test pressure to an initial test pressure equal to the lesser of 1/2 the test pressure or 25 pounds per square inch gauge.
   4. Perform initial check of joints and fittings for leakage.
   5. Gradually increase test pressure in steps no larger than the initial pressure. Check for leakage; at each step increase until test pressure reached.
   6. At each step in the pressure, examine and test piping being air tested for leaks with soap solution.
   7. Consider examination complete when piping section under test holds the test pressure for 15 minutes without losses.

3.03 TESTING GRAVITY FLOW PIPING

A. Test gravity flow piping indicated with "GR" in the Piping Schedule, as follows:
   1. Unless specified otherwise, subject gravity flow piping to the following tests:
      a. Alignment and grade.
      b. For plastic piping test for deflection.
      c. Visible leaks and pressure with maximum leakage allowance, except for storm drains and culverts.
   2. Inspect piping for visible leaks before backfilling.
   3. Provide temporary restraints when needed to prevent movement of piping.
   4. Pressure test piping with maximum leakage allowance after backfilling.
   5. With the lower end plugged, fill piping slowly with water while allowing air to escape from high points. Keep piping full under a slight head for the water at least 24 hours:
      a. Examine piping for visible leaks. Consider examination complete when no visible leaks are observed.
      b. Maintain piping with water, or allow a new water absorption period of 24 hours for the performance of the pressure test with maximum leakage allowance.
      c. After successful completion of the test for visible leaks and after the piping has been restrained and backfilled, subject piping to the test pressure for minimum of 4 hours while accurately measuring the volume of water added to maintain the test pressure:
         1) Consider the test complete when leakage is equal to or less than the following maximum leakage allowances:
            a) For concrete piping with rubber gasket joints: 80 gallons per day per inch of diameter per mile of piping under test:
               (1) Advise manufacturer of concrete piping with rubber gasket joints of more stringent than normal maximum leakage allowance.
            b) For vitrified clay piping: 500 gallons per day per inch of diameter per mile of piping under test.
            c) For other piping: 80 gallons per day per inch diameter per mile of piping under test.

3.04 TESTING HIGH-HEAD PRESSURE PIPING

A. Test piping for which the specified test pressure in the Piping Schedule is 20 pounds per square inch gauge or greater, by the high head pressure test method, indicated "HH" in the Piping Schedule.

B. General:
   1. Test connections, hydrants, valves, blowoffs, and closure pieces with the piping.
   2. Do not use installed valves for shutoff when the specified test pressure exceeds the valve's maximum allowable seat differential pressure. Provide blinds or other means to isolate test sections.
   3. Do not include valves, equipment, or piping specialties in test sections if test pressure exceeds the valve, equipment, or piping specialty safe test pressure allowed by the item's manufacturer.

4. During the performance of the tests, test pressure shall not vary more than plus or minus 5 pounds per square inch gauge with respect to the specified test pressure.
5. Select the limits of testing to sections of piping. Select sections that have the same piping material and test pressure.
6. When test results indicate failure of selected sections, limit tests to piping:
   a. Between valves.
   b. Between a valve and the end of the piping.
   c. Less than 500 feet long.
7. Test piping for minimum 2 hours for visible leaks test and minimum 2 hours for the pressure test with maximum leakage allowance.

C. Testing procedures:
1. Fill piping section under test slowly with water while venting air:
   a. Use potable water for all potable waterlines and where noted on the Piping Schedule.
2. Before pressurizing for the tests, retain water in piping under slight pressure for a water absorption period of minimum 24 hours.
3. Raise pressure to the specified test pressure and inspect piping visually for leaks:
   a. Consider visible leakage testing complete when no visible leaks are observed.

D. Pressure test with maximum leakage allowance:
1. Leakage allowance is zero for piping systems using flanged, National Pipe Thread threaded and welded joints.
2. Pressure test piping after completion of visible leaks test.
3. For piping systems using joint designs other than flanged, threaded, or welded joints, accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period:
   a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage and no damage to piping and appurtenances has occurred.
   b. Successful completion of the pressure test with maximum leakage allowance shall be achieved when the observed leakage during the test period is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.
   c. When leakage is allowed, calculate the allowable leakage by the following formula:

      $L = S \times D \times P^{1/2} \times 133{,}200^{-1}$

      wherein the terms shall mean:

      L = Allowable leakage in gallons per hour.

      S = Length of the test section in feet.

      D = Nominal diameter of the piping in inches.

P = Average observed test pressure in pounds per square inches gauge, at the lowest point of the test section, corrected for elevation of the pressure gauge.

x = The multiplication symbol.

3.05 TESTING LOW-HEAD PRESSURE PIPING

A. Test piping for which the specified test pressure is less than 20 pounds per square inch gauge, by the low head pressure test method, indicated "LH" in the Piping Schedule.

B. General:
   1. Test pressures shall be as scheduled in Section 15052 - Common Work Results for General Piping.
   2. During the performance of the tests, test pressure shall not vary more than plus or minus 2 pounds per square inch gauge with respect to the specified test pressure.
   3. Test connections, blowoffs, vents, closure pieces, and joints into structures, including existing bell rings and other appurtenances, with the piping.
   4. Test piping for minimum 2 hours for visible leaks test and minimum 2 hours for the pressure test with maximum leakage allowance.

C. Visible leaks test:
   1. Subject piping under test to specified pressure measured at the lowest end.
   2. Fill piping section under test slowly with water while venting air:
      a. Use potable water for all potable waterlines and where noted on the Piping Schedule.
   3. Before pressurizing for the tests, retain water in piping under slight pressure for the water absorption period of minimum 24 hours.
   4. Raise pressure to the specified test pressure and inspect piping visually for leaks. Consider testing complete when no visible leaks are observed.

D. Pressure test with maximum leakage allowance:
   1. Pressure test piping after completion of visible leaks test.
   2. Accurately measure the makeup water necessary to maintain the pressure in the piping section under test during the pressure test period:
      a. Consider the pressure test to be complete when makeup water added is less than the allowable leakage of 80 gallons per inch of nominal diameter, per mile of piping section under test after 24 hours, and no damage to piping and appurtenances has occurred.
      b. Successful completion of the leakage test shall have been achieved when the observed leakage is equal or less than the allowable leakage and no damage to piping and appurtenances has occurred.

E. Optional joint test:
   1. When joint testing is allowed by note in the Piping Schedule, the procedure shall be as follows:
      a. Joint testing will be allowed only for low head pressure piping.
      b. Joint testing does not replace and is not in lieu of any testing of the piping system or trust restraints.
   2. Joint testing may be performed with water or air.

3. Joint test piping after completion of backfill and compaction to the top of the trench.
4. Joint testing with water:
    a. Measure test pressure at the invert of the pipe. Apply pressure of 4 feet plus the inside diameter of the pipe in water column within 0.20 feet in water column.
    b. Maintain test pressure for 1 minute.
    c. Base the allowable leakage per joint on 80 gallons per inch nominal diameter, per mile of piping, per 24 hours equally distributed to the actual number of joints per mile for the type of piping.
    d. Consider the pressure test to be complete when makeup water added is less than the allowable leakage.
    e. Successful completion of the joint test with water shall have been achieved when the observed leakage is equal or less than the allowable leakage.
5. Joint testing with air:
    a. Apply test pressure of 3 pounds per square inch gauge with a maximum variation of plus 0.20 and minus 0.00 pounds per square inch.
    b. Maintain test pressure for 2 minutes.
    c. Consider the pressure test to be complete when the test pressure does not drop below 2.7 pounds per square inch for the duration of the test.

END OF SECTION

SECTION 15958

MECHANICAL EQUIPMENT TESTING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Testing of mechanical equipment and systems.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. S1.4 Specification for Sound Level Meters.

B. Hydraulic Institute (HI).

C. National Institute of Standards and Technology (NIST).

1.03 SUBMITTALS

A. Project closeout documents:
   1. Provide vendor operation and maintenance manual as specified in Section 01782 - Operation and Maintenance Data:
      a. Include motor rotor bar pass frequencies for motors larger than 500 horsepower.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 GENERAL

A. Commissioning of equipment as specified in:
   1. This Section.
   2. Section 01756 - Commissioning.
   3. Equipment sections:
      a. If testing requirements are not specified, provide Level 1 Tests.

B. Test and prepare piping as specified in Section 15956 - Piping Systems Testing.

C. Operation of related existing equipment:
   1. Owner will operate related existing equipment or facilities necessary to accomplish the testing.
   2. Schedule and coordinate testing as required by Section 01756 - Commissioning.

D. Provide necessary test instrumentation that has been calibrated within 1 year from date of test to recognized test standards traceable to the NIST or approved source:
   1. Properly calibrated field instrumentation permanently installed as a part of the Work may be utilized for tests.
   2. Prior to testing, provide signed and dated certificates of calibration for test instrumentation and equipment.

E. Test measurement and result accuracy:
   1. Use test instruments with accuracies as recommended in the appropriate referenced standards. When no accuracy is recommended in the referenced standard, use 1 percent or better accuracy test instruments:
      a. Improved (lower error tolerance) accuracies specified elsewhere prevail over this general requirement.
   2. Do not adjust results of tests for instrumentation accuracy.
      a. Measured values and values directly calculated from measured values shall be the basis for comparing actual equipment performance to specified requirements.

3.02 VARIABLE SPEED EQUIPMENT TESTS

A. Establish performance over the entire speed range and at the average operating condition.

B. Establish performance curves for the following speeds:
   1. The speed corresponding to the rated maximum capacity.
   2. The speed corresponding to the minimum capacity.
   3. The speed corresponding to the average operating conditions.

3.03 PUMP TESTS, ALL LEVELS OF TESTING

A. Test in accordance with the following:
   1. Applicable HI Standards.
   2. This Section.
   3. Equipment sections.

B. Test tolerances: In accordance with appropriate HI Standards, except the following modified tolerances apply:
   1. From 0 to plus 5 percent of head at the specified flows.
   2. From 0 to plus 5 percent of flow at the rated design point head.
   3. No negative tolerance for the efficiency at the specified flows.
   4. No positive tolerance for vibration limits. Vibration limits and test methods in HI Standards do not apply, use limits and methods specified in this or other Sections of the Specifications.

3.04 DRIVERS TESTS

A. Test motors as specified in Section 16222 - Low Voltage Motors up to 500 Horsepower.

B. Test other drivers as specified in the equipment section.

3.05 NOISE REQUIREMENTS AND CONTROL

A. Perform noise tests in conjunction with vibration test analysis.

B. Make measurements in relation to reference pressure of 0.0002 microbar.

C. Make measurements of emitted noise levels on sound level meter meeting or exceeding ANSI S1.4, Type II.

D. Set sound level meter to slow response.

E. Unless otherwise specified, maximum free field noise level not to exceed 85 dBA measured as sound pressure level at 3 feet from the equipment.

3.06 PRESSURE TESTING

A. Hydrostatically pressure test pressure containing parts at the appropriate standard or code required level above the equipment component specified design pressure or operating pressure, whichever is higher.

3.07 INSPECTION AND BALANCING

A. Statically and dynamically balance each of the individual rotating parts as required to achieve the required field vibration limits.

B. Statically and dynamically balance the completed equipment rotating assembly and drive shaft components.

C. Furnish copies of material and component inspection reports including balancing reports for equipment system components and for the completed rotating assembly.

D. Critical speed of rotating equipment:
   1. Satisfy the following:
      a. The first lateral and torsional critical speed of all constant, variable, and 2-speed driven equipment that is considered rigid such as horizontal pumps, all non-clog pumps, blowers, air compressors, and engines shall be at least 25 percent above the equipment's maximum operating speed.
      b. The first lateral and torsional critical speed of all constant, variable, and 2-speed driven equipment that is considered flexible or flexibly mounted such as vertical pumps (vertical in-line and vertical non-clog pumps excluded) and fans shall at least 25 percent below the equipment's lowest operating speed.
      c. The second lateral and torsional critical speed of all constant, variable, and 2-speed equipment that is considered flexible or flexibly mounted shall be at least 25 percent above the maximum operating speed.

E. Vibration tests:
   1. Definitions:
      a. Root mean square: for pumps operating at speeds greater than 600 rpm, the vibration measurement shall be measured as the overall velocity in inches per second root mean square (RMS).
      b. Peak-to-peak displacement: The root means squared average of the peak-to-peak displacement multiplied by the square root of 2.

c. Peak velocity: The root mean squared average of the peak velocity multiplied by the square root of 2.
d. Peak acceleration: The root mean squared average of the peak acceleration multiplied by the square root of 2.
e. High frequency enveloping: A process to extract very low amplitude time domain signals associated with impact or impulse events such as bearing or gear tooth defects and display them in a frequency spectrum of acceleration versus frequency.
    1) Manufacturers: One of the following or equal:
        a) Rockwell Automation, Entek Group, "Spike Energy" analysis.
        b) CSI, "PeakVue."
f. Rotor bar pass frequency (RBF), for detecting loose rotor bars.
g. Low speed equipment: Equipment or components of equipment rotating at less than 600 revolutions per minute.
h. High speed equipment: Equipment and equipment components operating at or above 600 revolutions per minute.
i. Preferred operating range: Manufacturer’s defined preferred operating range (POR) for the equipment.
j. Allowable operating range: Manufacturer’s defined allowable operating range (AOR) for the equipment.

2. Vibration instrumentation requirements:
    a. Analyzers: Use digital type analyzers or data collectors with anti-aliasing filter, 12-bit A/D converter, fast fourier transform circuitry, phase measurement capability, time wave form data storage, high-frequency enveloping capabilities, 35 frequency ranges from 21 to 1,500,000 cycles per minute, adjustable fast fourier transform resolution from 400 to 6,400 lines, storage for up to one hundred 3,200 line frequency spectra, data output port, circuitry for integration of acceleration data to velocity or double integration to displacement.
        1) Manufacturers: One of the following or equal:
            a) Computational Systems Inc., (CSI) Division of Emerson Process Management, Model 2120A, Data Collector/analyzer with applicable analysis software.
            b) Pruftechnik, VIBXPERT II.
    b. Analyzer settings:
        1) Units: English, inches/second, mils, and gravitational forces.
        2) Fast fourier transform lines: Most equipment 1,600 minimum; for motors, enough lines as required to distinguish motor current frequencies from rotational frequencies, use 3,200 lines for motors with a nominal speed of 3,600 revolutions per minute; 3,200 lines minimum for High Frequency Enveloping; 1,600 lines minimum for low speed equipment.
        3) Sample averages: 4 minimum.
        4) Maximum frequency (Fmax): 40 times rotational frequency for rolling element bearings, 10 times rotational frequency for sleeve bearings.
        5) Amplitude range: Auto select but full scale not more than twice the acceptance criteria or the highest peak, whichever is lower.
        6) Fast fourier transform windowing: Hanning Window.
        7) High pass filter: Minus 3 dB at 120 cycles per minute for high speed equipment. Minus 3 dB at 21 cycles per minute for low speed equipment.

c. Accelerometers:
    1) For low speed equipment: Low frequency, shear mode accelerometer, 500 millivolts per gravitational force sensitivity, 10 gravitational force range, plus/minus 5 percent frequency response from 0.5 hertz to 850 hertz, magnetic mount:
        a) Manufacturers: One of the following or equal:
            (1) Wilcoxon Research, Model 797L.
            (2) PCB, Model 393C.
    2) For high speed equipment: General purpose accelerometer, 100 millivolts per gravitational force sensitivity, 50 gravitational force range, plus/minus 3dB frequency response range from 2 hertz to 12,000 hertz when stud mounted, with magnetic mount holder:
        a) Manufacturers: One of the following or equal:
            (1) Wilcoxon Research, Model 793.
            (2) Entek-IRD Model 943.

3. Accelerometer mounting:
    a. Use magnetic mounting or stud mounting.
    b. Mount on bearing housing in location with best available direct path to bearing and shaft vibration.
    c. Remove paint and mount transducer on flat metal surface or epoxy mount for High Frequency Enveloping measurements.
4. Vibration acceptance criteria:
    a. Testing of rotating mechanical equipment: Tests are to be performed by an experienced, factory trained, and independent authorized vibration analysis expert.
    b. Vibration displacement limits: Unless otherwise specified, equipment operating at speeds 600 revolutions per minute or less is not to exhibit unfiltered readings in excess of following:

Operating Conditions and Application Data	Overall Peak-to-Peak Displacement	
	Field, mils	Factory, mils
Operation within the POR	3.0	4.0
Operation within the AOR	4.0	5.0
Additive value when measurement location is greater than 5 feet above foundation.	2.0	2.0
Additive value for solids-handling pumps	2.0	N/A
Additive value for slurry pumps	2.0	N/A

c. Vibration velocity limits: Unless otherwise specified, equipment operating at speeds greater than 600 revolutions per minute is not to exceed the following peak velocity limits:

HI Pump Type	Horsepower	Field Test	Factory Test
		Overall RMS	Overall RMS
Horizontal Solids Handling Centrifugal Pumps	Below 33 hp	0.25	0.28
Horizontal and Vertical In-Line Centrifugal Pumps (other than Non-Clog type) Vertical Solids Handling Centrifugal Pumps	Between 33 and 100 hp	0.28	0.31
	100 hp and above	0.31	0.34
	Below 33 hp	0.30	0.33
Vertical Turbine, Mixed Flow, and Propeller Pumps (solids-handling type pumps)	Between 33 and 100 hp	0.32	0.35
	100 hp and above	0.34	0.35
Non-Solids Handling Centrifugal Pumps HI Types BB1, BB2, BB3, BB4, BB5, OH1, OH2, OH3, OH4, OH5, and OH7	Below 268 hp	0.15	0.19
	268 hp and above	0.19	0.22
Vertical Turbine, Mixed Flow, and Propeller Pumps HI Types VS1, VS2, VS3, VS4, VS5, VS6, VS7, and VS8	Below 268 hp	0.13	
	268 hp and above	0.17	
Slurry Pumps		0.25	0.30
Motors		See Applicable Motor Specification	See Applicable Motor Specification
Gear Reducers, Radial		Not to exceed AGMA 6000-B96 limits	Not to exceed AGMA 6000-B96 limits
Other Reducers, Axial		0.1	N/A

d. Equipment operation: Measurements are to be obtained with equipment installed and operating within capacity ranges specified and without duplicate equipment running.

e. Additional criteria:

1) No narrow band spectral vibration amplitude components, whether sub-rotational, higher harmonic, or synchronous multiple of running speed, are to exceed 40 percent of synchronous vibration amplitude

component without manufacturer's detailed verification of origin and ultimate effect of such excitation.

2) The presence of discernable vibration amplitude peaks in Test Level 2 or 3 vibration spectra at bearing inner or outer race frequencies shall be cause for rejection of the equipment.
3) For motors, the following shall be cause for rejection:
    a) Stator eccentricity evidenced by a spectral peak at 2 times electrical line frequency that is more than 40 percent of the peak at rotational frequency.
    b) Rotor eccentricity evidenced by a spectral peak at 2 times electrical line frequency with spectra side bands at the pole pass frequency around the 2 times line frequency peak.
    c) Other rotor problems evidenced by pole pass frequency side bands around operating speed harmonic peaks or 2 times line frequency side bands around rotor bar pass frequency or around 2 times the rotor bar pass frequency.
    d) Phasing problems evidenced by 1/3 line frequency side band spectral peaks around the 2 times electrical line frequency peak.
4) The presence of peaks in a High Frequency Enveloping spectra plot corresponding to bearing, gear or motor rotor bar frequencies or harmonics of these frequencies shall be cause for rejection of the equipment; since inadequate lubrication of some equipment may be a cause of these peaks, lubrication shall be checked, corrected as necessary and the high frequency envelope analysis repeated.

5. Vibration testing results presentation:
    a. Provide equipment drawing with location and orientation of measurement points indicated.
    b. For each vibration measurement take and include appropriate data on equipment operating conditions at the time vibration data is taken; for pumps, compressors, and blowers record suction pressure, discharge pressure, and flow.
    c. When Vibration Spectra Data required:
        1) Plot peak vibration velocity versus frequency in cycles per minute.
        2) Label plots showing actual shaft or part rotation frequency, bearing inner and outer race ball pass frequencies, gear mesh frequencies and relevant equipment excitation frequencies on the plot; label probable cause of vibration peaks whether in excess of specification limits or not.
        3) Label plots with equipment identification and operating conditions such as tag number, capacity, pressure, driver horsepower, and point of vibration measurement.
        4) Plot motor spectra on a log amplitude scale versus frequency.
    d. For low speed equipment, plot peak vibration displacement versus frequency as well as velocity versus frequency.
    e. Provide name of manufacturer and model number of the vibration instrumentation used, including analyzer and accelerometer used together with mounting type.

3.08 TESTING LEVELS

A. Level 1 Tests:
   1. Level 1 General Equipment Performance Test:
      a. For equipment, operate, rotate, or otherwise functionally test for 15 minutes minimum after components reach normal operating temperatures.
      b. Operate at rated design load conditions.
      c. Confirm that equipment is properly assembled, equipment moves or rotates in the proper direction, shafting, drive elements, and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.
   2. Level 1 Pump Performance Test:
      a. Measure flow and head while operating at or near the rated condition; for factory testing, testing may be at reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
      b. Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16222 - Low Voltage Motors up to 500 Horsepower or the applicable equipment section. Use actual driver for field tests.
      c. Record measured flow, suction pressure, discharge pressure, and make observations on bearing temperatures and noise levels.
   3. Level 1 Vibration Test:
      a. Test requirement:
         1) Measure filtered vibration spectra versus frequency in 3 perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; 1 plane of measurement to be parallel to the axis of rotation of the component.
         2) Vibration spectra versus frequency shall be in accordance with Vibration Acceptance Criteria.
      b. Equipment operating condition: Test at specified maximum speed.
   4. Level 1 Noise Test:
      a. Measure unfiltered overall A-weighted sound pressure level in dBA at 3 feet horizontally from the surface of the equipment and at a mid-point of the equipment height.

B. Level 2 Tests:
   1. Level 2 General Performance Test:
      a. For equipment, operate, rotate, or otherwise functionally test for at least 2 hours after components reach normal operating temperatures.
      b. Operate at rated design load conditions.
      c. Confirm that equipment is properly assembled, equipment moves or rotates in the proper direction, shafting, drive elements, and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.
   2. Level 2 Pump Performance Test:
      a. Test 2 hours minimum for flow and head at the rated condition; for factory testing, testing may be at a reduced speeds with flow and head

corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.

b. Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16222 - Low Voltage Motors up to 500 Horsepower. Use actual driver for field tests.

c. Test for flow and head at 2 additional conditions; 1 at 25 percent below the rated flow and 1 at 10 percent above the rated flow.

d. Record measured flow, suction pressure, discharge pressure, and observations on bearing temperatures and noise levels at each condition.

3. Level 2 Vibration Test:

a. Test requirement:

1) Measure filtered vibration spectra versus frequency and measure vibration phase in 3 perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; 1 plane of measurement to be parallel to the axis of rotation of the component; measure actual rotational speeds for each vibration spectra measured using photometric or other tachometer input connected directly to the vibration data collector.

2) Vibration spectra versus frequency shall be in accordance with Vibration Acceptance Criteria.

b. Equipment operating condition: Repeat test requirements at design specified maximum speed and at minimum speed for variable speed equipment.

c. Natural frequency test of field installed equipment:

1) Excite the installed equipment and support system in 3 perpendicular planes, use same planes as operating vibration measurement planes, and determine the as-installed natural resonant frequency of the driven equipment, the driver, gears, and supports.

2) Perform test at each bearing housing, at each support pedestal, and for pumps on the suction and discharge piping.

3) Perform with equipment and attached piping full of intended service or process fluid.

4. Level 2 Noise Test:

a. Measure filtered A-weighted overall sound pressure level in dBA for each of 8 octave band mid-points beginning at 63 hertz measured at 3 feet horizontally from the surface of the equipment at mid-point height of the noise source.

C. Level 3 Tests:

1. Level 3 General Equipment Performance Tests:

a. For equipment, operate, rotate, or otherwise functionally test for at least 4 hours after components reach normal operating temperatures.

b. Operate at rated design load conditions for 1/2 the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.

c. Confirm that equipment is properly assembled, equipment rotates in the proper direction, shafting and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual noise, vibration, or temperatures are observed.

d. Take appropriate capacity, power or fuel consumption, torque, revolutions per minute, pressure, and temperature readings using appropriate test

instrumentation to confirm equipment meets specified performance requirements at the design rated condition.

e. Bearing temperatures: During maximum speed or capacity performance testing, measure and record the exterior surface temperature of each bearing versus time.

2. Level 3 Pump Performance Test:
   a. Test 4 hours minimum for flow and head at or near the rated condition; for factory testing, testing may be at a reduced speeds with flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.
   b. Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 16222 - Low Voltage Motors up to 500 Horsepower. Use actual driver for field tests.
   c. Test each specified flow and head condition at the rated speed and test at minimum as well as maximum specified speeds; operate at each test condition for a minimum of 15 minutes; for factory testing, test at other speeds may be omitted if test driver at reduced speeds is used for rated condition testing.
   d. Record measured shaft revolutions per minute, flow, suction pressure, discharge pressure; record measured bearing temperatures (bearing housing exterior surface temperatures may be recorded when bearing temperature devices are not required by the equipment section) and record observations on noise levels.
3. Level 3 Vibration Test:
   a. Requirements: Same as Level 2 vibration test except data taken at each operating condition tested and with additional requirements below.
   b. Perform High Frequency Enveloping Analysis for gears and bearings:
      1) Measure bearing element vibration directly on each bearing cap in a location close as possible to the bearing load zone that provides a smooth surface and direct path to the bearing to detect bearing defects.
      2) Report results in units of acceleration versus frequency in cycles per minute.
   c. Perform Time Wave Form analysis for gears, low speed equipment and reciprocating equipment; plot true peak amplitude velocity and displacement versus time and label the period between peaks with the likely cause of the periodic peaks (relate the period to a cause).
   d. Plot vibration spectra on 3 different plots; peak displacement versus frequency, peak acceleration versus frequency and peak velocity versus frequency.
4. Level 3 Noise Test: Measure filtered, un-weighted overall sound pressure level in dB at 3 feet horizontally from the surface of the equipment at mid-point height and at 4 locations approximately 90 degrees apart in plain view; report results for each of 8 octave band mid-points beginning at 63 hertz.

D. Level 4 Tests:
   1. Level 4 General Equipment Performance Test:
      a. For equipment, operate, rotate, or otherwise functionally test for at least 8 hours after components reach normal operating temperatures.

b. Operate at rated design load conditions for 1/2 the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.
c. Confirm that equipment is properly assembled, equipment rotates in the proper direction, shafting and bearings are installed and lubricated in accordance with proper tolerances, and that no unusual noise, vibration, or temperatures are observed.
d. Take appropriate capacity, power or fuel consumption, torque, revolutions per minute, pressure and temperature readings, using appropriate test instrumentation to confirm equipment meets specified performance requirements at the design rated condition.
e. Bearing temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.

2. Level 4 Pump Performance Test:
   a. Test 8 hours minimum for flow and head; begin tests at or near the rated condition; for factory and field-testing, test with furnished motor at full speed.
   b. Test each specified flow and head condition at the rated speed and test at minimum as well as maximum specified speeds; operate at each test condition for a minimum of 20 minutes or longer as necessary to measure required performance, vibration, and noise data at each test condition.
   c. Record measured shaft revolutions per minute, flow, suction pressure, discharge pressure; record measured bearing temperatures (bearing housing exterior surface temperatures may be recorded when bearing temperature devices not required by the equipment section) and record observations on noise levels.
   d. Bearing temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.
   e. Perform efficiency and/or Net Positive Suction Head Required (NPSHr) and/or priming time tests when specified in the equipment section in accordance with the appropriate HI standard and as follows:
      1) Perform NPSHr testing at maximum rated design speed, head and flow with test fluids at ambient conditions; at maximum rated speed, test at 15 percent above rated design flow, and 25 percent below rated design flow.
      2) Perform efficiency testing with test fluids at maximum rated speed.
      3) Perform priming time testing with test fluids at maximum rated speed.
3. Level 4 Vibration Test: Same as Level 3 vibration test.
4. Level 4 Noise Test: Same as Level 3 Noise Test except with data taken at each operating condition tested.

END OF SECTION

SECTION 16050

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. General requirements applicable to all Electrical Work.
   2. General requirements for electrical submittals.

B. Interfaces to equipment, instruments, and other components:
   1. The Drawings, Specifications, and overall design are based on preliminary information furnished by various equipment manufacturers which identify a minimum scope of supply from the manufacturers. This information pertains to, but is not limited to, instruments, control devices, electrical equipment, packaged mechanical systems, and control equipment provided with mechanical systems.
   2. Provide all material and labor needed to install the actual equipment furnished, and include all costs to add any additional conduit, wiring, terminals, or other electrical hardware to the Work, which may be necessary to make a complete, functional installation based on the actual equipment furnished:
      a. Make all changes necessary to meet the manufacturer's wiring requirements.
   3. Submit all such changes and additions to the Engineer for acceptance.
   4. Review the complete set of Drawings and Specifications in order to ensure that all items related to the electrical power and control systems are completely accounted for. Include any such items that appear on the Drawings or in the Specifications from another discipline in the scope of Work:
      a. If a conflict between Drawings and Specifications is discovered, refer conflict to the Engineer as soon as possible for resolution.
   5. Loop drawings:
      a. Provide all electrical information required in the preparation of loop drawings including, but not limited to:
         1) Conduit numbers and associated signal(s) contained within each conduit.
         2) Wire numbers.
         3) Equipment terminal numbers.
         4) Junction boxes and signal(s) contained within each junction box.
         5) Equipment power sources, and associated circuit numbers.
         6) As-built drawings detailing wiring.

C. All electrical equipment and systems for the entire Project must comply with the requirements of the Electrical Specifications, whether referenced in the individual Equipment Specifications or not:
   1. The requirements of the Electrical Specifications apply to all Electrical Work specified in other sections.

2. Inform all vendors supplying electrical equipment or systems of the requirements of the Electrical Specifications.
3. Owner is not responsible for any additional costs due to the failure of Contractor to notify all subcontractors and suppliers of the Electrical Specifications requirements.

D. Contract Documents:
   1. General:
      a. The Drawings and Specifications are complementary and are to be used together in order to fully describe the Work.
   2. Specifications:
      a. These requirements are in addition to all General Requirements.
   3. Contract Drawings:
      a. The Electrical Drawings show desired locations, arrangements, and components of the Electrical Work in a diagrammatic manner.
      b. Locations of equipment, control devices, instruments, boxes, panels, etc. are approximate only; exercise professional judgment in executing the Work to ensure the best possible installation:
         1) The equipment locations and dimensions indicated on the Drawings are approximate. Use the shop drawings to determine the proper layout, foundation, and pad requirements, etc., for final installation. Coordinate with all subcontractors to ensure that all electrical equipment is compatible with other equipment and space requirements. Make changes required to accommodate differences in equipment dimensions.
         2) The Contractor has the freedom to select any of the named manufacturers identified in the individual specification sections; however, the Engineer has designed the spatial equipment layout based upon a single manufacturer and has not confirmed that every named manufacturer's equipment fits in the allotted space. It is the Contractor's responsibility to ensure that the equipment being furnished fits within the defined space.
      c. Installation details:
         1) The Contract Drawings include typical installation details the Contractor is to use to complete the Electrical Work. For cases where a typical detail does not apply, develop installation details that may be necessary for completing the Work, and submit these details for review by the Engineer.
         2) Not all typical installation details are referenced within the Drawing set. Apply and use typical details where appropriate.
      d. Schematic diagrams:
         1) All controls are shown de-energized.
         2) Schematic diagrams show control function only. Incorporate other necessary functions for proper operation and protection of the system.
         3) Add slave relays, where required, to provide all necessary contacts for the control system or where needed to function as interposing relays for control voltage coordination, equipment coordination, or control system voltage drop considerations.

4) Mount all devices shown on motor controller schematic diagrams in the controller compartment enclosure, unless otherwise noted or indicated.
5) Schematic diagrams are to be used in conjunction with the descriptive operating sequences in the Contract Documents. Combine all information and furnish a coordinated and fully functional control system.

E. Alternates/Alternatives:
1. Coordinate with General Conditions for substitute item provisions.

F. Changes and change orders:
1. As specified in General Conditions.

1.02 REFERENCES

A. Code compliance:
1. As specified in Section 01410 - Regulatory Requirements.
2. The publications are referred to in the text by the basic designation only. The latest edition accepted by the Authority Having Jurisdiction of referenced publications in effect at the time of the bid governs.
3. The standards listed are hereby incorporated into this Section:
a. American National Standards Institute (ANSI).
b. American Society of Civil Engineers (ASCE):
1) ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
c. ASTM International (ASTM).
d. Illuminating Engineering Society (IES).
e. Institute of Electrical and Electronics Engineers (IEEE).
f. Insulated Cable Engineers Association (ICEA).
g. International Code Council (ICC):
1) International Code Council Evaluation Service (ICC-ES):
a) AC 156 - Acceptance Criteria for Seismic Certification by Shake Table Testing of Non-Structural Components (ICC-ES AC 156).
h. International Society of Automation (ISA).
i. National Electrical Manufacturers Association (NEMA):
1) 250 - Enclosures for Electrical Equipment (1000 V Maximum).
j. National Fire Protection Association (NFPA):
1) 70 - National Electrical Code (NEC).
k. National Institute of Standards and Technology (NIST).
l. Underwriters' Laboratories, Inc. (UL).

B. Compliance with laws and regulations:
1. As specified in General Conditions.

1.03 DEFINITIONS

A. Definitions of terms and other electrical and instrumentation considerations as set forth by:
1. IEEE.
2. NETA.
3. IES.
4. ISA.
5. NEC.

6. NEMA.
7. NFPA.
8. NIST.

B. Specific definitions:
1. FAT: Factory acceptance test.
2. ICSC: Instrumentation and controls subcontractor.
3. LCP: Local control panel: Operator interface panel that may contain an HMI, pilot type control devices, operator interface devices, control relays, etc., and does not contain a PLC or RIO.
4. PCM: Process control module: An enclosure containing any of the following devices: PLC, RTU, or RIO.
5. PCIS: Process control and instrumentation system.
6. RTU: Remote telemetry unit: A controller typically consisting of a PLC, and a means for remote communications. The remote communications devices typically are radios, modems, etc.
7. Space: That portion of the switchgear, motor control center, panelboard, switchboard or control panel that does not physically contain a device but is capable of accepting a device with no modifications to the equipment, i.e., provide all standoffs, bus, and hardware, as part of the space.
8. Spare: That portion of the switchgear, motor control center, panelboard, switchboard or control panel that physically contains a device with no load connections to be made.
9. VCP: Vendor control panel: Control panels that are furnished with particular equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, OIT, HMI, etc.
10. Unequipped space: That portion of the switchgear, motor control center, panelboard, switchboard or control panel that does not physically contain a device, standoff, bus, hardware, or other equipment.

1.04 SYSTEM DESCRIPTION

A. General requirements:
1. The Work includes everything necessary for and incidental to executing and completing the Electrical Work indicated on the Drawings and specified in the Specifications and reasonably inferable there from:
a. The Electrical Drawings are schematic in nature; use the Structural, Architectural, Mechanical, and Civil Drawings for all dimensions and scaling purposes.
2. It is the intent of these Specifications that the entire electrical power, instrumentation, and control system be complete and operable. Provide all necessary material and labor for the complete system from source of power to final utilization equipment, including all connections, testing, calibration of equipment furnished by others as well as equipment furnished by the Contractor, whether or not specifically mentioned but which are necessary for successful operation.
3. Provide all Electrical Work, including conduit, field wiring, and connections by the electrical subcontractor under the provisions of the Electrical Specifications for all aspects of the Work.

4. Coordinate all aspects of the Work with the electrical subcontractor and other subcontractors before bidding in order to ensure that all costs associated with a complete installation are included. The Owner is not responsible for any change orders due to lack of coordination of the Work between the Contractor, the electrical subcontractor, the other subcontractors or suppliers.
5. Portions of this Project involve installation in existing facilities and interfaces to existing circuits, power systems, controls, and equipment:
    a. Perform and document comprehensive and detailed field investigations of existing conditions (circuits, power systems, controls, equipment, etc.) before starting any Work. Determine all information necessary to document, interface with, modify, upgrade, or replace existing circuits, power systems, controls, and equipment.
    b. Provide and document interface with, modifications to, upgrades, or replacement of existing circuits, power systems, controls, and equipment.
6. Provide all trenching, forming, rebar, concrete, back filling, hard surface removal and replacement, for all items associated with the Electrical Work and installation:
    a. As specified in the Contract Documents.
7. Defective work:
    a. As specified in General Conditions.

B. Existing system:
1. Add two VFDs to 20-MCC-A to power new tertiary pump station pumps. Preform other work at the tertiary pump station as indicated on the Drawings.

C. New system:
1. Provide electrical work including panelboards, duct bank, lighting, conduit and wire to support two new tertiary filters. Additional work is indicated on the Drawings.
2. Provide electrical work to for the new support building including panelboards, lighting, and grounding as indicated on the Drawings.

D. Operating facility:
1. As specified in Section 01140 - Work Restrictions.
2. The Ellis Creek WRF is an operating facility. Portions of this facility must remain fully functional throughout the entire construction period. In consideration of this requirement, comply with the following guidelines:
    a. All outages must be of minimal duration and fully coordinated and agreed to by the Owner. Adjust the construction schedule to meet the requirements of the Owner. All changes in schedule and any needs to reschedule are included in the Work.
    b. As weather and water demand conditions dictate, re-adjust the construction schedule to meet the demands placed upon Owner by its users.
    c. Coordinate the construction and power renovation, bear all costs, so that all existing facilities can continue operation throughout construction.
3. According to individual circumstances and in compliance with the Drawings, extend or replace conduit and cable connections from existing locations.
4. The standards of documentation, instrument tagging, cable and conductor ferruling, terminal identification and labeling that apply to the new installation apply equally to the existing installation which forms part of the modified system.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 01330 - Submittal Procedures and this Section.

B. General:
   1. Instruct all equipment suppliers of submittals and operation and maintenance manuals of the requirements in this Section.
   2. Furnish the submittals required by each section in the Electrical Specifications.
   3. Adhere to the wiring numbering scheme specified in Section 16075 - Identification for Electrical Systems throughout the Project:
      a. Uniquely number each wire.
      b. Wire numbers must appear on all Equipment Drawings.
   4. Use equipment and instrument tags, as indicated on the Drawings, for all submittals.

C. Seismic requirements:
   1. Provide electrical equipment with construction and anchorage to supporting structures designed to resist site seismic loads based on the seismic design criteria in Section 01612 - Seismic Design Criteria.
   2. For equipment installed in structures designated as seismic design category C, D, E or F, prepare and submit the following:
      a. Statement of seismic qualification, and special seismic certification:
         1) “Statement of seismic qualification:” Provide manufacturer’s statement that the equipment satisfies the seismic design requirements of the building code indicated in Section 01410 - Regulatory Requirements, including the requirements of ASCE 7, Chapter 13.
         2) “Special seismic certification:” Provide manufacturer’s certification that the equipment, when subjected to shake table testing in accordance with ICC-ES AC 156, meets the “Post-Test Functional Compliance Verification” requirements of ICC-ES AC 156 for “Components with Ip = 1.5.” Compliance shall include both operability and containment of hazardous materials as appropriate to the unit being tested.
      b. Substantiating test data: With seismic qualification and special seismic certification statements, submit results of testing in accordance with ICC-ES AC 156.
      c. Anchoring design calculations and details:
         1) Submit project-specific drawings and supporting calculations, prepared and sealed by a professional engineer licensed in the state where the Project is being constructed, and showing details for anchoring electrical equipment to its supports and for anchoring supports provided with the equipment to the structure. Prepare calculations in accordance with the requirements of Section 01612 - Seismic Design Criteria.
   3. Exemptions: A “statement of seismic qualification” and a “special seismic certification” are not required for the following equipment:
      a. Temporary or moveable equipment.

b. Equipment anchored to the structure and having a total weight of 20 pounds or less.
c. Distribution equipment anchored to the structure and having a total unit weight of 3 pounds per linear foot, or less.

D. Operation and maintenance manuals:
1. As specified in Section 01782 - Operation and Maintenance Data.
2. Furnish the Engineer with a complete set of written operation and maintenance manuals 8 weeks before Functional Acceptance Testing.

E. Material and equipment schedules:
1. Furnish a complete schedule and/or matrix of all materials, equipment, apparatus, and luminaries that are proposed for use:
a. Include sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.

F. Schedule of values:
1. In addition to completing all items referred to in the schedule of values, Section 01292 - Schedule of Values, submit per unit material and labor costs used in developing the final bid for the electrical system, for the express purpose of pricing and cost justification for any proposed change orders. In addition to the items shown on the schedule of values, provide per unit material and labor costs for conduit and wire installation for specific types, sizes, and locations as indicated on the Drawings and Conduit Schedule. It is the responsibility of the electrical subcontractor to prove to the Engineer's satisfaction that said per unit costs were used in the development of the final Bid amount.

G. Roof penetrations:
1. Submit details of all portions of the electrical installation that penetrate the roof. Include details showing support of the penetrating component, and the sealing means to be utilized.

H. Record Documents:
1. Furnish as specified in Section 01770 - Closeout Procedures.

I. Test reports:
1. As specified in Section 01330 - Submittal Procedures.
2. Additional requirements for field acceptance test reports are specified in Sections 01756 - Commissioning and 16950 - Field Electrical Acceptance Tests.

J. Calculations:
1. Where required by specific Electrical Specifications:
a. Because these calculations are being provided by a registered professional engineer, they will be reviewed for form, format, and content but will not be reviewed for accuracy and calculation means.

1.06 QUALITY ASSURANCE

A. Furnish all equipment listed by and bearing the label of UL or of an independent testing laboratory acceptable to the Engineer and the Authority Having Jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 01600 - Product Requirements.

1.08 PROJECT OR SITE CONDITIONS

A. Site conditions:
   1. Provide an electrical, instrumentation and control system, including all equipment, raceways, and any other components required for a complete installation that meets the environmental conditions for the Site as specified in the General Requirements and below.
   2. Seismic load resistance:
      a. Provide electrical equipment with construction and anchorage to supporting structures designed to resist site seismic loads as specified in Section 01612 - Seismic Design Criteria.
   3. Wind load resistance:
      a. Provide electrical equipment with construction and anchorage to supporting structures designed to resist site wind loads as specified in Section 01614 - Wind Design Criteria.
   4. Altitude, temperature and humidity:
      a. As specified in Section 01610 - Project Design Criteria.
      b. Provide all electrical components and equipment fully rated for continuous operation at this altitude, with no additional derating factors applied.
      c. Provide additional temperature conditioning equipment to maintain all equipment in non-conditioned spaces subject to these ambient temperatures, with a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature, as determined by the equipment manufacturer's guidelines:
         1) Provide all power conduits wiring for these devices (e.g., heaters, fans, etc.) whether indicated on the Drawings or not.
   5. Site security:
      a. Abide by all security and safety rules concerning the Work on the Site, as specified in Sections 01329 - Safety Plan and 01500 - Temporary Facilities and Controls.
   6. Outdoor installations:
      a. Provide electrical, instrumentation and control equipment suitable for operation in the ambient conditions where the equipment is located.
      b. Provide heating, cooling, and dehumidifying devices incorporated into and included with electrical equipment, instrumentation and control panels to maintain the enclosures within the rated environmental operating ranges as specified in this Section for the equipment:
         1) Provide all wiring necessary to power these devices.

B. Provide enclosures for electrical, instrumentation and control equipment, regardless of supplier or subcontractor furnishing the equipment, that meet the requirements outlined in NEMA Standard 250 for the following types of enclosures:
   1. NEMA Type 1: Intended for indoor use, primarily to provide a degree of protection from accidental contact with energized parts or equipment.
   2. NEMA Type 4: Intended for indoor or outdoor use, primarily to protect equipment from exposure to windblown dust and rain, splashing or hose directed water, ice formation and freezing.

3. NEMA Type 4X: Made from corrosion resistant stainless steel and are intended for indoor or outdoor use, primarily to protect equipment from exposure to windblown dust and rain, splashing or hose directed water, ice formation and freezing, and corrosion.
4. NEMA Type 12: Intended for indoor use, primarily to provide a degree of protection from dust, falling dirt and dripping non-corrosive liquids.
5. Plant area Electrical Work requirements:
6. Provide all Electrical Work in accordance with the following table, unless otherwise specifically indicated on the Drawings:

Table 1				
PLANT AREA	**NEMA ENCLOSURE TYPE**	**EXPOSED CONDUIT TYPE**	**ENVIRONMENT W = WET D = DAMP C = CLEAN/DRY X = CORROSIVE H = HAZARDOUS**	**SUPPORT MATERIALS**
Electrical Rooms	1,12	GRC	C	Galvanized Steel
Exterior Areas	4X, stainless steel	PCS	W	Stainless Steel

7. Modify exposed conduit runs as specified in Section 16130 - Conduits.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING

A. General:
1. As specified in Section 01312 - Project Meetings and Section 01756 - Commissioning.
2. Testing requirements are specified in Section 01756 - Commissioning and Section16950 - Field Electrical Acceptance Tests and other sections.
3. General scheduling requirements are specified in Section 01321 - Progress Schedules and Reports - Medium Projects.
4. Work restrictions and other scheduling requirements are specified in Section 01140 - Work Restrictions.
5. Commissioning requirements as specified in Section 01756 - Commissioning.

1.11 WARRANTY

A. Warrant the Electrical Work as specified in the Contract Documents:
1. Provide additional warranty as specified in the individual Electrical Specifications.

1.12 SYSTEM START-UP

A. Replace or modify equipment, software, and materials that do not achieve design requirements after installation in order to attain compliance with the design requirements:
   1. Following replacement or modification, retest the system and perform additional testing to place the complete system in satisfactory operation and obtain compliance acceptance from the Engineer.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE

A. Before Substantial Completion, perform all maintenance activities required by any sections of the Specifications including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems in service.

B. Furnish all spare parts as required by other sections of the Specifications.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide similar items of same manufacturer throughout the electrical and instrumentation portion of the Project.

B. Allowable manufacturers are specified in individual Electrical Specifications.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Furnish all materials under this Contract that are new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these products and that bear all approvals and labels as required by the Specifications.

B. Provide materials complying with the applicable industrial standard.

C. Stainless steel:
   1. Where stainless steel is indicated or used for any portion of the Electrical Work, provide a non-magnetic, corrosion-resistant alloy, ANSI Type 316, satin finish.
   2. Provide exposed screws of the same alloys.
   3. Provide finished material free of any burrs or sharp edges.
   4. Use only stainless steel hardware, when chemically compatible, in all areas that are or could be in contact with corrosive chemicals.
   5. Use stainless steel hardware, when chemically compatible, in all chemical areas or areas requiring NEMA Type 4X construction.
   6. Do not use stainless steel in any area containing chlorine, gas or solution, chlorine products or ferric chloride.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. Provide all equipment that is new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these products.

PART 3 EXECUTION

3.01 EXAMINATION

A. The electrical subcontractor is encouraged to visit the site to examine the premises completely before bidding.

B. It is the electrical subcontractor's responsibility to be fully familiar with the existing conditions and local requirements and regulations.

C. Comply with pre-bid conference requirements.

D. Review the site conditions and examine all shop drawings for the various items of equipment in order to determine exact routing and final terminations for all wiring and cables.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. Equipment locations shown on Electrical Drawings may change due to variations in equipment size or minor changes made by others during construction:
   1. Verify all dimensions indicated on the Drawings:
      a. Actual field conditions govern all final installed locations, distances, and levels.
   2. Review all Contract Documents and approved equipment shop drawings and coordinate Work as necessary to adjust to all conditions that arise due to such changes.
   3. Make minor changes in location of equipment before rough in, as directed by the Owner or Engineer.
   4. Provide a complete electrical system:
      a. Install all extra conduits, cables, and interfaces as may be necessary to provide a complete and operating electrical system.

B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.

C. Cutting and patching:
   1. Perform all cutting, patching, channeling, core drilling, and fitting required for the Electrical Work, except as otherwise directed:
      a. Secure the permission of the Engineer before performing any operation likely to affect the strength of a structural member such as drilling, cutting or piercing:
         1) Before cutting, channeling, or core drilling any surface, ensure that no penetration of any other systems will be made:
            a) Verify that area is clear and free of conduits, cables, piping, ductwork, post-tensioning cables, etc.
            b) Use tone-locate system or X-ray to ensure that area is clear of obstructions.
      b. Review the complete Drawing set to ensure that there are no conflicts or coordination problems before cutting, channeling, or core drilling any surface.
   2. Perform all patching to the same quality and appearance as the original work. Employ the proper tradesmen to secure the desired results. Seal around all conduits, wires, and cables penetrating walls, ceilings, and floors in all locations with a fire stop material, typically:
      a. 3M: CP 25WB+: Caulk.
      b. 3M: Fire Barrier: Putty.
   3. Use the installation details indicated on the Drawings as a guide for acceptable sealing methods.

D. Install all conduits and equipment in such a manner as to avoid all obstructions and to preserve headroom and keep openings and passageways clear:
   1. Install all conduits and equipment in accordance with working space requirements in accordance with the NEC:
      a. This includes any panel, disconnect switch or other equipment that can be energized while open exposing live parts regardless of whether it is likely to require examination or has serviceable parts.
   2. Where the Drawings do not show dimensions for locating equipment, install equipment in the approximate locations indicated on the Drawings:
      a. Adjust equipment locations as necessary to avoid any obstruction or interferences.
   3. Where an obstruction interferes with equipment operation or safe access, relocate the equipment.
   4. Where the Drawings do not indicate the exact mounting and/or supporting method to be used, use materials and methods similar to the mounting details indicated on the Drawings.

E. Earthwork and concrete:
   1. Install all trenching, shoring, concrete, backfilling, grading and resurfacing associated with the Electrical Work:
      a. Requirements as specified in the Contract Documents.

F. Roof penetrations:
   1. Seal conduit penetrations in accordance with roofing manufacturer's instructions.

G. Terminations:
   1. Provide and terminate all conductors required to interconnect power, controls, instruments, panels, and all other equipment.

H. Miscellaneous installation requirements:
   1. In case of interference between electrical equipment indicated on the Drawings and the other equipment, notify the Engineer.
   2. Location of manholes and pullboxes indicated on the Drawings are approximate. Coordinate exact location of manholes and pullboxes with Mechanical and Civil Work.
   3. Provide additional manholes or pullboxes to those shown where they are required to make a workable installation.

I. Labeling:
   1. Provide all nameplates and labels as specified in Sections 16075 - Identification for Electrical Systems and 16305 - Electrical System Studies.

J. Equipment tie-downs:
   1. Anchor all instruments, control panels, and equipment by methods that comply with seismic and wind bracing criteria, which apply to the Site:
      a. All control panels must be permanently mounted and tied down to structures in accordance with the Project seismic criteria.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. For Owner and Engineer witnessed FAT:
   1. Contractor is responsible for the Owner's and Engineer's costs associated with FAT as specified in Section 01756 - Commissioning.

C. Owner training:
   1. As specified in Section 01756 - Commissioning and in this Section.

2. Provide source testing and owner training on electrical equipment as defined in the table below:

Table 2: Source Testing and Owner Training Requirements				
Section Number	**Section Title**	**Source Testing**	**Owner Training Requirements**	
		(Witnessed or Non-witnessed)	**Maintenance (hrs per session)**	**Operation (hrs per session)**
16262	Variable Frequency Drives 0.50 - 50 Horsepower	Non-witnessed	8	8

3.08 FIELD QUALITY CONTROL

A. Inspection:
   1. Allow for inspection of electrical system installation as specified in Section 01450 - Quality Control.
   2. Provide any assistance necessary to support inspection activities.
   3. Engineer inspections may include, but are not limited to, the following:
      a. Inspect equipment and materials for physical damage.
      b. Inspect installation for compliance with the Drawings and Specifications.
      c. Inspect installation for obstructions and adequate clearances around equipment.
      d. Inspect equipment installation for proper leveling, alignment, anchorage, and assembly.
      e. Inspect equipment nameplate data to verify compliance with design requirements.
      f. Inspect raceway installation for quality workmanship and adequate support.
      g. Inspect cable terminations.
      h. Schedule structural engineer to inspect all mounting of electrical devices and all penetration and connections to structures.
   4. Inspection activities conducted during construction do not satisfy inspection or testing requirements specified in Section 16950 - Field Electrical Acceptance Tests.

B. Field acceptance testing (Functional Testing):
   1. Notify the Engineer when the Electrical Work is ready for field acceptance testing.
   2. Perform the field acceptance tests as specified in Section 16950 - Field Electrical Acceptance Tests.
   3. Record results of the required tests along with the date of test:
      a. Use conduit identification numbers to indicate portion of circuit tested.

C. Workmanship:
   1. Leave wiring in panels, manholes, boxes, and other locations neat, clean, and organized:
      a. Neatly coil and label spare wiring lengths.
      b. Shorten, re-terminate, and re-label excessive used as well as spare wire and cable lengths, as determined by the Engineer.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 01770 - Closeout Procedures.

B. Remove all foreign material and restore all damaged finishes to the satisfaction of the Engineer and Owner.

C. Clean and vacuum all enclosures to remove all metal filings, surplus insulation and any visible dirt, dust or other matter before energization of the equipment or system start-up:
   1. Use of compressors or air blowers for cleaning is not acceptable.

D. Clean and re-lamp all new and existing luminaries that were used in the areas affected by the construction.

E. As specified in other sections of the Contract Documents.

3.11 PROTECTION

A. Protect all Work from damage or degradation until Substantial Completion.

B. Maintain all surfaces to be painted in a clean and smooth condition.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16060

GROUNDING AND BONDING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Grounding materials and requirements.

1.02 REFERENCES

A. As specified in Section 16050 - Common Work Results for Electrical.

B. ASTM International (ASTM):
   1. B3 - Standard Specification for Soft or Annealed Copper Wire.
   2. B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   3. B33 – Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.

C. Institute of Electrical and Electronics Engineers (IEEE):
   1. 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.

D. Underwriters Laboratories, Inc. (UL):
   1. 467 - Ground and Bonding Equipment.

1.03 DEFINITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.

B. Product data:
   1. Catalog cut sheets.

1.05 QUALITY ASSURANCE

A. As specified in Section 16050 - Common Work Results for Electrical.

B. All grounding components and materials shall be UL listed and labeled.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050 - Common Work Results for Electrical.

1.07 PROJECT/SITE CONDITIONS (NOT USED)

1.08 SEQUENCING (NOT USED)

1.09 SCHEDULING (NOT USED)

1.10 WARRANTY

A. As specified in Section 16050 - Common Work Results for Electrical.

1.11 SYSTEM START-UP

A. As specified in Section 16050 - Common Work Results for Electrical.

1.12 OWNER'S INSTRUCTIONS (NOT USED)

1.13 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Compression connectors: One of the following or equal:
   1. Erico.
   2. Harger.
   3. Burndy.
   4. Thomas & Betts.

B. Ground rods: One of the following or equal:
   1. Erico.
   2. Harger.
   3. Nehring
   4. Thomas & Betts.

C. Ground cable: One of the following or equal:
   1. Erico.
   2. Harger.
   3. Nehring.
   4. Southwire.

D. Precast ground well boxes: One of the following or equal:
   1. Brooks Products, 3-RT Valve Box.
   2. Christy Concrete Products, G12 Valve Box.

2.02 SYSTEM DESCRIPTION

A. Ground equipment and raceway systems so that the completed installation conforms to all applicable code requirements.

B. Provide a complete electrical grounding system as indicated on the Drawings and as specified including but not limited to:
   1. Grounding electrodes.

2. Bonding jumpers.
3. Ground connections.

C. Provide bonding jumpers and wire, grounding bushings, clamps and appurtenances required for complete grounding system to bond equipment and raceways to equipment grounding conductors.

D. The ground system resistance (electrode to ground) of the completed installation, as determined by tests specified in Section 16950 - Field Electrical Acceptance Tests, shall be:
1. 5 ohms or less for industrial systems.

2.03 EXISTING PRODUCTS (NOT USED)

2.04 MATERIALS

A. Ground rod:
1. Minimum: 3/4-inch diameter, 10 feet long.
2. Uniform 10 mil covering of electrolytic copper metallically bonded to a rigid steel core:
   a. The copper-to-steel bond shall be corrosion resistant.
3. In accordance with UL 467.
4. Sectional type joined by threaded copper alloy couplings.
5. Fit the top of the rod with a threaded coupling and steel-driving stud.

B. Ground cable:
1. Requirements:
   a. Soft drawn (annealed).
   b. Concentric lay, coarse stranded in accordance with ASTM B8.
   c. Bare copper in accordance with ASTM B3.

C. Size is as indicated on the Drawings, but not less than required by the NEC. Compression connectors:
1. Manufactured of high copper alloy specifically for the particular grounding application.
2. Suitable for direct burial in earth and concrete.
3. Identifying compression die number inscription to be impressed on compression fitting.

D. Equipment grounding conductors:
1. Conductors shall be the same type and insulation as the load circuit conductors:
   a. Use 600-volt insulation for the equipment grounding conductors for medium voltage systems.
2. Minimum size in accordance with the NEC.

E. Grounding electrode conductors:
1. Minimum size in accordance with the NEC.

F. Main bonding jumpers and bonding jumpers:
1. Minimum size in accordance with the NEC.

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT (NOT USED)

2.07 COMPONENTS (NOT USED)

2.08 ACCESSORIES

A. Precast ground well boxes:
   1. Minimum 10 inch interior diameter.
   2. Traffic-rated cast iron cover.
   3. Permanent “GROUND” marking on cover.

2.09 MIXES (NOT USED)

2.10 FABRICATION (NOT USED)

2.11 FINISHES (NOT USED)

2.12 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Provide a separate, green insulated, grounding conductor in each raceway independent of raceway material:
   1. Multi-conductor power and control cables shall include an integral green insulated grounding conductor.
   2. Provide a separate grounding conductor in each individual raceway for parallel feeders.

C. Provide a separate grounding conductor for each motor and connect at motor terminal box. Do not use bolts securing motor box to frame or cover for grounding connectors:
   1. When grounding motors driven by variable frequency drives (VFD) comply with the requirements of the VFD manufacturer.

D. Provide a grounding type bushing with lug for connection of grounding conductor for conduits that originate from each motor control center section, switchboard, or panelboard:
   1. Individually bond these raceways to the ground bus in the equipment.

E. Provide grounding type bushings with lugs for connection of grounding conductor at both ends of metallic conduit runs. Bond ground bushings to the grounding system.

F. Provide a green insulated wire-grounding jumper from the ground screw to a box grounding screw and, for grounding type devices, to equipment grounding conductor.

G. Interconnect the secondary switchgear, switchboard, or panelboard neutral bus to the ground bus in the secondary switchgear, switchboard, or panelboard compartment, only at service entrance point or after a transformer.

H. Duct bank ground system:
   1. Provide a bare copper grounding conductor the entire length of each duct bank, embedded in the concrete of the duct bank as indicated on the Drawings and specified in the Specifications.
   2. Bond duct bank ground conductors together where duct banks join, merge, intersect, or split.

I. Grounding at service (600 V or Less):
   1. Connect the neutral to ground only at one point within the enclosure of the first disconnecting means on the load side of the service transformer.

J. Ground connections:
   1. All connections to the ground grid system, the duct bank grounding system, equipment, ground rods, etc., shall be made using compression type grounding connectors as indicated on the Drawings, UL listed, and labeled for the application.
   2. Make ground connections in accordance with the manufacturer's instructions.
   3. Do not conceal or cover any ground connections until the Engineer or authorized representative has established and provided written confirmation that every grounding connection is as indicated on the Drawings and specified in the Specifications.

K. Grounding electrode system:
   1. Ground ring:
      a. Provide all trenching and materials necessary to install the ground ring as indicated on the Drawings.
      b. Ground ring conductor shall be in direct contact with the earth, or where embedded, concrete, of the size as indicated on the Drawings.
      c. Minimum burial depth 36 inches or as indicated on the Drawings.
      d. Re-compact disturbed soils to original density in 6-inch lifts.
   2. Ground rods:
      a. Locations as indicated on the Drawings.
      b. Length of rods forming an individual ground array shall be equal in length.
      c. Drive ground rods and install grounding conductors before construction of concrete slabs and duct banks.
      d. Pre-crimp all ground rods, as recommended by the manufacturer, before crimping connector to ground rod.
   3. Metal underground water pipe:
      a. Bond metal underground domestic water pipe to grounding electrode system.
   4. Metal frame of building or structure:
      a. Bond metal frame of building or structure to grounding electrode system.
   5. Extend grounding conductors through concrete to accessible points for grounding equipment and electrical enclosures.

6. Where grounding conductors are not concrete-encased or direct buried, install in Schedule 40 PVC conduit for protection.
7. Install grounding system at each structure where switchgear, motor control centers, switchboards, panelboards, panels, or other electrical equipment are installed.

L. Shield grounding:
1. Analog signal cables shields shall only be grounded at a single point in the loop. Unless otherwise noted, ground signal cable shields at control panel.
2. For communication and data line signal cable shields and drain wires should be grounded at both ends of the cable run.
3. Insulate the shielding and exposed drain wire for each signal cable with heat-shrink tubing.
4. Terminate the signal cable shield on a dedicated grounding terminal block.

M. Where indicated on the Drawings, install ground rods in precast ground wells.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Measure grounding electrode system resistance to ground in accordance with IEEE 81.

3.09 ADJUSTING

A. Under the direction of the Engineer, add additional parallel connected ground rods and/or deeper driven rods until the ground resistance measurement meets the specified resistance requirements:
1. Use of salts, water, or compounds to attain the specified ground resistance is not acceptable.

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 16050 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16070

HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Mounting and supporting electrical equipment and components.

1.02 REFERENCES

A. As specified in Section 16050 - Common Work Results for Electrical.

B. ASTM International (ASTM):
   1. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   3. A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

1.03 DEFINITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.04 SYSTEM DESCRIPTION

A. Design requirements:
   1. Conform to the requirements of the Building Code as specified in Section 01410 - Regulatory Requirements.
   2. Demonstrate the following using generally accepted engineering methods:
      a. That the anchors to the structure are adequate to resist the loads generated in accordance with the Building Code and equipment requirements.
      b. That the required load capacity of the anchors can be fully developed in the structural materials to which they are attached.
   3. Design loading and anchoring requirements:
      a. As indicated in the Building Code unless otherwise specified.
      b. Seismic loading requirements:
         1) Freestanding, suspended or wall-hung equipment shall be anchored in place by methods that will satisfy the requirements for the seismic design specified in Section 16050 - Common Work Results for Electrical.
      c. Wind loading requirements:
         1) All exterior equipment shall be anchored in place by methods that will satisfy the requirements for wind design specified in Section 16050 - Common Work Results for Electrical.

d. Minimum safety factor against overturning: 1.5.
e. The foundation and structures to which hangers and supports are attached shall be capable of withstanding all anchor loads.

B. Performance requirements:
1. Hangers and supports individually and as a system shall resist all weights and code-required forces without deflections and deformations that would damage the supporting elements, the equipment supported, or the surrounding construction.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.

B. Product data:
1. Supports:
a. Materials.
b. Geometry.
c. Manufacturer.
2. Hardware:
a. Materials.
b. Manufacturer.

C. Shop drawings:
1. Complete dimensioned and scalable shop drawings of all supporting structures, trapezes, wall supports, etc.
2. Complete anchoring details for equipment, lighting and raceway, supporting structures, trapezes, and wall supports for all equipment:
a. For free standing supports and wall supports supporting equipment weight in excess of 200 pounds:
1) Stamped by a professional engineer licensed in the state where the Project is being constructed.
b. Said submittals, by virtue of the fact that they bear the stamp of a registered engineer, will be reviewed for general consistency with the requirements specified in the Contract Documents, but not for context, accuracy, or method of calculation.
3. Include data on attachment hardware and construction methods that will satisfy the design loading and anchoring criteria.

D. Installation instructions:
1. Furnish anchorage instructions and requirements based on the seismic and wind conditions of the Site:
a. Stamped by a professional engineer licensed in the state where the Project is being constructed.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050 - Common Work Results for Electrical.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050 - Common Work Results for Electrical.

1.12 SYSTEM STARTUP

A. As specified in Section 16050 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Preformed channel:
      a. Thomas & Betts.
      b. Power-Strut.
      c. Unistrut.
      d. Cooper B-Line.
      e. Robroy.
      f. Tyco.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Use materials appropriate for the area as specified in Section 16050 - Common Work Results for Electrical.

B. Preformed channel:
   1. Hot dip galvanized steel:
      a. Supports:
         1) In accordance with ASTM A123 or A153.
         2) Minimum zinc coating thickness of 2.5 mils.
      b. Hardware:
         1) Electro-galvanized.
         2) In accordance with ASTM A153.
   2. Stainless steel:
      a. Supports:
         1) In accordance with ASTM A240.
         2) ANSI Type 316 material.

b. Hardware:
    1) ANSI Type 316 material.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Anchor bolts:
    1. As specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Paint and finish all supporting structures as specified in Section 09960 - High-Performance Coatings.

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Preformed Channel:
    1. Mount all raceways, cabinets, boxes, fixtures, instruments, and devices on Contractor-fabricated racks unless otherwise indicated on the Drawings:
        a. Provide the necessary sway bracing to keep trapeze type structures from swaying under seismic events or wind loading.
    2. Brace and anchor freestanding equipment supports using methods that provide structural support based on the seismic loads and wind loads:
        a. Lateral deflection at top of supports not to exceed support height divided by 240 unless otherwise approved by the Engineer.
    3. Provide fabricated steel support pedestals for wall mounted panels that weigh more than 200 pounds:
        a. Fabricate pedestals out of welded angle, tube sections, or preformed channel.
        b. If the supported equipment is a panel or cabinet, match the supported equipment in physical appearance and dimensions.

4. Mount all equipment, cabinets, boxes, instruments, and devices in damp or wet locations on minimum of 7/8-inch preformed mounting channel:
    1) Mount channel vertically along the length of the device so that water or moisture may run freely behind the device.
5. Corrosion protection:
    a. Isolate dissimilar metals, except where required for electrical continuity:
        1) Use neoprene washers, 9-mil polyethylene tape, or gaskets for isolation.
6. Raceway:
    a. Furnish all racks and trapeze structures needed to support the raceway from the structure:
        1) Group raceway and position on racks to minimize crossovers.
        2) Provide the necessary bracing to keep trapeze type structures from swaying under loads from cable installation, seismic forces, or wind forces.
7. Anchoring methods:
    a. Solid concrete: Anchor bolts, anchor rods or post-installed anchors as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
    b. Metal surfaces: Machine screws or bolts.
    c. Hollow masonry units: Post-installed anchors as specified in Section 05190 - Mechanical Anchoring and Fastening to Concrete and Masonry.
8. Recoat or seal all drilled holes, cut or scratched surfaces or with products recommended by the manufacturer.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 16050 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16075

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Identification of electrical equipment, devices and components.
   2. Material, manufacturing and installation requirements for identification devices.

1.02 REFERENCES

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Occupational Safety and Health Administration (OSHA).

1.03 DEFINITIONS

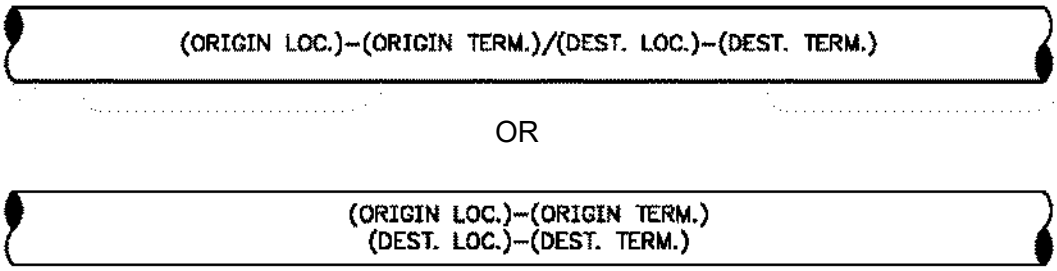
A. As specified in Section 16050 - Common Work Results for Electrical.

1.04 SYSTEM DESCRIPTION

A. Nameplates:
   1. Provide a nameplate for each piece of electrical equipment and devices, control panel and control panel components.
   2. Provide all nameplates of identical style, color, and material throughout the facility.
   3. Device nameplates information:
      a. Designations as indicated on the Drawings and identified on the Process and Instrumentation Drawings.

B. Wire numbers:
   1. Coordinate the wire numbering system with all vendors of equipment so that every field wire has a unique number associated with it for the entire system:
      a. Wire numbers shall correspond to the wire numbers on the control drawings or the panel and circuit numbers for receptacles and lighting.
      b. Wire numbers shall correspond to the terminal block number to which they are attached in the control panel.
      c. Internal panel wires on a common terminal shall have the same wire number.
      d. Multi-conductor cables shall be assigned a cable number that shall be attached to the cable at intermediate pull boxes and stub-up locations beneath freestanding equipment. All multi-conductor and instrumentation cables shall be identified at pull points as described above:
         1) Label armored multi-conductor cable using the conduit number as indicated on the Drawings, following the requirements for conduit markers in Section 16130 - Conduits.

2. Provide the following wiring numbering schemes throughout the project for field wires between process control module, (PCM), vendor control panels, (VCP), motor control centers, (MCC), field starters, field instruments, etc.



Where:

ORIGIN LOC .= Designation for originating panel or device
ORIGIN TERM. = Terminal designation at originating panel or device
DEST. LOC. = Designation for destination panel or device
DEST. TERM. = Terminal designation at destination panel or device or PLC I/O address at destination panel:

a. Identify equipment and field instruments as the origin.
b. PCMs are always identified as the destination.
c. Location is the panel designation for VCP, LCP, or PCM. For connections to MCCs, location is the specific starter tag and loop number. Location is the tag and loop number for motor starters, field instruments and equipment. Any hyphen in the panel designation or tag and loop number shall be omitted.
d. Terminal designation is the actual number on the terminal block where the conductor terminates at field devices and vendor control panels. For multi- conductor cables, all terminal numbers shall be shown, separated by commas.
e. Terminal designations at motor leads shall be the motor manufacturer's standard terminal designation (e.g. T1, T2, T3, etc.).
f. Terminal designations at PCMs where the field conductor connects to field terminal blocks for a PLC input or output shall be the PLC address (Note: the following PLC I/O numbering scheme is typical for Allen-Bradley, the numbering scheme should be modified to match that of the actual PLC manufacturer used for the project):
    1) Discrete Point: W:X:Y/Z.
       Analog Point: W:X:Y.Z.
       Where:
       W= I for input, O for output
       X= PLC number (1, 2, 3…)
       Y= Slot number (01, 02, 03…)
       Z= Terminal number (00, 01, 02…) for a discrete point or a word number for an analog point (1, 2, 3…)
g. Terminal designations at PCMs where the conductor does not connect to a PLC I/O point shall be the terminal number with a "C" prefix (e.g., C0010). For common power after a fuse or neutrals after a switch, the subsequent points shall have and capital letter suffix starting with "A" (e.g., C0010A).

3. **Case 1**: Vendor control panel (VCP) to process control module (PCM):
   Field wire number/label: A-B/C-D
   A = Vendor control panel number without hyphen (VCP#)
   B = Terminal number within VCP (manufacturer's or vendor's standard terminal number)
   C = Process control module number without hyphen (PCM#)
   D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)

   Examples: VCP#-10/PCM#-I: 1:01/01
   VCP#-10/PCM#-O: 1:10/07
   VCP#-10/PCM#-C0100

4. **Case 2**: Field instrument to process control module (PCM):
   Field wire number/label: E-F/C-D
   C = Process control module number without hyphen (PCM#)
   D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)
   E = Field mounted instrument tag and loop numbers without hyphen (EDV#)
   F = Manufacturer's standard terminal number within instrument. Use both terminal numbers for analog points separated by a comma

   Examples: TIT#-2,3/PCM#-I: 1:01.1
   TSH#-1/PCM#-I: 2:01/00

5. **Case 3**: Motor control center (MCC) to process control module (PCM):
   Field wire number/label: G-B/C-D
   B =Terminal number within Motor Control Center (manufacturer's or vendor's standard terminal number)
   C = Process control module without hyphen (PCM#)
   D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)
   G = Actual starter designation in the motor control center without hyphen (MMS#)

   Examples: MMS#-10/PCM#-I: 1:01/01
   MMS#-10/PCM#-O: 1:10/07
   MMS#-10/PCM#-C0100

6. **Case 4**: Motor control center (MCC) to vendor control panel (VCP):
   Field wire number/label: G-B/A-B
   A = Vendor control panel number without hyphen (VCP#)
   B = Terminal number within motor control center or vendor control panel (manufacturer's or vendors standard terminal number)
   G = Actual starter designation in the motor control center without hyphen (MMS#)

   Example: MMS#-X2/VCP#-10

7. **Case 5**: Motor leads to a motor control center (MCC):
   Field wire number/label: H-I/G-B
   B = Terminal number within motor control center (manufacturer's standard terminal number)
   G = Actual starter designation in the motor control center without hyphen (MMS#)
   H = Equipment tag and loop number without hyphen (PMP#)
   I = Motor manufacturer's standard motor lead identification (e.g. T1, T2, T3, etc.)

   Example: PMP-#-T3/MMS#-T3

8. **Case 6**: Remote or separately mounted starter or variable frequency drive (VFD) to process control module (PCM):
   Field wire number/label: J-B/C-D
   B = Terminal number within starter or variable frequency drive (manufacturer's standard terminal number)
   C = Process control module number without hyphen (VCP#)
   D = Either the PLC address if the field terminal is connected directly to a PLC input or output point or the terminal number with a "C" prefix if not connected directly to a PLC I/O point (C0010)
   J = Starter or variable frequency drive tag and loop number without hyphen (MMS#)

   Examples: MMS#-10/PCM#-I: 1:01/01
   MMS#-10/PCM#-O: 2: 10/07
   MMS#-10/PCM#-C0010

9. Identify all spare conductors as required for other field wires with an "S" prefix:

   Example: S MMS#-10/PCM#-C011

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.

B. Product data:
   1. Nameplates:
      a. Color.
      b. Size:
         1) Outside dimensions.
         2) Lettering.
      c. Material.
      d. Mounting means.
   2. Nameplate schedule:
      a. Show exact wording for each nameplate.
      b. Include nameplate and letter sizes.
   3. Wire numbers:
      a. Manufacturer's catalog data for wire labels and label printer.

C. Record documents:
    1. Update the conduit schedule to reflect the exact quantity of wire numbers including spares and destination points for all wires.

1.06 QUALITY ASSURANCE (NOT USED)

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050 - Common Work Results for Electrical.

1.08 PROJECT SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 16050 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Nameplates and signs:
    1. One of the following or equal:
        a. Brady.
        b. Seton.

B. Conductor and cable markers:
    1. Heat-shrinkable tubing:
        a. One of the following or equal:
            1) Raychem.
            2) Brady.
            3) Thomas & Betts.
            4) Kroy.

C. Conduit and raceway markers:
    1. Stainless steel, one of the following or equal:
        a. Panduit.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Nameplates:
   1. Colors:
      a. Warning nameplates: White-center, red face.
      b. Other nameplates: Black-center, white face.
   2. Laminated plastic engraving stock:
      a. 3/32-inch thick material.
      b. 2-ply.
      c. With chamfered edges.
   3. Block style engraved characters of adequate size to be read easily from a distance of 6 feet:
      a. No characters smaller than 1/8-inch in height.

B. Signs:
   1. Automatic equipment and high voltage signs:
      a. Suitable for exterior use.
      b. In accordance with OSHA regulations.

C. Conductor and cable markers:
   1. Machine printed black characters on white tubing.
   2. 10 point type or larger.

D. Conduit and raceway markers:
   1. Stainless steel:
      a. Type 304 or 316.
      b. Letter characters stamped.
      c. Character height: 3/16-inch**.**

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. Nameplates:
   1. Provide all nameplates for control panel operator devices (e.g., pushbuttons, selector switches, pilot lights, etc.):
      a. Same material and same color and appearance as the device nameplates, in order to achieve an aesthetically consistent and coordinated system.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Nameplates:
   1. Attach nameplates to equipment with rivets, bolts or sheet metal screws, approved waterproof epoxy-based cement or install in metal holders welded to the equipment.
   2. On NEMA Type 4, NEMA Type 4X, enclosures, use epoxy-based cement to attach nameplates.
   3. Nameplates shall be aligned and level or plumb to within 1/64 inch over the entire length:
      a. Misaligned or crooked nameplates shall be remounted or provide new enclosures at the discretion of the Engineer.

C. Conductor and cable markers:
   1. Apply all conductor and cable markers before termination.
   2. Heat-shrinkable tubing:
      a. Tubing shall be shrunk using a heat gun that produces low temperature heated air.
      b. Tubing shall be tight on the wire after it has been heated.
      c. Characters shall face the open panel and shall read from left to right or top to bottom.
      d. Marker shall start within 1/32 inch of the end of the stripped insulation point.

D. Conduit markers:
   1. Furnish and install conduit markers for every conduit in the electrical system that is identified in the conduit schedule or part of the process system:
      a. Conduit markings shall match the conduit schedule.
   2. Mark conduits at the following locations:
      a. Each end of conduits that are greater than 10 feet in length.
      b. The middle of conduits that are 10 feet or less in length.
      c. Where the conduit penetrates a wall or structure.
      d. Where the conduit emerges from the ground, slab, etc.
   3. Mark conduits after the conduits have been fully painted.
   4. Position conduit markers so that they are easily read from the floor.
   5. Attach stainless steel tags with stainless steel cable ties.
   6. Mark conduits before construction review by Engineer for punch list purposes.

E. Signs and labeling:
   1. Furnish and install permanent warning signs at mechanical equipment that may be started automatically or from remote locations:
      a. Fasten warning signs with round head stainless steel screws or bolts.
      b. Locate and mount in a manner to be clearly legible to operations personnel.

2. Furnish and install permanent and conspicuous warning signs on equipment (front and back), doorways to equipment rooms, pull boxes, manholes, etc., where the voltage exceeds 600 volts.
3. Furnish and install warning signs on equipment that has more than one source of power:
    a. Warning signs to identify every panel and circuit number of the disconnecting means of all external power sources.
4. Place warning signs on equipment that has 120 VAC control voltage source used for interlocking:
    a. Identify panel and circuit number or conductor tag for control voltage source disconnecting means.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.08 FIELD QUALITY CONTROL

A. Replace any nameplates, signs, conductor markers, cable markers or raceway labels that in the sole opinion of the Engineer do not meet the Engineer’s aesthetic requirements.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16123

600-VOLT OR LESS WIRES AND CABLES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. 600 volt class or less wire and cable.

1.02 REFERENCES

A. As specified in Section 16050 - Common Work Results for Electrical.

B. ASTM International (ASTM):
   1. B3 - Standard Specification for Soft or Annealed Copper Wire.
   2. B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.

C. CSA International (CSA).

D. Insulated Cable Engineers Association (ICEA):
   1. NEMA WC 70/ICEA S-95-658-1999 - Standard for Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
   2. NEMA WC 57/ICEA S-73-532 - Standard for Control, Thermocouple Extension, and Instrumentation Cables.

E. National Fire Protection Association (NFPA):
   1. 72 - National Fire Alarm and Signaling Code.
   2. 101 - Life Safety Code.

F. Telecommunications Industry Association/Electronics Industry Association (TIA/EIA):
   1. 568-C.2 - Balanced Twisted-Pair Telecommunication Cabling and Components Standard.
   2. 569-B – Commercial Building Standards for Telecommunications Pathways and Spaces.
   3. 1005 – Industrial Cabling Standard.

G. Underwriter's Laboratories Inc., (UL):
   1. 44 - Thermoset-Insulated Wires and Cables.
   2. 1277 - Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
   3. 1424 - Standard for Cables for Power-Limited Fire-Alarm Circuits.
   4. 1569 - Standard for Metal-Clad Cables.
   5. 2196 - Standard for Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control, and Data Cables.
   6. 2225 - Standard for Cables and Cable-Fittings for Use in Hazardous (Classified) Locations.

1.03 DEFINITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Specific definitions and abbreviations:
   1. AWG: American wire gauge.
   2. BCCS: Bare copper-covered steel.
   3. CPE: Chlorinated polyethylene.
   4. FEP: Fluorinated ethylene propylene.
   5. FHDPE: Foam high-density polyethylene.
   6. FPE: Foam polyethylene.
   7. OD: Outside diameter.
   8. PVC: Polyvinyl chloride.
   9. XHHW: Cross-linked high heat water resistant insulated wire.

C. Definitions of terms and other electrical considerations as set forth in the:
   1. ASTM.
   2. ICEA.

1.04 SYSTEM DESCRIPTION

A. Furnish and install the complete wire and cable system.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.

B. Product data:
   1. Manufacturer of wire and cable.
   2. Insulation:
      a. Type.
      b. Voltage class.
   3. AWG size.
   4. Conductor material.
   5. Pulling compounds.

C. Shop drawings:
   1. Show splice locations.
      a. For each proposed splice location provide written justification describing why the splice is necessary.

D. Test reports:
   1. Submit test reports for meg-ohm tests.

E. Calculations:
   1. Submit cable pulling calculations to the Engineer for review and comment for all cables that will be installed using mechanical pulling equipment. Show that

the maximum cable tension and sidewall pressure will not exceed manufacturer recommended values:

a. Provide a table showing the manufacturer's recommended maximum cable tension and sidewall pressure for each cable type and size included in the calculations.
b. Submit the calculations to the Engineer a minimum of 2 weeks before conduit installation.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050 - Common Work Results for Electrical.

B. All wires and cables shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 16050 - Common Work Results for Electrical.

1.13 OWNER`S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. 600 volt class wire and cable:
      a. General Cable.
      b. Okonite Co.
      c. Southwire Co.
      d. Service Wire.
   2. Instrumentation class wire and cable:
      a. Alpha Wire Co.
      b. Belden CDT.
      c. General Cable.
      d. Okonite Co.
      e. Rockbestos Surprenant Cable Corp.

3. Network cables:
    a. General Cable.
    b. Belden.
    c. CommScope.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Conductors:
    1. Copper in accordance with ASTM B3.

2.04 MANUFACTURED UNITS

A. General:
    1. Provide new wires and cables manufactured within 1 year of the date of delivery to the Site.
    2. Permanently mark each wire and cable with the following at 24-inch intervals:
        a. AWG size.
        b. Voltage rating.
        c. Insulation type.
        d. UL symbol.
        e. Month and year of manufacture.
        f. Manufacturer's name.
    3. Identify and mark wire and cable as specified in Section 16075 - Identification for Electrical Systems:
        a. Use integral color insulation for No. 2 AWG and smaller wire.
        b. Wrap colored tape around cable larger than No. 2 AWG.

B. 600 volt class wire and cable:
    1. Provide AWG or kcmil sizes as indicated on the Drawings or in the Conduit Schedules:
        a. When not indicated on the Drawings, size wire as follows:
            1) In accordance with the NEC:
                a) Use 75 degree Celsius ampacity ratings.
                b) Ampacity rating after all derating factors, equal to or greater than rating of the overcurrent device.
            2) Provide No. 12 AWG minimum for power conductors.
            3) Provide No. 14 AWG minimum for control conductors.
    2. Provide Class B stranding in accordance with ASTM B8:
        a. Provide Class C stranding where extra flexibility is required.
    3. Insulation:
        a. XHHW-2.

C. Instrumentation class cable:
    1. Type TC.
    2. Suitable for use in wet locations.
    3. Voltage rating: 600 volts.
    4. Temperature rating:
        a. 90 degree Celsius rating in dry locations.
        b. 75 degree Celsius rating in wet locations.

5. Conductors:
    a. Insulation:
        1) Flame-retardant PVC, 15 mils nominal thickness, with nylon jacket 4 mils nominal thickness.
    b. No. 16 AWG stranded and tinned.
    c. Color code: ICEA Method 1:
        1) Pair: Black and white.
        2) Triad: Black, white and red.
        3) Multiple pairs or triads:
            a) Color-coded and numbered.
6. Drain wire:
    a. No. 18 AWG.
    b. Stranded, tinned.
7. Jacket:
    a. Flame retardant, moisture and sunlight resistant PVC.
    b. Ripcord laid longitudinally under jacket to facilitate removal.
8. Shielding:
    a. Individual pair/triad:
        1) Minimum 1.35-mil double-faced aluminum foil-polyester tape overlapped to provide 100 percent coverage.
    b. Multiple pair or triad shielding:
        1) Group shield: Minimum 1.35-mil double-faced aluminum foil-polyester tape overlapped to provide 100 percent coverage.
        2) Completely isolate group shields from each other.
        3) Cable shield: 2.35 mils double-faced aluminum and synthetic polymer backed tape overlapped to provide 100 percent coverage.
    c. All shielding to be in contact with the drain wire.

D. Network cables:
1. Category 6:
    a. General:
        1) Provide Cat 6 cables meeting the standards set by TIA/EIA-568-C.2 and verified by third-party testing laboratory.
    b. Conductors:
        1) No. 23 AWG solid bare annealed copper.
        2) 4 Bonded pairs.
    c. Drain wire:
        1) No. 24 AWG stranded (7/32) tinned copper.
    d. Insulation:
        1) Non-Plenum: Polyolefin.
        2) Plenum: Fluoropolymer.
    e. Shielding:
        1) Overall Foil Shield.
    f. Color code:
        1) Pair 1: White/blue stripe and blue.
        2) Pair 2: White/orange stripe and orange.
        3) Pair 3: White/green stripe and green.
        4) Pair 4: White/brown stripe and brown.
    g. Outer jacket:
        1) Non-Plenum: Flame-Retardant PVC.
        2) Plenum: Low-Smoke, Flame-Retardant PVC.

h. Electrical characteristics:
1) Voltage rating: 600VAC.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Wire ties:
1. One of the following or equal:
a. T&B, "Ty-Rap" cable ties.
b. Panduit, cable ties.

B. Wire markers:
1. As specified in Section 16075 - Identification for Electrical Systems.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. Assembly and testing of cable shall comply with the applicable requirements of ICEA S-95-658-1999.

B. Test Type XHHW-2 in accordance with the requirements of UL 44.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Color-coding:
1. Color-coding shall be consistent throughout the facility.
2. The following color code shall be followed for all 240/120 volt and 208/120-volt systems:
a. Phase A: Black.
b. Phase B: Red.
c. Phase C: Blue.
d. Single phase system: Black for 1 hot leg, red for the other.
e. Neutral: White.
f. High phase or wild leg: Orange.
g. Equipment ground: Green.

3. The following color code shall be followed for all 480/277-volt systems:
    a. Phase A: Brown.
    b. Phase B: Orange.
    c. Phase C: Yellow.
    d. Neutral: Gray.
    e. Equipment ground: Green.
4. The following color code shall be followed for all 120 VAC control wiring:
    a. Power: Red.
    b. Neutral: White.
5. The following color code shall be followed for all general purpose DC control circuits:
    a. Grounded conductors: White with blue stripe.
    b. Ungrounded conductors: Blue.
6. Switch legs shall be violet. 3-way switch runners shall be pink.
7. Wire colors shall be implemented in the following methods:
    a. Wires manufactured of the desired color.
    b. Continuously spiral wrap the first 6 inches of the wire from the termination point with colored tape:
        1) Colored tape shall be wrapped to overlap 1/2 of the width of the tape.

C. Install conductors only after the conduit installation is complete, and all enclosures have been vacuumed clean, and the affected conduits have been swabbed clean and dry:
1. Install wires only in approved raceways.
2. Do not install wire:
    a. In incomplete conduit runs.
    b. Until after the concrete work and plastering is completed.

D. Properly coat wires and cables with pulling compound before pulling into conduits:
1. For all No. 4 AWG and larger, use an approved wire-pulling lubricant while cable is being installed in conduit:
    a. Ideal Products.
    b. Polywater Products.
    c. 3M Products.
    d. Greenlee Products.
    e. Or equal as recommended by cable manufacturer.
    f. Do not use oil, grease, or similar substances.

E. Cable pulling:
1. Prevent mechanical damage to conductors during installation.
2. For cables No. 1 AWG and smaller, install cables by hand.
3. For cables larger than No. 1 AWG, power pulling winches may be used if they have cable tension monitoring equipment.
4. Provide documentation that maximum cable pulling tension was no more than 75 percent of the maximum recommended level as published by the cable manufacturer. If exceeded, the Engineer may, at his discretion, require replacement of the cable.
5. Ensure cable pulling crews have all calculations and cable pulling limitations while pulling cable.

6. Make splices or add a junction box or pullbox where required to prevent cable pulling tension or sidewall pressure from exceeding 75 percent of manufacturer’s recommendation for the specified cable size:
    a. Make splices in manholes or pull boxes only.
    b. Leave sufficient slack to make proper connections.

F. Install and terminate all wire in accordance with manufacturer's recommendations.

G. Neatly arrange and lace conductors in all switchboards, panelboards, pull boxes, and terminal cabinets by means of wire ties:
    1. Do not lace wires in gutter or panel channel.
    2. Install all wire ties with a flush cutting wire tie installation tool:
        a. Use a tool with an adjustable tension setting.
    3. Do not leave sharp edges on wire ties.

H. Terminate stranded conductors on equipment box lugs such that all conductor strands are confined within the lug:
    1. Use ring type lugs if box lugs are not available on the equipment.

I. Lighting circuits:
    1. Each circuit shall have a dedicated neutral.

J. Splices:
    1. Provide continuous circuits from origin to termination whenever possible:
        a. Obtain Engineer’s approval prior to making any splices.
    2. Lighting and receptacle circuit conductors may be spliced without prior approval from the Engineer.
    3. Where splices are necessary because of extremely long wire or cable lengths that exceed standard manufactured lengths:
        a. Splice box NEMA rating requirements as specified in Section 16050 - Common Work Results for Electrical.
        b. Make splices in labeled junction boxes for power conductors.
        c. Make splices for control and instrument conductors in terminal boxes:
            1) Provide terminal boards with setscrew pressure connectors, with spade or ring lug connectors.
    4. Power and control conductors routed in common raceways may be spliced in common junction boxes.
    5. Clearly label junction and terminal boxes containing splices with the word "SPLICE LOCATED WITHIN”.
    6. Leave sufficient slack at junction boxes and termination boxes to make proper splices and connections. Do not pull splices into conduits.
    7. Install splices with compression type butt splices and insulate using a heat-shrink sleeve:
        a. In NEMA Type 4 or NEMA Type 4X areas, provide heat-shrink sleeves that are listed for submersible applications.
    8. Splices in below grade pull boxes, in any box subject to flooding, and in wet areas shall be made waterproof using:
        a. A heat shrink insulating system listed for submersible applications.
        b. Or an epoxy resin splicing kit.

K. Apply wire markers to all wires at each end after being installed in the conduit and before meg-ohm testing and termination.

L. Instrumentation class cable:
   1. Install instrumentation class cables in separate raceway systems from power cables:
      a. Install instrument cable in metallic conduit within non-dedicated manholes or pull boxes.
      b. Install cable without splices between instruments or between field devices and instrument enclosures or panels.
   2. Do not make intermediate terminations, except in designated terminal boxes as indicated on the Drawings.
   3. Shield grounding requirements as specified in Section 16060 - Grounding and Bonding.

M. Copper Ethernet cables:
   1. Comply with TIA/EIA-568-C.2.
   2. Pathways:
      a. For initial installation, the maximum fill capacity for pathways (i.e., conduit, raceways, trays, baskets) is 40 percent. The maximum fill capacity of 60 percent is allowed to accommodate future additions after initial installation.
      b. Conduit should be run in the most direct route possible with no more than two 90 degree bends between pull boxes and serve no more than 3 outlet boxes.
   3. Cable bend radius:
      a. Proper cable bend radius control must be maintained throughout the pathways. The bend radius needs to be at a minimum 10 times the cable diameter.
   4. Cable pulling:
      a. Provide cable pulling swivel system to prevent winding and tangling of rope and cables during pull.
      b. The maximum pulling tension is not to exceed manufacturer recommendations. Cable installation should not in any way deform the cable jacket.
      c. 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.
   5. Cable management:
      a. Organize and manage cables for quick and easy moves, adds and changes.
   6. Testing:
      a. All cables and termination hardware shall be 100 percent tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of TIA/EIA-568-C.1 Section 11.
         1) All pairs of each installed cable shall be verified prior to system acceptance.
         2) Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100 percent useable conductors in all cables installed.
      b. All twisted-pair copper cable links shall be tested for compliance to the requirements in TIA/EIA/568-C.2 for the appropriate Category of cabling installed.

c. All cables shall be tested in accordance with the contract documents, TIA/EIA standards, and best industry practice.
d. The field test equipment shall meet the requirements of TIA/EIA-568-C. The appropriate level III tester shall be used to verify Category 6 cabling.
e. Visually inspect UTP 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/EIA-568-C.1.
f. Visually inspect cable placement, cable termination, grounding and bonding, equipment and labeling of all components.
g. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors:
    1) Test operation of shorting bars in connection blocks.
    2) Test cables after termination but not cross-connection:
        a) Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-C.2:
            (1) 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.
            (2) Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

7. Separation from EMI sources:
    a. Comply with TIA/EIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
    b. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
        1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
        2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
        3) Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
    c. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
        1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
        2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
        3) Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
    d. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
        1) Electrical Equipment Rating Less Than 2 kVA: No requirement.

2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
3) Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

e. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.

N. Signal cable:
1. Separate and isolate electrical signal cables from sources of electrical noise and power cables by minimum 12 inches.

O. Submersible cable in wet wells:
1. Provide Kellem's grip or stainless steel wire mesh to support cable weight and avoid stress on insulation.

P. Wiring allowances:
1. Equipment locations may vary slightly from the drawings. Include an allowance for necessary conductors and terminations for motorized equipment, electrical outlets, fixtures, communication outlets, instruments, and devices within 10 linear feet of locations indicated on the Drawings.
2. Locations for pull boxes, manholes, and duct banks may vary slightly from the drawings. Include an allowance for necessary conductors and related materials to provide conductors to all pull boxes, manholes and duct banks within 20 linear feet of locations indicated on the Drawings.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Grounding:
1. As specified in Section 16060 - Grounding and Bonding.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 16050 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16125

FIBER OPTIC CABLE AND APPURTENANCES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Fiber optic cable.
   2. Fiber splices and terminations.
   3. Accessories.

B. Furnish a complete fiber optic network as indicated on the Drawings.

1.02 REFERENCES

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Bellcore Standards:
   1. GR-409, “Generic Requirements for Indoor Fiber.”

C. Electronic Industry Association (EIA) 455B "Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components":
   1. FOTP-25 - Impact testing of Fiber Optic Cables and Cable Assemblies.
   2. FOTP-33 - Fiber Optic Cable Tensile Loading and Bending Test.
   3. FOTP-41 - Compressive Loading Resistance of Fiber Optic Cables.
   4. FOTP-81 - Compound Flow (Drip) Test for Filled Fiber Optic Cable.
   5. FOTP-104 - Fiber Optic Cable Cyclic Flexing Test.
   6. FOTP-181 - Lightning Damage Susceptibility Test for Fiber Optic Cables with Metallic Components.

D. Insulated Cable Engineer’s Association (ICEA):
   1. S-83-596, “Optic Fiber Premises Distribution Cables.”
   2. S-87-640, “Optic Fiber Outside Plant Communications Cable.”
   3. S-104-696, “Indoor-Outdoor Optic Fiber Cable.”

E. TIA/EIA Standards:
   1. 598 - “Optical Fiber Cable Color Coding.”
   2. 11801 – Information technology – Generic cabling for customer premises.

F. Underwriters Laboratories, Inc. (UL):
   1. 1666 - Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts.
   2. 1685 - Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables.

1.03 DEFINITIONS

A. As specified in Sections 16050 - Common Work Results for Electrical and 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Specific definition:
   1. N/Cm: Newtons per centimeter.
   2. OTLS: Optical Loss Test Set (Tier 1 test).
   3. OTDR: Optical Time Domain Reflectometer (Tier 2 test).

1.04 SYSTEM DESCRIPTION (NOT USED)

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.

B. Product data:
   1. Complete manufacturer's brochures that identify materials and options.
   2. Completed data sheets, including catalog number and source for determining catalog number.
   3. Manufacturer's installation instructions.
   4. Include the following:
      a. Manufacturer's data on testing equipment used on this project.
      b. Manufacturer's specifications and data sheets for all fiber types.
      c. Manufacturer's specifications and data sheets for all connectors, bulkheads, splicing kits, breakout devices, and appurtenances used connecting and terminating the fiber spans.
   5. Catalog data on all testing devices proposed for use plus certifications of accuracy, calibration, and traceability to standards of the NIST.
   6. Manufacturer's test procedures and quality assurance procedures:
      a. After review, the Engineer may require that additional tests be performed before installation.

C. Shop drawings:
   1. Interconnection cabling diagrams for the complete system including every fiber in each cable.
   2. Drawings indicating the locations of all pull boxes including pull box identifiers and lengths.
   3. Submit optical power budget calculations for all fiber segments. Include the following:
      a. Minimum transmit power of active devices.
      b. Minimum receive sensitivity.
      c. Available power, in dBm.
      d. Loss for each segment in dBm, including cable attenuation and connector losses. Use manufacturer's data for cable attenuation, at the wavelength to be used. Assume 0.5 dB per connector.
      e. Demonstrate that remaining power budget at each receiver is equal to or greater than 3.0 dBm.

D. Installation instructions:
   1. Submit a cable pulling and splicing work plan a minimum of 45 days before the planned initiation of cable pulling. The cable pulling and splicing work plan must be approved a minimum of 15 days before pulling cable. Include the following:
      a. Pull tension calculations.
      b. Detailed description of pull operation methods for all conduit runs.
      c. Tools and equipment to be used for cable installation and testing.
      d. Physical location of equipment setup and type.
      e. Exact locations of splice points.
      f. Safety and manual assist cable-pulling operations.
      g. Detailed schedule for pulling and testing cables.
      h. The name and qualifications of the supervisory personnel directly responsible for the installation of the conduit system.
      i. Sample fiber optic cable test sheets.
      j. All signed test sheet results.

E. Operation and maintenance manuals:
   1. Compile completed test reports, instruction manuals, and manufacturer's information into the operating manuals and submitted in accordance with Section 01782 - Operation and Maintenance Data.

F. Test reports:
   1. Submit the results of all specified tests to the Engineer.
   2. Submit 3 copies of all test reports showing the results of all tests specified herein or in Section 16950 - Field Electrical Acceptance Tests:
      a. Test forms shall include the following information at a minimum:
         1) Test type.
         2) Test location.
         3) Test date.
         4) Wavelength.
         5) Index of refraction.
         6) Cable identification.
         7) Fiber type.
         8) Fiber number.
         9) Fiber color.
         10) Result of the value of the tested parameter.
   3. Furnish hard copy and electronic copy for all OTDR traces.
   4. Submit certification that the fiber optic cable has passed each testing stage:
      a. Submit separate documentation for each testing stage result.

G. Record documents:
   1. Furnish updated electrical drawings, network diagrams, and fiber cable block diagrams at the end of construction and submit as Record Drawings.

H. Calculations:
   1. Cable pulling calculations for all conduit runs:
      a. Indicate on the submittal any additional pull boxes that are required, including pull box identifiers and a written description of the location.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Furnish all cable and appurtenances manufactured within 1 year of installation.

C. Proof test all optical fibers by the fiber manufacturer at a minimum load of 50 kpsi.

D. Provide 100 percent attenuation testing for all optical fibers:
   1. Include with each cable reel the attenuation of each fiber.

E. Provide information on at least 5 successful fiber optic cable installations of comparable size and complexity in the past 3 years with name, address, and telephone number of facility owner, name of project with completion date, and type of conduit system and length of cable pulled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Package the cable for shipment on wooden reels:
   1. Seal both ends of the cable to prevent the ingress of moisture.
   2. Place fiber cable assemblies on reels such that both cable ends are available for testing.
   3. Weatherproof cable reel markings shall include the following:
      a. Manufacturer.
      b. Date of manufacture.
      c. Shipping date.
      d. Cable identification.
      e. Cable configuration/fiber count.
      f. Cable length.
      g. Gross weight.
      h. Cable test date.
      i. Handling instructions.
      j. Direction to unreel.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.09 SEQUENCING

A. Testing:
   1. Perform testing of each fiber in each cable as follows:
      a. At the factory before shipment.
      b. At the project site upon delivery.
      c. After installation, before breakout and terminations.
      d. After installation is complete.
   2. Submit test reports following each set of tests as specified in this Section.

B. Notify the Engineer and Owner a minimum of 15 days before post-installation testing.

1.10 SCHEDULING

A. As specified in Section 16050 - Common Work Results for Electrical.

1.11 WARRANTY

A. As specified in Section 16050 - Common Work Results for Electrical.

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable manufacturers are indicated with each component type as listed in the remainder of this specification.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. General fiber cable requirements:
   1. Suitable for the installed environment.
   2. Color-coded fibers according to EIA/TIA-598.
   3. Color-coded buffer tubes according to EIA/TIA-598.
   4. Furnish buffer tubes of a single layer nylon construction or of a material with similar mechanical performance.
   5. Fillers may be included in the cable core to lend symmetry to the cable cross-section where needed.
   6. Apply binders with sufficient tension to secure the buffer tubes to the central member without crushing the buffer tubes:
      a. Provide binders that are:
         1) Non-hygroscopic.
         2) Non-wicking (or rendered so by the flooding compound).
         3) Dielectric with low shrinkage.
   7. Provide a minimum of 1 ripcord under the cable sheath.
   8. Provide the high tensile strength Aramid yarns, Kevlar, and/or fiberglass helically stranded evenly around the cable core:
      a. No metallic elements whatsoever are allowed in non-armored cable.
   9. The jacket or sheath shall be free of holes, splits, and blisters.
   10. Mark the jacket or sheath with:
      a. Manufacturer's name.
      b. The words "Optical Cable”.
      c. Year of manufacture.
      d. Sequential meter marks.
      e. Repeat markings every 1-meter.

f. The actual length of the cable to be within 1 percent of the length marking.
g. The marking must be in a contrasting color to the cable jacket.
h. The height of the marking:
1) Approximately 2.5 millimeters.

11. The shipping, storage, and operating temperature range of the cable shall be -40 degrees Celsius to +70 degrees Celsius.
12. General performance characteristics:
a. The rated tensile load of the cables:
1) Indoor/outdoor:
a) Short term: 1,330 N.
b) Long term: 400 N.
b. Non-armored fiber optic cables: Compressive load withstand of 220 N/cm applied uniformly over the length of the cable.
c. Armored fiber optic cables: Compressive load withstand of 440 N/cm applied uniformly over the length of the cable.
d. The average increase in attenuation for the fibers: Less than or equal to 0.10 dB at 1,550 nm for a cable subjected to this load:
1) With no measurable increase in attenuation after load removal.
e. Test in accordance with FOTP-41, "Compressive Loading Resistance of Fiber Optic Cable," except that the load must be applied at the rate of 3 millimeters to 20 millimeters per minute and maintained for 10 minutes.
f. Capable of withstanding 25 cycles of mechanical flexing at a rate of 30 within 1 cycles/minute.
g. The average increase in attenuation for the fibers: Less than or equal to 0.10 dB at 1,550 nm at the completion of the test.
h. For armored cables, any visible cracks causing separation of the armor and propagating more than 5 millimeters constitutes failure.
i. Outer cable jacket cracking or splitting observed under 10X times magnification, constitutes failure.

B. Indoor/outdoor cable:
1. Cable construction:
a. General:
1) Cable type: Indoor/Outdoor - Flame retardant, low smoke, zero halogen, UV resistant.
2) Fiber count: As indicated on the Drawings.
3) Fiber type: As indicated on the Drawings.
4) Buffer tube: Tight buffer Loose tube.
5) Armoring: None.
6) Waterproofing: Water blocking layer.
7) Strength member:
a) Loose tube: Utilize a central, nonmetallic strength member with a coefficient of thermal expansion similar to the fibers as the central anti-buckling member.
8) Approvals and listings: UL 1666 and UL 1685.
9) Design and test criteria: In accordance with ICEA S-104-696.
b. Testing:
1) All fibers in the cable:
a) Proof test of 100 kpsi.
b) Each optical fiber: Bellcore GR-409 strip force testing.
c) No gaps are allowed between the coating material and the buffer material visible under a 50-power microscope.

c. Outer jacket material:
1) Linear low-density polyethylene.
2) Meet all requirements of the NEC for use in all indoor/outdoor areas (excluding plenums) without being enclosed in conduit.
3) Flame retardant OFNR riser rated conforming to UL 1666.
4) Printed with all necessary UL marks and manufacturer identification.
5) Sequential printing of footage in 2-foot increments.
6) With a ripcord incorporated under the cable jacket.

C. Multimode fibers:
1. All fibers in the cable must be usable fibers and meet required specifications.
2. Each optical fiber shall consist of a doped silica core surrounded by a concentric silica cladding.
3. Multimode fiber characteristics:
a. Category: OM3 compliant with ISO/IEC 11801.
b. Jacket color: Aqua.

D. Indoor/outdoor:
1. Loose tube:
a. Corning Cable Systems, Freedm®.
b. CommScope, LazrSPEED/TerraSPEED.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Patch cords:
1. General:
a. Connector types to match supplied equipment and the patch panel terminations.
b. Maximum length of patch cords: 25 feet.
c. Provide 2 spare patch cords (or 1 duplex patch cord) of each type used at each PLC or network cabinet.
d. Factory assembled and optically tested.
e. Provide mode-conditioning cords for multimode fibers operating at 1310 nm.
2. Manufacturers: One of the following or equal:
a. CommScope.
b. Corning Cable Systems.

B. Fiber optic identification/warning tags:
1. Black letters on orange or yellow background.
2. UV resistant polyethylene or other suitable material.
a. Manufacturers: The following or equal:
1) Almetek.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify the condition of the conduit system before installation of the fiber optic cable or inner duct.

B. Pass a test mandrel through all fiber optic conduits prior to pulling fiber or installing inner duct:
   1. Run the mandrel in both directions.

C. Examine all materials and equipment before installation and verify they are free from physical damage and defects.

3.02 PREPARATION

A. Before fiber splicing terminating or testing activities, verify sufficient workspace is available to perform the activity without interferences from other trades.

B. Pre-installation test:
   1. Conduct pre-installation tests on all fiber optic cable.
   2. Upon arrival at the site:
      a. Inspect the cable and reel for damage.
      b. Test all fibers with an optical time domain reflectometer (OTDR) for fiber integrity.
      c. Verify that the fiber lengths are consistent with the cable manufacture.
      d. Verify that all traces yield no point discontinuities.
   3. Complete test sequence and obtain approval from the Engineer of submitted test results before cable installation:
      a. Replace any cable failing to meet the requirements of the required tests and test before installation.
   4. Submit copies of the test results to the Engineer within 5 days after the delivery to the site.

3.03 INSTALLATION

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Install fiber optic patch cords in open network trays or in dedicated conduits no longer than 25 feet in length.

C. Install all fiber optic system components in accordance with the recommendations of the manufacturer.

D. Install fiber optic cable in continuous lengths without intermediate splices, except where approved by the Engineer.

E. Installation:
1. Utilize personnel certified by the manufacturer with specific knowledge of the cable manufacturer's recommended procedures:
    a. Schedule Engineer, 5 days before installation, to witness all cable installations.
2. Properly attach the fiber optic cable's strength elements to a 600-pound breakaway swivel containing tension or shear pins using Kellums pulling grips that are a minimum of 18 inches long.
3. Certify that cable tensile limits do not exceed cable pull tension and bend limits using tension monitoring devices.
4. Leave an extra loop of fiber optic cable in each pull box.
5. Conform with the cable manufacturer's specifications, practices, and the following requirements:
    a. When power equipment is used to install fiber optic cables, use low speeds and do not exceed a rate of 30 meters per minute.
    b. Do not exceed the tensile and bending limitation for fiber optic cables under any circumstances.
    c. Use large diameter wheels, pulling sheaves, and cable guides to maintain the specified bending radius.
    d. Use commercial dynamometers or load cells to monitor pulling tension.
    e. A nonfreezing type of swivel inserted between the pulling line and cable pulling grip to prevent twisting under strain.
    f. All cable to be installed using a breakaway swivel.
6. Apply to all conduits a lubricant at each conduit ingress and egress location during the pull operation:
    a. Pour or pump lubricant into the end of the conduit at the feed location at a nominal application rate of 3 gallons per 1,000 feet of cable.
    b. If the conduit is open at intermediate locations, then apply the appropriate proportion of lubricant at each opening.
    c. Continuously lubricate the cable as it is being pulled by pouring or pumping the lubricant into the conduit at the feed location and at each intermediate location.
    d. Station workers at each intermediate location as required.
    e. Remove all excess lubricant that has collected.
    f. Remove and clean the surrounding area after cable installation.
7. Install using a hydraulic capstan or winch equipped with a recording running line dynamometer graph which measures and records pulling tensions:
    a. Use pulling equipment with "slip-load" capability to allow the winch to maintain a constant pulling force without taking up the winch line.
    b. Use pulling equipment equipped with a hydraulic bypass set so that a maximum tension of 600 pounds is not exceeded.
    c. Use only equipment designed to prevent a preset pulling tension from being exceeded.
    d. Fiber optic cable manufacturer to provide the pulling tension setpoint.
    e. If during the pulling operation excessive tension is detected, cease all operations and notify the Engineer.
8. Position the cable reel at the feed point in alignment with the raceway and in such a position that the cable can be passed from the top of the reel in a long, smooth bend into the raceway system:
    a. The use of a cable feeder is required, unless the cable is hand-pulled.

9. Supply all bull wheels, blocks, split wheels, cable feeders, and necessary equipment required to provide a clean and safe operation:
    a. The cable shall not be allowed to travel over any wheel or block that has a radius less than the minimum radius allowed by the cable manufacturer.
10. Minimize the use of snatch blocks and rollers to guide the cable into the conduit at the feed point:
    a. Slack feed by hand the cable into the feed point and raceway without the use of rollers.
11. Tend the cable reel at all times and turn by hand to provide the required cable slack:
    a. Under no circumstances shall the cable tension be allowed to turn the cable reel.
12. Use a rim roller, with a wheel radius greater than the minimum cable bending radius placed at the manhole or vault opening to prevent the cable from dragging on the manhole rim or steps.
13. Perform a continuous thorough visual inspection for flaws, breaks, and abrasions in the cable sheath as the cable leaves the reel, and maintain a slow pulling speed to permit this inspection.
14. Damage to the sheath or finish of the cable is cause for rejecting the cable:
    a. Replace any cable damaged in any way during installation.
15. If the cable becomes damaged during installation, stop operations and notify the Engineer immediately:
    a. Engineer to determine whether to replace the entire reel of cable or to install a termination panel to eliminate the damaged section.
16. Document all pulls by a graph which is annotated with the following information:
    a. Reel number.
    b. Pull point ID.
    c. Date and time.
    d. Explanations for abnormalities in readings or interruptions.
    e. Sign-off by Contractor and Engineer.
17. Under no conditions shall the fiber optic cable be left exposed or unattended.

F. After the cables are installed and spliced:
    1. Rack the cables.
        a. Loosely secure in racked position with wire ties.
        b. Attach imprinted plastic coated cloth identification/warning tags to each cable in at least 2 locations in each handhole/manhole.

G. Armored fiber optic cables containing metallic members shall be grounded in accordance with NEC.

H. Splices:
    1. Submit all splice locations to the Engineer for approval before installation of the fiber cables.
    2. Provide field splices in a splice tray located in a waterproof splice enclosure:
        a. Manufacturers: The following or equal:
            1) Tyco/Raychem, FOSC style splice enclosure.
    3. Loop the individual fibers a minimum of 1 full turn within the splice tray to avoid macro/micro bending.
    4. After completion of cable terminations, neatly dress all cables.
    5. Protect all splices with a thermal shrink sleeve.

6. Provide fusion type fiber optic cable splicing meeting the following requirements:
    a. Joins multimode or single mode fibers.
    b. Establishes a permanent fusion splice.
    c. Waterproof.
    d. Re-enterable, rearrangable, and reusable.
    e. Splice loss less than 0.10 dB.
    f. Protected by a splice enclosure.
7. Requirement for outdoor fiber splice enclosures:
    a. Seal.
    b. Bond.
    c. Anchor.
    d. Protect fiber optic cable splices.
    e. Stand-alone unit that does not require an outer enclosure.
    f. Provide for a maximum of 6 cable entries in a butt-end configuration.
    g. Used in aerial, underground, and direct buried applications.
8. Requirement for indoor fiber splice enclosures:
    a. Anchor.
    b. Protect fiber optic cable splices.
    c. Stand-alone unit that does not require an outer enclosure.
    d. Suitable for the minimum number of splices at that location plus additional capacity for reconfigurations.
9. Re-splice any splice that has a loss greater than 0.10 dB.
10. Leave a minimum of 20 feet of fiber optic cable at each end of splice.

I. Terminations:
1. Terminate all fiber inside a patch panel:
    a. Direct landing to a switch, router hub, or PLC will not be allowed.
2. Terminate outdoor cables using a breakout kit that seals the cable and provides physical protection for the fiber strands.
3. Terminate indoor cables using factory assembled terminations pig tail spliced to the cable ends.
4. Labeling:
    a. Permanently label all cable terminations. Use labels produced by a wire printer using pressure sensitive polyester labels. Label patch panels as specified in Section 16075 - Identification for Electrical Systems.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Factory test:
1. Before shipment and while on the shipping reel, test 100 percent of all fibers for attenuation:
    a. Copies of the results shall be:
        1) Maintained on file.

2) Attached to the cable reel in a waterproof pouch.
3) Submitted before the delivery of the cable to the job site to Engineer for approval.

2. Conduct the flex test in accordance with FOTP-104 test condition I and III with a maximum sheave diameter of 20 times the cable OD.
3. Verify that the cable withstands 25 impact cycles with:
   a. The average increase in attenuation for the fibers less than 0.20 dB at 1,550 nm.
   b. No evidence of cracking or splitting.
   c. Conduct the test in accordance with FOTP-25.
4. Certify that the cable withstands a tensile load of 2,700 N (600 pounds):
   a. Without exhibiting an average increase in attenuation of greater than 0.10 dB.
   b. Test in accordance with FOTP-33 using a maximum mandrel and sheave diameter of 560 millimeters.
   c. Apply the load for 1 hour in Test Condition II.
5. Certify that the cable withstands a simulated lightning strike:
   a. Peak value of the current pulse greater than 105kA.
   b. Use a test current with a damped oscillatory maximum time-to-peak value of 15 µs (which corresponds to a minimum frequency of 16.7 kHz) and a maximum frequency of 30 kHz.
   c. The time to half-value of the waveform envelope 40 to 70 µs.
   d. Conduct the test in accordance with the FOTP-181.
   e. In addition to the analysis criterion set forth in FOTP-181, the integrity of the buffer tubes (or analogous loose tube, i.e. core tube) and strength members must be intact after removal of the cable specimens from the test box.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

B. General:
1. All test results shall meet or exceed manufacturer specifications:
   a. Test each fiber of each cable for breaks, abnormalities, and overall attenuation characteristics.
   b. Replace any fiber that does not meet or exceed manufacturer specifications.
2. Conduct post-installation tests of the fiber optic system in accordance with Section 16950 - Field Electrical Acceptance Tests.
3. Pre-installation tests and post-installation tests to be witnessed and signed off by Engineer and Owner.
4. Perform OLTS test with equipment capable and calibrated to show anomalies of 0.1 dB as a minimum:
   a. Test multimode fibers at 850 nm and 1,300 nm.
   b. Test single mode fibers at 1,310 and 1,550 nm.
5. Perform OTDR tests on fiber cables less than 100 meters with the aid of a launch cable:
   a. Adjust OTDR pulse width settings to a maximum setting of 1/1000th of the cable length or 10 nanoseconds.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. Clean all fiber optic connectors after termination and before testing. After cleaning, cover all un-terminated connectors with a protective boot.

B. At the completion of construction, touch up the finish on all fiber patch panels and enclosures.

3.11 PROTECTION

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Protect the fiber system from physical damage and the encroachment of dust, before, during, and after installation.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16130

CONDUITS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Metallic conduits.
   2. Nonmetallic conduits.
   3. Conduit bodies.
   4. Conduit fittings and accessories.
   5. Conduit installation.

1.02 REFERENCES

A. As specified in Section 16050 - Common Work Results for Electrical.

B. American National Standards Institute (ANSI):
   1. C80.1 - Electrical Rigid Steel Conduit.
   2. C80.3 - Steel Electrical Metallic Tubing.
   3. C80.5 - Electrical Rigid Aluminum Conduit.
   4. C80.6 - Electrical Intermediate Metal Conduit.

C. National Electrical Manufacturer's Association (NEMA):
   1. RN-1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Steel Conduit.
   2. TC2 - Electrical Polyvinyl Chloride (PVC) Conduit.
   3. TC3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
   4. TC7 - Smooth-Wall Coilable Electrical Polyethylene Conduit.
   5. TC13 - Electrical Nonmetallic Tubing.
   6. TC14 - Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

D. Underwriters Laboratories (UL):
   1. 1 - Standard for Flexible Metal Conduit.
   2. 6 - Standard for Electrical Rigid Metal Conduit - Steel.
   3. 6A - Standard for Electrical Rigid Metal Conduit - Aluminum, Red Brass, and Stainless Steel.
   4. 360 - Standard for Liquidtight Flexible Steel Conduit.
   5. 651 - Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
   6. 651B - Standard for Continuous Length HDPE Conduit.
   7. 797 - Standard for Electrical Metallic Tubing - Steel.
   8. 1242 - Standard for Electrical Intermediate Metal Conduit - Steel.
   9. 1653 - Standard for Electrical Nonmetallic Tubing.
   10. 1660 - Standard for Liquidtight Flexible Nonmetallic Conduit.
   11. 1684 - Standard for Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

1.03 DEFINITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Specific definitions and abbreviations:
   1. Conduit bodies: A separate portion of a conduit system that provides access through a removable cover to the interior of the system at a junction of 2 or more conduit sections. Includes, but not limited to, Shapes C, E, LB, T, X, etc.
   2. Conduit fitting: An accessory that primarily serves a mechanical purpose. Includes, but not limited to, bushings, locknuts, hubs, couplings, reducers, etc.
   3. GRC: Galvanized rigid steel conduit.
   4. PCS: Polyvinyl chloride (PVC) coated rigid steel conduit.
   5. PVC: Polyvinyl chloride rigid nonmetallic conduit.
   6. SLT: Sealtight-liquidtight flexible conduit.
   7. FRD: Fiberglass-reinforced duct.
   8. NPT: National pipe thread.

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.

B. Product data:
   1. Furnish complete manufacturer’s catalog sheets for every type and size of conduit, fitting, conduit body, and accessories to be used on the Project.
   2. Furnish complete manufacturer’s recommended special tools to be used for installation if required.
   3. Certified test results for PVC-coated metallic conduit showing the adhesive bond is stronger than the tensile strength of the PVC.

C. Certifications:
   1. Furnish PVC-coated conduit manufacturer’s certification for each installer.

D. Record Documents:
   1. Incorporate all changes in conduit routing on electrical plan drawings.
   2. Dimension underground and concealed conduits from building lines.
   3. Furnish hard copy drawings.

1.05 QUALITY ASSURANCE

A. As specified in Section 16050 - Common Work Results for Electrical.

B. All conduits, conduit bodies, and fittings shall be UL listed and labeled.

C. Every installer of PVC-coated metallic conduit shall be certified by the manufacturer for installation of the conduit.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Do not expose non-metallic conduit to direct sunlight.

C. Do not store conduit in direct contact with the ground.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.08 SEQUENCING

A. Before installing any conduit or locating any device box:
   1. Examine the complete set of Drawings and Specifications, and all applicable shop drawings.
   2. Verify all dimensions and space requirements and make any minor adjustments to the conduit system as required to avoid conflicts with the building structure, other equipment, or the work of other trades.

1.09 SCHEDULING (NOT USED)

1.10 WARRANTY

A. As specified in Section 16050 - Common Work Results for Electrical.

1.11 SYSTEM START-UP

A. As specified in Section 16050 - Common Work Results for Electrical.

1.12 OWNER'S INSTRUCTIONS (NOT USED)

1.13 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Galvanized rigid steel conduit:
   1. One of the following or equal:
      a. Western Tube and Conduit.
      b. Allied Tube and Conduit.
      c. Wheatland Tube Co.

B. PVC-coated rigid steel conduit:
   1. One of the following or equal:
      a. Robroy Ind.
      b. Ocal, Inc.
      c. Calbond.
      d. Allied.
      e. NEC, Inc. BlackGuard.

C. Sealtight-liquidtight flexible conduit:
   1. One of the following or equal:
      a. Southwire.
      b. AFC Cable Systems.
      c. Electri-Flex Co.
      d. Anaconda.

D. Rigid nonmetallic PVC conduit:
   1. One of the following or equal:
      a. Carlon.
      b. Cantex.
      c. Triangle Conduit and Cable.

E. Fiberglass reinforced duct:
   1. One of the following or equal:
      a. Champion Fiberglass.
      b. Smith Fiberglass.
      c. FRE Composites.

F. Conduit bodies:
   1. One of the following or equal:
      a. Crouse-Hinds.
      b. Appleton.
      c. O-Z/Gedney.
      d. Ocal, Inc.
      e. Robroy Ind.
      f. Calbond.
      g. Carlon.

G. Joint compound:
   1. The following or equal:
      a. Thomas & Betts.

H. Galvanized rigid steel conduit expansion fittings:
   1. One of the following or equal:
      a. Crouse-Hinds.
      b. Appleton.
      c. O-Z/Gedney.

I. PVC-coated rigid steel conduit expansion fittings:
   1. One of the following or equal:
      a. Ocal, Inc.
      b. Robroy Ind.
      c. NEC, Inc. BlackGuard.

J. Conduit hangers and supports:
   1. As specified in Section 16070 - Hangers and Supports.

2.02 SYSTEM DESCRIPTION

A. Provide conduits, conduit bodies, fittings, junction boxes, and all necessary components, whether or not indicated on the Drawings, as required, to install a complete electrical raceway system.

2.03 EXISTING PRODUCTS (NOT USED)

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT (NOT USED)

2.07 COMPONENTS

A. GRC:
   1. All threads: NPT standard conduit threads with a 3/4-inch taper per foot:
      a. Running conduit threads are not acceptable.
   2. Hot-dip galvanized inside and out:
      a. Ensures complete coverage and heats the zinc and steel to a temperature that ensures the zinc alloys with the steel over the entire surface.
      b. Electro-galvanizing is not acceptable.
   3. Manufactured in accordance with:
      a. UL-6.
      b. ANSI C80.1.

B. PCS:
   1. The steel conduit, before PVC coating, shall be new, unused, hot-dip galvanized material, conforming to the requirements for Type GRC.
   2. Coated conduit NEMA Standard RN-1:
      a. The galvanized coating may not be disturbed or reduced in thickness during the cleaning and preparatory process.
   3. Factory-bonded PVC jacket:
      a. The exterior galvanized surfaces shall be coated with primer before PVC coating to ensure a bond between the zinc substrate and the PVC coating.
      b. Nominal thickness of the exterior PVC coating shall be 0.040 inch except where part configuration or application of the piece dictates otherwise.
      c. PVC coating on conduits and associated fittings shall have no sags, blisters, lumps, or other surface defects and shall be free of holes and holidays.
      d. The PVC adhesive bond on conduits and fittings shall be greater than the tensile strength of the PVC plastic coating:
         1) Confirm bond with certified test results.
   4. A urethane coating shall be uniformly and consistently applied to the interior of all conduits and fittings:
      a. Nominal thickness of 0.002 inch.
      b. Conduits having areas with thin or no coating are not acceptable.
      c. All threads shall be coated with urethane.
   5. The PVC exterior and urethane interior coatings applied to the conduits shall afford sufficient flexibility to permit field bending without cracking or flaking at temperature above 30 degrees Fahrenheit (-1 degree Celsius).
   6. PCS conduit bodies and fittings:
      a. Malleable iron.
      b. The conduit body, before PVC coating, shall be new, unused material and shall conform to appropriate UL standards.

c. The PVC coating on the outside of conduit bodies shall be 0.040-inch thick and have a series of ribs to protect the coating from tool damage during installation.
d. 0.002-inch interior urethane coating.
e. Utilize the PVC coating as an integral part of the gasket design.
f. Stainless steel cover screw heads shall be encapsulated with plastic to ensure corrosion protection.
g. A PVC sleeve extending 1 conduit diameter or 2 inches, whichever is less, shall be formed at each female conduit opening.
1) The inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used.
2) The sleeve shall provide a vapor- and moisture resistant seal at every connection.

C. SLT:
1. Temperature rated for use in the ambient temperature at the installed location but not less than the following:
a. General purpose:
1) Temperature range: -20 degrees Celsius to +80 degrees Celsius.
b. Oil-resistant:
1) Temperature range: -20 degrees Celsius to +60 degrees Celsius.
2. Sunlight-resistant, weatherproof, and watertight.
3. Manufactured from single strip steel, hot-dip galvanized on all 4 sides before conduit fabrication.
4. Strip steel spiral wound resulting in an interior that is smooth and clean for easy wire pulling.
5. Overall PVC jacket.
6. With integral copper ground wire, built in the core, in conduit trade sizes 1/2 inch through 1-1/4 inch.

D. PVC:
1. Extruded from virgin PVC compound:
a. Schedule 40 unless otherwise specified.
b. Schedule 80 extra-heavy wall where specified.
2. Rated for 90 degrees Celsius conductors or cable.
3. Rated for use in direct sunlight.

E. FRD:
1. Suitable for use at -40 degrees Celsius to 110 degrees Celsius.
2. Integral bell and spigot either glued together or assembled with an integral urethane tri-seal gasket held in place with a retainer ring.
3. For underground use only.
4. Conduits and fittings shall be pigmented with UV-inhibiting carbon black.

F. Conduit bodies:
1. Material consistent with conduit type:
a. Malleable iron bodies and covers when used with Type GRC.
b. PVC-coated malleable iron bodies and covers when used with Type PCS.
2. Conduit bodies to conform to Form 8, Mark 9, or Mogul design:
a. Mogul design conforming to NEC requirements for bending space for large conductors for conduit trade sizes of 1 inch and larger with

conductors No. 4 AWG and larger, or where required for wire-bending space.

3. Gasketed covers attached to bodies with stainless steel screws secured to threaded holes in conduit body.

2.08 ACCESSORIES

A. Connectors and fittings:
   1. Manufactured with compatible materials to the corresponding conduit.

B. Insulated throat metallic bushings:
   1. Construction:
      a. Malleable iron or zinc-plated steel when used with steel conduit.
      b. Positive metallic conduit end stop.
      c. Integrally molded non-combustible phenolic-insulated surfaces rated at 150 degrees Celsius.
      d. Use fully insulated bushings on nonmetallic conduit system made of high-impact 150 degrees Celsius rated non-combustible thermosetting phenolic.

C. Insulated grounding bushings:
   1. Construction:
      a. Malleable iron or steel, zinc-plated, with a positive metallic end stop.
      b. Integrally molded non-combustible phenolic-insulated surfaces rated at 150 degrees Celsius.
      c. Tin-plated copper grounding saddle for use with copper or aluminum conductors.

D. Electrical unions (Erickson Couplings):
   1. Construction:
      a. Malleable iron for use with steel conduit.
      b. Concrete tight, 3-piece construction.
      c. Rated for Class I Division 1 Group D in hazardous areas.

E. SLT fittings:
   1. Construction:
      a. Malleable iron.
      b. Furnished with locknut and sealing ring.
      c. Liquidtight, raintight, oiltight.
      d. Insulated throat.
      e. Furnish as straight, 45-degree elbows, and 90-degree elbows.
      f. Designed to prevent sleeving:
         1) Verify complete bonding of the raceway jacket to the plastic gasket seal.
      g. Equipped with grounding device to provide ground continuity irrespective of raceway core construction. Grounding device, if inserted into raceway and directly in contact with conductors, shall have rolled-over edges for sizes under 5 inches.
      h. Where terminated into a threadless opening using a threaded hub fitting, a suitable moisture-resistant/oil-resistant synthetic rubber gasket shall be provided between the outside of the box or enclosure and the fitting

shoulder. Gasket shall be adequately protected by and permanently bonded to a metallic retainer.

2. Corrosion-resistant and outdoor SLT fittings:
    a. Construction:
        1) PVC-coated liquidtight fittings with a bonded 0.040-inch thick PVC coating on the metal connector to form a seal around the SLT conduit.
        2) Insulated throat and an integral sealing ring.

F. Hubs for threaded attachment of steel conduit to sheet metal enclosures:
1. Construction:
    a. Insulated throat.
    b. PVC-coated when used in corrosive areas.
    c. Bonding locknut.
    d. Recessed neoprene o-ring to ensure watertight and dusttight connector.
    e. 1/2-inch through 1-1/4-inch steel zinc electroplated.
    f. 1-1/2-inch through 6-inch malleable iron zinc plated.
2. Usage:
    a. All conduits in damp, wet, outdoor, and corrosive areas shall use threaded hubs for connections to sheet metal enclosures.

G. Expansion/deflection couplings:
1. Use to compensate for movement in any directions between 2 conduit ends where they connect.
2. Shall allow movement of 3/4 inch from the normal in all directions.
3. Shall allow angular movement for a deflection of 30 degrees from normal in any direction.
4. Constructed to maintain electrical continuity of the conduit system.
5. Materials:
    a. End couplings: Bronze or galvanized ductile iron.
    b. Sleeve: Neoprene.
    c. Bands: Stainless steel.
    d. Bonding jumper: Tinned copper braid.

H. Expansion couplings:
1. Shall allow for expansion and contraction of conduit:
    a. Permitting 8-inch movement, 4 inches in either direction.
2. Constructed to maintain electrical continuity of the conduit system.
3. Materials:
    a. Head: Malleable or ductile iron.
    b. Sleeve: Steel.
    c. Insulating bushing: Phenolic.
    d. Finish: Hot-dip galvanized.
    e. PVC-coated when used with Type PCS.

I. Conduit markers:
1. As specified in Section 16075 - Identification for Electrical Systems.

2.09 MIXES (NOT USED)

2.10 FABRICATION (NOT USED)

2.11 FINISHES (NOT USED)

2.12 SOURCE QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050 - Common Work Results for Electrical.

B. General:
   1. Conduit routing:
      a. The electrical drawings are diagrammatic in nature:
         1) Install conduit runs as specified with schematic representation indicated on the Drawings and as specified.
         2) Modify conduit runs to suit field conditions, as accepted by the Engineer:
            a) Make changes in conduit locations that are consistent with the design intent but are dimensionally different, or routing to bypass obstructions.
            b) Make changes in conduit routing due to the relocation of equipment.
         3) The electrical drawings do not indicate all required junction boxes and pull boxes:
            a) Provide junction boxes and pull boxes to facilitate wire pulling as required:
               (1) To meet cable manufacturer’s pulling tension requirements.
               (2) To limit total conduit bends between pull locations.
            b) Install junction boxes and pull boxes at locations acceptable to the Engineer.
      b. The Contractor is responsible for any deviations in general location, conduit size, routing, or changes to the conduit schedule without the express written approval or direction by the Engineer:
         1) The Engineer is the sole source in determining whether the change is constituted as a deviation:
            a) Perform any changes resulting in additional conduits, or extra work from such deviations.
            b) Incorporate any deviations on the Record Documents.
   2. Use only tools recommended by the conduit manufacturer for assembling the conduit system.
   3. Provide adequate clearances from high-temperature surfaces for all conduit runs. Provide minimum clearances as follows:
      a. Clearance of 6 inches from surfaces 113 degrees Fahrenheit to 149 degrees Fahrenheit.
      b. Clearance of 12 inches from surfaces greater than 149 degrees Fahrenheit.

c. Keep conduits at least 6 inches from the coverings on hot water and steam pipes, 18 inches from the coverings on flues and breechings, and 12 inches from fuel lines and gas lines.
d. Where it is necessary to route conduits close to high-temperature surfaces, provide a high-reflectance thermal barrier between the conduit and the surface.

4. Support conduit runs on water-bearing walls a minimum of 7/8-inch away from wall on an accepted preformed channel:
   a. Do not run conduits within water-bearing walls unless otherwise indicated on the Drawings.
5. Do not install 1-inch or larger conduits in or through structural members unless approved by the Engineer.
6. Run conduits exposed to view parallel with or at right angles to structural members, walls, or lines of the building:
   a. Install straight and true conduit runs with uniform and symmetrical elbows, offsets, and bends.
   b. Make changes in direction with long radius bends or with conduit bodies.
7. Install conduits with total conduit bends between pull locations less than or equal to 270 degrees.
8. Route all exposed conduits to preserve headroom, access space and work space, and to prevent tripping hazards and clearance problems:
   a. Install conduit runs so that runs do not interfere with proper and safe operation of equipment and do not block or interfere with ingress or egress, including equipment-removal hatches.
   b. Route conduits to avoid drains or other gravity lines. Where conflicts occur, relocate the conduit as required.
9. When installing conduits through existing slabs or walls, make provisions for locating any possible conflicting items where the conduit is to penetrate. Use tone signal or X-ray methods to make certain that no penetrations will be made into the existing conduits, piping, cables, post-tensioning cables, etc.
10. Plug conduits brought into pull boxes, manholes, handholes, and other openings until used to prevent entrance of moisture.
11. Install conduits through wall and floor seals where indicated on the Drawings.
12. For existing and new 2-inch and larger conduit runs, snake conduits with a conduit cleaner equipped with a cylindrical mandrel of a diameter not less than 85 percent of nominal diameter of the conduit:
    a. Remove and replace conduits through which mandrel will not pass.
13. Provide all sleeves and openings required for the passage of electrical raceways or cables even when these openings or sleeves are not specifically indicated on the Drawings.
14. Install complete conduit systems before conductors are installed.
15. Provide metallic conduits terminating in transformer, switchgear, motor control center, or other equipment conduit windows with grounding bushings and ground with a minimum No. 6 AWG ground wire.
16. Underground conduits:
    a. Install underground conduits, including conduit runs below slabs-on-grade in concrete-reinforced duct bank construction:
       1) As specified in Section 16133 - Duct Banks.
    b. Make underground conduit size transitions at handholes and manholes.

c. Install spare conduits in underground duct banks towards top center of runs to allow for ease of installation of future cables as conduits enter underground manholes and handholes.
d. Seal around conduit penetrations of below grade walls with a mechanical seal.

C. Lighting and receptacle conduits:
1. Provide conduit runs for lighting and receptacle circuits, whether or not indicated on the Drawings:
2. Install conduits in accordance with the requirements of this Section unless otherwise indicated.
3. Minimum conduit size:
a. 3/4-inch for exposed conduits.
b. 1-inch for underground or in-slab conduits.
4. Provide conduit materials for the installed location as specified in Section 16050 - Common Work Results for Electrical.

D. Conduit usage:
1. Exposed conduits:
a. Rigid conduit:
1) Install the rigid conduit type for each location as specified in Section 16050 - Common Work Results for Electrical.
2) Minimum size: 3/4-inch.
b. Flexible conduit:
1) Use flexible conduit for final connections between rigid conduit and motors, vibrating equipment, instruments, control equipment, or where required for equipment servicing:
a) Use Type SLT with rigid metallic conduit.
2) Minimum size: 3/4-inch:
a) 1/2 when required for connection to instruments.
3) Maximum length:
a) Fixed equipment:

Conduit Trade Size	Flexible Conduit Length (inch)
3/4	18
1	18
1-1/4	18
1-1/2	18
2	36
2-1/2	36
3	36
3-1/2	38
4	40

b) Removable instruments or hinged equipment:
(1) As required to allow complete removal or full movement without disconnecting or stressing the conduit.

2. Concrete-encased and embedded conduits:
    a. Straight runs and bends less than 45 degrees:
        1) Type PVC Schedule 40.
    b. Bends with total deflection greater than 45 degrees:
        1) PCS, or FRD.
    c. Entering and exiting duct bank, underground or embedded conduit runs a minimum 12 inches above and below grade, finished floor, or entering equipment:
        1) PCS.
    d. Minimum size:
        1) 2-inch in duct banks.
        2) 1-inch for in-slab conduits.
        3) Provide conduit fittings to enlarge the conduit from the exposed size in the conduit schedule as required.
3. PVC-coated rigid metallic conduit:
    a. Use specifically manufactured or machined threading dies to manufacturer's specifications to accommodate the PVC jacket.
4. GRC:
    a. Conduit shall be cut square and reamed before threading.

E. Conduit joints and bends:
1. General:
    a. Where conduit is underground, under slabs on grade, exposed to the weather, or in NEMA Type 4 or NEMA Type 4X locations, make joints liquidtight.
    b. Keep bends and offsets in conduit runs to an absolute minimum.
    c. All bends shall be symmetrical.
    d. The following conduit systems shall use large-radius sweep elbows:
        1) Underground conduits.
        2) Conduits containing fiber optic cables.
    e. Provide large-radius factory-made bends for 1-1/4-inch trade size or larger.
    f. Make field bends with a radius of not less than the requirements found in the NEC:
        1) The minimum bending radius of the cable must be less than the radius of the conduit bend.
        2) Make all field bends with power bending equipment or manual benders specifically intended for the purpose:
            a) Make bends so that the conduit is not damaged and the internal diameter is not effectively reduced.
            b) For the serving utilities, make bends to meet their requirements.
    g. Replace all deformed, flattened, or kinked conduit.
2. Threaded conduit:
    a. Cut threads on rigid metallic conduit with a standard conduit-cutting die that provides a 3/4-inch per foot taper and to a length such that all bare metal exposed by the threading operation is completely covered by the couplings or fittings used. In addition, cut the lengths of the thread such that all joints become secure and wrench-tight just preceding the point where the conduit ends would butt together in couplings or where conduit ends would butt into the ends or shoulders of other fittings.
    b. Thoroughly ream conduit after threads have been cut to remove burrs.
    c. Use bushings or conduit fittings at conduit terminations.

d. On exposed conduits, repair scratches and other defects with galvanizing repair stick, Enterprise Galvanizing “Galvabar™,” or CRC “Zinc It.”
e. Coat conduit threads with an approved electrically conductive sealant and corrosion inhibitor that is not harmful to the conductor insulation:
1) Apply to the male threads and tighten joints securely.
2) Clean excess sealant from exposed threads after assembly.
f. Securely tighten all threaded connections.
g. Any exposed threaded surfaces must be cleaned and coated with a galvanizing solution so that all exposed surfaces have a galvanized protective coating.

3. PVC:
a. Use approved solvent-weld cement specifically manufactured for the purpose. Spray-type cement is not allowed.
b. Apply heat for bends so that conduit does not distort or discolor. Use a spring mandrel as required to ensure full inside diameter at all bends:
1) Utilize a heater specifically for PVC conduit as recommended by the conduit manufacturer.

F. Conduit sealing and drainage:
1. Conduit drainage and sealing other than required for hazardous and classified areas:
a. Provide sealing and drainage in vertical drops of long (in excess of 20 feet), exterior, above-grade conduit runs at the points at which the conduit enters buildings, switchgear, control panels, lighting panelboards, and other similar enclosures.
b. Provide seal fittings with drains in vertical drops directly above grade for exterior and above-grade conduit runs that are extended below grade.
c. Provide conduit seals with drains in areas of high humidity and rapidly changing temperatures:
1) Where portions of an interior raceway pass through walls, ceilings, or floors that separate adjacent areas having widely different temperatures.
d. Provide conduit seals similar to O-Z/Gedney (Type CSM) on all conduits between corrosive and non-corrosive areas.
e. Seal one end only of all underground conduits at highest point with O-Z/Gedney sealing (non-hazardous) filling, or equal.

2. Install seals with drains at any location along conduit runs where moisture may condense or accumulate. This requirement includes, but is not limited to, the following locations: control panels, junction boxes, pullboxes, or low points of the conduit.

G. Conduit supports:
1. General:
a. Provide appropriate hangers, supports, fasteners, and seismic restraints to suit applications:
1) As specified in Section 16070 - Hangers and Supports.
2) Provide support materials consistent with the type of conduit being installed as specified in Section 16050 - Common Work Results for Electrical.
b. Support conduit at the intervals required by the NEC.
c. Perforated strap and plumbers tape are not acceptable for conduit supports.

2. Conduit on concrete or masonry:
    a. Use 1-hole malleable iron straps with metallic or plastic expansion anchors and screws or support from preset inserts.
    b. Use preset inserts in concrete when possible.
    c. Use pipe spacers (clamp backs) in wet locations.
3. Suspended conduit:
    a. Use malleable-iron factory-made split-hinged pipe rings with threaded suspension rods sized for the weight to be carried (minimum 3/8-inch diameter), Kindorf, or equal.
    b. For grouped conduits, construct racks with threaded rods and tiered angle iron or preformed channel cross members. Clamp each conduit individually to a cross member. Where rods are more than 2-feet long, provide rigid sway bracing.
4. Supports at structural steel members:
    a. Use beam clamps.
    b. Drilling or welding may be used only as specified or with approval of the Engineer.
5. PVC-coated rigid metal systems:
    a. Provide right-angle beam clamps and “U” bolts specially formed and sized to snugly fit the outside diameter of the coated conduit. Provide "U" bolts with PVC-encapsulated nuts that cover the exposed portions of the threads.
    b. Securely fasten exposed conduits with Type 316 stainless steel clamps or straps.

H. Expansion or expansion/deflection fittings:
1. General:
    a. Align expansion coupling with the conduit run to prevent binding.
    b. Follow manufacturer’s instructions to set the piston opening.
    c. Install expansion fittings across concrete expansion joints and at other locations where necessary to compensate for thermal or mechanical expansion and contraction.
    d. Furnish fittings of the same material as the conduit system.
2. For metallic conduit, provide expansion or expansion/deflection couplings, as appropriate, where:
    a. Install expansion fittings a minimum of every 200 feet in straight conduit runs.

I. Empty conduits:
1. Provide a polyethylene rope rated at 250 pounds tensile strength in each empty conduit more than 10 feet in length.
2. Seal ends of all conduits with approved, manufactured conduit seals, caps, or plugs immediately after installation:
    a. Keep ends sealed until immediately before pulling conductors.

J. Miscellaneous:
1. Seal roof penetrations for raceways and other items that penetrate the roof in accordance with roofing manufacturer’s instructions and as indicated on the Drawings.
2. Provide electrical unions at all points of union between ends of rigid conduit systems that cannot otherwise be coupled:
    a. Running threads and threadless couplings are not allowed.

3. Replace any conduits installed that the Engineer determines do not meet the requirements of this Specification.
4. Provide conduit housekeeping curb around all embedded or below-grade conduits exiting or entering the slab, per the Typical Details.

3.04 ERECTION, INSTALLATION, APPLICATIONS, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 16050 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16133

DUCT BANKS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Electrical underground duct banks.
   2. Duct bank installation requirements.

1.02 REFERENCES

A. As specified in Section 16050 - Common Work Results for Electrical.

1.03 DEFINITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.04 SYSTEM DESCRIPTION

A. Provide trenching, forming, rebar, spacers, conduit, concrete, backfill, and compaction necessary for the complete installation of the duct banks.

B. Provide reinforced concrete duct banks for all conduits installed below grade, on the site, below structures, or in contact with the earth, unless otherwise indicated on the Drawings.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.

B. Product data:
   1. PVC conduit spacers.
   2. Detectable underground marking tape.
   3. Pull line.

C. Provide applicable submittal documents as specified in:
   1. Section 02318 - Trenching.
   2. Section 03200 - Concrete Reinforcing.
   3. Section 03300 - Cast-in-Place Concrete.

D. Shop drawings:
   1. Submit site plan drawings of duct banks including underground profiles indicating all underground utilities.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050 - Common Work Results for Electrical.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 16050 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Conduit spacers:
   1. One of the following or equal:
      a. Carlon Snap-Loc.
      b. Cantex.
      c. Osburn Associates, Inc.

B. Detectable underground marking tape:
   1. One of the following or equal:
      a. Blackburn Manufacturing Co.
      b. Pro-Line Safety Products.
      c. Panduit.

C. Pull line:
   1. One of the following or equal:
      a. Arnco.
      b. Greenlee.
      c. Osburn Associates, Inc.

D. Duct seal:
   1. The following or equal:
      a. OZ Gedney type DUX.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Provide conduit as specified in Section 16130 - Conduits:
   1. Use duct suitable for use with 194 degree Fahrenheit rated conductors.

B. Provide reinforcing steel as specified in Section 03200 - Concrete Reinforcing:
   1. Provide minimum Number 4 reinforcing steel.

2.04 MANUFACTURED UNITS

A. Conduit spacers:
   1. Provide conduit spacers recommended by the conduit manufacturer or specified above.
   2. Saddle type.
   3. Non-metallic, non-corrosive, non-conductive.
   4. Interlocking type:
      a. Vertical interlocking.
      b. Horizontal interlocking.
   5. Suitable for concrete encasement.
   6. Molded-in rebar holder.
   7. Accommodates 2-inch through 6-inch conduit sizes.
   8. Relieves the conduit from both horizontal and vertical stresses.

B. Pull line:
   1. Minimum 1/4-inch wide, flat design.
   2. Polyester.
   3. Minimum pulling strength 1,200 pounds.

C. Detectable marking tape:
   1. Provide a detectable tape, locatable by a cable or metal detector from above the undisturbed grade.
   2. Aluminum core laminated between polyethylene film.
   3. 6-inch wide red tape imprinted with black lettering stating "CAUTION - BURIED ELECTRIC LINE BELOW" or equivalent.

D. Duct seal:
   1. Non-hardening sealing compound.
   2. Flexible, can be applied by hand.
   3. UL Listed for use with installed conductors.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES

A. Concrete mix requirements as specified in Section 03300 - Cast-in-Place Concrete.

B. Provide a red-oxide conduit encasement coloring agent as specified in Section 03300 - Cast-in-Place Concrete.

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Duct banks:
   1. Install duct banks encased in concrete at least 24 inches below finish grade, unless otherwise indicated on the Drawings.
   2. Damage minimization:
      a. Conduit should not be left exposed in an open trench longer than is necessary.
      b. Protect all underground duct banks against damage during pouring of concrete or backfilling.
   3. All plastic conduit fittings to be joined should be exposed to the same temperature conditions for a reasonable length of time before assembly.
   4. Provide No. 4/0 American Wire Gauge bare copper ground wire the entire length of duct bank and bond to the grounding system at each end of the duct bank and every 20 feet to steel reinforcing bar.
   5. Install underground ducts to be self-draining:
      a. Slope duct banks away from buildings to manholes, handholes, or pullboxes.
      b. Slope duct banks uniformly from manholes, handholes, or pullboxes to manholes, handholes, or pullboxes or both ways from high points between manholes, handholes, or pullboxes.
      c. Slope a minimum of 1/4 inch per 10 feet.
   6. Where new duct banks join to existing manholes, handholes, or pullboxes, make the proper fittings and fabricate the concrete envelopes to ensure smooth durable transitions, as indicated on the Drawings.
   7. Install pull line in spare conduits:
      a. Provide adequate pull line at both ends of conduits to facilitate conductor pulling.
      b. Cap above ground spare conduit risers at each end with screw-on conduit caps.

C. Trenching:
   1. Perform trenching as specified in Section 02318 - Trenching.
   2. Trench must be uniformly graded with the bottom, rock free and covered with select material.
   3. Whenever possible, use the walls of the trench as forms for concrete encasement:
      a. Forms are required where the soil is not self-supporting.
   4. Avoid damaging existing ducts, conduits, cables, and other utilities.

D. Duct spacing:
   1. Separate conduits with manufactured plastic spacers using a minimum space between the outside surfaces of adjacent conduits of 2 inches, unless otherwise indicated on the Drawings:
      a. Separate medium voltage ducts a minimum of 7.5 inches on center.
   2. Install spacers to maintain uniform spacing of duct assembly a minimum of 4 inches above the bottom of the trench during concrete pour. Install spacers on 8-foot maximum intervals:
      a. Due to some distortion of conduit from heat, and other means, it may be necessary to install extra spacers within the duct bank:
         1) Install the intermediate set of spacers within normal required spacing to maintain the proper horizontal clearance:
            a) Clearance is required to allow the proper amount of concrete to infiltrate vertically among the duct to ensure proper protection.
   3. Spacers shall not be located at the center of a bend:
      a. Locate spacer in the tangent, free of the coupling on fabricated bends.
      b. Locate spacers midway between the tangent and the center bend on trench formed sweeps.

E. Terminating:
   1. Use bell ends in duct at entrances into cable vaults.
   2. Make conduit entrances into cable vaults tangential to walls of cable vault.
   3. Form trapezoidal transitions between duct bank and cable vaults as needed in order to ensure adequate cable bending radius for the duct bank-to-vault transition.
   4. Install duct seal in all conduits including spare conduits, at**,** entrance to manholes/handholes**.** Form by hand to conduit and around cables to develop moisture barrier.
   5. New manhole or handhole applications, provide a single opening or “window” per duct bank, sized to accommodate the duct bank envelope.

F. Concrete:
   1. Install concrete as specified in Section 03300 - Cast-in-Place Concrete.
   2. Provide nonferrous tie wires to prevent displacement of the conduits during pouring of concrete:
      a. Tie wire shall not act as a substitute for spacers.
   3. Install minimum 3-inch cover around conduit and rebar.
   4. Consolidation of encasement concrete around duct banks shall be by hand puddling, with no mechanical vibration.
   5. Conduit is subject to temperature rise. As concrete cures, allow the free end to expand by pouring the concrete from the center of the run or from one tie in point.

G. Marking tape:
   1. Install a detectable marking tape 12 inches above the duct bank the entire length of the duct bank.

H. For conduit installations beneath building slabs:
   1. Duct banks shall be continued under building slabs to the final destination of the conduits:
      a. Construct separate duct banks as required.
      b. Concrete for encasement under building slabs need not be colored red.
      c. For duct banks crossing under building footers or foundations, install the top of the duct bank a minimum of 12 inches below the footer.
      d. Where duct banks enter through building walls, foundation walls, stem walls, etc. make connections as indicated on the Drawings.
      e. Where duct banks terminate with conduit risers entering building walls, install an expansion/deflection fitting or a flat-wise elbow (elbow parallel to building wall) in order to accommodate differential movement between the conduits and structure.

I. Restore all surfaces to their original condition as specified in Section 02952 - Pavement Restoration and Rehabilitation, unless otherwise specified.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. Clean conduits of dirt and debris by use of an appropriately sized steel mandrel no less than 1/2-inch smaller than the inside diameter of the conduit.

3.11 PROTECTION

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Provide shoring and pumping to protect the excavation and safety of workers.

C. Protect excavations with barricades as required by applicable safety regulations.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16134

BOXES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Device boxes.
   2. Raceway system boxes.

1.02 REFERENCES

A. As specified in Section 16050 - Common Work Results for Electrical.

B. American Association of State Highway and Transportation Officials (AASHTO):
   1. Standard Specifications for Highway Bridges.

C. ASTM International (ASTM):
   1. A47 - Standard Specification for Ferritic Malleable Iron Castings.
   2. D149 - Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
   3. D495 - Standard Test Method for High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation.
   4. D570 - Standard Test Method for Water Absorption of Plastics.
   5. D648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.
   6. D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   7. D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

D. Joint Industry Conference (JIC).

E. Underwriters Laboratories, Inc. (UL):
   1. 94 - Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.03 DEFINITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Specific definitions:
   1. Arcing parts: Circuit breakers, motor controllers, switches, fuses, or any device intended to interrupt current during its operation.
   2. Raceway system boxes: Boxes that are used for wire and cable pullboxes, conduit junction boxes, or terminal boxes.

1.04 SYSTEM DESCRIPTION

A. Provide outlet boxes for devices such as switches, receptacles, telephone and computer jacks, security systems, junction, and pullboxes for use in the raceway systems, etc.

B. Provide boxes as indicated on the Drawings or as needed to complete the raceway installation.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.

B. Product data:
   1. Manufacturer.
   2. Materials.
   3. Dimensions:
      a. Height.
      b. Width.
      c. Depth.
      d. Weight.
      e. NEMA rating.
   4. Conduit entry locations.
   5. Catalog cut sheets.
   6. Installation instructions.

C. Shop drawings:
   1. Include identification and sizes of pullboxes.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Regulatory requirements:
   1. Outlet boxes shall comply with all applicable standards of:
      a. JIC.
      b. NEC.
      c. NEMA.
      d. UL.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.09 SEQUENCING

A. As specified in Section 16050 - Common Work Results for Electrical.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 16050 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Plastic coated boxes:
      a. Rob Roy.
      b. OCAL.
   2. Formed steel enclosures:
      a. Hoffman.
      b. Thomas & Betts.
      c. Stahlin.
      d. Rittal.
   3. Stainless steel enclosures:
      a. Hoffman.
      b. Stahlin.
      c. Rittal.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. Cast device boxes:
   1. Construction:
      a. With internal green ground screw.
      b. Furnished with a suitable gasketed cover.
      c. With integral cast mounting lugs when surface mounted.
      d. Conduit sizes range from 3/4 inch to 1 inch.
      e. Tapered threaded hubs with integral bushing.
   2. Aluminum (copper free) boxes:
      a. High strength copper free 4/10 of 1 percent maximum alloy for use with aluminum rigid conduit.
   3. Malleable iron boxes:
      a. Conforming to ASTM A47 Grade 32510.

B. Plastic coated cast device boxes:
   1. Construction:
      a. With internal green ground screw.
      b. Furnished with a suitable gasketed cover.
      c. With integral cast mounting lugs when surface mounted.
      d. Conduit sizes range from 3/4 inch to 1 inch.
      e. Double coated with a nominal 0.002-inch (2 mil) urethane on both the interior and exterior before application of PVC coating.
      f. With a minimum 0.040-inch (40 mil) PVC coating bonded to exterior.
      g. With pressure sealing sleeve to protect the connection with conduit.

C. Formed steel enclosures:
   1. Steel:
      a. NEMA Type 12.
      b. Fabricated from 14-gauge steel, minimum.
      c. All seams continuously welded ground smooth.
      d. Door:
         1) Rolled lip around 3 sides.
         2) Attached to enclosure by means of a continuous stainless steel hinge and pin.
      e. Neoprene door gasket to provide a watertight, dusttight, oiltight seal:
         1) Attached with an adhesive.
         2) Retained by a retaining strip.
      f. Fabricate all external removable hardware for clamping the door to the enclosure body from zinc-plated heavy gauge steel:
         1) With a hasp and staple for padlocking.
      g. Provide large enclosures with door and body stiffeners for extra rigidity.
      h. No holes or knockouts.
      i. Finish:
         1) ANSI-61 gray electrostatically applied polyester powder inside and out over cleaned and primed surfaces.
         2) White electrostatically applied polyester powder mounting plate.
      j. Heavy gauge steel external mounting brackets when surface mounted.
   2. Stainless steel:
      a. NEMA Type 4X:
         1) Boxes in locations subject to flooding or temporary submersion:
            a) NEMA Type 6.
      b. Fabricated from 14-gauge Type 316 stainless steel.
      c. All seams continuously welded.
      d. Door:
         1) Rolled lip around 3 sides.
         2) Attached to enclosure by means of a continuous stainless steel hinge and pin.
      e. Neoprene door gasket to provide a watertight seal:
         1) Attached with an adhesive.
         2) Retained by a retaining strip.
      f. Fabricate all external removable hardware for clamping the door to the enclosure body from heavy gauge stainless steel:
         1) With a hasp and staple for padlocking.
      g. Provide large enclosures with door and body stiffeners for extra rigidity.
      h. No holes or knockouts.

i. Finish:
1) Brushed.
j. Stainless steel external mounting brackets when surface mounted.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Fasteners:
1. Electroplated or stainless steel in boxes with wiring devices.
2. Screws, nuts, bolts, and other threaded fasteners:
a. Stainless steel.

B. Provide breather and drain fittings where appropriate.

C. Internal panels:
1. Provide internal panels where required for mounting of terminal strips or other equipment.
2. With plated steel shoulder studs.
3. Steel with white polyester powder finish.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050 - Common Work Results for Electrical.

B. General:
1. Provide materials and construction suitable for environmental conditions at the location of the box as specified in Section 16050 - Common Work Results for Electrical.
2. Provide outlet box materials to match the conduit system:
a. GRC - Cast ferrous boxes.
b. PCS - PVC coated cast ferrous boxes.
3. Solid type gang boxes:
a. For more than 2 devices.
b. For barriered outlets.

4. Support all wall mounted NEMA Type 4 or NEMA Type 4X boxes to maintain a minimum of 7/8-inch free air space between the back of the enclosure and the wall:
    a. Use machined spacers to maintain air space; built-up washers are not acceptable.
    b. Use stainless steel or nylon materials for spacers.
5. Use cast malleable iron boxes when box must support other devices.
6. Boxes serving luminaires or devices:
    a. Use as pullboxes wherever possible.
7. Fit all cast boxes and pressed steel boxes for flush mounting in concrete with cast, malleable box covers and gaskets.
8. In terminal boxes, furnish terminals as indicated on the Drawings, with a minimum of 50 percent spare terminals:
    a. Furnish wireways for discrete and analog/DC wiring.
    b. Separate analog wiring from 120 V discrete or power wiring.
9. Size boxes in accordance with NEC requirements and to provide sufficient room for the future components and cables indicated on the Drawings.
10. For fire-rated construction, provide materials and installation for use in accordance with the listing requirements of the classified construction.

C. Outlet boxes:
1. Locate outlet boxes as indicated on the Drawings:
    a. Adjust locations so as not to conflict with structural requirements or other trades.
2. Use deep threaded-hub malleable iron or aluminum boxes:
    a. In hazardous areas.
    b. Where exposed to the weather.
    c. In unheated areas.
    d. Where subject to mechanical damage:
        1) Defined as exposed boxes less than 10 feet above the floor.
    e. To act as a pullbox for conductors in a conduit system.
    f. Accommodate wiring devices.
3. Use deep threaded-hub plastic coated malleable iron boxes in corrosive and NEMA Type 4X area and when the conduit system is PVC coated steel.
4. Outlet boxes may be used as junction boxes wherever possible.

D. Pullboxes and junction boxes:
1. Size pullboxes in accordance with NEC requirements and to provide sufficient room for any future conduits and cables as indicated on the Drawings.
2. Install pullboxes such that access to them is not restricted.

E. For boxes not indicated:
1. Provide types and mountings as required to suit the equipment and that will be consistent with the conduit system and environmental conditions as indicated in Section 16050 - Common Work Results for Electrical.
2. Outlet, switch, and junction boxes for flush-mounting in general purpose locations:
    a. One-piece, galvanized, pressed steel.
3. Ceiling boxes for flush mounting in concrete:
    a. Deep, galvanized, pressed steel.

4. Outlet, switch, and junction boxes where surface mounted in exposed locations:
    a. Cast ferrous boxes with mounting lugs, zinc or cadmium plating finish.
5. Outlet, control station, and junction boxes for installation in corrosive locations:
    a. Fiberglass reinforced polyester, stainless steel, or plastic coated steel to match the conduit system.
    b. Furnished with mounting lugs.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 REINSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 16050 - Common Work Results for Electrical.

3.11 PROTECTION

A. As specified in Section 16050 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16136

WIREWAY

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Wireway systems as indicated on the Drawings.

1.02 REFERENCES

A. As specified in Section 16050 - Common Work Results for Electrical.

B. National Electrical Manufacturers Association (NEMA):
   1. ICS-6 - Industrial Control and Systems: Enclosures.

C. Underwriter's Laboratories (UL):
   1. Article 870 - Wireways, Auxiliary Gutters, and Associated Fittings.

1.03 DEFINITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.04 SYSTEM DESCRIPTION

A. System includes horizontal and/or vertical straight runs of wireway, fittings, covers, splices, barriers, and related accessory and supports:
   1. Connected to form a complete system.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.

B. Product data:
   1. Technical information:
      a. Catalog cut sheets.
      b. Wireway construction and materials.
      c. Maximum loading and span.
      d. NEMA enclosure type.
   2. Dimensions:
      a. Width.
      b. Depth.
   3. Weight of wireway sections and fittings.
   4. Complete bill of materials.
   5. Manufacturer's installation instructions.

C. Shop drawings:
   1. Provide complete details and scaled drawings for the layout of the installed wireway system showing all components and proposed mounting details.

D. Calculations:
   1. Provide cross sectional area and fill calculations.
      a. Cross sectional area and fill shall be in accordance with the NEC.
   2. Provide structural calculations to ensure that the installed system meets all structural, seismic as specified in Section 16050 - Common Work Results for Electrical, wind as specified in Section 16050 - Common Work Results for Electrical requirements at the Project Site with respect to support and mounting:
      a. Stamped by a professional engineer licensed in the state where the Project is being constructed.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Manufacturer qualifications:
   1. Member of NEMA for the manufacturer of wireway systems and fittings of types and capacities required.

C. Wireway shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.09 SEQUENCING

A. The Drawings indicate the general route of the wireway systems. Data presented on those drawings are as accurate as preliminary surveys and planning can determine until final equipment selection is made.

B. Specifications and Drawings are for assistance and guidance but exact routing, locations, distances, and levels will be governed by actual field conditions. Make field surveys as part of the work before ordering material.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 16050 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Metallic wireway:
   1. One of the following or equal:
      a. B-Line.
      b. Hoffman.
      c. Hammond.
      d. Rittal Electromate.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. Provide wireways as indicated on the Drawings and the following:
   1. Dimensions : 4-inches by 4-inches.
   2. NEMA enclosure rating : NEMA 4X.
   3. Wireway material: Stainless steel.
   4. Feed-through.

2.06 COMPONENTS

A. Fittings:
   1. Elbows, tees, and crossings:
      a. Of the same materials and construction as the straight runs.
   2. Expansion fittings:
      a. Provide flexible or sliding fittings.

B. Covers:
   1. Hinged on one side.
   2. Held closed with latches or bolts.

C. Gaskets:
   1. As required to meet NEMA enclosure requirements:
      a. Provide gaskets at each flange and door opening to ensure complete seal between wireway components.
      b. Held in place with adhesive or formed in place.

2.07 ACCESSORIES

A. Mounting hardware:
   1. As specified in Section 16050 - Common Work Results for Electrical.

2.08 MIXES (NOT USED)

2.09 FABRICATIONS (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. Manufactured in accordance with NEMA ICS-6.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify all dimensions and route before ordering wireway:
   1. Make all necessary field measurements.
   2. Coordinate with all subcontractors and suppliers to determine structural dimensions and equipment dimensions to avoid all potential conflicts with other systems.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Install the wireway per the manufacturer's guidelines and submitted installation instructions to meet the seismic and wind requirements at the project site.

C. General:
   1. Install in straight runs as much as possible, minimizing the number of turns.
   2. Expansion fittings:
      a. Install as recommended by the manufacturer to accommodate thermal expansion.
      b. Install where wireway crosses structural expansion joints.
   3. Fittings:
      a. Not all fittings are indicated on the Drawings:
         1) Provide all fittings required to suit the installation.
   4. Wireway supports:
      a. Support wireway in accordance with manufacturer's instructions and as required by the seismic conditions.
      b. Support bracket spacing shall meet the requirements of the wireway manufacturer, and NEC.
      c. Provide wireway supports with channels under the entire width of wireway.
      d. Secure wireway to supports with manufacturer-approved fittings.
   5. Mounting:
      a. Oriented to allow hinged doors to be opened minimum 90 degrees.
      b. Oriented to allow safe access to doors for maintenance and future installations.
   6. Wiring installation:
      a. In accordance the NEC.

b. Begin wiring installation only after the complete raceway system is installed.
c. Verify that all wireway surfaces and accessories are smooth, free from burrs or sharp edges.
d. Only install wiring that is UL listed for wireway use.

3.04 ERECTION, INSTALLATION, APPLICATION, AND CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 PRE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Inspect entire wireway system for the following:
   1. Secure anchoring.
   2. Proper supports.
   3. Burrs or sharp edges.
   4. Sufficient clearance from ducts and piping.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 16050 - Common Work Results for Electrical.

3.11 PROTECTION

A. As specified in Section 16050 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Switches.
   2. Receptacles.
   3. Plates.

1.02 REFERENCES

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Federal Specifications (FS):
   1. W-C 596 - Connector, Electrical, Power, General Specification for.
   2. W-S 896/2 - Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).

C. National Electrical Manufacturers Association (NEMA):
   1. WD1 - General Color Requirements for Wiring Devices.
   2. ICS 5 - Industrial Control and Systems, Control Circuit and Pilot Devices.
   3. OS1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
   4. WD6 - Wiring Devices Dimensional Specifications.

D. Telecommunications Industry Association:
   1. T568A - Eight-position jack pin/pair assignment.
   2. T568B - Optional eight-position jack pin/pair assignment.

E. Underwriters Laboratories, Inc. (UL):
   1. 20 - General Use Snap Switches.
   2. 498 - Standard for Attachment Plugs and Receptacles.
   3. 514D - Cover Plates for Flush-Mounted Wiring Devices.
   4. 943 - Ground-Fault Circuit-Interrupters.
   5. 1472 - Solid State Dimming Controls.

1.03 DEFINITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Specific definitions:
   1. GFCI: Ground fault circuit interrupter.

1.04 SYSTEM DESCRIPTION

A. Switches, receptacles, and plates as indicated on the Drawings wired and operable to form a complete system.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.

B. Product data:
   1. Catalog cut sheets.

C. Shop drawings:
   1. Engraving schedule:
      a. Furnish complete engraving schedule for engraved nameplates.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Wiring devices shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 16050 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Switches:
   1. One of the following or equal:
      a. Hubbell.
      b. Leviton.
      c. Cooper Wiring Devices.

B. Receptacles:
    1. General purpose receptacles:
        a. One of the following or equal:
            1) Hubbell.
            2) Leviton.
            3) Cooper Wiring Devices.
    2. 480-Volt, 3-phase receptacles:
        a. One of the following or equal:
            1) Crouse-Hinds.
            2) Hubbell.
            3) Russellstol™.

C. Plates:
    1. Wet or corrosive areas and the Support Building:
        a. One of the following or equal:
            1) Hubbell.
            2) Cooper Wiring Devices.
            3) Thomas & Betts.
            4) Pass and Seymour.
    2. In-use covers:
        a. One of the following or equal:
            1) TayMac.
            2) Cooper Wiring Devices.
            3) Pass and Seymour.
            4) Thomas & Betts.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. Switches:
    1. General:
        a. 120-277 VAC.
        b. 20 ampere.
        c. Listed in accordance with UL 20.
        d. Designed and constructed in accordance with FS W-S-896/2.
        e. Back and side wired unless otherwise indicated.
        f. Integral grounding terminal.
        g. Totally enclosed:
            1) Color-coded body with color corresponding to ampere rating.
        h. Provide switches with the operator style and contact arrangement as indicated on the Drawings and as required for proper operation.
        i. Color:
            1) Brown.
    2. General purpose switches:
        a. Toggle type.

B. Receptacles:
    1. General purpose receptacles:
        a. Single or duplex as indicated on the Drawings.

b. 125 VAC.
c. 20 ampere or as indicated on the Drawings.
d. NEMA Type 5-20R configuration for 20 ampere receptacles.
e. Other NEMA configurations as indicated on the Drawings.
f. Listed in accordance with UL 498.
g. Designed and constructed in accordance with FS W-C-596.
h. Back and side wired.
i. 1-piece, rivet-less mounting strap.
j. Color:
1) Ivory in finished areas.
2) Brown in all other areas.
3) Orange when powered by a UPS.

2. Ground fault interrupter receptacles (GFCI):
a. 125 VAC.
b. 20 ampere.
c. Trip level 4-6 milliamperes.
d. Individual and feed through protection.
e. UL 943 and UL 498 listed.
f. NEMA Type 5-20R configuration.
g. For damp or wet locations:
1) Weather resistant, in accordance with UL 498.

3. 480 VAC receptacles:
a. 3-pole, 4-wire grounding.
b. Ampere rating as indicated on the Drawings.
c. Spring door on receptacle.
d. Furnish one matching plug for each 480-volt power receptacle.

C. Plates:

D. Outdoor and wet areas requiring NEMA Type 4 or NEMA Type 4X enclosures and the Storage Building:
1. General:
a. UL listed for wet locations.
b. Gasketed.
c. Die cast metal:
1) Match material to box material.

2. Switches:
a. Lever operated:
1) Provide toggle switch.

3. Receptacles:
a. Weatherproof in-use cover:
1) Die cast metal construction with electrostatic powder coating for corrosion resistance.
2) Gasketed.
3) Lockable.
4) UL listed and in accordance with NEC.

4. Corrosive areas:
a. Neoprene.
b. Gasketed.
c. Weatherproof.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Mounting heights:
   1. Process and production areas:
      a. Switches and receptacles 48 inches from finished floor to top of plate.
   2. Offices and finished areas:
      a. Switches: 48 inches from finished floor to top of plate.
      b. Receptacles: 18 inches from finished floor to center of plate.

C. Switches:
   1. Over 300 Volts:
      a. Where switches used in systems of more than 300 volts between conductors, are to be ganged in outlet boxes, provide switches having no exposed live parts or use barriers between the individual switches.

D. Receptacles:
   1. Provide GFCI receptacles as indicated on the Drawings:
      a. Provide weather resistant GFCI receptacles in all wet or damp areas.
         1) As specified in Section 16050 - Common Work Results for Electrical.
   2. Mount non-weatherproof receptacles vertically:
      a. Ground slot down.
   3. Mount weatherproof receptacles horizontally:
      a. Neutral slot up.
   4. 3-phase receptacles shall be consistent with respect to phase connection at the receptacle terminals. Correct errors in phasing at the source and not the receptacle.

E. Ensure all plates make a firm seal with wall for recessed mounted devices:
   1. Outside edges of plates parallel with building lines.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 REINSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 16050 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16150

LOW VOLTAGE WIRE CONNECTIONS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Wire connecting devices.
   2. Terminations.
   3. Splices.

1.02 REFERENCES

A. As specified in Section 16050 - Common Work Results for Electrical.

B. ASTM International (ASTM):
   1. D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape.

C. CSA International (CSA):
   1. C22.2 - No.197-M1983 (R2208) - PVC Insulating Tape.

D. Underwriters Laboratories, Inc. (UL):
   1. 510 - Standard for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.

1.03 DEFINITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.04 SYSTEM DESCRIPTION

A. Provide a complete system of wiring connectors, terminators, fittings, etc., for a complete wiring system suitable for the cables and conductors used.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.

B. Product data:
   1. Catalog cut sheets.
   2. Installation instructions.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050 - Common Work Results for Electrical.

B. All materials shall be UL listed.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 16050 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers for each type of technology are specified with the equipment in this Section.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. Control connections:
   1. Use insulated ring type wire terminators for connections to all screw terminals:
      a. With chamfered/funneled terminal barrel entry.
      b. Deep internal serrations.
      c. Long barrel design to reduce electrical resistance and increased insulator-barrel surface area to ensure that the insulator remains in contact with the barrel.
      d. Electroplated-tin copper conductor.
      e. Manufacturers: The following or equal:
         1) Thomas & Betts, Stakon.
   2. For process equipment connections work from manufacturer's drawings.

B. Joints, splices, taps, and connections:
   1. 600-volt conductors:
      a. Use solderless connectors.
      b. Use only plated copper alloy connectors or lugs:
         1) Aluminum connectors or lugs are not acceptable for copper conductors.
      c. Under those specific conditions where aluminum conductors have been allowed or are specified then the connectors for aluminum conductors shall be specifically designed for that purpose.
      d. For wire Number 10 AWG and smaller use compression splice caps, with insulating caps:
         1) Manufacturers: The following or equal:
            a) Buchanan, 2006S or 2011S, with 2007 or 2014 insulating caps.
      e. For wire Number 8 AWG and larger, use heavy duty copper compression connectors:
         1) Manufacturers: One of the following or equal:
            a) Burndy.
            b) Thomas & Betts.
      f. Heat shrink tubing:
         1) Suitable for indoors, outdoors, overhead, direct burial or submerged applications.
         2) Minimum shrink ratio: 4 to 1.
         3) Continuous operating temperature: -55 degrees Celsius to 110 degrees Celsius.
         4) Internally applied adhesive sealant.
         5) Cross-linked polyolefin:
            a) Manufacturers: One of the following or equal:
               (1) 3M, ITCSN.
               (2) Thomas & Betts, Shrink-Kon.
   2. Instrumentation class cable splices:
      a. Suitable for indoor, outdoors, weather exposed, direct buried, or submersed applications.
      b. Utilizing an epoxy, polyurethane, and re-enterable compounds.
      c. For use with shielded or unshielded plastic- and rubber-jacketed, signal, control, and power cables rated up to 1 kilovolt.
      d. Two-part mold body with tongue and groove seams and built in spacer webbing.
      e. Manufacturers: The following or equal:
         1) 3M, Scotchcast 72-N.

C. Insulating tape:
   1. General purpose insulating tape:
      a. Minimum 7 mil vinyl tape.
      b. Suitable for application in an ambient of -18 degrees Celsius (0 degrees Fahrenheit).
      c. Operating range up to 105 degrees Celsius (220 degrees Fahrenheit).
      d. Flame retardant, hot- and cold- weather resistant, UV resistant.
      e. For use as a primary insulation for wire cable splices up to 600 VAC.
      f. Meeting and complying with:
         1) ASTM D3005 Type I.
         2) UL 510.
         3) CSA C22.2.

g. Manufacturers: The following or equal:
    1) 3M, Scotch Number Super 33+.

2. General-purpose color-coding tape:
    a. Minimum 7 mil vinyl tape.
    b. Suitable for application on PVC and polyethylene jacketed cables.
    c. For use indoors and outdoors in weather protected enclosures.
    d. Available with the following colors:
        1) Red.
        2) Yellow.
        3) Blue.
        4) Brown.
        5) Gray.
        6) White.
        7) Green.
        8) Orange.
        9) Violet.
    e. For use as phase identification, marking, insulating, and harnessing.
    f. Meeting and complying with:
        1) UL 510.
        2) CSA C22.2.
    g. Manufacturers: The following or equal:
        1) 3M, Scotch Number 35.

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Load connections:
    1. Connect loads to the circuits as indicated. Color-code all branch circuits as specified in Section 16123 - 600-Volt or Less Wires and Cables.

C. Zero to 600-volt systems:
    1. Make all connections with the proper tool and die as specified by the device manufacturer.

2. Use only tooling and dies manufactured by the device manufacturer.
3. Insulate all connections and splices with Scotch 33+ tape and Scotchfill, or pre-molded plastic covers, or heat shrink tubing and caps.
4. Number all power and control wires before termination.

D. Motor connections (600 volts and below):
1. Terminate all leads and wires with compression type ring lugs.
2. Terminations on all motor leads, including leads that are connected together to accommodate the motor voltage, and the machine wires entering the motor terminal box from the power source, shall have ring type compression lugs.
3. Cover bolted connectors with a heat shrinkable, cross-linked polyolefin material formed as a single opening boot:
   a. In damp and wet locations, use a complete kit containing mastic that shall seal out moisture and contamination.
   b. Shrink cap with low heat as recommended by manufacturer.
4. Wire markers shall be readable after boot installation.
5. Manufacturers: The following or equal:
   a. Raychem, MCK.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 16050 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16222

LOW VOLTAGE MOTORS UP TO 500 HORSEPOWER

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Low voltage motors up to 500 horsepower (hp).

1.02 REFERENCES

A. As specified in Section 16050 - Common Work Results for Electrical.

B. American Bearing Manufacturers Association (ABMA):
   1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
   2. 11 - Load Ratings and Fatigue Life for Roller Bearings.

C. American Petroleum Institute (API):
   1. 670 - Machinery Protection Systems.

D. ASTM International (ASTM).
   1. B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.

E. Institute of Electrical and Electronic Engineers (IEEE):
   1. 43 - IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
   2. 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators.
   3. 303 - Recommended Practice for Auxiliary Devices for Rotating Electrical Machines in Class I, Division 2 and Zone 2 Locations.
   4. 841 - IEEE Standard for Petroleum and Chemical Industry-Premium-Efficiency, Severe Duty, Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors - Up to and Including 370 kW (500 hp).
   5. 1349 - Guide for Application of Electric Motors in Class I, Division 2 and Class I, Zone 2 Hazardous (Classified) Locations.

F. National Electrical Manufacturers' Association (NEMA):
   1. MG-1 - Motors and Generators.
   2. MG-2 - Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators.

G. Underwriters Laboratories Inc. (UL):
   1. 674 - Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.

1.03 DEFINITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.04 SYSTEM DESCRIPTION

A. Furnish and install electric motors and accessories as specified in this Section and the Sections specifying driven equipment to provide a complete and operable installation.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.

B. Submit completed motor data sheets for each motor supplied:
   1. Conform to data sheet in the appendix of this Section.
   2. Manufacturer's or other data sheets are not acceptable.

C. Product data:
   1. Descriptive bulletins.
   2. Machine tag and loop number as indicated on the Drawings and in the specification section number of the driven machine.
   3. Complete electrical data.
   4. Torque, current, and power factor versus speed curves:
      a. At 100 percent rated voltage for all full voltage started and VFD-driven motors.
      b. For motors on reduced voltage start at 70, 80, 90, and 100 percent rated voltage.
   5. Accessories data:
      a. Power factor correction capacitors:
         1) Size in KVAR, for all motors not connected to variable frequency drives.
      b. Motor winding heaters:
         1) Voltage.
         2) Watts.
      c. Winding temperature detectors:
         1) Type.
         2) Rating.
      d. Moisture detectors.
   6. Mechanical data:
      a. Bearing design and bearing life calculations.
      b. Resonant frequencies for all VFD-driven motors 50 hp or greater.

D. Shop drawings:
   1. Motor weight.
   2. Frame size.
   3. Conduit box(es), size(s), and location(s).
   4. Outline drawings with dimensions.
   5. Installation details for the project seismic criteria.

E. Test reports:
   1. Factory test reports with test reference standard identified.

F. Certification:
   1. When motors are driven by variable speed drive systems, submit certification that selected motor:
      a. Is capable of satisfactory performance under the intended load.
      b. Meets the requirements of the latest edition of NEMA MG-1 Part 31.

G. Calculations:
   1. Where site conditions specified in Section 16050 - Common Work Results for Electrical exceed manufacturer's ratings, provide derating calculations for each motor.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050 - Common Work Results for Electrical.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Motors 200 hp and larger:
   1. Rotate shaft 90 degrees once per month.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 16050 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTION (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. US Motors.
   2. General Electric.
   3. Reliance.
   4. Toshiba.
   5. Baldor.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. 3-phase induction motors - general:
   1. Voltage:
      a. All motors 1/2 hp and larger shall be rated 460 V, 3-phase unless otherwise indicated on the Drawings.
      b. Dual voltage motors rated 230/460 V, 3-phase are acceptable provided all leads are brought to the conduit box.
   2. Motors driving identical machines shall be identical.
   3. All motors greater than 1 hp and up to 500 hp shall meet the "NEMA Premium Efficiency" percent listed in NEMA MG-1.
   4. Horsepower as indicated on the Drawings:
      a. Horsepower ratings indicated on the Drawings are based on vendor's estimates. Provide motors sized for the load of the actual equipment furnished without operating in the service factor.
   5. Service factor:
      a. 1.15 service factor on sine wave power.
      b. 1.0 when driven by VFD.
   6. Torque:
      a. Provide motors that develop sufficient torque for acceleration to full speed at voltage 10 percent less than motor nameplate rating.
      b. When started using reduced voltage starters:
         1) Provide motors that develop sufficient torque for acceleration to full speed.
      c. NEMA Design B except where driven load characteristics require other than normal starting torque:
         1) In no case shall starting torque or breakdown torque be less than the values specified in NEMA MG-1.
   7. Enclosures:
      a. As specified in the individual equipment Specifications or in this Section.
      b. Totally enclosed fan cooled:
         1) Cast iron conduit box.
         2) Tapped drain holes with Type 316 stainless steel plugs for frames 286 and smaller, and automatic breather and drain devices for frames 324 and larger.
      c. Lifting devices: All motors weighing 265 pounds (120 kilograms) or more shall have suitable lifting devices for installation and removal.
   8. Manufactured with cast iron frames in accordance with NEMA MG-1 or manufacturer's standard material for the specified rating.
   9. Nameplates:
      a. Provide all motors with a permanent, stainless steel nameplate indelibly stamped or engraved with:
         1) NEMA standard motor data:
            a) Indicate compliance with NEMA MG-1 Part 31 for inverter duty motors.
         2) AFBMA bearing numbers and lubrication instructions.

10. Hardware:
    a. Type 316 stainless steel.
11. Conduit boxes:
    a. Cast iron or stamped steel.
    b. Split from top to bottom.
    c. Provide gaskets at the following interfaces:
        1) Frames and conduit boxes.
        2) Conduit boxes and box covers.
    d. Rotatable through 360 degrees in 90-degree increments:
        1) Where available based on the size of the conduit box.
    e. Exceeding the dimensions defined in NEMA MG-1.
    f. Provide grounding lugs inside conduit boxes for motor frame grounding.
12. Motor bearings:
    a. Antifriction.
    b. Regreasable and initially filled with grease for horizontal motors and vertical motors per manufacturer's standard design.
    c. Bearings and lubrication suitable for ambient temperature and temperature rise.
    d. Suitable for intended application and have ABMA L-10 rating life of 60,000 hours or more.
    e. Fit bearings with easily accessible grease supply, flush, drain, and relief fittings using extension tubes where necessary.
    f. Where specified in the equipment Specifications, provide split-sleeve type hydrodynamic radial bearings. Provide a bearing isolator to protect bearings from contaminants.
13. Insulation systems:
    a. Motors installed in ambient temperatures 40 degrees Celsius or less:
        1) Provide Class F insulation.
        2) Design temperature rise consistent with Class B insulation.
        3) Rated to operate at an ambient temperature of 40 degrees Celsius at the altitude where the motor will be installed.
    b. Motors installed in ambient temperatures between 40 degrees Celsius and 50 degrees Celsius:
        1) Provide Class F insulation.
        2) Design temperature rise consistent with Class B insulation.
        3) Rated to operate at an ambient temperature of 50 degrees Celsius at the altitude where the motor will be installed.
14. Motor leads:
    a. Insulated leads with non-wicking, non-hydroscopic material. Class F insulation.
15. Noise:
    a. Maximum operating noise level in accordance with NEMA MG-1.

B. Submersible motors:
    1. Enclosures:
        a. Totally enclosed non-ventilated (TENV) watertight casing.
        b. Inner and outer shaft seals separated by an oil chamber.

2. Cooling:
    a. Suitable for continuous operation in totally, partially, or nonsubmerged condition without overheating.
    b. Convection cooling by the surrounding environment or pump cooling by circulating a portion of the pumped media through a cooling water jacket as recommended by the manufacturer based on hp and application.
3. Electrical cables:
    a. Wire unit without splices. Coordinate with Contractor to ensure cables of adequate length.
    b. Epoxy encapsulated cable entry into terminal box.
4. Insulation:
    a. Sealed moisture resistant windings.
    b. Class H.
5. Motor protection:
    a. Provide temperature detection in motor windings.
    b. Provide moisture detection in motor housing.
    c. Other detection and protection functions specified in the in the driven equipment Section.

C. Motors driven by variable frequency drives:
1. Compatible with the variable frequency drives specified.
2. Inverter duty rated and labeled.
3. Meet the requirements of NEMA MG-1 Part 31.
4. Winding insulation meets the requirements of NEMA MG-1 Part 31.4.4.2.
5. Capable of running continuously at 1/10th of full speed, with no harmful effects or overheating.
6. All motors except explosion proof motors:
    a. Shaft grounding ring:
        1) Provide a shaft grounding ring for each VFD-driven motor.
        2) Aluminum frame and internal components.
        3) Conductive microfiber brushes.
        4) Maintenance free design.
        5) Aegis Bearing Protection ring as manufactured by Electro Static Technology or equal.

D. Motors installed in corrosive environments:
1. Stator double dipped in varnish and baked.
2. Stator and rotor coated with corrosion resistant epoxy.
3. Frame, brackets, fan guard and conduit box coated with minimum of 2 coats of epoxy paint.
4. Withstand salt spray tests in accordance with ASTM B117.

E. Single-phase motors:
1. Capacitor start type rated for operation at 115 volts, 60 hertz, unless otherwise specified or as indicated on the Drawings.
2. Totally enclosed fan cooled (TEFC) motors manufactured in accordance with NEMA MG 1.
3. Ball bearings: Sealed.
4. 1/2 hp or less fan motors:
    a. Split-phase or shaded pole type when standard for the equipment.
    b. Open type when suitably protected from moisture, dripping water, and lint accumulation.

5. Wound rotor or commutator type single-phase motors only when their specific characteristics are necessary for application and their use is acceptable to the Engineer.
6. Integral overload protection.

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Motor winding heaters:
   1. Provide all 3-phase motors with belted or cartridge space heaters mounted within the motor enclosure.
   2. Space heater rating shall be 120 volts, single-phase, unless otherwise indicated on the Drawings.
   3. Power leads for heaters wired into conduit box.
   4. Installed within motor enclosure adjacent to core iron.

B. Winding temperature detectors:
   1. Provide factory installed winding temperature detector with leads terminating in the conduit box:
      a. Where required by the driven equipment Specification or as indicated on the Drawings.
   2. Temperature switches with normally closed contacts as indicated on the Drawings.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Install motors in accordance with manufacturer's instructions.

C. Install shaft grounding ring on VFD-driven motors in accordance with the manufacturer’s instructions.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING AND PROCESS START-UP

A. As specified in Section 01756 - Commissioning.

B. Factory testing:
   1. Motors less than 250 hp:
      a. Perform manufacturer's standard production tests including but not limited to:
         1) No load current.
         2) High potential test.
         3) Winding resistance.
      b. Furnish copies of standard test reports on prototype or identical units.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Before start-up, perform insulation resistance test on each motor furnished or installed on this project:
   1. Windings energized to 1,000 volts DC for 1 minute.
   2. Resistance measured at the end of the test, recorded, and submitted to the Engineer for review.
   3. Inform the Engineer of any unusual or unacceptable test results.
   4. This test is in addition to the acceptance tests in Section 16950 - Field Electrical Acceptance Tests.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 16050 - Common Work Results for Electrical.

END OF SECTION

MOTOR DATA SHEET

MOTOR/ EQUIPMENT TAG _____ MOTOR NUMBER _____

SPECIFICATION NUMBER OF DRIVEN MACHINE _____

MOTOR NAMEPLATE DATA

MANUFACTURER _____ MODEL/SERIES _____ MODEL NO. _____

FRAME _____ ENCLOSURE _____ NEMA DESIGN _____

HP _____ SERVICE FACTOR _____ RPM _____

INSULATION CLASS _____ VOLTS _____ FULL LOAD AMPS _____

AMBIENT TEMP _____ PHASE _____ NO LOAD AMPS _____

DESIGN TEMP _____ HERTZ _____ LOCK ROTOR AMPS _____

INRUSH CODE LETTER _____

	100% LOAD	75% LOAD	50% LOAD
GUARANTEED MINIMUM EFFICIENCIES:			
GUARANTEED MINIMUM POWER FACTOR:			

MAXIMUM SIZE OF POWER FACTOR CORRECTION CAPACITOR: _____ KVAR

ACCESSORIES

MOTOR WINDING HEATER _____ VOLTS _____ WATTS

WINDING THERMAL PROTECTION

WINDING TEMP SWITCHES (YES/NO) _____

RTD:

TYPE _____ QUANTITY PER PHASE _____ # OF WIRES _____

NOMINAL RESISTANCE _____ NOMINAL TEMP _____ COEFFICIENT _____

RECOMMENDED ALARM _____ DEGREES CELSIUS RECOMMENDED TRIP _____ DEGREES CELSIUS

SPECIAL APPLICATIONS

INVERTER DUTY* (YES/NO) _____ PART WINDING (YES/NO) _____ WYE - DELTA (YES/NO) _____

2 SPEED, 1 WINDING (YES/NO) _____ 2 SPEED, 2 WINDING (YES/NO) _____

AREA CLASSIFICATION:

CLASS _____ DIVISION _____ GROUP _____ TEMP CODE _____

* Conforms to NEMA MG-1 Part 31.

SECTION 16262

VARIABLE FREQUENCY DRIVES 0.50 - 50 HORSEPOWER

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Variable frequency drives (VFD) 0.5 to 50 horsepower for control of NEMA Design B squirrel cage induction motors.

1.02 REFERENCES

A. As specified in Section 16050 - Common Work Results for Electrical.

B. International Organization for Standardization (ISO):
   1. 9001 - Quality Management Systems - Requirements.

C. National Electrical Manufacturers Association (NEMA):
   1. MGI, Part 31 – Motors with higher peak voltage capability.

D. Underwriters' Laboratories (UL):
   1. 508A - Standard for Safety for Industrial Control Panels.
   2. 508C - Standard for Power Conversion Equipment.
   3. 845 - Standard for Motor Control Centers.

1.03 DEFINITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Specific definitions:
   1. Point of common coupling: the point of common coupling for all harmonic calculation and field measurements for both voltage and current distortions is defined as the closest directly connected bus supplying power to the VFD.

1.04 SYSTEM DESCRIPTION

A. Design requirements:
   1. Each VFD system consists of all components required to meet the performance, protection, safety, testing, and certification criteria of this Section.
   2. The VFD system:
      a. Is a fully integrated package.
      b. Includes all material necessary to interconnect all VFD system elements, even if shipped separately.
   3. Coordinate bearing protection methods with the supplier of the driven equipment.

B. Any modifications to a standard product necessary to meet this Section shall be made only by the VFD manufacturer:
   1. Each VFD shall be completely factory pre-wired, assembled, and then tested as a complete system by the VFD manufacturer to ensure a properly coordinated, fully integrated drive system.
   2. The VFD shall be capable of operating standard NEMA Design B motors. It is the responsibility of the VFD manufacturer to ensure that the drive will not damage motor insulation due to high carrier frequency, reflected wave, dv/dt or other drive electrical characteristics based upon the installed conditions:
      a. Provide equipment necessary to mitigate potential damage to motor insulation.
      b. Motors as specified in Section 16222 - Low Voltage Motors up to 500 Horsepower.

C. Performance:
   1. Operating envelope:
      a. Speed and torque requirements:
         1) Provide a variable torque or constant torque VFD as required by the driven load.
         2) The VFD shall be capable of producing a variable alternating voltage/frequency output to provide continuous operation over the 40 to 200 percent (25 to 120 hertz) speed range.
      b. Current requirements:
         1) Full rated current output on a continuous basis.
         2) Variable torque VFD:
            a) Minimum 110 percent current overload for 1 minute.
         3) Constant torque VFD:
            a) Minimum 150 percent current overload for 1 minute.
   2. Minimum VFD system efficiency:
      a. 96 percent when operating at the rated kW output.
      b. VFD system efficiency shall be calculated as follows:

$$\text{Efficiency (\%)} = \frac{\text{Power (Load)}}{\text{Power (Supply)}} \text{ x } 100$$

         Power (Load) is the total power measured at the output terminals of the drive system, including VFD, output filters, or transformers. Power (Supply) is the total power measured at the input terminals of the VFD including input filters, line reactors, isolation transformers, harmonic distortion attenuation equipment and auxiliary equipment (e.g., controls, fans) for complete system operation.

   3. Total power factor:
      a. Minimum of 0.96 lagging across the entire speed range.
      b. At no speed shall the VFD have a leading power factor.
   4. Frequency accuracy:
      a. Minimum of within 0.01 percent.
   5. Speed regulation:
      a. Minimum of within 0.5 percent across the entire speed range.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical:
   1. Custom prepared by the VFD manufacturer and specific for the equipment furnished.

B. Product data:
   1. Manufacturer of the VFD.
   2. Manufacturer of all components of the VFD.
   3. Dimensions:
      a. Height.
      b. Width.
      c. Depth.
      d. Weight.
   4. Nameplate schedule.
   5. Bill of material.
   6. Ratings:
      a. Voltage.
      b. Phase.
      c. Input current.
      d. Output current.
      e. Interrupting rating.
      f. Momentary current rating.
   7. List of recommended spare parts.
   8. Catalog cut sheets for major components.
   9. Design data:
      a. Efficiency and power factor values.
      b. Certification that the drive is sized for the full nameplate motor horsepower and current of the driven load at the installed altitude and ambient temperature.
      c. Certification that based upon VFD design, cable length to motor, and motor dielectric insulation level that the VFD will not damage motor insulation due to carrier frequency, reflected wave, dv/dt, or other VFD produced characteristics.
      d. Certification that all electronic circuits and printed circuit boards are conformally coated.
   10. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 16050 - Common Work Results for Electrical:
      a. Manufacturer’s statement of seismic qualification with substantiating test data.
      b. Manufacturer’s special seismic certification with substantiating test data.

C. Shop drawings:
   1. Complete plan and elevation drawings showing:
      a. All dimensions.
      b. Panel, sub-panel, and component layout indexed to the bill of material.
      c. Conduit connections.
   2. Block diagram showing the basic control and protection systems specifying the protection, control, trip and alarm functions, the reference signals and commands and the auxiliary devices.

3. Complete schematic, wiring and interconnection diagrams showing connections to both internal and external devices:
    a. Include terminal number and wire numbers.
4. Complete single-line and 3-line diagrams including, but not limited to, circuit breakers, motor circuit protectors, contactors, instrument transformers, meters, relays, timers, control devices, and other equipment comprising the complete system:
    a. Clearly indicate device electrical ratings on the drawings.

D. Installation instructions:
1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
2. For equipment installed in structures designated as seismic design category A or B:
    a. Provide manufacturer's installation instructions and anchoring details for connecting equipment to supports and structures.
3. For equipment installed in structures designated as seismic design category C, D, E, or F:
    a. Provide project-specific installation instructions and anchoring details based on support conditions and requirements to resist seismic and wind loads as specified in Section 16050 - Common Work Results for Electrical.
    b. Submit anchoring drawings with supporting calculations.
    c. Drawings and calculations shall be stamped by a professional engineer registered in the state where the Project is being constructed.

E. Operation and maintenance manuals:
1. Spare parts list with supplier names and part numbers.
2. Startup and commissioning instructions and data.
3. Operating manuals:
    a. Submit operating instructions and a maintenance manual presenting full details for care and maintenance of each model of VFD provided under this Contract.
4. Operating instructions:
    a. Written descriptions detailing the operational functions of all controls on the front panel.
5. Maintenance manual:
    a. Furnish maintenance manuals with instructions covering all details pertaining to care and maintenance of all equipment as well as identifying all parts.
    b. Manuals shall include, but are not limited to the following:
        1) Adjustment and test instructions covering the steps involved in the initial test, adjustment, and start-up procedures.
        2) Detailed control instructions which outline the purpose and operation of every control device used in normal operation.
        3) All schematic wiring and external diagrams:
            a) Furnish drawings in a reduced 11-inch by 17-inch format that are fully legible at that size.

F. Test forms and reports.
1. Submit complete factory acceptance test procedures and all forms used during the test.

G. Manufacturer's Certificate of Installation and Functionality Compliance.

H. Manufacturer's field reports:
   1. Report listing the setting of all VFD adjustable parameters and their values after start-up.

I. Record Documents:
   1. Certified Record Documents of equipment with information listed above.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Qualifications:
   1. Any third-party certification, safety or protection requirements shall be applied to the VFD system as a whole. Certification or protection of system elements or individual components by themselves is not acceptable.
   2. VFDs shall be UL 508C listed and labeled:
      a. UL 508C for individual units.
      b. UL 508A for VFD systems in control panels.
      c. UL 845 for VFD systems in motor control centers.
   3. Variable frequency drives shall be manufactured by the VFD manufacturer at its own facility which shall have a quality assurance program that is certified in conformance with ISO 9001.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Ship the VFDs and associated equipment to the job site on a dedicated air ride vehicle that will allow the Contractor to utilize on site offloading equipment:
   1. VFDs shall be delivered to the site preassembled and wired.

C. Furnish temporary equipment heaters within the VFD to prevent condensation from forming.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.09 SEQUENCING

A. Conduct factory acceptance test and submit certified test results for Engineer's review.

B. Ship equipment to project site after successful completion of factory acceptance test.

C. Assemble equipment in the field.

D. Conduct field acceptance test and submit results for Engineer's review.

E. Submit Manufacturers Certificate of Installation and Functionality Compliance.

F. Conduct Owner's training sessions.

G. Commissioning and process start-up as specified in Section 01756 - Commissioning.

1.10 SCHEDULING

A. As specified in Section 16050 - Common Work Results for Electrical.

1.11 WARRANTY

A. As specified in Section 16050 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 16050 - Common Work Results for Electrical.

B. The VFD manufacturer shall be responsible for start-up of the VFDs in the presence of the equipment suppliers, Contractor, Engineer, and Owner.

1.13 OWNERS INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE

A. Spare parts:
   1. The following spare parts shall be furnished:
      a. 1 complete VFD of each size furnished.
      b. Any special dedicated tools for emergency service and troubleshooting.
      c. All hardware and software required for configuration, maintenance, troubleshooting, and inquiry of all drive parameters.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following to match the existing motor control center.
   1. Eaton.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. General:
   1. Sinusoidal pulse width modulated (PWM) type drive:
      a. 6-pulse insulated gate bipolar transistor (IGBT) power section.
      b. Microprocessor based controls.
      c. Line and load reactors.

B. Ratings:
   1. Voltage:
      a. Input voltage as indicated on the Drawings.

C. Operational features:
   1. Protective features:
      a. Provide the following minimum protective features:
         1) Motor overload protection.
         2) Instantaneous overcurrent.
         3) Instantaneous overvoltage.
         4) Undervoltage.
         5) Power unit overtemperature.
         6) Phase loss.
         7) VFD output short circuit.
   2. Control mode:
      a. Operation in either a constant volts/hertz or sensorless vector mode:
         1) The control mode selectable using the programming keypad.
   3. Frequency control:
      a. Minimum of 3 selectable skip frequencies with adjustable bandwidths.
      b. Programmable minimum frequency.
      c. Programmable maximum frequency.
   4. Acceleration/deceleration:
      a. Separately adjustable acceleration and deceleration rates:
         1) Each rate adjustable from 0.01 to 1,800 seconds.
   5. Spinning load:
      a. The VFD shall be capable of determining the speed and direction of a spinning load, “catch” the load and accelerate or decelerate it without damage to the load.
   6. Programmable loss of signal:
      a. Upon loss of speed reference the VFD shall be programmable to either:
         1) Stop.
         2) Maintain current speed.
         3) Default to pre-selected speed.
   7. Power interrupt ride-through:
      a. The VFD shall be capable of continuous operation in the event of a power loss of 5 cycles or less.
   8. Inputs/Outputs:
      a. Manufacturer’s standard number the following:
         1) Analog inputs:
            a) Configurable as either 0 to 10 volts or 4 to 20 milliamperes.
         2) Analog outputs:
            a) Programmable 4 to 20 milliamperes isolated.
         3) Discrete inputs:
            a) Programmable.
         4) Discrete outputs:
            a) Programmable.
            b) Form C relay contacts.
         5) Potentiometer 3-wire input.
      b. Provide additional inputs/outputs as required to meet the control functions indicated on the Drawings.

9. Diagnostics:
    a. Store a minimum of 4 fault conditions in non-volatile memory on a first in-first out basis.
    b. Operational parameters stored at the time of the fault:
        1) Operating frequency.
        2) Drive status.
        3) Power mode.
    c. Fault memory accessible via RS-232, RS-422, or RS-485.
10. Automatic restart:
    a. User selectable automatic restart feature allowing the VFD to restart following a momentary power failure or other VFD fault:
        1) Programmable for up to 9 restart attempts.
        2) Adjustable time delay between restart attempts.

2.06 COMPONENTS

A. Enclosure:
    1. Motor control center as indicated on the Drawings.
    2. Provide cooling devices required to maintain the VFD within the manufacturer's specified temperature limits for the Project conditions:
        a. Provide cooling device failure alarm.

B. Power disconnect:
    1. Flange-mounted thermal magnetic circuit breaker.
    2. Lockable in the OFF position.

C. Input Reactor:
    1. 3 percent input line reactor.

D. Output Device:
    1. 3 percent output load reactor.

E. Keypad:
    1. Provide each VFD with a keypad for programming and control.
    2. Keypad requirements:
        a. Password security to protect drive parameters.
        b. Mounted on the door of the motor control center.
        c. Back-lit LCD:
            1) Minimum of 2 lines with a minimum of 16 characters per line.
        d. Programming and display features language: English.
        e. Capable of displaying the following parameters:
            1) Speed (percent).
            2) Output current (amperes).
            3) Output frequency (hertz).
            4) Input voltage.
            5) Output voltage.
            6) Total 3-phase kilowatt.
            7) Kilowatt-hour meter.
            8) Elapsed run time meter.
            9) Revolutions per minute.
            10) Direct current bus voltage.

3. In addition to all keys required for programming, provide the following controls on the keypad:
    a. Auto/manual selector.
    b. Start pushbutton.
    c. Stop pushbutton.
    d. Jog pushbutton.
    e. Speed increment.
    f. Speed decrement.
    g. Forward/reverse selector.
    h. Run LED indicator.
    i. Program LED indicator.
    j. Fault LED indicator.
4. Provide the VFD with the hardwired controls as indicated on the Drawings.

F. Control power transformer:
1. Furnish a control power transformer mounted and wired inside the VFD enclosure.
2. With primary and secondary fusing.
3. Sized to power all VFD controls and options as well as any external devices indicated on the Drawings including the motor winding heater.

2.07 ACCESSORIES

A. Metal oxide varistors:
1. Provide protection for the VFD against:
    a. Line transients: 5,000 volt peak minimum.
    b. Line to ground transients: 7,000 peak minimum.

B. Conformal coating:
1. Provide conformal coating material applied to electronic circuitry and printed circuit boards to act as a protection against moisture, dust, temperature extremes, and chemicals such as H_2S and chlorine.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Enclosure finish shall be manufacturer's standard gray.

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.

C. General:
   1. Furnish all cables, conduit, lugs, bolts, expansion anchors, sealants, and other accessories needed to complete the installation of the VFD (free-standing or within motor control center).
   2. Assemble and install the VFD in the locations and with the layouts indicated on the Drawings.
   3. Perform work in accordance with manufacturer's instructions and shop drawings.
   4. Furnish components and equipment as required to complete the installation.
   5. Replace any hardware lost or damaged during the installation or handling to provide a complete installation.
   6. Provide openings in top or bottom of the VFD (free-standing or within motor control center) enclosure for conduit only, no additional openings will be allowed:
      a. Improperly cut holes will require that the entire panel be replaced:
         1) No hole closers or patches will be allowed.
   7. Bundle circuits together and terminate in each unit:
      a. Tie with nylon wire ties.
      b. Label all wires at each end with wire numbers shown on the approved control drawings.
      c. All connections to and from the VFD (free-standing or within motor control center) enclosure must be made via terminal blocks.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Source testing (Factory Acceptance Tests):
   1. Owner and Engineer will witness the Factory Acceptance Test as specified in Section 16050 - Common Work Results for Electrical.
   2. General:
      a. Incoming inspection of components and raw materials based on strategic supplier base and experience.
      b. All VFDs furnished under this Section shall be tested and inspected as specified below. Testing of VFDs based on sampling plans is not allowed.
      c. The testing procedures specified are the minimum acceptable requirements. The manufacturer may perform additional tests at its discretion.
   3. Failure of any component during testing requires repair of the faulted component and complete retest.
   4. Tests:
      a. Perform manufacturer's standard factory acceptance tests.

C. Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.

D. Owner training:
   1. As specified in Sections 01756 - Commissioning and 16050 - Common Work Results for Electrical.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Provide the services of a VFD manufacturer representative for startup assistance and training:
   1. Inspection and field adjustment:
      a. Supervise the following and submit written certification that the equipment and controls have been properly installed, aligned, adjusted, and readied for operation.
   2. Startup field testing:
      a. Provide technical direction for testing, checkout, and startup of the VFD equipment in the field.
      b. Under no circumstances are any portions of the drive system to be energized without authorization from the manufacturer's representative.

3.09 ADJUSTING

A. Make all adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

B. Provide the services of a VFD manufacturer factory technician to make all drive parameters and protective device settings:
   1. Protective device settings provided by the VFD manufacturer in accordance with the manufacturer of the driven equipment requirements.
   2. Provide documentation of VFD settings included but not limited to:
      a. Minimum speed.
      b. Maximum speed.
      c. Skip speeds.
      d. Current limit.
      e. Acceleration time.
      f. Deceleration time.

3.10 CLEANING

A. As specified in Section 16050 - Common Work Results for Electrical.

3.11 PROTECTION

A. As specified in Section 16050 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16272

DRY-TYPE TRANSFORMERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Enclosed dry-type transformers:
      a. Rated 1 to 1,000 kilovolt-amperes, single and 3-phase.
      b. Primary voltage 600 volts and below.

1.02 REFERENCES

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Institute of Electrical and Electronics Engineers (IEEE):
   1. 389 - IEEE Recommended Practice for Testing Electronics Transformers and Inductors.
   2. C57.12.01 - IEEE Standard General Requirements for Dry-Type Distribution and Power Transformers Including Those with Solid Cast and/or Resin Encapsulated Windings.
   3. C57.12.91 - IEEE Standard Test Code for Dry-Type Distribution and Power Transformers.
   4. C57.96 - IEEE Guide for Loading Dry-Type Distribution and Power Transformers.

C. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

D. Underwriters Laboratory (UL):
   1. 1561 - Standard for Dry-Type General Purpose and Power Transformers.

E. U.S. Department of Energy (DOE):
   1. 10 CFR Part 431 - Energy Efficiency Program for Certain Commercial and Industrial Equipment.

1.03 DEFINITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

B. NEMA:
   1. Type 2 enclosure in accordance with NEMA 250.
   2. Type 3R enclosure in accordance with NEMA 250.

1.04 SYSTEM DESCRIPTIONS

A. Provide 3-phase or 1-phase, 60 hertz dry-type with voltage ratings, kilovolt-ampere capacities, and connections as indicated on the Drawings:
   1. Transformers shall provide full capacity at the Project elevation and environmental conditions as specified in Section 16050 - Common Work Results for Electrical after all derating factors have been applied.
   2. Suitable for continuous operation at full rating with normal life expectancy in accordance with IEEE C57.96.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.

B. Product data:
   1. Catalog cut sheets.
   2. Nameplate data.
   3. Dimensions:
      a. Height.
      b. Width.
      c. Depth.
   4. Inrush current.
   5. Insulation system and temperature constraints.
   6. Number and rating of taps.
   7. Sound levels.
   8. Connection diagrams:
      a. Primary.
      b. Secondary.
   9. BIL rating.
   10. Required clearances.
   11. Percent impedance.
   12. Efficiency.
   13. Certification of full capacity capability at the Project elevation and ambient conditions.
   14. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 16050 - Common Work Results for Electrical:
      a. Manufacturer’s statement of seismic qualification with substantiating test data.
      b. Manufacturer’s special seismic certification with substantiating test data.

C. Installation instructions:
   1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
   2. For equipment installed in structures designated as seismic design category A or B:
      a. Provide manufacturer’s installation instructions and anchoring details for connecting equipment to supports and structures.

3. For equipment installed in structures designated as seismic design category C, D, E, or F:
    a. Provide project-specific installation instructions and anchoring details based on support conditions and requirements to resist seismic and wind loads as specified in Section 16050 - Common Work Results for Electrical.
    b. Submit anchoring drawings with supporting calculations.
    c. Drawings and calculations shall be stamped by a professional engineer registered in the state where the Project is being constructed.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050 - Common Work Results for Electrical.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 16050 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
    1. General Electric.
    2. Jefferson.
    3. Schneider Electric.
    4. Eaton.
    5. ABB.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Cores:
   1. Non-aging, grain-oriented silicon steel.
   2. Magnetic flux densities below the saturation point.

B. Windings:
   1. High-grade magnet wire.
   2. Impregnated assembly with non-hydroscopic, thermo-setting varnish:
      a. Cured to reduce hot-spots and seal out moisture.
   3. Material electrical grade:
      a. Copper.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. General:
   1. 10 kilovolts BIL for 600-volt class windings.
   2. Sound levels, in accordance with IEEE 389 test conditions, not to exceed:

Kilovolt-Amperes Range	Audible Sound Level (db)
1-9	40
10-50	45
51-150	50
151-300	55
301-500	60
501-700	62
701-1000	64

   3. Taps:
      a. 15 kilovolt-amperes and less:
         1) Two 5 percent full capacity primary taps below rated voltage.
      b. 25 kilovolt-amperes and larger:
         1) Four 2.5 percent full capacity primary taps below rated voltage.
         2) Two 2.5 percent full capacity primary taps above rated voltage.
      c. Operated by a tap changer handle or tap jumpers accessible through a panel.
   4. Terminals:
      a. UL listed for either copper or aluminum conductors.
      b. Rated for 75 degrees Celsius.
   5. Daily overload capacities, at rated voltage and without reduction in life, in accordance with IEEE C57.96.

B. Transformers less than 15 kilovolt-amperes:
   1. Insulation class: 185 degrees Celsius.
   2. Temperature rise: 115 degrees Celsius.

C. Energy efficient transformers 15 kilovolt-amperes and larger:
   1. Insulation class: 220 degrees Celsius.

2. Temperature rise: 115 degrees Celsius, except as noted below:
    a. 150-degree Celsius rise for dry-type transformers located in motor control centers.
3. Efficiency:
    a. In accordance with DOE 10 CFR Part 431.

D. Enclosures:
1. Heavy gauge steel:
    a. Outdoor: Moisture and water resistant with rodent screens over all openings and in a weather-protected enclosure, NEMA Type 3R.
    b. Indoor: NEMA Type 2.
2. Louvers to limit coil temperature rise to the value stated above, and case temperature rise to 50 degrees Celsius.
3. Built-in vibration dampeners to isolate the core and coils from the enclosure:
    a. Neoprene vibration pads and sleeves.

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Nameplates:
1. Non-corrosive metal or UL listed non-metallic:
    a. Stamped, engraved or printed with the following information:
        1) Phases.
        2) Frequency.
        3) Kilovolt-ampere rating.
        4) Voltage ratings.
        5) Temperature rise.
        6) Impedance.
        7) Insulation class.
        8) BIL rating.
        9) Connection diagram.
        10) Weight.
        11) Manufacturer.
        12) The identification “transformer”.
        13) Classes of cooling.
        14) Tap voltage(s).
        15) Vector diagram.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Finish to consist of de-greasing, phosphate cleaning, and an electrodeposited manufacturer’s standard gray enamel rust-inhibiting paint.

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.

C. General:
   1. Floor, wall, platform, motor control center, packaged power supply, or roof mounted, as indicated on the Drawings.
   2. Install where not in direct contact with building structure.
   3. Install on single layer vibration pad under the entire mounting surface:
      a. Manufacturers: The following or equal:
         1) Korfund.
   4. Make any necessary connections to the enclosure with liquid tight flexible conduit having neoprene gaskets and insulated ground bushings.
   5. Ground the enclosure:
      a. To an equipment ground conductor in the conduit.
      b. To the facility grounding electrode system.
   6. Floor mounted transformers:
      a. Install transformers on a housekeeping pads.
      b. Install transformers with adequate space from walls or other enclosures for proper ventilation in accordance with the manufacturer’s recommendations.

3.04 ERECTION, INSTALLATION, APPLICATIONS, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Factory tests:
   1. Applied voltage test to each winding and from each winding to the core:
      a. 600-volt class winding 4.5 kilovolt.
   2. Induced voltage test at 2 times normal voltage and 400 hertz for 1,080 cycles.
   3. Voltage ratio and polarity.
   4. Sound level, performed in a test room with ambient sound level not exceeding 24 db.
   5. Perform all tests in accordance with UL 1561.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

3.09 ADJUSTING

A. Set the transformer taps as required to obtain nominal output voltage on the secondary terminals.

3.10 CLEANING

A. As specified in Section 16050 - Common Work Results for Electrical.

3.11 PROTECTION

A. As specified in Section 16050 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16305

ELECTRICAL SYSTEM STUDIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Short-circuit fault analysis study.
   2. Protective device coordination study.
   3. Arc-flash hazard study.

1.02 REFERENCES

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Institute of Electrical and Electronics Engineers (IEEE):
   1. 1584 - IEEE Guide for Specification of Scope and Deliverable Requirements for an Arc-Flash Hazard Calculations Study in Accordance with IEEE Std 1584(TM).

C. National Fire Protection Association (NFPA).

1.03 DEFINITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.04 SYSTEM DESCRIPTION

A. General study requirements:
   1. Scope:
      a. The short-circuit fault analysis, protective device coordination, and arc- flash hazard studies shall include all new and modified equipment in the power distribution system including, but not limited to:
         1) Utility equipment.
         2) Switchgear.
         3) Switchboards.
         4) Generators.
         5) Transformers:
            a) Including all dry-type transformers.
         6) Motor control centers.
         7) Freestanding variable frequency drives and starters.
         8) Disconnect switches.
         9) Motors.
         10) Panelboards:
            a) Including all 240- and 208-volt systems.
         11) Vendor control panels.
         12) HVAC equipment.

b. Study scenarios:
1) The studies shall include all possible electrical system configurations, for example:
a) Operation on normal (utility) source.
b) Operation on generator source.
c) Main-breakers closed, tie-breaker open.
d) Either main-breaker open, tie-breaker closed.

2. Obtain, for all equipment, the required data for preparation of the study including, but not limited to:
a. Transformer kilovolt-ampere (kVA) and impedances.
b. Generator impedances.
c. Generator decrement curves.
d. Bus withstand ratings.
e. Cable and bus data.
f. Protective device taps, time dials, instantaneous pickups, and time-delay settings.
3. Obtain the Electric Utility information on the minimum and maximum available fault current, minimum and maximum utility impedances, utility protective device settings including manufacturer and model number, interrupting ratings, X/R ratios, and model information one level above the point of connection:
a. Utility tolerances and voltage variations.
4. The individual performing the studies shall visit the site and collect all necessary field data in order to perform and complete comprehensive electrical system studies.
5. Obtain equipment layouts and configurations from the manufacturer’s final submittal requirements and project layout drawings as required.
6. Bus and conductor data:
a. Use impedances of the actual installed or specified conductors, unless otherwise indicated.
b. Use cable and bus impedances calculated at 25 degrees Celsius, unless otherwise indicated.
c. Use 600-volt cable reactance based on typical dimensions of actual installed or specified conductors, unless otherwise indicated.
d. Use bus withstand values for all equipment having buses.
e. Use medium-voltage cable reactance's based on typical dimensions of shielded cables with 133-percent insulation levels, unless otherwise indicated.
7. Motors:
a. Each motor shall be individually modeled:
1) Grouping of motors for fault contribution current is not acceptable.
b. Motors with variable frequency drives may be assumed to have no contribution to fault current.
8. Use the equipment, bus, and device designations as indicated on the Drawings for all studies.

B. Short-circuit fault analysis study additional requirements:
1. The short-circuit fault analysis shall be performed and submitted in 2 phases:
a. Initial short-circuit fault analysis:
1) Based on the Contract Documents and Electric Utility information.

2) The initial short-circuit fault analysis study shall indicate the estimated available short-circuit current at the line side terminals of each piece of equipment covered by the scope of the study.
3) Provide a list of assumptions used in the initial study.

b. Final short-circuit fault analysis:
1) The final short-circuit fault analysis shall modify the initial analysis as follows:
a) Utilize the actual equipment provided on the project.
b) Utilize conductor lengths based on installation.

2. Calculate 3-phase bolted fault, line-to-line fault, line-to-ground fault, double line-to-ground fault, short-circuit 1/2 cycle momentary symmetrical and asymmetrical RMS, 1-1/2 to 4 cycle interrupting symmetrical RMS, and 30-cycle steady-state short-circuit current values at each piece of equipment in the distribution system.
3. Evaluate bus bracing, short-circuit ratings, fuse interrupting capacity and circuit-breaker-adjusted interrupting capacities against the fault currents, and calculate X/R values:
a. Identify and document all devices and equipment as either inadequate or acceptable.
4. Calculate line-to-ground and double line-to-ground momentary short-circuit values at all buses having ground-fault devices.
5. Provide calculation methods, assumptions, one-line diagrams, and source impedance data, including utility X/R ratios, typical values, recommendations, and areas of concern.

C. Protective device coordination study additional requirements:
1. Furnish protective device settings for all functions indicated on the Drawings including, but not limited to:
a. Current.
b. Voltage:
1) Provide settings for all voltage relays based upon actual utility and generator tolerances and specifications.
c. Frequency:
1) Provide settings for all frequency relays based upon actual utility and generator tolerances and specifications.
d. Negative sequence.
e. Reverse power.
f. Machine protection functions:
1) Provide settings for all motor and generator protective relays based on the manufacturer’s recommended protection requirements.
2. Provide log-log form time-current curves (TCCs) graphically indicating the coordination proposed for the system:
a. Include with each TCC a complete title and one-line diagram with legend identifying the specific portion of the system covered by the particular TCC:
1) Typical TCCs for identical portions of the system, such as motor circuits, are acceptable as allowed by the Engineer.
b. Include a detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics:
1) These details can be included on the TCC.

c. Include a detailed description of each protective device tap, time dial, pickup, instantaneous, and time delay settings:
1) These details can be included on the TCC.

3. TCCs shall include all equipment in the power distribution system where required to demonstrate coordination. Include utility relay and fuse characteristics, medium-voltage equipment protective relay and fuse characteristics, low-voltage equipment circuit breaker trip device characteristics, transformer characteristics, motor and generator characteristics, and characteristics of other system load protective devices:
   a. Include all devices down to the largest branch circuit and largest feeder circuit breaker in each motor control center, main breaker in branch panelboards, and fused disconnect switches.
   b. Provide ground fault TCCs with all adjustable settings for ground fault protective devices.
   c. Include manufacturing tolerances and damage bands in plotted fuse and circuit breaker characteristics.
   d. On the TCCs, show transformer full load currents, transformer magnetizing inrush, ANSI transformer withstand parameters, and transformer damage curves.
   e. Cable damage curves.
   f. Terminate device characteristic curves at a point reflecting the maximum symmetrical or asymmetrical fault current to which the device is exposed based on the short-circuit fault analysis study.
   g. Coordinate time interval medium-voltage relay characteristics with upstream and downstream devices to avoid nuisance tripping.
4. Site generation: When site generation (including cogeneration, standby, and emergency generators) is part of the electrical system, include phase and ground coordination of the generator protective devices:
   a. Show the generator decrement curve and damage curve along with the operating characteristic of the protective devices.
5. Suggest modifications or additions to equipment rating or settings in a tabulated form.

D. Arc-flash hazard study additional requirements:
1. Include the calculated arc-flash boundary and incident energy (calories/square centimeter) at each piece of equipment in the distribution system:
   a. Perform study with 15 percent arcing fault variation as defined by IEEE 1584.
   b. Perform arc-flash calculations at minimum and maximum utility fault contributions.
   c. Perform arc-flash calculations for both the line side and load side of the switchgear, switchboard, motor control center, and panelboard main breakers.
   d. Perform arc-flash calculations for all short-circuit scenarios with all motors on for 3 to 5 cycles and with all motors off.
   e. Protective device clearing time shall be limited to 2 seconds, maximum.
2. Provide executive summary of the study results:
   a. Provide summary based upon worst case results.
3. Provide a detailed written discussion and explanation of the tabulated outputs:
   a. Include all scenarios.

4. Provide alternative device settings to allow the Owner to select the desired functionality of the system:
    a. Minimize the arc-flash energy by selective trip and time settings for equipment maintenance purposes.
    b. Identify the arc-flash energy based upon the criteria of maintaining coordination and selectivity of the protective devices.

E. Electrical system study meetings:
1. The individual conducting the short-circuit fault analysis, protective device coordination, and the arc-flash hazard studies shall meet with the Owner and Engineer 3 times.
2. The purpose of the 3 meetings is as follows:
    a. Initial meeting:
        1) Meet with the Owner and Engineer to discuss the scope of the studies.
        2) Discuss the Owner's operational requirements for both normal operation and maintenance.
    b. Preliminary results meeting:
        1) This meeting will be held after the studies have been completed, reviewed, and accepted by the Engineer.
        2) The purpose of this meeting is to inform the Owner of the results of the study and impacts on normal operation and maintenance including:
            a) Protective device coordination problems and recommended solutions.
            b) Explanation of the arc-flash hazard study results and its potential impact on operations.
            c) Recommendations for reduction of arc-flash category levels including reduction of protective device settings or changes in operational practices.
    c. Final meeting:
        1) Discuss changes to the studies based on the previous meeting.
        2) Discuss with the Owner how changes to the electrical system may change the arc-flash hazard category.
        3) Deliver the final electrical system studies report.
3. The meetings will be at the Owner's facility:
    a. Provide a minimum of 3-weeks notice to the Owner and Engineer in advance of the projected meeting date.
    b. Submit a draft of the meeting agenda when each meeting is requested.
4. Meeting materials:
    a. Prepare and provide the following materials:
        1) Meeting agenda. Include, at a minimum, the scope of the meeting, estimated time length for the meeting, and meeting goals.
        2) Electronic copies (PDF format) of the project one-line diagrams for the initial meeting.
        3) Electronic copies (PDF format) copies of the submitted studies.

F. By virtue of the fact that this is a professional study, the Owner reserves the right to modify the requirements of the study to comply with its operational requirements. The protective device coordination study and the arc-flash hazard study shall be modified based on the results of the meetings with the Owner.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.

B. Initial studies and reports:
   1. Include the following in the initial short-circuit current report:
      a. List of all devices included in the studies.
      b. A description of all operating scenarios.
      c. Form and format of arc-flash labels.

C. Final studies and reports:
   1. Format and quantity:
      a. Provide 6 bound copies of all final reports.
      b. Provide 3 complete sets of electronic files on CD or DVD media, including the electrical system model(s), configuration files, custom libraries, and any other files used to perform the studies and produce the reports. Also provide an electronic version of the bound reports in PDF format.
      c. Provide the number of copies specified in Section 01330 - Submittal Procedures.
   2. Include the sections below in the final report:
      a. Copies of correspondence and data obtained from the electric utility company.
      b. Letter certifying the inspection and verification of existing equipment.
      c. One-line diagrams:
         1) The following information shall be included at a minimum:
            a) Motor horsepower.
            b) Transformer data:
               (1) kVA.
               (2) Configuration.
            c) Cable data:
               (1) Insulation.
               (2) Size.
               (3) Length.
         2) One-line diagrams shall be fully legible at 11-inch by 17-inch size.
      d. Include in the short-circuit fault analysis study:
         1) Descriptions, purpose, basis, assumptions, recommendations, and scope of the study.
         2) Normal system connections and those that result in maximum fault conditions.
         3) Tabulation of circuit breaker, fuse, and other protective device ratings compared to maximum calculated short-circuit duties.
         4) Fault current calculations for the cases run including a definition of terms and guide for interpretation of computer software printouts.
      e. Protective device coordination study shall include:
         1) Descriptions, purpose, basis, assumptions, recommendations, and scope of the study.
         2) List all requirements used in the selection and setting criteria for any protective devices.
         3) Manufacturer’s time-current curves for circuit breakers, fuses, motor circuit protectors, and other protective devices for all new equipment.

4) TCCs graphically indicating the coordination proposed for the system on log-log graphs.
5) Tabulation of relay, fuse, circuit breaker, and other protective devices in graphical form with a one-line diagram to display area coordination.
6) Where coordination could not be achieved, an explanation shall be included in the report to support the statement along with recommendations to improve coordination. Recommended equipment modifications or settings shall be in a tabulated form.

f. Include in the arc-flash hazard study:
1) Descriptions, purpose, basis, assumptions, recommendations, and scope of the study.
2) Normal system connections and those that result in maximum arc-flash conditions.
3) Arc-flash raw data, calculations, and assumptions.
4) Arc-flash label data:
a) Identifying the content of each label.
b) Identifying the location of each label.

D. Certification:
1. Submit written certification, sealed and signed by the professional engineer conducting the study, equipment supplier, and electrical subcontractor stating that the data used in the study is correct.

E. Submit the credentials of the individual(s) performing the study and the individual in responsible charge of the study.

F. The Engineer will review all studies and reports. After review, the Engineer will make recommendations and/or require changes to be made to the short-circuit fault analysis, protective device coordination, or arc-flash hazard studies. These changes shall be provided as part of the scope of work.

G. Submit course outline for Owner's training.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Qualifications of the entity responsible for electrical system studies:
1. The studies shall be performed, stamped, and signed by a professional engineer registered in the state where the project is located.
2. A minimum of 5 years of experience in power system analysis is required for the individual in responsible charge of the studies.
3. The short-circuit fault analysis, protective device coordination, and arc-flash hazard studies shall be performed with the aid of a digital computer program:
a. Point-to-point calculations are not acceptable.

C. The study shall be performed by the equipment manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT/SITE CONDITIONS (NOT USED)

1.09 SEQUENCING

A. Site visit to gather data on the existing facility systems for all studies:
   1. Make multiple trips as required to obtain all data for the short-circuit fault analysis, protection device coordination, and arc flash hazard studies.

B. Submit the initial short-circuit fault analysis study before submittal of any electrical equipment.

C. Initial electrical system study meeting.

D. Submit the preliminary short-circuit fault analysis, protective device coordination, and arc-flash hazard studies.

E. Second electrical system study meeting for preliminary results.

F. Final arc-flash meeting and final short-circuit fault analysis, protective device coordination, and arc-flash hazard studies.

G. Label equipment with approved arc-flash labels.

H. Owner's training.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY (NOT USED)

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Electrical system study software: One of the following or equal:
   1. Operation Technology, Inc., ETAP.
   2. SKM Systems Analysis, Powertools.
   3. Power Analytics Corp., Paladin DesignBase.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

A. Arc-flash hazard labels:
   1. Dimensions:
      a. Minimum 5 inches by 3.5 inches.
   2. Materials:
      a. Polyester with polyvinyl polymer over-laminate.
      b. Self-adhesive.
      c. Resistant to:
         1) UV.
         2) Chemicals and common cleaning solvents.
         3) Scuffing.
         4) Wide temperature changes.
   3. Contents:
      a. Short-circuit bus identification.
      b. Calculated incident energy (calories/square centimeter) range:
         1) Based on worst-case study results.
      c. Site specific personnel protective equipment level number.
      d. Arc-flash protection boundary.
      e. Shock hazard boundary:
         1) The Contractor may provide separate labels for indication of the shock hazard boundary.
   4. Color scheme:
      a. For locations above 40 calories/square centimeter:
         1) White label with red “DANGER” strip across the top.
         2) Black lettering.
      b. For locations below 40 calories/square centimeter:
         1) White label with orange “WARNING” strip across the top.
         2) Black lettering.

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050 - Common Work Results for Electrical.

B. After review and acceptance of the arc-flash hazard study by the Engineer, install all arc-flash hazard labels:
   1. Install labels at all locations required by NFPA, ANSI, or IEEE standards.
   2. At a minimum, install labels in the following locations:
      a. The front of each main or incoming service compartment.
      b. The front of each low-voltage switchgear section.
      c. The front of each medium-voltage circuit breaker door.
      d. The front of each accessible auxiliary or conductor compartment.
      e. Each accessible rear or side vertical section.
      f. Each motor control center vertical section.
      g. Each panelboard covered by the study.
      h. Each control panel, individual starter or VFD, or other equipment covered by the scope of the study.
   3. Install labels prior to equipment energization.

C. After review and acceptance of the arc-flash hazard study and protective device coordination study by the Engineer, adjust protective device settings per final study prior to equipment energization:
   1. Devices that require power for configuration may be set during energization, but before any sub fed loads are energized.
   2. Ensure that settings for upstream equipment are set prior to energizing downstream devices.

3.04 ERECTION, INSTALLATION, APPLICATION, AND CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

B. The individual performing the arc-flash hazard study shall direct the installation of the arc-flash hazard labels:
   1. Remove and replace any improperly applied labels.
   2. Repair the equipment finish damaged by removal of any label.
   3. Install labels level or plumb across the entire dimension of the label.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16411

DISCONNECT SWITCHES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Fusible and non-fusible disconnect switches.

1.02 REFERENCES

A. As specified in Section 16050 - Common Work Results for Electrical.

B. National Electric Manufacturer's Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment.
   2. KS 1-2001 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).

C. Underwriters Laboratories Inc. (UL):
   1. 20 - General-Use Snap Switches.
   2. 98 - Enclosed and Dead-Front Switches.
   3. 508 - Standard for Industrial Control Equipment.

1.03 DEFINITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Specific definitions:
   1. Safety switches and disconnect switches are to be considered synonymous.

1.04 SYSTEM DESCRIPTION

A. Provide heavy-duty type disconnect switches as indicated on the Drawings and specified in the Contract Documents.

B. Provide disconnect switches with the number of poles, voltage, current, short circuit, and horsepower ratings as required by the load and the power system.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.

B. Product data:
   1. Manufacturer.
   2. Manufacturer's specifications and description.
   3. Ratings:
      a. Voltage.
      b. Current.

c. Horsepower.
d. Short circuit rating.
4. Fused or non-fused.
5. NEMA enclosure type.
6. Dimensions:
a. Height.
b. Width.
c. Depth.
7. Weight.
8. Cross-referenced to the disconnect schedule indicated on the Drawings.

C. Shop drawings:
1. Manufacturer's installation instructions:
a. Indicate application conditions and limitations of use stipulated by product testing agency specified under Quality Assurance, Regulatory Requirements below.
b. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
2. Identify motor or equipment served by each switch; indicate nameplate inscription.

D. Installation instructions:
1. Provide anchorage instructions and requirement based on the seismic requirements at the Project Site as specified in Section 16050 - Common Work Results for Electrical and calculations:
a. Stamped by a professional engineer registered in the state where the Project is being constructed.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Regulatory requirements:
1. NEMA KS1- Enclosed and Miscellaneous Distribution Switches (600 V Maximum).
2. UL 98 - Enclosed and Dead-Front Switches.

C. Disconnect switches shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.09 SEQUENCING

A. Conduct the initial fault current study as specified in Section 16305 - Electrical System Studies and submit results for Engineer's review.

B. After successful review of the initial fault current study, submit complete equipment submittal.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 16050 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Schneider Electric.
   2. Eaton.
   3. General Electric.
   4. Siemens.
   5. Appleton.
   6. Crouse-Hinds.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. Switch mechanism:
   1. Quick-make, quick-break heavy-duty operating mechanisms:
      a. Provisions for padlocking the switch in the Off position.
      b. A minimum of 90-degree handle travel position between Off and On positions:
         1) Provide handle position indicators to identify the handle position.
      c. Full cover interlock to prevent opening of the switch door in the On position and to prevent closing the switch mechanism with the door open:
         1) With an externally operated override.

B. Switch interior:
   1. Switch blades visible when the switch is Off and the cover is open.
   2. Lugs:
      a. Front accessible.
      b. Removable.
      c. UL listed for 60/75-degree Celsius copper conductors.
   3. Current carrying parts completely plated to resist corrosion.
   4. Removable arc suppressors to facilitate easy access to line side lugs.
   5. Furnish equipment ground kits for every switch.

C. Ratings:
   1. UL horsepower rated for AC or DC with the rating not less than the load served.
   2. Current:
      a. 30 to 1,200 amperes.
   3. Voltage:
      a. 250 volts AC, DC.
      b. 600 volts (30 A to 200 A, 600 volts DC).
   4. Poles:
      a. 2, 3, 4, and 6 poles.
   5. UL listed short circuit ratings:
      a. 10,000 RMS symmetrical amperes when used with or protected by Class H or K fuses (30-600 amperes).
      b. 200,000 RMS symmetrical amperes when used with or protected by Class R or J fuses (30-600 amperes employing appropriate fuse rejection).
      c. 200,000 RMS symmetrical amperes when used with or protected by Class L fuses (800-1,200 amperes).
   6. Where not indicated on the Drawings, provide switches with the NEMA ratings specified in Section 16050 - Common Work Results for Electrical for the installed location.

D. Size, fusing and number poles as indicated on the Drawings or as required:
   1. Provide solid neutral where indicated on the Drawings.

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Disconnect switches to have provisions for a field installable “B” type electrical interlock for position indication as indicated on the Drawings.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.

C. General:
   1. Use Myers hubs or bolt-on hubs for all conduit penetrations on NEMA Type 12, Type 4, and Type 4X enclosures.
   2. Provide all mounting brackets, stands, supports and hardware as required:
      a. Match finish and materials for all brackets, stands, and hardware with the switch installed.
      b. Provide adequate supporting pillar(s) for disconnect switches in accordance with the approved seismic calculations, and locate aboveground or above decks, where there is no structural wall or surface for box.
   3. When possible, mount switches rigidly to exposed building structure or equipment structural members:
      a. For NEMA Type 4 and Type 4X locations, maintain a minimum of 7/8 inch air space between the enclosure and supporting surface.
      b. When mounting on preformed channel, position channel vertically so that water may freely run behind the enclosure.
   4. Provide a nameplate for each disconnect switch:
      a. Provide per requirements specified in Section 16075 - Identification for Electrical Systems.
      b. Identify voltage, circuit, fuse size, and equipment served on the nameplate.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 16050 - Common Work Results for Electrical.

3.11 PROTECTION

A. As specified in Section 16050 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16412

LOW VOLTAGE MOLDED CASE CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Low voltage molded case circuit breakers.

1.02 REFERENCES

A. As specified in Section 16050 - Common Work Results for Electrical.

B. National Electrical Manufacturers Association (NEMA):
   1. AB 3. - Molded Case Circuit Breakers and Their Application.

C. Underwriter's Laboratories (UL):
   1. 489 - Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
   2. 943 - Ground Fault Circuit Interrupters.

1.03 DEFINITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

B. In accordance with UL 489.

1.04 SYSTEM DESCRIPTION

A. Molded case thermal magnetic or motor circuit protector type circuit breakers as indicated on the Drawings and connected to form a completed system.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.

B. Product data:
   1. Catalog cut sheets.
   2. Manufacturer's time-current curves for all molded case circuit breakers furnished.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Low voltage molded case circuit breakers shall be UL listed and labeled.

1.07 DELIVERY, STORAGE AND HANDLING

A. As specified in Section 16050 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 16050 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Eaton.
   2. General Electric Co.
   3. Schneider Electric.
   4. ABB.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. General:
   1. Conforming to UL 489.
   2. Operating mechanism:
      a. Quick-make, quick-break, non-welding silver alloy contacts.
      b. Common Trip, Open and Close for multi-pole breakers such that all poles open and close simultaneously.
      c. Mechanically trip free from the handle.
      d. Trip indicating handle - automatically assumes a position midway between the manual ON and OFF positions to clearly indicate the circuit breaker has tripped.
      e. Lockable in the "OFF" position.

3. Arc extinction:
    a. In arc chutes.
4. Voltage and current ratings:
    a. Minimum ratings as indicated on the Drawings.
    b. Minimum frame size 100A.
5. Interrupting ratings:
    a. Minimum ratings as indicated on the Drawings.
    b. Modify as required to meet requirements of the short circuit fault analysis - as specified in Section 16305 - Electrical System Studies.
    c. Not less than the rating of the assembly (panelboard, switchboard, motor control center, etc.).

B. Motor circuit protectors:
1. Instantaneous only circuit breaker as part of a listed combination motor controller.
2. Each pole continuously adjustable in a linear scale with 'LO' and 'HI' settings factory calibrated.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

A. Terminals:
1. Line and load terminals suitable for the conductor type, size, and number of conductors in accordance with UL 489.

B. Case:
1. Molded polyester glass reinforced.
2. Ratings clearly marked.

C. Trip units:
1. Provide thermal magnetic or solid-state trip units as indicated on the Drawings.
2. Thermal magnetic:
    a. Instantaneous short circuit protection.
    b. Inverse time delay overload.
    c. Ambient or enclosure compensated by means of a bimetallic element.
3. Solid state:
    a. With the following settings as indicated on the Drawings:
        1) Adjustable long time current setting.
        2) Adjustable long time delay.
        3) Adjustable short time pickup.
        4) Adjustable short time delay.
        5) Adjustable instantaneous pickup.
        6) Adjustable ground fault pickup as indicated on the Drawings.
        7) Adjustable ground fault delay as indicated on the Drawings.

D. Molded case circuit breakers for use in panelboards:
1. Bolt-on type:
    a. Plug-in type breakers are not acceptable.
2. Ground fault trip devices as indicated on the Drawings.

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. Test breakers in accordance with:
   1. UL 489.
   2. Manufacturer's standard testing procedures.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. Install breakers to correspond to the accepted shop drawings.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

3.09 ADJUSTING

A. Adjust trip settings in accordance with Protective Device Coordination Study as accepted by the Engineer and in accordance with manufacturer's recommendations.

B. Adjust motor circuit protectors in accordance with NEC and the manufacturer's recommendation based on the nameplate values of the installed motor.

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 16050 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16445

PANELBOARDS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Panelboards serving feeder circuits and branch circuits.

1.02 REFERENCES

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Underwriter's Laboratories, Inc. (UL):
   1. 67 - Standard for Panelboards.

1.03 DEFINITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.04 SYSTEM DESCRIPTION

A. Circuit breaker panelboards as indicated in the panelboard schedules, one-lines, and where indicated on the Drawings:
   1. Service voltage and configuration as indicated on the panel schedules.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.

B. Product data:
   1. Manufacturer of panelboard.
   2. Bill of material.
   3. Assembly ratings including:
      a. Voltage.
      b. Phase.
      c. Continuous current.
      d. Short circuit interrupting rating.
   4. NEMA enclosure type.
   5. Cable terminal sizes based upon actual feeder and sub-feeder conductors used.
   6. Furnish circuit breaker submittals as specified in Section 16412 - Low Voltage Molded Case Circuit Breakers.

7. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 16050 - Common Work Results for Electrical:
    a. Manufacturer's statement of seismic qualification with substantiating test data.
    b. Manufacturer's special seismic certification with substantiating test data.

C. Shop drawings:
    1. Drawings to contain:
        a. Overall panelboard dimensions, interior panel dimensions, and wiring gutter dimensions:
            1) Height.
            2) Length.
            3) Width.
        b. Weight.
        c. Anchoring locations.
        d. Breaker layout drawing with dimensions:
            1) Location of the main, branches, solid neutral, and ground.
        e. Conduit entry/exit locations:
            1) Identify all conduit entry/exit locations and restrictions.
        f. Individual panel schedules identifying breaker locations, ratings, and nameplate designations within the panelboard, for every panelboard.

D. Installation instructions:
    1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
    2. For equipment installed in structures designated as seismic design category A or B:
        a. Provide manufacturer's installation instructions and anchoring details for connecting equipment to supports and structures.
    3. For equipment installed in structures designated as seismic design category C, D, E, or F:
        a. Provide project-specific installation instructions and anchoring details based on support conditions and requirements to resist seismic and wind loads as specified in Section 16050 - Common Work Results for Electrical.
        b. Submit anchoring drawings with supporting calculations.
        c. Drawings and calculations shall be stamped by a professional engineer registered in the state where the Project is being constructed.

E. Operations and maintenance manual:
    1. Provide a complete manual for the operation and maintenance of the panelboard, circuit breakers, devices, and accessories:
        a. Including but not limited to:
            1) Instruction narratives and bulletins.
            2) Renewal parts lists.
            3) Time-current curves for all devices.

F. Calculations:
    1. Detailed calculations or details of the actual physical testing performed on the panelboard to prove the panelboard is suitable for the seismic requirements at the Project Site.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Panelboards shall be UL listed and labeled:
   1. Where indicated as service entrance equipment, panelboards shall be UL labeled and listed “Suitable for Service Entrance.”

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 16050 - Common Work Results for Electrical.

1.13 OWNER’S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Eaton.
   2. General Electric Co.
   3. Schneider Electric.

B. Circuit breakers:
   1. Same manufacturer as the panelboard.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. Provide panelboards with:
   1. Molded-case circuit breakers with trip ratings as shown on the panel schedules.
   2. Spares and spaces for future circuit breakers in panels as shown on the panel schedules.

B. Short circuit rating:
   1. Provide panelboards with short-circuit ratings as indicated on the Drawings:
   2. Testing method in accordance with UL 67.
   3. Mark each panelboard with its maximum short circuit rating at the supply voltage.
   4. Panelboards shall be fully rated.

2.06 COMPONENTS

A. Enclosure:
   1. NEMA enclosure type as indicated on the Drawings:
      a. Where not indicated on the Drawings, as specified in Section 16050 - Common Work Results for Electrical for the installed location.
   2. Minimum width: 20 inches.
   3. Gutter space in accordance with the NEC:
      a. Minimum of 4 inches of gutter space.
   4. Dead-front, no live parts when the panelboard is in service.
   5. Enclose entire panelboard bus assembly in a corrosion resistant galvanized steel cabinet.
   6. 4-piece front to provide ease of wiring access.
   7. Lockable, hinged door over the protective devices with a flush, cylinder tumbler-type lock with catch and door pull:
      a. Minimum 2 keys per panelboard.
      b. Key all panelboard locks alike.
   8. Circuit directory frame and card on the inside of the door.
   9. Door-in-door construction consists of a one-piece front with 2 doors:
      a. The smaller door provides access to all device handles and rating labels and shall be lockable.
      b. The larger door provides access to all conductors and wiring terminals.
   10. Interior design such that replacement of circuit breakers does not require disturbing adjacent units or removal of the main bus connectors.

B. Bus:
   1. General:
      a. Tin-plated copper.
   2. Phase bus:
      a. Full size and height without reduction.
      b. Dimensions and temperature rise in accordance with UL 67:
         1) Limit current density to less than 1,000 amps per square inch.
      c. Insulate all current carrying parts from ground and phase-to-phase with a high dielectric strength insulator.
   3. Ground bus:
      a. Copper, solidly bonded.

4. Neutral bus:
    a. Provide where indicated on the Drawings.
    b. 100 percent rated.
    c. Provide lugs for each outgoing feeder requiring a neutral connection.
5. Provide insulation barriers over the vertical bus behind the dead front shield to provide increased safety during field service.

C. Lugs:
1. UL listed for copper and aluminum wire:
    a. Provide lugs rated for 75-degree Celsius terminations.
    b. Provide bolted or compression main lug terminations as required for the incoming cable size.

D. Circuit breakers: As specified in Section 16412 - Low Voltage Molded Case Circuit Breakers and as indicated on the Drawings:
1. Provide all circuit breakers with bolt-on connections:
    a. Plug-in circuit breakers are not allowed.

2.07 ACCESSORIES

A. Nameplates:
1. As specified in Section 16075 - Identification for Electrical Systems.
2. Install on outside of door.
3. Indicating:
    a. Panel designation.
    b. Voltage.
    c. Number of phases and configuration.

B. Circuit identification labels:
1. Provide index cards behind heavy clear plastic in cardholders on the inside of the doors.
2. Type all information on the cards using designations in the panel schedules.
3. Laminated on both sides.

C. Pad locking mechanism:
1. Provide a pad locking attachment to allow circuit breakers to be locked in the off position.
2. At a minimum, provide 1 mechanism per panelboard:
    a. Provide multiple mechanisms if required to accommodate all circuit breaker frame sizes in the panelboard.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Finish stand-alone panelboards with a primer, rust-resistant phosphate undercoat, and 2 coats of oven-baked enamel with manufacturer's standard gray.

B. Finish panelboards mounted in motor control centers to match the motor control center finish and color.

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Install the equipment in accordance with the accepted installation instructions and anchorage details to meet the seismic and wind load requirements at the Project site.

C. General:
   1. Surface mounted as indicated on the Drawings.
   2. Mount rigidly to structural members with exposed surfaces plumb and level to within 1/32 inch.
   3. Perform work in accordance with the manufacturer's instructions and shop drawings.
   4. Provide all brackets, hangers, supports, and hardware for mounting as required.
   5. Mount panelboard so that top operating handle is not more than 6 feet-7 inches above the operating floor.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Factory testing:
   1. Perform standard factory tests on the panelboards:
   2. Test in accordance with the latest version of NEMA and UL standards.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 16050 - Common Work Results for Electrical.

3.11 PROTECTION

A. As specified in Section 16050 - Common Work Results for Electrical.

3.12 SCHEDULES

A. Circuiting within the panelboard shall match the panel schedules as indicated on the Drawings.

B. Provide typewritten schedule in each panelboard.

END OF SECTION

SECTION 16510

LIGHTING: LED LUMINAIRES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: LED luminaires, drivers, poles, and accessories.

1.02 REFERENCES

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Illuminating Engineering Society of North America (IESNA):
   1. LM-79 - IES Approved Method for the Electrical and Photometric Measurements of Solid-State Lighting Products.
   2. LM-80 - IES Approved Method: Measuring Lumen Maintenance of LED Light Sources.
   3. TM-21 - Projecting Long Term Lumen Maintenance of LED Light Sources.

C. Institute of Electrical and Electronics Engineers (IEEE):
   1. C62.41 - IEEE Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.

D. National Electrical Manufacturers Association (NEMA):
   1. 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts.

E. Underwriters Laboratories (UL):
   1. 1598 - Luminaires.
   2. 8750 - Light Emitting Diode (LED) Equipment For Use In Lighting Products.

1.03 DEFINITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Specific definitions and abbreviations:
   1. CCT: Correlated color temperature - Scientific scale to describe how “warm” or how “cool” the light source is, measured in Kelvin. The lower the Kelvin temperature, the warmer the light feels, or appears.
   2. CRI: Color Rendering Index - A quantitative measure of the ability of a light source to reveal the colors of various objects faithfully in comparison with an ideal or natural light source.
   3. Driver - Device that manages power and controls the current flow from AC to DC for an LED lighting product.
   4. Efficacy - Lumen output of a light source per unit of power supplied to that source (lumens per watt).
   5. EMI: Electromagnetic Interference - Electrical interference (noise) generated by electrical and electronic devices.
   6. FC: Foot Candles - Measure of light level on a surface being illuminated.

7. L70 - The extrapolated life in hours of the luminaire when the luminous output depreciates 30 percent from initial values.
8. LED: Light emitting diode - A solid-state semiconductor device that produces light when electrical current flows through it.
9. LED light source - See LED luminaire.
10. LED luminaire - A complete lighting unit consisting of LED-based light emitting elements and a matched driver together with parts to distribute light, to position and protect the light emitting elements, and to connect the unit to a branch circuit.
11. Lumen - The international (SI) unit of luminous flux or quantity of light. The amount of light that is spread over a square foot of surface by one candle power when all parts of the surface are exactly one foot from the light source.
12. Lumen ambient temperature multiplier - LED light source relative lumen output when compared to a standard ambient temperature.
13. Lumen maintenance factor - How well an LED light source is able to retain its intensity when compared to new.
14. Luminaire - Lighting unit.
15. THD: Total harmonic distortion - The combined effect of harmonic Distortion on the AC waveform produced by a driver or other device.

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.

B. Product data:
   1. LED Luminaires:
      a. Catalog literature for each luminaire specified, cross-referenced to the luminaire type on the Luminaire Schedule in the Drawings.
      b. Provide for each luminaire type:
         1) Materials.
         2) Type of diffuser.
         3) Hardware.
         4) Gasketing.
         5) Reflector.
         6) Chassis.
         7) Finish and color.
         8) Driver type and protection.
         9) LED luminaire:
            a) Initial lumen output at 40 degrees Celsius ambient.
            b) Correlated color temperature.
            c) Lumen maintenance factors.
            d) Lumen ambient temperature multipliers.
            e) Drive current.
            f) Efficacy.
         10) Picture of luminaire.
         11) IES optical distributions.
         12) Dimensioned drawings:
            a) Effective projected area rating for pole mounted luminaires.
         13) Weight.

14) Photometric data:
    a) Coefficient of utilization tables based on the IES zonal cavity system by an approved testing laboratory.
    b) Luminaire dirt depreciation factor.
    c) Candlepower distribution curves.
    d) Average luminaire brightness.
    e) Lumen output charts.
15) Furnish support method for interior luminaires weighing more than 30 pounds and all wall-mounted luminaires:
    a) Support methods shall be based on seismic requirements at the project site as specified in Section 16050 - Common Work Results for Electrical.

c. Luminaire substitutions:
    1) Provide complete literature for each luminaire substitution:
    2) Submittals for substituted luminaires shall be sufficient for competent comparison of the proposed luminaire to the originally specified luminaire:
        a) Photometric data:
            (1) IES file in standard IES format.
            (2) Coefficient of utilization tables based on the IES zonal cavity system by an approved testing laboratory.
            (3) Candlepower distribution curves.
            (4) Average luminaire brightness.
            (5) Lumen output charts.
            (6) Power requirements in watts and volt-amperes.
        b) Calculations:
            (1) Provide software generated calculations showing illuminance levels in footcandles and power usage in watts per square foot for each of the areas in which substitutions are proposed:
                (a) Use surface reflectance values and luminaire light loss factors approved by the Engineer to perform all calculations.
        c) Specification sheets:
            (1) If lacking sufficient detail to indicate compliance with contract documents, standard specification sheets will not be accepted. This includes, but is not limited to, luminaire type designation, manufacturer's complete catalog number, voltage, LED type, CCT, CRI, specific driver information, system efficacy, L70 life rating, and any modifications necessary to meet the requirements of the contract documents.
    3) Substitutions for specified luminaires will be evaluated upon quality of construction, light distribution, energy use, appearance, and maintenance.
    4) Substitutions shall comply with all applicable building and energy codes.

2. Driver: Provide for each driver type:
    a. Catalog number.
    b. Type of driver.
    c. Output wattage.
    d. Input voltage.

e. Operating voltage range.
f. Maximum input power.
g. Efficiency.
h. Operating line current.
i. Power factor.
j. Operating temperature range.
k. Current output range in ambient temperatures of 30 to 55 degrees Celsius.
l. Surge suppression data.

3. Photocell:
   a. Provide for each photocell type:
      1) Switching capacity.
      2) Life expectancy when used on LED sources.
      3) The means of adjusting the lighting pickup level.
      4) Enclosure type.
      5) Mounting method.
4. Luminaire poles:
   a. Submit complete data for each pole type including but not limited to:
      1) Material.
      2) Finish and color.
      3) Handholes.
      4) Anchoring.
      5) Luminaire attachment methods and fittings.
      6) Pole height.
      7) Pole dimensions.
      8) Bolt hole circle layout and hardware.
      9) Accessories.
      10) Provide the EPA wind load rating.

C. Calculations:
   1. Provide complete design calculations and installation documents for pole mounting piers and poles mounted from structures:
      a. Include in the calculations the wind and seismic requirements at the project site.
      b. Calculations and design shall be performed by and signed by a Professional Engineer registered in the state where the project is being constructed:
         1) Because this design is being provided by a Professional Engineer, the submittal will be reviewed for form and content but not reviewed for technical completeness, methods, or calculations.

D. Record documents:
   1. Update the Luminaire Schedule in the Drawings to reflect the acceptable substitutions, after the substitution has been reviewed and accepted by the Engineer.

1.05 QUALITY ASSURANCE

A. As specified in Section 16050 - Common Work Results for Electrical.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 16050 - Common Work Results for Electrical.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.08 SEQUENCING (NOT USED)

1.09 SCHEDULING

A. Exterior and outdoor lighting system operation shall be demonstrated during the hours of darkness.

B. Lighting demonstration shall occur within 2 weeks before substantial completion.

1.10 WARRANTY

A. As specified in Section 16050 - Common Work Results for Electrical.

B. LED luminaire:
   1. 5 year warranty from the date of installation including material, workmanship, photometrics, driver, and LED modules.

1.11 SYSTEM START-UP

A. As specified in Section 16050 - Common Work Results for Electrical.

1.12 OWNER'S INSTRUCTIONS (NOT USED)

1.13 MAINTENANCE

A. Furnish 1 complete spare LED luminaire, with driver, of each type used.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Luminaires:
   1. The following or equal:
      a. As noted on the Luminaire Schedule.

B. Drivers:
   1. One of the following or equal:
      a. Philips Advance.
      b. Thomas Research.
      c. eldoLED.

C. Photo-electric cells:
   1. One of the following or equal:
      a. Cooper.

b. Tork.
c. Intermatic.

D. Substitutions:
1. The lighting design and luminaire selection has been based upon the photometric data of the identified luminaire. It is the Contractor's responsibility to ensure and prove to the Engineer at time of submittal the substitutions meet the quality and photometric requirements of the original design.

2.02 SYSTEM DESCRIPTION

A. Provide luminaires, and accessories for all lighting systems, complete and operable, in accordance with the requirements of the Contract Documents.

B. Individual luminaire types are indicated on the Drawings and on the Luminaire Schedule.

2.03 EXISTING PRODUCTS (NOT USED)

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT

A. LED Luminaires:
1. General:
a. Pre-wired with leads of 18-AWG, minimum, for connection to building circuits.
b. Provide the luminaires furnished per the Luminaire Schedule in the Drawings:
1) The Specifications noted in this Section are an addition or supplement to the Luminaire Schedule.
c. Individual LEDs connected such that a catastrophic loss or the failure of 1 LED will not result in the loss of the entire luminaire.
2. Minimum ambient temperature range of 0 degrees Celsius to 40 degrees Celsius.
3. Minimum rated life:
a. Office Areas: 70,000 hours when operated at 25 degrees Celsius.
b. Process Areas: 60,000 hours when operated at 40 degrees Celsius.
c. Hazardous Areas: 50,000 hours when operated at 40 degrees Celsius.
4. Minimum efficacy of 70 lumens/watt.
a. Hazardous Areas: Minimum 60 lumens/watt.
5. Minimum Color Rendering Index of 70.
6. Tested according to IESNA LM-79 and LM-80.
7. Lumen maintenance projection in accordance with IESNA TM-21.
8. RoHS compliant.
9. Integral driver.
10. Suitable for dry, damp, or wet locations as indicated on the Drawings or on the Luminaire Schedule.
a. Wet or damp locations: UL 1598 listed.
11. Designed as a complete LED assembly. Retrofit LED lamps in luminaires not designed specifically for LED light sources shall not be used.

12. Exterior/outdoor luminaires:
    a. Luminaires in combination with their mounting pole and bracket shall be capable of withstanding:
        1) Wind levels at the project site without damage.
        2) Seismic levels at the project site.
    b. Corrosion-resistant hardware and hinged doors or lens retainer.
    c. Luminaires furnished with integral photoelectrical control shall be of the luminaire manufacturer's standard design.
    d. California Energy Code Light Pollution Reduction Compliance:
        1) Provide all exterior luminaires with cutoff photometrics.

B. Photo-electric cells:
1. Photoelectric cells for control of multiple luminaires:
    a. Self-contained.
    b. Weatherproof.
    c. Provided with time-delay features.
    d. Sized to meet switching capacity of the circuit:
        1) Based on luminaire VA as indicated on the Drawings.
2. Photoelectric cell for control of a single luminaire:
    a. Integral to the luminaire.

C. Drivers:
1. Dimmable, with dimming signal protocol of 0-10 VDC or DALI.
2. Input power source:
    a. As indicated on the Drawings.
3. Drive current:
    a. As indicated in the Luminaire Schedule.
4. Power factor: greater than 0.90.
5. Efficiency: greater than 80 percent.
6. Total harmonic distortion (THD) of the input current less than 20 percent.
7. Rated life of 60,000 hours in an LED luminaire operated at an ambient temperature of 40 degrees Celsius.
8. Minimum operating temperature of 0 degrees Celsius.
9. Sound rating: Class A+ or quieter.
10. UL listed Class 2 Outdoor in accordance with UL 8750.
11. In accordance with IEEE C62.41 Category A for transient protection.
12. Driver must limit inrush current:
    a. Meet or exceed NEMA 410 driver inrush standard:
        1) 230 Amps per 10 Amp load with a maximum of 106 Amps squared-seconds at 120V.
        2) 430 Amps per 10 Amp load with a maximum of 370 Amps squared-seconds at 277V.

2.07 COMPONENTS

A. Luminaire poles:
   1. As indicated on the Luminaire Schedule.
   2. Anchor bolts:
      a. Use anchor bolts, bolts, or welded studs for anchors for resisting seismic and wind forces.
         1) Standard hex bolt head.
         2) Do not use anchor bolts fabricated from rod stock with an L or J-shape.
      b. Complete with leveling shims.
   3. Anchor base:
      a. Fabricated from the same type of material as the pole shaft.
      b. Base plate to telescope the pole shaft.
      c. Welded top and bottom along the entire perimeter.
      d. With slotted bolt holes on the bolt circles as submitted.
   4. Pole shaft:
      a. As indicated on the Luminaire Schedule.
   5. Handhole:
      a. Reinforced handhole located approximately 18 inches above the base.
      b. Complete with cover fabricated from the same material as the pole shaft and stainless steel attachment screws.
      c. With an integral ground connection nut, 1/2 inch by 13 inch UNC welded to the pole for connection to the grounding system.
   6. Shroud:
      a. Fabricated from the same type of material as the pole shaft.
      b. 1-piece formed channel section that shall conform to the pole shaft taper.
      c. Secured by a locking device with provisions for a padlock to prevent accidental lowering.
   7. Fastening hardware:
      a. All fasteners shall be stainless steel.
   8. Finish:
      a. As indicated on the Luminaire Schedule.

2.08 ACCESSORIES

A. Pole mounted convenience outlet:
   1. Where indicated, furnish a 120 Volt, GFCI protected receptacle:
      a. Integrally mounted in the pole shaft at 36 inches above the base.
   2. Complete with corrosion resistant and weatherproof cover.

2.09 MIXES (NOT USED)

2.10 FABRICATION (NOT USED)

2.11 FINISHES (NOT USED)

2.12 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Install luminaires per the manufacturer's guidelines and submitted installation calculations to meet seismic and wind requirements at the project site.

C. Special techniques:
   1. Support luminaires from structural elements capable of carrying the total weight.
   2. Install luminaires plumb and square with building and wall intersections:
      a. Suspend pendant-mounted luminaries that are mounted from sloping ceilings with ball hangers, unless otherwise indicated on the Drawings.
      b. Install luminaires in machinery rooms after machines have been installed, so as to ensure no conflict with machinery, piping, or ductwork.
   3. In all cases, coordinate luminaire locations with work of other trades to prevent obstruction of light from the fixtures:
      a. Locate bottom of luminaire approximately at the bottom of ductwork, unless otherwise specified or indicated on the Drawings.
   4. Support luminaires weighing more than 25 pounds independently of the outlet box and the conduit.
   5. Provide ceiling or pendent mounted luminaires with a safety chain connecting the lens, driver, and other components to the building structure.
   6. Provide recessed luminaires with auxiliary safety supports attached directly to the building structure:
      a. The safety supports shall consist of number 12 AWG soft drawn galvanized wires.
   7. Install luminaires in accordance with the architectural reflected ceiling Drawings:
      a. Center luminaires on ceiling tiles unless otherwise indicated.
   8. Support luminaires installed in suspended grid ceilings, independently of the grid:
      a. Provide seismic restraint clips for all luminaires installed in suspended grid ceilings.

D. Luminaire poles:
   1. Set poles on anchor bolts and secured with double nuts on each bolt.
   2. Dry-pack the pole base, after the luminaire and pole has been leveled and plumbed.
   3. Bond metal poles to the plant grounding system, utilizing a ground lug connection within the pole:
      a. Route ground conductor through pier and pole base sleeve using Schedule 40 PVC conduit.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 16050 - Common Work Results for Electrical.

3.09 ADJUSTING

A. Aim and verify all exterior and outdoor luminaires alignment, during dark evening hours, as directed by Owner or the Engineer.

3.10 CLEANING

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Clean all lenses, diffusers, and reflectors.

C. Refinish all luminaires' trim, poles, and support brackets, where finish has been damaged.

D. Clean all LED luminaires (new and old), used during construction for construction lighting, before substantial completion.

E. Clean and re-lamp all existing fluorescent and HID luminaires used during construction for construction lighting, before substantial completion.

3.11 PROTECTION

A. As specified in Section 16050 - Common Work Results for Electrical.

3.12 SCHEDULES

A. Refer to the Luminaire Schedule in the Drawings.

END OF SECTION

SECTION 16950

FIELD ELECTRICAL ACCEPTANCE TESTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Responsibilities for testing the electrical installation.
   2. Adjusting and calibration.
   3. Acceptance tests.

B. Copyright information:
   1. Some portions of this Section are copyrighted by the InterNational Electrical Testing Association, Inc. (NETA). See NETA publication ATS for details.

1.02 REFERENCES

A. As specified in Section 16050 - Common Work Results for Electrical.

B. American National Standards Institute (ANSI).

C. Institute of Electrical and Electronics Engineers (IEEE):
   1. 43 - IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
   2. 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.
   3. 95 - IEEE Recommended Practice for Insulation Testing of AC Electric Machinery (2300 V and Above) With High Direct Voltage.
   4. 421.3 - IEEE Standard for High-Potential Test Requirement for Excitation Systems for Synchronous Machines.
   5. 450 - IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.
   6. 1106 - IEEE Recommended Practice for Installation, Maintenance, Testing, and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications.
   7. 1188 - IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications.
   8. C57.13 - IEEE Standard Requirements for Instrument Transformers.
   9. C57.13.1 - IEEE Guide for Field Testing of Relaying Current Transformers.
   10. C57.13.3 - IEEE Guide for Grounding of Instrument Transformer Secondary Circuits and Cases.
   11. C57.104 - IEEE Guide for the Interpretation of Gases Generated in Oil-Immersed Transformers.

D. Insulated Cable Engineer’s Association (ICEA).

E. InterNational Electrical Testing Association (NETA):
   1. ATS- Standard for Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.

F. International Electrotechnical Commission (IEC).

G. Manufacturer's testing recommendations and instruction manuals.

H. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).
   2. 110 - Standard for Emergency and Standby Power Systems.

I. National Institute of Standards and Technology (NIST).

J. Specification sections for the electrical equipment being tested.

K. Shop drawings.

1.03 DEFINITIONS

A. As specified in Sections 01756 - Commissioning and 16050 - Common Work Results for Electrical.

B. Specific definitions:
   1. Testing laboratory: The organization performing acceptance tests.

1.04 SYSTEM DESCRIPTION

A. Testing of all electrical equipment installed under this Contract in accordance with the manufacturer's requirements and as specified in this Section.

B. Conduct all tests in the presence of the Engineer or the Engineer's representative:
   1. Engineer will witness all visual, mechanical, and electrical tests, and inspections.

C. The testing and inspections shall verify that the equipment is operational within the tolerances required and expected by the manufacturer, and these Specifications.

D. Responsibilities:
   1. Contractor responsibilities:
      a. Ensure that all resources are made available for testing, and that all testing requirements are met.
   2. Electrical subcontractor responsibilities:
      a. Perform routine tests during installation.
      b. Demonstrate operation of electrical equipment.
      c. Commission the electrical installation.
      d. Provide the necessary services during testing, and provide these services to the testing laboratory, Contractor, and other subcontractors, including but not limited to:
         1) Providing electrical power as required.
         2) Operating of electrical equipment in conjunction with testing of other equipment.
         3) Activating and shutting down electrical circuits.

4) Making and recording electrical measurements.
5) Replacing blown fuses.
6) Installing temporary jumpers.

3. Testing laboratory responsibilities:
   a. Perform all acceptance tests specified in this Section.
   b. Provide all required equipment, materials, labor, and technical support during acceptance tests.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 16050 - Common Work Results for Electrical.

B. LAN cable test form:
   1. LAN cable test reports:
      a. Submit 3 copies of test reports showing the results of all tests specified in this Section:
         1) Test type.
         2) Test location.
         3) Test date.
         4) Cable number.
         5) Cable length.
         6) Certification that the cable meets or exceeds the specified standard.
      b. Furnish hard copy and electronic copy for all traces.

C. Manufacturers' testing procedures:
   1. Submit manufacturers' recommended testing procedures and acceptable test results for review by the Engineer prior to beginning testing.

D. Test report:
   1. Include the following:
      a. Summary of Project.
      b. Description of equipment tested.
      c. Description of tests performed.
      d. Test results.
      e. Conclusions and recommendations.
      f. Completed test forms.
      g. List of test equipment used and calibration dates.
      h. LAN cable test reports.

E. Test data records:
   1. Include the following:
      a. Identification of the testing organization.
      b. Equipment identification.
      c. Nameplate data.
      d. Humidity, temperature and or other conditions that may affect the results of the tests and or calibrations.
      e. Dates of inspections, tests, maintenance and or calibrations.
      f. Indication of the inspections, tests, maintenance, and or calibrations to be performed and recorded.
      g. Expected results when calibrations are to be performed.

h. Indication of as-found and as-left results as applicable.
i. Indication of all test results outside specified tolerances.

F. Testing laboratory qualifications:
1. Submit a complete resume and statement of qualifications from the proposed testing laboratory detailing their experiences in performing the tests specified:
a. This statement will be used to determine whether the laboratory is acceptable, and shall include:
1) Corporate history and references.
2) Resume of individual performing test.
3) Equipment list and test calibration data.

G. Division of responsibilities:
1. Submit a list identifying who is responsible for performing each portion of the testing.

1.06 QUALITY ASSURANCE

A. As specified in Section 16050 - Common Work Results for Electrical.

B. Testing laboratory qualifications:
1. The testing laboratory may be qualified testing personnel from the electrical subcontractor's staff or an independent testing company.
2. NETA certification required.
3. Selection of the testing laboratory and testing personnel is subject to approval by the Engineer based on testing experience and certifications of the individuals and testing capabilities of the organization.

1.07 DELIVERY, STORAGE, AND PROTECTION (NOT USED)

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 16050 - Common Work Results for Electrical.

1.09 SEQUENCING

A. At least 30 days before commencement of the acceptance tests, submit the manufacturer's complete field testing procedures to the Engineer and to the testing laboratory, complete with expected test results and tolerances for all equipment to be tested.

B. Perform testing in the following sequence:
1. Perform routine tests as the equipment is installed including:
a. Insulation-resistance tests.
b. Continuity tests.
c. Rotational tests.
2. Adjusting and preliminary calibration.
3. Acceptance tests.
4. Demonstration.
5. Commissioning and plant start-up.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 16050 - Common Work Results for Electrical.

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION

A. Test instrument calibration:
   1. Utilize a testing laboratory with a calibration program which maintains all applicable test instrumentation within rated accuracy:
      a. The calibrating standard shall be of better accuracy than that of the equipment tested.
   2. The accuracy shall be traceable to the NIST in an unbroken chain.
   3. Calibrate instruments in accordance with the following frequency schedule:
      a. Field instruments: 6 months maximum.
      b. Laboratory instruments: 12 months maximum.
      c. Leased specialty equipment where the accuracy is guaranteed by the lessor (such as Doble): 12 months maximum.
   4. Dated calibration labels shall be visible on all test equipment.
   5. Maintain an up-to-date instrument calibration record for each test instrument:
      a. The records shall show the date and results of each calibration or test.
   6. Maintain an up-to-date instrument calibration instruction and procedure for each test instrument.

B. Do not begin testing until the following conditions have been met:
   1. All instruments required are available and in proper operating condition.
   2. All required dispensable materials such as solvents, rags, and brushes are available.
   3. All equipment handling devices such as cranes, vehicles, chain falls and other lifting equipment are available or scheduled.
   4. All instruction books, calibration curves, or other printed material to cover the electrical devices are available.
   5. Data sheets to record all test results are available.

3.03 INSTALLATION

A. Test decal:
   1. The testing laboratory shall affix a test decal on the exterior of equipment or equipment enclosure of protective devices after performing electrical tests.

2. The test decal shall be color coded to communicate the condition of maintenance of the protective. The color scheme for condition of maintenance of overcurrent protective devices shall be:
    a. White: electrically and mechanically acceptable.
    b. Yellow; minor deficiency not affecting fault detection and operation, but minor electrical or mechanical condition exists.
3. The decal shall include the following information at a minimum:
    a. Testing organization.
    b. Project identifier.
    c. Test date.
    d. Technician identifier.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Testing and Training Phase: Installation Testing:
1. Also called "Field Acceptance Testing".
2. Panelboards:
    a. Cleaning:
        1) Visually inspect panelboard for evidence of discoloration, abnormal dust accumulation, metal shards, or any other indication of overheating, wear, or other abnormal conditions prior to cleaning.
        2) Clean cabinet with a brush, vacuum cleaner, or clean, dry, lint-free rags to remove any accumulation of dust, dirt, or other foreign matter. Do not use liquids, solvents or detergents when cleaning panelboards or components.
        3) Avoid blowing dust into panelboards. Do not use a blower or compressed air.
        4) Clean Supports, terminals, and other major insulating surfaces with clean, dry, lint-free rags or soft bristled brushes.
        5) Remove dust, soot, grease, moisture, and foreign material from surface of circuit breakers.
    b. General:
        1) Compare equipment nameplate data with the Contract Documents.
        2) Check panelboard circuit schedule for accuracy.
        3) Verify appropriate anchorage, required area clearances, and correct alignment.
        4) Inspect overall general condition for physical damage. Check for broken studs and loose or damaged wires, connector, terminations, etc. Check all bolts, nuts, washer, and pins for tightness. Tighten or use manufacture’s replacement parts as required.
        5) Inspect cabinets for signs of rust, corrosion, or deteriorating paint. Inspect cabinets for evidence of localized heat damage to the paint. Investigate sources of heat. Repair painted surfaces.

6) Check that covers are in place and fastened. Plug any open unused knockouts.
7) Inspect panelboard for moisture. Seal off any cracks or openings which have allowed moisture to enter the cabinet. Inspect all component devices. Replace any components that show evidence of damage from moisture.
8) Look for any recent changes in sprinklers or other plumbing that might expose indoor panelboards to a source of liquids. Eliminate sources of water, moisture, or liquids, or provide adequate barriers to protect panelboards from sources of water, moisture, or liquids.
9) Inspect panelboards and internal components for evidence of overheating, arc spatter, sooty deposits, and tracking. Investigate and correct sources of arcing or overheating. Consult the panelboard manufacturer for recommendations.
10) Verify that fuse and/or circuit breaker sizes and types correspond to record drawings, if available, as well as to the circuit breaker's address for microprocessor communications packages, if equipped.
11) Set adjustable circuit breakers in accordance with engineering coordination study supplied by Engineer.

c. Terminations, Connections, and Lugs:
1) Inspect bolted electrical connections for high resistance using one of the following methods:
a) Use of low-resistance ohmmeter.
(1) Compare bolted connection resistance values to values of similar connections:
(a) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
b) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
(1) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
2) Inspect terminations, connection, and lugs for alignment, physical damage, burns, corrosion, discoloration, flaking, heat damage, arcing, pitting, melting, deterioration, carbonization, cracks, chips, breaks, partial discharge, or moisture. Investigate and eliminate sources of any damage.
3) Follow manufacturer recommendations for cleaning, repairing, and replacing damaged parts.
4) Replace overheated connections. Tighten connections to proper to proper torque levels as specified above.

d. Conductors and raceways:
1) Inspect supply conductors and terminations for overheating, discoloration, and oxidation. Investigate and correct any deficiencies.
2) Ensure the conductors are protected within their ampacities.
3) Visually check panelboard, cables, and raceways for proper bonding and grounding. Correct improper bonding and grounding.
4) Inspect conductors for discoloration, arcing, pitting, melting, flaking of insulation and/or metal parts. Repair or replace damaged components in accordance with manufacturer's recommendations.
5) Inspect for frayed or broken wires. Replace or repair damaged components in accordance with manufacturer recommendations.

6) Inspect for frayed or broken wires. Replace or repair conductors as necessary.
7) Inspect conduits for moisture. Seal conduits which are a source of moisture and provide means to drain moisture away from the panelboard.

e. Circuit breakers:
1) Breakers rated less than 100 A:
a) Operate circuit breakers several times in order to exercise the mechanisms and the contacts, and to ensure smooth operation. Do not oil or grease parts of molded case circuit breakers.
b) Visually check circuit breakers for evidence of overheating and thermal damage. Investigate and eliminate sources of overheating.
c) Check circuit breakers for visual defects, chipping, cracks, breaks, burns, and deterioration. Replace damaged circuit breakers.
d) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, and antipump function.
e) Inspect interchangeable trip-unit circuit breakers for tightness of trip units.
f) Check circuit breaker terminals and connections for tightness as specified above.
2) Breakers rated 100 A and higher:
a) Perform visual and mechanical inspection as specified in this Section.
b) Perform electrical tests as specified in this Section.

3. Dry type transformers:
a. Visual and mechanical inspection:
1) Compare equipment nameplate data with the Contract Documents.
2) Inspect physical and mechanical condition.
3) Inspect anchorage, alignment, and grounding.
4) Verify that resilient mounts are free and that any shipping brackets have been removed.
5) Inspect equipment for cleanliness.
6) Inspect bolted electrical connections for high resistance using one of the following methods:
a) Use of low-resistance ohmmeter.
b) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
(1) Refer to manufacturer’s instructions for proper foot-pound levels or NETA ATS tables.
7) Verify that as-left tap connections are as specified.

b. Electrical tests:
1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
2) Perform insulation-resistance tests winding-to-winding and each winding-to-ground:
a) Apply voltage in accordance with manufacturer’s published data:
(1) Refer to NETA ATS tables in the absence of manufacturer’s published data.

3) Calculate dielectric absorption ration or polarization index.
4) Verify correct secondary voltage, phase-to-phase and phase-to-neutral after energization and before loading.

c. Test values:
1) Compare bolted connection resistance values to values of similar connections:
a) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2) Bolt-torque levels shall be in accordance with manufacturer's published data:
a) Refer to NETA ATS tables in the absence of manufacturer's published data.
3) Tap connections are left as found unless otherwise specified.
4) Minimum insulation-resistance values of transformer insulation shall be in accordance with manufacturer's published data:
a) Refer to NETA ATS tables in the absence of manufacturer's published data.
b) Investigate insulation values less than the allowable minimum.
5) The dielectric absorption ratio or polarization index shall not be less than 1.0.
6) Turns-ratio results should not deviate more than 1/2 percent from either the adjacent coils or calculated ratio.
7) Phase-to-phase and phase-to-neutral secondary voltages shall be in agreement with nameplate data.

4. Low voltage cables, 600 volt maximum:
a. Visual and mechanical inspection:
1) Compare cable data with the Drawings and Specifications.
2) Inspect exposed sections of cable for physical damage and correct connection as indicated on the Drawings.
3) Inspect bolted electrical connections for high resistance by one of the following methods:
a) Use of low-resistance ohmmeter.
b) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
(1) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
4) Inspect compression applied connectors for correct cable match and indentation.
5) Inspect for correct identification and arrangement.
6) Inspect cable jacket insulation and condition.

b. Electrical tests:
1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
2) Perform insulation resistance test on each conductor with respect to ground and adjacent conductors:
a) Applied potential shall be 500 volts dc for 300 volt rated cable and 1,000 volts dc for 600 volt rated cable.
b) Test duration shall be 1 minute.
3) Perform continuity tests to insure correct cable connection.
4) Verify uniform resistance of parallel conductors.

c. Test values:
    1) Compare bolted connection resistance values to values of similar connections:
        a) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    2) Insulation-resistance values shall be in accordance with manufacturer's published data:
        a) Refer to NETA ATS tables in the absence of manufacturer's published data.
        b) Investigate values of insulation-resistance less than the allowable minimum.
    3) Cable shall exhibit continuity.
    4) Deviations in resistance between parallel conductors shall be investigated.

5. Grounding systems:
    a. Visual and mechanical inspection:
        1) Inspect ground system for compliance with the Contract Documents, and the NEC.
        2) Inspect physical and mechanical condition.
        3) Inspect bolted electrical connections for high resistance using one of the following methods:
            a) Use of low-resistance ohmmeter.
            b) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
                (1) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
        4) Inspect anchorage.
    b. Electrical tests:
        1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
        2) Perform fall of potential test or alternative test in accordance with IEEE 81 on the main grounding electrode or system.
        3) Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, the system neutral and any derived neutral points.
    c. Test values:
        1) Grounding system electrical and mechanical connections shall be free of corrosion.
        2) Compare bolted connection resistance values to values of similar connections:
            a) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
        3) Bolt-torque levels shall be in accordance with manufacturer's published data:
            a) Refer to NETA ATS tables in the absence of manufacturer's published data.
        4) The resistance between the main grounding electrode and ground shall be as specified in Section 16060 - Grounding and Bonding.
        5) Investigate point-to-point resistance values that exceed 0.5 ohm.

6. Rotating machinery, ac induction motors and generators:
    a. Visual and mechanical inspection:
        1) Compare equipment nameplate information with the Contract Documents.
        2) Inspect physical and mechanical condition.
        3) Inspect anchorage, alignment, and grounding.
        4) Inspect air baffles, filter media, cooling fans, slip rings, brushes, and brush rigging.
        5) Inspect bolted electrical connections for high resistance using one or more of the following methods:
            a) Use of low-resistance ohmmeter.
            b) Verify tightness of accessible bolted electrical connections by calibrated torque wrench method:
                (1) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
        6) Verify correct application of appropriate lubrication and lubrication systems.
        7) Verify that resistance temperature detector (RTD) circuits conform to that indicated on the Drawings.
    b. Electrical tests - AC Induction:
        1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
        2) Perform insulation-resistance test in accordance with IEEE 43:
            a) On motors 200 horsepower and smaller, test duration shall be 1 minute. Calculate dielectric absorption ratio for 60/30 second periods.
            b) On motors larger than 200 horsepower, test duration shall be 10 minutes. Calculate polarization index.
        3) On machines rated at 2,300 volts and greater, perform dielectric withstand voltage tests in accordance with:
            a) IEEE 95 for dc dielectric withstand voltage tests.
            b) NEMA MG1 for ac dielectric withstand voltage tests.
        4) Perform phase-to-phase stator resistance test on machines rated at 2,300 volts and greater.
        5) Perform insulation-resistance test on insulated bearings in accordance with manufacturer's published data.
        6) Test surge protection devices as specified in this Section.
        7) Test motor starter as specified in this Section.
        8) Perform resistance tests on resistance temperature detector (RTD) circuits.
        9) Verify operation of motor space heater, if applicable.
    c. Test values:
        1) Inspection:
            a) Air baffles shall be clean and installed in accordance with the manufacturer's published data.
            b) Filter media shall be clean and installed in accordance with the manufacturer's published data.
            c) Cooling fans shall operate.
            d) Slip ring alignment shall be within manufacturer's published tolerances.

e) Brush alignment shall be within manufacturer's published tolerances.
f) Brush rigging shall be within manufacturer's published tolerances.

2) Compare bolted connection resistance values to values of similar connections:
a) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.

3) Bolt-torque levels shall be in accordance with manufacturer's published data:
a) Refer to NETA ATS tables in the absence of manufacturer's published data.

4) Air-gap spacing and machine alignment shall be in accordance with manufacturer's published data.

5) The recommended minimum insulation-resistance ($IR_{1\ min}$) test results in megohms shall be in accordance with NETA ATS tables:
a) The polarization index value shall not be less than 2.0.
b) The dielectric absorption ratio shall not be less than 1.4.

6) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.

7) Investigate phase-to-phase stator resistance values that deviate by more than 5 percent.

8) Power factor or dissipation factor values shall be compared to manufacturer's published data:
a) In the absence of manufacturer's published data, compare values of similar machines.

9) Tip-up values shall indicate no significant increase in power factor.

10) If no evidence of distress, insulation failure, or waveform nesting is observed by the end of the total time of voltage application during the surge comparison test, the test specimen is considered to have passed the test.

11) Bearing insulation-resistance measurements shall be within manufacturer's published tolerances:
a) In the absence of manufacturer's published data, compare values of similar machines.

12) Test results of surge protection devices shall be as specified in this Section.

13) Test results of motor starter equipment shall be as specified in this Section.

14) RTD circuits shall conform to the design intent and machine protection device manufacturer's published data.

15) Heaters shall be operational.

16) Vibration amplitudes of the uncoupled and unloaded machine shall be in accordance with manufacturer's published data:
a) In the absence of manufacturer's published data, vibration amplitudes shall not exceed values in NETA ATS tables.
b) If values exceed those in the NETA ATS tables, perform a complete vibration analysis.

7. Motor control centers, low voltage:
a. Visual and mechanical inspection:
1) Compare equipment nameplate data with the Contract Documents.

2) Inspect physical and mechanical condition.
3) Inspect anchorage, alignment, grounding and required clearances.
4) Verify the unit is clean and all shipping bracing, loose parts, and documentation shipped inside cubicles have been removed.
5) Verify that circuit breaker/fuse sizes and types correspond to the approved submittals and the coordination study.
6) Verify that current and voltage transformer ratios correspond to those indicated on the Drawings.
7) Verify that wiring connections are tight and that wiring is secure to prevent damage during routine operation of moving parts.
8) Inspect bolted electrical connections for high resistance using one of the following methods:
    a) Use of low-resistance ohmmeter.
    b) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
        (1) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
9) Verify operation and sequencing of interlocking systems:
    a) Attempt closure on locked-open devices.
    b) Attempt to open locked-closed devices.
    c) Make/attempt key-exchanges in all positions.
10) Lubrication requirements:
    a) Verify appropriate lubrication on moving current-carrying parts.
    b) Verify appropriate lubrication on moving and sliding surfaces.
11) Inspect insulators for evidence of physical damage or contaminated surfaces.
12) Verify correct barrier and shutter installation and operation.
13) Exercise all active components.
14) Inspect all indicating devices for correct operation.
15) Verify that filters are in place and/or vents are clear.
16) Perform visual and mechanical inspection of instrument transformers as specified in this Section.
17) Perform visual and mechanical inspection of surge arresters as specified in this Section.
18) Inspect control power transformers:
    a) Inspect for physical damage, cracked insulation, broken leads, and tightness of connections, defective wiring, and overall general condition.
    b) Verify that primary and secondary fuse/circuit breaker ratings match the submittal drawings.
    c) Verify correction functioning of grounding contacts.
19) Perform visual and mechanical inspection of all motor control center components as specified in this Section.

b. Electrical tests:
1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
2) Perform insulation-resistance tests on each bus section, phase- to- phase and phase-to-ground for 1 minute:
    a) Perform test in accordance with NETA ATS tables.
3) Perform a dielectric withstand test on each bus section, each phase to ground with phases not under test grounded, in accordance with

manufacturer's published data or NETA ATS tables. Apply the test voltage for 1 minute.

4) Perform ground-resistance tests:
    a) Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral and derived neutral points.
5) Control power transformers:
    a) Perform insulation-resistance tests, winding-to-winding and winding-to-ground:
        (1) Test voltages shall be in accordance with NETA ATS tables or as specified by the manufacturer.
    b) Perform secondary wiring integrity test:
        (1) Disconnect transformer at secondary terminals and connect secondary wiring to a rated secondary voltage source:
            (a) Verify correct potential at all devices.
    c) Verify correct secondary voltage by energizing primary winding with system voltage:
        (1) Measure secondary voltage with the secondary wiring disconnected.
6) Verify operation of space heaters.
7) Perform electrical tests of all motor control center components as specified in this Section.

c. Test values:
1) Compare bolted connection resistance values to values of similar connections:
    a) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2) Bolt-torque levels shall be in accordance with manufacturer's published data:
    a) Refer to NETA ATS tables in the absence of manufacturer's published data.
3) Insulation-resistance values for bus and control power transformers shall be in accordance with manufacturer's published data:
    a) Refer to NETA ATS tables in the absence of manufacturer's published data.
    b) Investigate insulation values less than the allowable minimum.
    c) Do not proceed with dielectric withstand voltage tests until insulation-resistance values are above minimum values.
4) Bus insulation shall withstand the over potential test voltage applied.
5) Instrument transformer test values shall be as specified in this Section.
6) Investigate grounding system point-to-point resistance values that exceed 0.5 ohm.
7) Meter accuracy shall be in accordance with manufacturer's published data.
8) Control power transformers:
    a) Insulation-resistance values of control power transformers shall be in accordance with manufacturer's published data:
        (1) Refer to NETA ATS tables in the absence of manufacturer's published data.

(2) Investigate insulation values less than the allowable minimum.
(3) Do not proceed with dielectric withstand voltage tests until insulation-resistance values are above minimum values.
b) Secondary wiring shall be as indicated on the Drawings and specified in the Specifications.
c) Secondary voltage shall be as indicated on the Drawings.
9) Heaters shall be operational.
10) Test values for motor control center components shall be as specified in this Section.

8. Variable frequency drive systems:
a. Visual and mechanical inspection:
1) Compare equipment nameplate data with the Contract Documents.
2) Inspect physical and mechanical condition.
3) Inspect anchorage, alignment, and grounding.
4) Verify the unit is clean.
5) Ensure vent path openings are free from debris and that heat transfer surfaces are clean.
6) Verify correct connections of circuit boards, wiring, disconnects, and ribbon cables.
7) Motor running protection:
a) Verify drive overcurrent setpoints are correct for their application.
b) If drive is used to operate multiple motors, verify individual overload element ratings are correct for their application.
c) Apply minimum and maximum speed setpoints. Verify setpoints are within limitations of the load coupled to the motor.
8) Inspect bolted electrical connections for high resistance using one of the following methods:
a) Use of low-resistance ohmmeter.
b) Verify tightness of accessible bolted electrical connections by the calibrated torque wrench method:
(1) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
9) Verify correct fuse sizing in accordance with manufacturer's published data.
10) Perform visual and mechanical inspection of input circuit breaker as specified in this Section.
b. Electrical tests:
1) Perform resistance measurements through bolted connections with low resistance ohmmeter.
2) Test the motor overload relay elements by injecting primary current through the overload circuit and monitoring trip time of the overload element.
3) Test for the following parameters in accordance with relay calibration procedures specified in NETA ATS or as recommended by the manufacturer:
a) Input phase loss protection.
b) Input overvoltage protection.
c) Output phase rotation.
d) Overtemperature protection.
e) Direct current overvoltage protection.

f) Overfrequency protection.
g) Drive overload protection.
h) Fault alarm outputs.

4) Perform continuity tests on bonding conductors as specified in accordance with NETA ATS.
5) Perform start-up of drive in accordance with manufacturer's published data. Calibrate drive to the system's minimum and maximum speed control signals.
6) Perform operational tests by initiating control devices:
   a) Slowly vary drive speed between minimum and maximum. Observe motor and load for unusual noise or vibration.
   b) Verify operation of drive from remote start/stop and speed control signals.
7) Perform electrical tests of input circuit breaker as specified in this Section.
8) Measure fuse resistance.

c. Test values:
1) Compare bolted connection resistance values to values of similar connections:
   a) Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
2) Bolt-torque levels shall be in accordance with manufacturer's published data:
   a) Refer to NETA ATS tables in the absence of manufacturer's published data.
3) Overload test trip times at 300 percent of overload element rating shall be in accordance with manufacturer's published time-current curve.
4) Test values for input circuit breaker shall be as specified in this Section.
5) Relay calibration results shall be as specified in this Section.
6) Continuity of bonding conductors shall be in accordance with NETA ATS.
7) Control devices shall perform in accordance with system requirements.
8) Operational tests shall conform to system design requirements.
9) Investigate fuse resistance values that deviate from each other by more than 15 percent.

9. Fiber-optic cables:
a. Visual and mechanical inspection:
1) Compare cable, connector, and splice data with the Contract Documents.
2) Inspect cable and connections for physical and mechanical damage.
3) Verify that all connectors and splices are correctly installed.

b. Optical tests:
1) Perform cable length measurement, fiber fracture inspection, and construction defect inspection using an optical time domain reflectometer (OTDR):
   a) OTDR test performed on fiber cables less than 100 meters shall be performed with the aid of a launch cable.
   b) Adjust OTDR pulse width settings to a maximum setting of 1/1,000th of the cable length or 10 nanoseconds.

2) Perform connector and splice integrity test using an optical time domain reflectometer.
3) Perform cable attenuation loss measurement with an optical power loss test set:
   a) Perform attenuation tests with an Optical Loss Test Set capable and calibrated to show anomalies of 0.1 dB as a minimum.
   b) Test multimode fibers at 850 nanometer and 1,300 nanometer.
   c) Test single mode fibers at 1,310 nanometer and 1,550 nanometer.
4) Perform connector and splice attenuation loss measurement from both ends of the optical cable with an optical power loss test set:
   a) At the conclusion of all outdoor splices at 1 location, and before they are enclosed and sealed, all splices shall be tested with OTDR at the optimal wavelengths (850 and 1,300 for multimode, 1,310 and 1,550 for single mode), in both directions. The splices shall be tested for integrity as well as attenuation.
5) Perform fiber links integrity and attenuation tests using each link shall be an OTDR and an Optical Loss Test Set:
   a) OTDR traces shall be from both directions on each fiber at the 2 optimal wavelengths, 850 nanometer, and 1,300 nanometer for multimode fibers.
   b) Optical loss testing shall be done with handheld test sets in 1 direction at the 2 optimal wavelengths for the appropriate fiber type. Test equipment shall equal or exceed the accuracy and resolution of Agilent/HP 8147 high performance OTDR.

c. Test values:
1) Cable and connections shall not have been subjected to physical or mechanical damage.
2) Connectors and splices shall be installed in accordance with industry standards.
3) The optical time domain reflectometer signal should be analyzed for excessive connection, splice, or cable backscatter by viewing the reflected power/distance graph.
4) Attenuation loss measurement shall be expressed in dB/km. Losses shall be within the manufacturer's recommendations when no local site specifications are available.
5) Individual fusion splice losses shall not exceed 0.1 dB. Measurement results shall be recorded, validated by trace, and filed with the records of the respective cable runs.

10. LAN cable testing:
a. Visual and mechanical inspections:
1) Compare cable type and connections with that indicated on the Drawings and specified in the Specifications.
2) Inspect cable and connectors for physical and mechanical damage.
3) Verify that all connectors are correctly installed.

b. Pre-testing:
1) Test individual cables before installation:
   a) Before physical placement of the cable, test each cable while on the spool with a LAN certification test device.
   b) Before the cable is installed, verify that the cable conforms to the manufacturer's attenuation specification and that no damage has been done to the cable during shipping or handling.

c) The test shall be fully documented and the results submitted to the Engineer, including a hard copy of all traces before placement of the cable.
d) The Engineer shall be notified if a cable fails to meet specification and the cable shall not be installed unless otherwise directed by the Engineer.

c. Electrical tests:
1) Perform cable end-to-end testing on all installed cables after installation of connectors from both ends of the cable.
2) Test shall include cable system performance tests and confirm the absence of wiring errors.

d. Test results:
1) Cables shall meet or exceed TIA standards for a Category 6 installation.

e. Test equipment:
1) LAN certification equipment used for the testing shall be capable of testing Category 6 cable installation to TIA proposed Level III accuracy. Tests performed shall include:
a) Near end cross talk.
b) Attenuation.
c) Equal level far end cross talk.
d) Return loss.
e) Ambient noise.
f) Effective cable length.
g) Propagation delay.
h) Continuity/loop resistance.
2) LAN certification test equipment shall be able to store and produce plots of the test results.
3) Manufacturers: The following or equal:
a) Agilent Technologies, WireScope 350.

3.08 FIELD QUALITY CONTROL (NOT USED)

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 16050 - Common Work Results for Electrical.

B. After the acceptance tests have been completed, dispose of all testing expendables, vacuum all cabinets, and sweep clean all surrounding areas.

3.11 PROTECTION

A. As specified in Section 16050 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 16990

CONDUIT SCHEDULE

PART 1 GENERAL

1.01 SUMMARY

A. Specific definitions:

1. Conduits:

a.	ARM:	Armored cable.
b.	GRC:	Galvanized rigid conduit.
c.	PCS:	PVC jacketed rigid steel conduit.
d.	IMC:	Intermediate metallic conduit.
e.	EMT:	Electrical metallic steel tubing.
f.	PVC:	Polyvinyl chloride rigid plastic conduit.
g.	SLT:	Sealtight - liquidtight flexible conduit.
h.	RAC:	Rigid aluminum conduit.
i.	FLX:	Flexible metallic conduit.
j.	NFC:	Non-metallic flexible conduit.

2. Cables:

a.	DN Thick:	DeviceNet “thick” cable.
b.	DN Thin:	DeviceNet “thin” cable.
c.	PBPA:	Profibus PA cable.
d.	PBDP:	Profibus DP cable.
e.	PBDPP:	Profibus DP cable with 24VDC power.
f.	FFBUS:	Foundation Fieldbus cable.
g.	RS-485	RS-485 cable.
h.	CAT5e:	Category 5 enhanced Ethernet cable.
i.	CAT6:	Category 6 Ethernet cable.
j.	CNET:	ControlNet cable.
k.	DH+:	Data Highway Plus cable.
l.	RIO:	Remote I/O cable.
m.	DF1:	Serial cable.
n.	MODB:	Modbus cable.
o.	MODB+:	Modbus Plus cable.
p.	*/FO:	Fiber optic cable (* indicates number of fibers).
q.	2/C#16S:	2 conductor, 16 gauge, twisted shielded pair. (*/2/C#16S * indicates number of pairs).
r.	3/C#16S:	3 conductor, 16 gauge, twisted shielded triplet. (*/3/C#16S * indicates number of triplets).
s.	*/C#Y:	Multiconductor cable (* indicates number of conductors, Y indicates conductor size and insulation).
t.	MFR:	Manufacturer or vendor furnished cable.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 CONDUIT SCHEDULE

A. As specified in Attachment A - Conduit Schedule.

END OF SECTION

ATTACHMENT A - CONDUIT SCHEDULE

SECTION 16990A

CONDUIT SCHEDULE
AREA 6 - TERTIARY FILTERS

PART 1 GENERAL

1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. */FO: Fiber optic (* indicates strand count).
   4. PULL: Pull Rope.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

CONDUIT SCHEDULE AREA 06

TERTIARY PROCESS UPGRADES

TERTIARY FILTERS

ENGINEER	**BCS**
REVISION	**0**
DATE	4/20/23

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C6601		0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: 06-EDR-6601 TO: CONDUIT TEE 10 #14 >> 06-EDR-6601 CONTROL	C6711
C6602		0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: 06-EDR-6602 TO: CONDUIT TEE 10 #14 >> 06-EDR-6602 CONTROL	C6613
C6603		0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: 06-EDR-6603 TO: CONDUIT TEE 10 #14 >> 06-EDR-6603 CONTROL	C6613
C6613		1.5"	20	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE TO: J-BOX 10 #14 >> 06-EDR-6602 CONTROL 10 #14 >> 06-EDR-6603 CONTROL	C6631 C6602 C6603
C6631		2"	20	#14	XHHW-2	1	#14	XHHW-2	FR: J-BOX TO: IPB-41 10 #14 >> 06-EDR-6602 CONTROL 10 #14 >> 06-EDR-6603 CONTROL	C6750 C6613 C6613
C6632		0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: 06-LSHH-6632 TO: WW-6602 2 #14 >> 06-LSHH-6632 CONTROL	C6670
C6660		0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: EDM-631 TO: CONDUIT TEE 8 #14 >> EDM-631 CONTROL	C6662
C6661		0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: EDM-635 TO: CONDUIT TEE 8 #14 >> EDM-635 CONTROL	C6662
C6662		1"	16	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE TO: CONDUIT TEE 8 #14 >> EDM-631 CONTROL 8 #14 >> EDM-635 CONTROL	C6664 C6660 C6661
C6663		0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: EDM-651 TO: CONDUIT TEE 8 #14 >> EDM-651 CONTROL	C6664
C6664		1.5"	24	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE TO: CONDUIT TEE 8 #14 >> EDM-631 CONTROL 8 #14 >> EDM-635 CONTROL 8 #14 >> EDM-651 CONTROL	C6666 C6662 C6662 C6663
C6665		0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: EDM-655 TO: CONDUIT TEE 8 #14 >> EDM-655 CONTROL	C6666
C6666		1.5"	32	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE TO: CONDUIT TEE 8 #14 >> EDM-631 CONTROL 8 #14 >> EDM-635 CONTROL 8 #14 >> EDM-651 CONTROL 8 #14 >> EDM-655 CONTROL	C6668 C6664 C6664 C6664 C6665
C6667		0.75"	8	#14	XHHW-2	1	#14	XHHW-2	FR: EDM-660 TO: CONDUIT TEE 8 #14 >> EDM-660 CONTROL	C6668
C6668		2"	40	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE TO: J-BOX 8 #14 >> EDM-631 CONTROL 8 #14 >> EDM-635 CONTROL 8 #14 >> EDM-651 CONTROL 8 #14 >> EDM-655 CONTROL 8 #14 >> EDM-660 CONTROL	C6731 C6666 C6666 C6666 C6666 C6667
C6670		1.5"	42	#14	XHHW-2	1	#14	XHHW-2	FR: 06-VCP-6600 TO: WW-6602 2 #14 >> 06-LSHH-6632 CONTROL 40 #14 >> EDR STATUS	 C6632
C6701		0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: 06-EDR-6701 TO: CONDUIT TEE 10 #14 >> 06-EDR-6701 CONTROL	C6711
C6702		0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: 06-EDR-6702 TO: CONDUIT TEE 10 #14 >> 06-EDR-6702 CONTROL	C6713

CONDUIT SCHEDULE AREA 06

TERTIARY PROCESS UPGRADES

TERTIARY FILTERS

ENGINEER	**BCS**
REVISION	**0**
DATE	4/20/23

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C6703		0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: 06-EDR-6703	C6713
									TO: CONDUIT TEE	
									10 #14 >> 06-EDR-6703 CONTROL	
C6711		1.5"	20	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE	
									TO: J-BOX	
									10 #14 >> 06-EDR-6701 CONTROL	C6701
									10 #14 >> 06-EDR-6601 CONTROL	C6601
C6713		1.5"	20	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE	C6731
									TO: J-BOX	
									10 #14 >> 06-EDR-6702 CONTROL	C6702
									10 #14 >> 06-EDR-6703 CONTROL	C6703
C6731		2"	80	#14	XHHW-2	1	#14	XHHW-2	FR: J-BOX	C6750
									TO: IPB-41	
									8 #14 >> EDM-631 CONTROL	C6668
									8 #14 >> EDM-635 CONTROL	C6668
									8 #14 >> EDM-651 CONTROL	C6668
									8 #14 >> EDM-655 CONTROL	C6668
									8 #14 >> EDM-660 CONTROL	C6668
									10 #14 >> 06-EDR-6702 CONTROL	C6713
									10 #14 >> 06-EDR-6703 CONTROL	C6713
									10 #14 >> 06-EDR-6701 CONTROL	C6730
									10 #14 >> 06-EDR-6601 CONTROL	C6730
C6732		0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: 06-LSHH-6732	C6770
									TO: WW-6702	
									2 #14 >> 06-LSHH-6732 CONTROL	
C6750		2.5"	100	#14	XHHW-2	1	#14	XHHW-2	FR: IPB-41	
									TO: PLC-1	
									10 #14 >> 06-EDR-6602 CONTROL	C6631
									10 #14 >> 06-EDR-6603 CONTROL	C6631
									8 #14 >> EDM-631 CONTROL	C6731
									8 #14 >> EDM-635 CONTROL	C6731
									8 #14 >> EDM-651 CONTROL	C6731
									8 #14 >> EDM-655 CONTROL	C6731
									8 #14 >> EDM-660 CONTROL	C6731
									10 #14 >> 06-EDR-6702 CONTROL	C6731
									10 #14 >> 06-EDR-6703 CONTROL	C6731
									10 #14 >> 06-EDR-6701 CONTROL	C6731
									10 #14 >> 06-EDR-6601 CONTROL	C6731
C6770		3"	140	#14	XHHW-2	1	#14	XHHW-2	FR: 06-VCP-6700	
									TO: WW-6702	
									10 #14 >> 06-EDR-6602 CONTROL	C6732
									10 #14 >> 06-EDR-6603 CONTROL	C6732
									8 #14 >> EDM-631 CONTROL	C6732
									8 #14 >> EDM-635 CONTROL	C6732
									8 #14 >> EDM-651 CONTROL	C6732
									8 #14 >> EDM-655 CONTROL	C6732
									8 #14 >> EDM-660 CONTROL	C6732
									10 #14 >> 06-EDR-6702 CONTROL	C6732
									10 #14 >> 06-EDR-6703 CONTROL	C6732
									10 #14 >> 06-EDR-6701 CONTROL	C6732
									10 #14 >> 06-EDR-6601 CONTROL	C6732
									40 #14 >> EDR STATUS	
C7001		0.75"	5	#14	XHHW-2	1	#14	XHHW-2	FR: MCC-07	
									TO: PLC1-RIO2	
									5 #14 >> 07-EF-7001 CONTOL	
L6651		0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: 06-FIT-6651	L6655
									TO: CONDUIT TEE	
									2 #12 >> 06-FIT-6651 POWER	
L6655		0.75"	4	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE	L6660
									TO: J-BOX	
									2 #12 >> 06-FIT-6651 POWER	L6651
									2 #12 >> 06-FIT-6751 POWER	L6751
L6660		0.75"	4	#12	XHHW-2	1	#12	XHHW-2	FR: J-BOX	
									TO: 07-LPD	
									2 #12 >> 06-FIT-6651 POWER	L6655
									2 #12 >> 06-FIT-6751 POWER	L6655
L6751		0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: 06-FIT-6751	L6655
									TO: CONDUIT TEE	
									2 #12 >> 06-FIT-6751 POWER	

CONDUIT SCHEDULE AREA 06

TERTIARY PROCESS UPGRADES

TERTIARY FILTERS

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
L6761		0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: FIT-6001 TO: CONDUIT TEE 2 #12 >> FIT-6001 POWER	L6763
L6762		0.75"	2	#12	XHHW-2	1	#12	XHHW-2	FR: FIT-6002 TO: CONDUIT TEE 2 #12 >> FIT-6002 POWER	L6763
L6763		0.75"	4	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE TO: JUNCTION BOX 2 #12 >> FIT-6001 POWER 2 #12 >> FIT-6002 POWER	L6764 L6761 L6762
L6764		2"	4	#12	XHHW-2	1	#12	XHHW-2	FR: JUNCTION BOX TO: 07-LPD (VIA LVPB-42) 2 #12 >> FIT-6001 POWER 2 #12 >> FIT-6002 POWER	 L6763 L6763
N6600		1.5"	1		12/FO	1	#14	XHHW-2	FR: 06-VCP-6600 TO: J-BOX 1 12/FO >> 06-VCP-6600 NETWORK	N6600A
N6700		1.5"	1		12/FO	1	#14	XHHW-2	FR: 06-VCP-6700 TO: J-BOX 1 12/FO >> 06-VCP-6700 NETWORK	N6700A
N6701		2"	2		12/FO	1	#14	XHHW-2	FR: IPB-41 TO: PLC-1 1 12/FO >> 06-VCP-6600 NETWORK 1 12/FO >> 06-VCP-6700 NETWORK	 N6600A N6700A
N6600A		2"	1		12/FO	1	#14	XHHW-2	FR: J-BOX TO: IPB-41 1 12/FO >> 06-VCP-6600 NETWORK	N6701 N6600
N6700A		2"	1		12/FO	1	#14	XHHW-2	FR: J-BOX TO: IPB-41 1 12/FO >> 06-VCP-6700 NETWORK	N6701 N6700
P7650		1.5"	3	#2	XHHW-2	1	#8	XHHW-2	FR: 07-DPA TO: 07-MCC-A 3 #2 >> 07-DPA POWER	
P6600		0.75"	3	#10	XHHW-2	1	#10	XHHW-2	FR: 06-VCP-6600 TO: J-BOX 3 #10 >> 06-VCP-6600 POWER	P6600A
P6601		0.75"	3	#10	XHHW-2	1	#10	XHHW-2	FR: 06-EDR-6601 TO: DISCONNECT 3 #10 >> 06-EDR-6601 POWER	
P6602		0.75"	3	#10	XHHW-2	1	#10	XHHW-2	FR: 06-EDR-6602 TO: DISCONNECT 3 #10 >> 06-EDR-6602 POWER	
P6603		0.75"	3	#10	XHHW-2	1	#10	XHHW-2	FR: 06-EDR-6603 TO: DISCONNECT 3 #10 >> 06-EDR-6603 POWER	
P6605		1.5"	30	#12	XHHW-2	1	#12	XHHW-2	FR: 06-VCP-6600 TO: WW-6601 30 #12 >> EDR POWER	
P6606		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: 06-FLT-6600 TO: 06-VCP-6600 3 #12 >> 06-FLT-6600 POWER	
P6611		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: WW-6602 TO: DISCONNECT 3 #12 >> 06-EDR-6611 POWER	
PC6611		0.75"	3 4	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: 06-EDR-6611 TO: WW-6602 3 #12 >> 06-EDR-6611 POWER 4 #14 >> 06-EDR-6611 CONTROL	
P6614		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: WW-6602 TO: DISCONNECT 3 #12 >> 06-EDR-6614 POWER	

CONDUIT SCHEDULE AREA 06

TERTIARY PROCESS UPGRADES

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
PC6614		0.75"	3 4	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: 06-EDR-6614 TO: WW-6602 3 #12 >> 06-EDR-6614 POWER 4 #14 >> 06-EDR-6614 CONTROL	
P6615		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: WW-6602 TO: DISCONNECT 3 #12 >> 06-EDR-6615 POWER	
PC6615		0.75"	3 4	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: 06-EDR-6615 TO: WW-6602 3 #12 >> 06-EDR-6615 POWER 4 #14 >> 06-EDR-6615 CONTROL	
P6616		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: WW-6602 TO: DISCONNECT 3 #12 >> 06-EDR-6616 POWER	
PC6616		0.75"	3 4	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: 06-EDR-6616 TO: WW-6602 3 #12 >> 06-EDR-6616 POWER 4 #14 >> 06-EDR-6616 CONTROL	
P6617		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: WW-6602 TO: DISCONNECT 3 #12 >> 06-EDR-6617 POWER	
PC6617		0.75"	3 4	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: 06-EDR-6617 TO: WW-6602 3 #12 >> 06-EDR-6617 POWER 4 #14 >> 06-EDR-6617 CONTROL	
P6621		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: WW-6602 TO: DISCONNECT 3 #12 >> 06-EDR-6621 POWER	
PC6621		0.75"	3 4	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: 06-EDR-6621 TO: WW-6602 3 #12 >> 06-EDR-6621 POWER 4 #14 >> 06-EDR-6621 CONTROL	
P6622		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: WW-6602 TO: DISCONNECT 3 #12 >> 06-EDR-6622 POWER	
PC6622		0.75"	3 4	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: 06-EDR-6622 TO: WW-6602 3 #12 >> 06-EDR-6622 POWER 4 #14 >> 06-EDR-6622 CONTROL	
P6623		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: WW-6602 TO: DISCONNECT 3 #12 >> 06-EDR-6623 POWER	
PC6623		0.75"	3 4	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: 06-EDR-6623 TO: WW-6602 3 #12 >> 06-EDR-6623 POWER 4 #14 >> 06-EDR-6623 CONTROL	
P6624		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: WW-6602 TO: DISCONNECT 3 #12 >> 06-EDR-6624 POWER	
PC6624		0.75"	3 4	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: 06-EDR-6624 TO: WW-6602 3 #12 >> 06-EDR-6624 POWER 4 #14 >> 06-EDR-6624 CONTROL	
P6625		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: WW-6602 TO: DISCONNECT 3 #12 >> 06-EDR-6625 POWER	
PC6625		0.75"	3 4	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: 06-EDR-6625 TO: WW-6602 3 #12 >> 06-EDR-6625 POWER 4 #14 >> 06-EDR-6625 CONTROL	
P6640		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: 06-PMP-6640 TO: 06-VCP-6600 3 #12 >> 06-PMP-6640 POWER	

CONDUIT SCHEDULE AREA 06

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P6645		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: 06-PMP-6645 TO: 06-VCP-6600 3 #12 >> 06-PMP-6645 POWER	
P6650		2"	6	#10	XHHW-2	1	#10	XHHW-2	FR: J-BOX TO: 07-DPA (VIA LVPB-42) 3 #10 >> 06-EDR-6602 POWER 3 #10 >> 06-EDR-6603 POWER	P6602A P6603A
P7651		0.75"	3	#8	XHHW-2	1	#10	XHHW-2	FR: 07-XFMR-D TO: 07-MCC-A 3 #8 >> 07-LPD POWER	
P7652		1"	4	#8	XHHW-2	1	#8	XHHW-2	FR: 07-LPD TO: 07-XFMR-D 4 #8 >> 07-LPD POWER	
P6660		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: EDM-631 TO: DISCONNECT 3 #12 >> EDM-631 POWER	P6660A
P6661		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: EDM-635 TO: DISCONNECT 3 #12 >> EDM-635 POWER	P6661A
P6662		0.75"	6	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE TO: CONDUIT TEE 3 #12 >> EDM-631 POWER 3 #12 >> EDM-635 POWER	P6664 P6660A P6661A
P6663		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: EDM-651 TO: DISCONNECT 3 #12 >> EDM-651 POWER	P6663A
P6664		1"	9	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE TO: JUNCTION BOX 3 #12 >> EDM-631 POWER 3 #12 >> EDM-635 POWER 3 #12 >> EDM-651 POWER	P6732 P6662 P6662 P6663A
P6665		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: EDM-655 TO: DISCONNECT 3 #12 >> EDM-655 POWER	P6665A
P6666		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: EDM-660 TO: DISCONNECT 3 #12 >> EDM-660 POWER	P6666A
P6667		0.75"	6	#12	XHHW-2	1	#12	XHHW-2	FR: CONDUIT TEE TO: JUNCTION BOX 3 #12 >> EDM-655 POWER 3 #12 >> EDM-660 POWER	P6733 P6665A P6666A
P6700		0.75"	3	#10	XHHW-2	1	#10	XHHW-2	FR: 06-VCP-6700 TO: J-BOX 3 #10 >> 06-VCP-6700 POWER	P6700A
P6701		0.75"	3	#10	XHHW-2	1	#10	XHHW-2	FR: 06-EDR-6701 TO: DISCONNECT 3 #10 >> 06-EDR-6701 POWER	
P7701		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: 07-EF-0701 TO: DISCONNECT 3 #12 >> 07-EF-0701 POWER	
P6702		0.75"	3	#10	XHHW-2	1	#10	XHHW-2	FR: 06-EDR-6702 TO: DISCONNECT 3 #10 >> 06-EDR-6702 POWER	
P6703		0.75"	3	#10	XHHW-2	1	#10	XHHW-2	FR: 06-EDR-6703 TO: DISCONNECT 3 #10 >> 06-EDR-6703 POWER	
P6705		1.5"	30	#12	XHHW-2	1	#12	XHHW-2	FR: 06-VCP-6700 TO: WW-6701 30 #12 >> EDR POWER	
P6706		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: 06-FLT-6700 TO: 06-VCP-6700 3 #12 >> 06-FLT-6700 POWER	

CONDUIT SCHEDULE AREA 06

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P6710		2"	6	#10	XHHW-2	1	#10	XHHW-2	FR: LVPB-42 TO: 07-DPA 3 #10 >> 06-VCP-6600 POWER 3 #10 >> 06-VCP-6700 POWER	 P6600A P6700A
P6711		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: WW-6702 TO: DISCONNECT 3 #12 >> 06-EDR-6711 POWER	
PC6711		0.75"	3 4	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: 06-EDR-6711 TO: WW-6702 3 #12 >> 06-EDR-6711 POWER 4 #14 >> 06-EDR-6711 CONTROL	
P6714		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: WW-6702 TO: DISCONNECT 3 #12 >> 06-EDR-6714 POWER	
PC6714		0.75"	3 4	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: 06-EDR-6714 TO: WW-6702 3 #12 >> 06-EDR-6714 POWER 4 #14 >> 06-EDR-6714 CONTROL	
P6715		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: WW-6702 TO: DISCONNECT 3 #12 >> 06-EDR-6715 POWER	
PC6715		0.75"	3 4	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: 06-EDR-6715 TO: WW-6702 3 #12 >> 06-EDR-6715 POWER 4 #14 >> 06-EDR-6715 CONTROL	
P6716		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: WW-6702 TO: DISCONNECT 3 #12 >> 06-EDR-6716 POWER	
PC6716		0.75"	3 4	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: 06-EDR-6716 TO: WW-6702 3 #12 >> 06-EDR-6716 POWER 4 #14 >> 06-EDR-6716 CONTROL	
P6717		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: WW-6702 TO: DISCONNECT 3 #12 >> 06-EDR-6717 POWER	
PC6717		0.75"	3 4	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: 06-EDR-6717 TO: WW-6702 3 #12 >> 06-EDR-6717 POWER 4 #14 >> 06-EDR-6717 CONTROL	
P6721		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: WW-6702 TO: DISCONNECT 3 #12 >> 06-EDR-6721 POWER	
PC6721		0.75"	3 4	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: 06-EDR-6721 TO: WW-6702 3 #12 >> 06-EDR-6721 POWER 4 #14 >> 06-EDR-6721 CONTROL	
P6722		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: WW-6702 TO: DISCONNECT 3 #12 >> 06-EDR-6722 POWER	
PC6722		0.75"	3 4	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: 06-EDR-6722 TO: WW-6702 3 #12 >> 06-EDR-6722 POWER 4 #14 >> 06-EDR-6722 CONTROL	
P6723		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: WW-6702 TO: DISCONNECT 3 #12 >> 06-EDR-6723 POWER	
PC6723		0.75"	3 4	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: 06-EDR-6723 TO: WW-6702 3 #12 >> 06-EDR-6723 POWER 4 #14 >> 06-EDR-6723 CONTROL	
P6724		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: WW-6702 TO: DISCONNECT 3 #12 >> 06-EDR-6724 POWER	

CONDUIT SCHEDULE AREA 06

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
PC6724		0.75"	3 4	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: 06-EDR-6724 TO: WW-6702 3 #12 >> 06-EDR-6724 POWER 4 #14 >> 06-EDR-6724 CONTROL	
P6725		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: WW-6702 TO: DISCONNECT 3 #12 >> 06-EDR-6725 POWER	
PC6725		0.75"	3 4	#12 #14	XHHW-2 XHHW-2	1	#12	XHHW-2	FR: 06-EDR-6725 TO: WW-6702 3 #12 >> 06-EDR-6725 POWER 4 #14 >> 06-EDR-6725 CONTROL	
P6730		0.75"	6	#10	XHHW-2	1	#10	XHHW-2	FR: CONDUIT TEE TO: J-BOX 3 #10 >> 06-EDR-6601 POWER 3 #10 >> 06-EDR-6701 POWER	P6731 P6601A P6701A
P6731		2"	6	#10	XHHW-2	1	#10	XHHW-2	FR: J-BOX TO: 07-DPA (VIA LVPB-42) 3 #10 >> 06-EDR-6601 POWER 3 #10 >> 06-EDR-6701 POWER	 P6730 P6730
P6732		2"	9	#10	XHHW-2	1	#10	XHHW-2	FR: J-BOX TO: 07-DPA (VIA LVPB-42) 3 #10 >> EDM-631 POWER 3 #10 >> EDM-635 POWER 3 #10 >> EDM-651 POWER	 P6664 P6664 P6664
P6733		2"	6	#10	XHHW-2	1	#10	XHHW-2	FR: J-BOX TO: 07-DPA (VIA LVPB-42) 3 #10 >> EDM-655 POWER 3 #10 >> EDM-660 POWER	 P6667 P6667
P6740		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: 06-PMP-6740 TO: 06-VCP-6700 3 #12 >> 06-PMP-6740 POWER	
P6745		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: 06-PMP-6745 TO: 06-VCP-6700 3 #12 >> 06-PMP-6745 POWER	
P6750		2"	6	#10	XHHW-2	1	#10	XHHW-2	FR: J-BOX TO: 07-DPA (VIA LVPB-42) 3 #10 >> 06-EDR-6703 POWER 3 #10 >> 06-EDR-6702 POWER	 P6703A P6702A
P6660A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: CONDUIT TEE 3 #12 >> EDM-631 POWER	P6662 P6660
P6661A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: CONDUIT TEE 3 #12 >> EDM-635 POWER	P6662 P6661
P6663A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: CONDUIT TEE 3 #12 >> EDM-651 POWER	P6664 P6663
P6665A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: CONDUIT TEE 3 #12 >> EDM-655 POWER	P6667 P6665
P6666A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: CONDUIT TEE 3 #12 >> EDM-660 POWER	P6667 P6666
P6621A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: WW-6601 3 #12 >> 06-EDR-6621 POWER	
P6625A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: WW-6601 3 #12 >> 06-EDR-6625 POWER	
P6624A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: WW-6601 3 #12 >> 06-EDR-6624 POWER	
P6623A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: WW-6601 3 #12 >> 06-EDR-6623 POWER	

CONDUIT SCHEDULE AREA 06

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CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P6622A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: WW-6601 3 #12 >> 06-EDR-6622 POWER	
P6617A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: WW-6601 3 #12 >> 06-EDR-6617 POWER	
P6616A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: WW-6601 3 #12 >> 06-EDR-6616 POWER	
P6615A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: WW-6601 3 #12 >> 06-EDR-6615 POWER	
P6614A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: WW-6601 3 #12 >> 06-EDR-6614 POWER	
P6611A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: WW-6601 3 #12 >> 06-EDR-6611 POWER	
P6711A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: WW-6701 3 #12 >> 06-EDR-6711 POWER	
P6714A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: WW-6701 3 #12 >> 06-EDR-6714 POWER	
P6715A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: WW-6701 3 #12 >> 06-EDR-6715 POWER	
P6716A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: WW-6701 3 #12 >> 06-EDR-6716 POWER	
P6717A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: WW-6701 3 #12 >> 06-EDR-6717 POWER	
P6721A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: WW-6701 3 #12 >> 06-EDR-6721 POWER	
P6722A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: WW-6701 3 #12 >> 06-EDR-6722 POWER	
P6723A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: WW-6701 3 #12 >> 06-EDR-6723 POWER	
P6724A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: WW-6701 3 #12 >> 06-EDR-6724 POWER	
P6725A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: WW-6701 3 #12 >> 06-EDR-6725 POWER	
P6603A		0.75"	3	#10	XHHW-2	1	#10	XHHW-2	FR: DISCONNECT TO: J-BOX 3 #10 >> 06-EDR-6603 POWER	P6650
P6703A		0.75"	3	#10	XHHW-2	1	#10	XHHW-2	FR: DISCONNECT TO: J-BOX 3 #10 >> 06-EDR-6703 POWER	P6750
P6602A		0.75"	3	#10	XHHW-2	1	#10	XHHW-2	FR: DISCONNECT TO: J-BOX 3 #10 >> 06-EDR-6602 POWER	P6650
P6702A		0.75"	3	#10	XHHW-2	1	#10	XHHW-2	FR: DISCONNECT TO: J-BOX 3 #10 >> 06-EDR-6702 POWER	P6750
P6601A		0.75"	3	#10	XHHW-2	1	#10	XHHW-2	FR: DISCONNECT TO: CONDUIT TEE 3 #10 >> 06-EDR-6601 POWER	P6730

CONDUIT SCHEDULE AREA 06

TERTIARY PROCESS UPGRADES

TERTIARY FILTERS

ENGINEER	**BCS**
REVISION	**0**
DATE	4/20/23

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P6701A		0.75"	3	#10	XHHW-2	1	#10	XHHW-2	FR: DISCONNECT	P6730
									TO: CONDUIT TEE	
									3 #10 >> 06-EDR-6701 POWER	
P6600A		2"	3	#10	XHHW-2	1	#10	XHHW-2	FR: J-BOX	P6710
									TO: LVPB-42	
									3 #10 >> 06-VCP-6600 POWER	P6600
P6700A		2"	3	#10	XHHW-2	1	#10	XHHW-2	FR: J-BOX	P6710
									TO: LVPB-42	
									3 #10 >> 06-VCP-6700 POWER	P6700
P7001		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT	
									TO: MCC-07	
									3 #12 >> 07-EF-7001 POWER	P7002
P7002		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: 07-EF-7001	P7001
									TO: DISCONNECT	
									3 #12 >> 07-EF-7001 POWER	
P7701A		0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT	
									TO: 07-DPA	
									3 #12 >> 07-EF-0701 POWER	
S6604		0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: 06-AIT-6604	S6605
									TO: CONDUIT TEE	
									1 2/CS-#16 >> 06-AIT-6604 SIGNAL	
S6605		1"	4	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE	S6606
									TO: J-BOX	
									1 2/CS-#16 >> 06-AIT-6704 SIGNAL	S6652
									1 2/CS-#16 >> 06-FIT-6751 SIGNAL	S6652
									1 2/CS-#16 >> 06-FIT-6651 SIGNAL	S6652
									1 2/CS-#16 >> 06-AIT-6604 SIGNAL	S6604
S6606		2"	4	2/CS-#16		1	#14	XHHW-2	FR: J-BOX	
									TO: PLC1	
									1 2/CS-#16 >> 06-AIT-6704 SIGNAL	S6605
									1 2/CS-#16 >> 06-FIT-6751 SIGNAL	S6605
									1 2/CS-#16 >> 06-FIT-6651 SIGNAL	S6605
									1 2/CS-#16 >> 06-AIT-6604 SIGNAL	S6605
S6631		0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: 06-LIT-6631	
									TO: 06-VCP-6600	
									1 2/CS-#16 >> 06-LIT-6631 SIGNAL	
S6634		0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: 06-PIT-6634	
									TO: 06-VCP-6600	
									1 2/CS-#16 >> 06-PIT-6634 SIGNAL	
S6651		0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: 06-FIT-6651	S6652
									TO: CONDUIT TEE	
									1 2/CS-#16 >> 06-FIT-6651 SIGNAL	
S6652		1"	3	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE	S6605
									TO: CONDUIT TEE	
									1 2/CS-#16 >> 06-AIT-6704 SIGNAL	S6705
									1 2/CS-#16 >> 06-FIT-6751 SIGNAL	S6705
									1 2/CS-#16 >> 06-FIT-6651 SIGNAL	S6651
S6660		0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: EDM-631	S6662
									TO: CONDUIT TEE	
									1 2/CS-#16 >> EDM-631 SIGNAL	
S6661		0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: EDM-635	S6662
									TO: CONDUIT TEE	
									1 2/CS-#16 >> EDM-635 SIGNAL	
S6662		0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE	S6664
									TO: CONDUIT TEE	
									1 2/CS-#16 >> EDM-631 SIGNAL	S6660
									1 2/CS-#16 >> EDM-635 SIGNAL	S6661
S6663		0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: EDM-651	S6664
									TO: CONDUIT TEE	
									1 2/CS-#16 >> EDM-651 SIGNAL	
S6664		1"	3	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE	S6666
									TO: CONDUIT TEE	
									1 2/CS-#16 >> EDM-631 SIGNAL	S6662
									1 2/CS-#16 >> EDM-635 SIGNAL	S6662
									1 2/CS-#16 >> EDM-651 SIGNAL	S6663

CONDUIT SCHEDULE AREA 06

TERTIARY PROCESS UPGRADES

TERTIARY FILTERS

ENGINEER	**BCS**
REVISION	**0**
DATE	4/20/23

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
S6665		0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: EDM-655	S6666
									TO: CONDUIT TEE	
									1 2/CS-#16 >> EDM-655 SIGNAL	
S6666		1"	4	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE	S6668
									TO: CONDUIT TEE	
									1 2/CS-#16 >> EDM-631 SIGNAL	S6664
									1 2/CS-#16 >> EDM-635 SIGNAL	S6664
									1 2/CS-#16 >> EDM-651 SIGNAL	S6664
									1 2/CS-#16 >> EDM-655 SIGNAL	S6665
S6667		0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: EDM-660	S6668
									TO: CONDUIT TEE	
									1 2/CS-#16 >> EDM-660 SIGNAL	
S6668		2"	5	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE	S6669
									TO: JUNCTION BOX	
									1 2/CS-#16 >> EDM-631 SIGNAL	S6666
									1 2/CS-#16 >> EDM-635 SIGNAL	S6666
									1 2/CS-#16 >> EDM-651 SIGNAL	S6666
									1 2/CS-#16 >> EDM-655 SIGNAL	S6666
									1 2/CS-#16 >> EDM-660 SIGNAL	S6667
S6669		2"	7	2/CS-#16		1	#14	XHHW-2	FR: JUNCTION BOX	
									TO: PLC1	
									1 2/CS-#16 >> FIT-6002 SIGNAL	S6763
									1 2/CS-#16 >> FIT-6001 SIGNAL	S6763
									1 2/CS-#16 >> EDM-631 SIGNAL	S6668
									1 2/CS-#16 >> EDM-635 SIGNAL	S6668
									1 2/CS-#16 >> EDM-651 SIGNAL	S6668
									1 2/CS-#16 >> EDM-655 SIGNAL	S6668
									1 2/CS-#16 >> EDM-660 SIGNAL	S6668
S6704		0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: 06-AIT-6704	S6705
									TO: CONDUIT TEE	
									1 2/CS-#16 >> 06-AIT-6704 SIGNAL	
S6705		0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE	S6652
									TO: CONDUIT TEE	
									1 2/CS-#16 >> 06-AIT-6704 SIGNAL	S6704
									1 2/CS-#16 >> 06-FIT-6751 SIGNAL	S6751
S6731		0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: 06-LIT-6731	
									TO: 06-VCP-6700	
									1 2/CS-#16 >> 06-LIT-6731 SIGNAL	
S6734		0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: 06-PIT-6734	
									TO: 06-VCP-6700	
									1 2/CS-#16 >> 06-PIT-6734 SIGNAL	
S6751		0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: 06-FIT-6751	S6705
									TO: CONDUIT TEE	
									1 2/CS-#16 >> 06-FIT-6751 SIGNAL	
S6761		0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: FIT-6001	S6763
									TO: CONDUIT TEE	
									1 2/CS-#16 >> FIT-6001 SIGNAL	
S6762		0.75"	1	2/CS-#16		1	#14	XHHW-2	FR: FIT-6002	S6763
									TO: CONDUIT TEE	
									1 2/CS-#16 >> FIT-6002 SIGNAL	
S6763		0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE	S6669
									TO: JUNCTION BOX	
									1 2/CS-#16 >> FIT-6002 SIGNAL	S6762
									1 2/CS-#16 >> FIT-6001 SIGNAL	S6761
X6600		2"	1	PULL	ROPE				FR: LVPB-42	
									TO: FILTER 6	
									1 PULL >> SPARE	
X6601		2"	1	PULL	ROPE				FR: LVPB-42	
									TO: FILTER 6	
									1 PULL >> SPARE	
X6700		2"	1	PULL	ROPE				FR: LVPB-42	
									TO: FILTER 7	
									1 PULL >> SPARE	
X6701		2"	1	PULL	ROPE				FR: LVPB-42	
									TO: FILTER SUPPORT BLDG	
									1 PULL >> SPARE	

CONDUIT SCHEDULE AREA 06

TERTIARY PROCESS UPGRADES

TERTIARY FILTERS

ENGINEER	**BCS**
REVISION	**0**
DATE	4/20/23

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
X6702		2"	1	PULL	ROPE				FR: LVPB-42 TO: FILTER SUPPORT BLDG 1 PULL >> SPARE	

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 16990B

CONDUIT SCHEDULE
AREA 6 - TERTIARY PUMP STATION

PART 1 GENERAL

1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

CONDUIT SCHEDULE AREA 6

TERTIARY PROCESS UPGRADES

TERTIARY PUMP STATION

ENGINEER	**CAC**
REVISION	**0**
DATE	4/20/23

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C604C	06E01	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: 06-PSH-604 TO: JUNCTION BOX 2 #14 >> 06-PSH-604 CONTROL	
C605A	06E01	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: 06-PSH-605 TO: JUNCTION BOX 2 #14 >> 06-PSH-605 CONTROL	
C606C	06E01	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: 06-PSH-606 TO: JUNCTION BOX 2 #14 >> 06-PSH-606 CONTROL	
C6004 EXISTING	20E01	2"	10	#14	XHHW-2	1	#14	XHHW-2	FR: MCC-20-A TO: LVPB-7 4 #14 >> PMP-6004 MOISTURE AND TEMP 4 #14 >> 06-LCP-6004 2 #14 >> 06-PSH-6004 CONTROL	
C6004A EXISTING	06E01	2"	10	#14	XHHW-2	1	#14	XHHW-2	FR: LVPB-7 TO: JUNCTION BOX 4 #14 >> PMP-6004 MOISTURE AND TEMP 4 #14 >> 06-LCP-6004 2 #14 >> 06-PSH-6004 CONTROL	
C6004B	06E01	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: 06-LCP-004 TO: JUNCTION BOX 4 #14 >> 06-LCP-004 CONTROL	
C6004C	06E01	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: 06-PSH-6004 TO: JUNCTION BOX 2 #14 >> 06-PSH-6004 CONTROL	
C6005 EXISTING	20E01	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: MCC-20-A TO: LVPB-7 4 #14 >> PMP-6005 MOISTURE AND TEMP 4 #14 >> 06-LCP-6005 2 #14 >> 06-PSH-6005 CONTROL	
C6005A EXISTING	06E01	0.75"	10	#14	XHHW-2	1	#14	XHHW-2	FR: LVPB-7 TO: JUNCTION BOX 4 #14 >> PMP-6005 MOISTURE AND TEMP 4 #14 >> 06-LCP-6005 2 #14 >> 06-PSH-6005 CONTROL	
C6005B	06E01	0.75"	4	#14	XHHW-2	1	#14	XHHW-2	FR: 06-LCP-005 TO: JUNCTION BOX 4 #14 >> 06-LCP-005 CONTROL	
C6005C	06E01	0.75"	2	#14	XHHW-2	1	#14	XHHW-2	FR: 06-PSH-6005 TO: JUNCTION BOX 2 #14 >> 06-PSH-6005 CONTROL	
C2110	20E01	0.75"	9	#14	XHHW-2	1	#14	XHHW-2	FR: 20-MCC-A TO: CONDUIT TEE 9 #14 >> 06-PMP-6004 CONTROL	C2112
C2111	20E01	0.75"	9	#14	XHHW-2	1	#14	XHHW-2	FR: 20-MCC-A TO: CONDUIT TEE 9 #14 >> 06-PMP-6005 CONTROL	C2112
C2112	20E01	1"	18	#14	XHHW-2	1	#14	XHHW-2	FR: CONDUIT TEE TO: PLC-2 9 #14 >> 06-PMP-6004 CONTROL 9 #14 >> 06-PMP-6005 CONTROL	C2110 C2111
P6004 EXISTING	20E01	2"	3	#6	XHHW-2	1	#6	XHHW-2	FR: 20-MCC-A TO: LVPB-7 3 #6 >> 06-PMP-6004 PWER	
P6004A EXISTING	06E01	2"	3	#6	XHHW-2	1	#6	XHHW-2	FR: LVPB-7 TO: JUNCTION BOX 3 #6 >> 06-PMP-6004 PWER	
P6005 EXISTING	20E01 E05	2"	3	#6	XHHW-2	1	#6	XHHW-2	FR: 20-MCC-A TO: LVPB-7 3 #6 >> 06-PMP-6005 POWER	
P6005A EXISTING	06E01	2"	3	#6	XHHW-2	1	#6	XHHW-2	FR: LVPB-7 TO: JUNCTION BOX 3 #6 >> 06-PMP-6005 POWER	
S2110	20E01	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: 20-MCC-A TO: CONDUIT TEE 2 2/CS-#16 >> 06-PMP-6004 SIGNAL	S2112

CONDUIT SCHEDULE AREA 6

TERTIARY PROCESS UPGRADES

TERTIARY PUMP STATION

ENGINEER	**CAC**
REVISION	**0**
DATE	4/20/23

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
S2111	20E01	0.75"	2	2/CS-#16		1	#14	XHHW-2	FR: 20-MCC-A	S2112
									TO: CONDUIT TEE	
									2 2/CS-#16 >> 06-PMP-6005 SIGNAL	
S2112	20E01	1"	4	2/CS-#16		1	#14	XHHW-2	FR: CONDUIT TEE	
									TO: PLC-2	
									2 2/CS-#16 >> 06-PMP-6004 SIGNAL	S2110
									2 2/CS-#16 >> 06-PMP-6005 SIGNAL	S2111

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 16990D

CONDUIT SCHEDULE
AREA 9 - MCC-09 BUILDING

PART 1 GENERAL

1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

CONDUIT SCHEDULE AREA 09

TERTIARY PROCESS UPGRADES

MCC-09 BUILDING

ENGINEER	**BCS**
REVISION	**1**
DATE	4/20/23

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
P9000	09E01	3"	4	350	XHHW-2	1	#3/0	XHHW-2	FR: 09-GENTAPBOX TO: 09-MCC-A 4 350 >> 09-GENTAPBOX POWER	
P9001	09E01	3"	4	350	XHHW-2	1	#3/0	XHHW-2	FR: 09-GENTAPBOX TO: 09-MCC-A 4 350 >> 09-GENTAPBOX POWER	
P9002	09E01	3"	4	350	XHHW-2	1	#3/0	XHHW-2	FR: 09-GENTAPBOX TO: 09-MCC-A 4 350 >> 09-GENTAPBOX POWER	
P9003	09E01	3"	4	350	XHHW-2	1	#3/0	XHHW-2	FR: 09-GENTAPBOX TO: 09-MCC-A 4 350 >> 09-GENTAPBOX POWER	
P9004	09E01	3"	3	500	XHHW-2	1	#3	XHHW-2	FR: 09-VFD-PMP-003 TO: 09-MCC-A 3 500 >> 09-VFD-PMP-003 POWER	
P9005	09E01	3"	3	500	XHHW-2	1	#3	XHHW-2	FR: 09-VFD-PMP-003 TO: 09-MCC-A 3 500 >> 09-PMP-003 POWER	
I9000	09E01	2"	23	#14	XHHW-2	1	#14	XHHW-2	FR: 09-VFD-PMP-003 TO: 09-MCC-A 5 #14 >> 09HS903E 16 #14 >> 09PSH03, 09TSH03, 09YL03, 09YA03, 09L 2 #14 >> LOW-LEVEL SHUTDOWN INTERLOCK	
I9001	09E01	2"	20 3	#14 2/CS-#16	XHHW-2	1	#14	XHHW-2	FR: 09-VFD-PMP-003 TO: PLC-7 20 #14 >> 09YL903A, 09YL903B, 09LAL903, 09PAH9 3 2/CS-#16 >> 09SI903, 90AC903	

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 16990E

CONDUIT SCHEDULE
AREA 22 - STORAGE BUILDING

PART 1 GENERAL

1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 16050 and Section 16130.

B. Cable requirements and definitions:
   1. As defined in Section 16050 and Section 16123.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

CONDUIT SCHEDULE AREA 22

TERTIARY PROCESS UPGRADES

STORAGE BUILDING

ENGINEER	**BCS**
REVISION	**0**
DATE	4/20/23

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
L2210	22E01	1.5"	4	#1	XHHW-2	1	#6	XHHW-2	FR: 22-XFMR TO: 22-LPA 4 #1 >> 22-LPA POWER	
P2200	E05	2"	3	#8	XHHW-2	1	#10	XHHW-2	FR: 22-DPA TO: 09-MCC-A 3 #8 >> 22-DPA POWER	
P2201	22E01	1"	3	#12	XHHW-2	1	#12	XHHW-2	FR: 22-EF-2201 TO: 22-LCP-2201 3 #12 >> 22-EF-2201 POWER	
P2202	22E01	1"	3	#12	XHHW-2	1	#12	XHHW-2	FR: 22-EUH-2202 TO: DISCONNECT 3 #12 >> 22-EUH-2202 POWER	
P2203	22E01	1"	3	#12	XHHW-2	1	#12	XHHW-2	FR: 22-EUH-2203 TO: DISCONNECT 3 #12 >> 22-EUH-2203 POWER	
P2204	22E01	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: 22-OHD-2201 TO: DISCONNECT 3 #12 >> 22-OHD-2201 POWER	
P2205	22E01	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: 22-OHD-2202 TO: DISCONNECT 3 #12 >> 22-OHD-2202 POWER	
P2206	22E01	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: 22-OHD-2203 TO: DISCONNECT 3 #12 >> 22-OHD-2203 POWER	
P2210	22E01	1"	2	#2	XHHW-2	1	#8	XHHW-2	FR: 22-XFMR TO: 22-DPA 2 #2 >> 22-XFMR POWER	
P2220	19E01 22E01	2"				1	#14	XHHW-2	FR: 19 - OP AND MAINT BUILDING PULL BOX TO: 22-DPA PULL STRING	
P2221	19E01 22E01	2"	3	#2	XHHW-2	1	#2	XHHW-2	FR: MOTOR TEST STATION TO: 22-PDC 3 #2 >> MOTOR TEST STATION POWER	
P2201A	22E01	1"	3	#12	XHHW-2	1	#12	XHHW-2	FR: 22-LCP-2201 TO: 22-DPA 3 #12 >> 22-EF-2201 POWER	
P2202A	22E01	1"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: 22-DPA 3 #12 >> 22-EUH-2202 POWER	
P2203A	22E01	1"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: 22-DPA 3 #12 >> 22-EUH-2203 POWER	
P2204A	22E01	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: 22-DPA 3 #12 >> 22-OHD-2201 POWER	
P2205A	22E01	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: 22-DPA 3 #12 >> 22-OHD-2202 POWER	
P2206A	22E01	0.75"	3	#12	XHHW-2	1	#12	XHHW-2	FR: DISCONNECT TO: 22-DPA 3 #12 >> 22-OHD-2203 POWER	

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 17050

COMMON WORK RESULTS FOR PROCESS CONTROL AND INSTRUMENTATION SYSTEMS

TABLE OF CONTENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. General requirements applicable to all Process Control and Instrumentation Work.
   2. General requirements for process control and instrumentation submittals.
   3. As specified in this Section, some PLC programming and SCADA/HMI software configuration will be provided by the Owner, through the services of a consultant, hereinafter referred to as the Owner's Programmer.

B. Interfaces to equipment, instruments, and other components:
   1. Drawings, Specifications, and overall design are based on preliminary information furnished by various equipment manufacturers, which identify a minimum scope of supply from the manufacturers. This information pertains to, but is not limited to, instruments, control devices, electrical equipment, packaged mechanical systems, and control equipment provided with mechanical systems.
   2. Provide all material and labor needed to install the actual equipment furnished, include all costs to add any additional instruments, wiring, control system inputs/outputs, controls, interlocks, electrical hardware etc., which may be necessary to make a complete, functional installation based on the actual equipment furnished:
      a. Make all changes necessary to meet the manufacturer's wiring requirements.
   3. Review the complete set of Drawings and Specifications in order to ensure that all items related to the instrumentation, control systems, and related services are provided. Include any items indicated on the Drawings or in Specifications from other disciplines in the scope of Work.
   4. Review the complete set of Drawings and Specifications in order to ensure all items related to the instrumentation and control systems are completely accounted for. Include any items indicated on the Drawings or in Specifications from another discipline in the scope of Work:
      a. If a conflict between Drawings and Specifications is discovered, refer conflict to the Engineer as soon as possible for resolution.
   5. Loop drawings:
      a. Provide complete loop drawings for all systems, including packaged equipment furnished as part of a vendor furnished package, and for all pre-purchased equipment.
      b. The form, minimum level of detail, and format for the loop drawings must match that of the sample loop drawings included in the Contract Documents.
      c. The Owner and Engineer are not responsible for providing detailed loop diagrams for Contractor furnished equipment.

C. All instrumentation, and control equipment and systems for the entire project to comply with the requirements specified in the Instrumentation and Control Specifications, whether referenced in the individual Equipment Specifications or not:
   1. The requirements of the Instrumentation and Control Specifications apply to all Instrumentation and Control Work specified in other Specifications, including HVAC controls, packaged mechanical systems, LCPs, VCPs, etc.

2. Inform all vendors supplying instrumentation, control systems, panels, and/or equipment of the requirements of the Instrumentation and Control Specifications.
3. Contractor shall be responsible for informing all subcontractor's and/or suppliers of all applicable requirements as specified in Section 15936 - Instrumentation and Control Specification, including but not limited to programming, configuration, interface, and other requirements described in this Section:
    a. Owner shall not be responsible for any additional costs due to the failure of Contractor to notify all subcontractors and/or suppliers of Section 15936 - Instrumentation and Control Specification requirements.

D. Contract Documents:
1. General:
    a. The drawings and specifications are complementary and are to be used together in order to fully describe the Work.
2. Specifications:
    a. General Conditions and Special Provisions of the Contract Documents govern the Work.
    b. These requirements are in addition to all General Requirements.
3. Contract drawings:
    a. The Instrumentation and Control Drawings show in a diagrammatic manner, the desired locations, and arrangements of the components of the Instrumentation Work. Follow the drawings as closely as possible, use professional judgment and coordinate with the other trades to secure the best possible installation, use the entire drawing set for construction purposes.
    b. Locations of equipment, control devices, instruments, boxes, panels, etc. are approximate only, exercise professional judgment in executing the Work to ensure the best possible installation:
        1) The equipment locations and dimensions indicated on the Drawings and elevations are approximate. Use the shop drawings to determine the proper layout, foundation, and pad requirements, etc. for final installation. Coordinate with all subcontractors to ensure that all instrumentation and control equipment is compatible with other equipment and space requirements. Make changes required to accommodate differences in equipment dimensions.
        2) The Contractor has the freedom to select any of the named manufacturers as identified in the individual Specifications; however, the Engineer has designed the spatial equipment layout based upon a single manufacturer and has not confirmed that every named manufacturer's equipment fits in the allotted space. It is the Contractor's responsibility to ensure that the equipment being furnished fits within the defined space.
    c. Installation details:
        1) The Contract Drawings include installation details showing means and methods for installing instrumentation and control equipment. For cases where typical details are not provided or compatible with an installed location, develop installation details that are necessary for completing the Work, and submit these details for review by the Engineer.

d. Schematic diagrams:
    1) All controls are shown de-energized.
    2) Schematic diagrams show control function only. Incorporate other necessary functions for proper operation and protection of the system.
    3) Add slave relays, where required, to provide all necessary contacts for the control system or where needed to function as interposing relays for control voltage coordination, equipment coordination, or control system voltage drop considerations.
    4) Mount all devices shown on motor controller schematic diagrams in the controller compartment enclosure, unless otherwise noted or indicated.
    5) Control schematics are to be used as a guide in conjunction with the descriptive operating sequences indicated on the Drawings or in the Specifications. Combine all information and furnish a coordinated and fully functional control system.

E. Alternates/Alternatives:
    1. Substitute item provisions as specified in General Conditions.

F. Changes and change orders:
    1. As specified in Section 01600 - Product Requirements.

1.02 REFERENCES

A. Code compliance:
    1. As specified in Section 01410 - Regulatory Requirements:
        a. The publications are referred to in the text by basic designation only. The latest edition accepted by the Authority Having Jurisdiction of referenced publications in effect at the time of Bid governs.
    2. The following codes and standards are hereby incorporated into this Section:
        a. American National Standards Institute (ANSI).
        b. American Petroleum Institute (API):
            1) RP 550 - Manual on Installation of Refinery Instruments and Control Systems; Part II-Process Stream Analyzers; Section 5-Oxygen Analyzers.
            2) RP 551 - Process Measurement Instrumentation.
        c. International Organization for Standardization (ISO):
            1) 9001 - Quality Management Systems - Requirements.
        d. International Society of Automation (ISA):
            1) 5.1 - Instrumentation Symbols and Identification.
            2) 5.4 - Instrument Loop Diagrams.
            3) 20 - Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.
        e. National Electrical Manufacturers Association (NEMA):
            1) 250 - Enclosures for Electrical Equipment (1000 V Maximum).
        f. National Fire Protection Association (NFPA).
        g. National Institute of Standards and Technology (NIST).
        h. Underwriters Laboratories, Inc. (UL):
            1) 508 - Standard of Safety for Industrial Control Equipment.
            2) 508A - Standard of Safety for Industrial Control Panels.

B. Compliance with Laws and Regulations:
   1. As specified in General Conditions.

1.03 DEFINITIONS

A. Definitions of terms and other electrical and instrumentation considerations in accordance with:
   1. Factory Mutual (FM).
   2. International Electrotechnical Commission (IEC).
   3. Institute of Electrical and Electronics Engineers (IEEE).
   4. International Society of Automation (ISA).
   5. International Organization for Standardization (ISO).
   6. National Electrical Code (NEC).
   7. National Electrical Manufacturers Association (NEMA).
   8. InterNational Electrical Testing Association (NETA).
   9. National Fire Protection Association (NFPA).
   10. National Institute of Standards and Technology (NIST).
   11. Underwriters Laboratories (UL).

B. Specific definitions:
   1. Control circuit: Any circuit operating at 120 volts alternating current (VAC) or direct current (VDC) or less, whose principal purpose is the conveyance of information (including performing logic) and not the conveyance of energy for the operation of an electrically powered device.
   2. Panel: An instrument support system that may be a flat surface, a partial enclosure, or a complete enclosure for instruments and other devices used in process control systems.
   3. Power circuit: Any circuit operating at 90 volts (AC or DC) or more, whose principal purpose is the conveyance of energy for the operation of an electrically powered device.
   4. Signal circuit: Any circuit operating at less than 50 VAC or VDC, which conveys analog information or digital communications information.
   5. Digital bus: A communication network, such as PROFIBUS, Foundation Fieldbus, or DeviceNet, allowing instruments and devices to transmit data, control functions, and diagnostic information.
   6. 2-Wire transmitter (loop powered): A transmitter that derives its operating power supply from the signal transmission circuit and requires no separate power supply connections. As used in this Section, 2-wire transmitter refers to a transmitter that provides a signal such as 4 to 20 mA 24 VDC regulation of a signal in a series circuit with an external 24 VDC driving potential:
      a. Fieldbus communications signal or both.
   7. Powered transmitters: A transmitter that requires a separate power source (120 VAC, 240 VAC, etc.) in order for the transmitter to develop its signal. As used in this Section, the produced signal may be a 4 to 20 mA 24 VDC signal, a digital bus communications signal, or both.
   8. Modifications: Changing, extending, interfacing to, removing, or altering an existing circuit.

C. NEMA:
   1. Type 1 enclosure in accordance with NEMA 250.
   2. Type 2 enclosure in accordance with NEMA 250.
   3. Type 3 enclosure in accordance with NEMA 250.

4. Type 3R enclosure in accordance with NEMA 250.
5. Type 3S enclosure in accordance with NEMA 250.
6. Type 3X enclosure in accordance with NEMA 250.
7. Type 3RX enclosure in accordance with NEMA 250.
8. Type 3SX enclosure in accordance with NEMA 250.
9. Type 4 enclosure in accordance with NEMA 250.
10. Type 4X enclosure in accordance with NEMA 250.
11. Type 5 enclosure in accordance with NEMA 250.
12. Type 6 enclosure in accordance with NEMA 250.
13. Type 6P enclosure in accordance with NEMA 250.
14. Type 12 enclosure in accordance with NEMA 250.
15. Type 12K enclosure in accordance with NEMA 250.
16. Type 13 enclosure in accordance with NEMA 250.

D. Acronym definitions:
1. ACB: Automatic current balance.
2. ATS: Automatic Transfer Switch.
3. CCS: The PCS central computer system (CCS) consisting of computers and software. The personal computer-based hardware and software system that includes the operator interface, data storage, data retrieval, archiving, alarming, historian, reports, trending, and other higher level control system software and functions.
4. DPDT: Double-pole, double-throw.
5. ES: Enterprise system: Computer based communications or data sharing system utilized for non-process control functions such as E-mail, sharing files, creating documents, etc.
6. FAT: Factory acceptance test also known as Source Test.
7. HART: Highway addressable remote transducer.
8. HOA: Hand-Off-Auto control function that is totally PLC based. In the Hand mode, equipment is started or stopped, valves are opened or closed through operator direction under the control of the PLC software. In the Auto mode, equipment is started or stopped and valves are opened or closed through a control algorithm within the PLC software. In the Off mode, the equipment is prohibited from responding from the PLC control.
9. HMI: Human machine interface is a software application that presents information to an operator or user about the state of a process, and to accept and implement the operators control instructions. Typically information is displayed in a graphical format.
10. ICSC: Instrumentation and control system contractor: Subcontractor who specializes in the design, construction, fabrication, software development, installation, testing, and commissioning of industrial instrumentation and control systems.
11. IJB: Instrument junction boxes: A panel designed with cord sets to easily remove, replace, or relocate instrument signals.
12. I/O: Input/Output.
13. IP: Internet protocol or ingress protection.
14. LCP: Local control panel: Operator interface panel that may contain an HMI, pilot type control devices, operator interface devices, control relays, etc., and does not contain a PLC or RIO.
15. LAN: Local area network: A control or communications network that is limited to the physical boundaries of the facility.

16. LOI: Local Operator Interface is an operator interface device consisting of an alphanumeric or graphic display with operator input functionality. The LOI is typically a flat panel type of display mounted on the front of an enclosure with either a touch screen or tactile button interface.
17. LOR: Local-Off-Remote control function. In the Remote mode, equipment is started or stopped, and valves are opened or closed through the PLC based upon the selection of the HOA. In the Local mode, equipment is started or stopped, valves are opened or closed based upon hardwired control circuits completely independent of the PLC with minimum interlocks and permissive conditions. In the Off mode, the equipment is prohibited from responding to any control commands.
18. NJB: Network junction box. An enclosure that contains multiple access points to various networks within the facility. Networks could be Ethernet, Ethernet/IP, Fieldbus, RIO, etc.
19. P&ID: Process and instrumentation diagram.
20. PC: Personal computer.
21. PCIS: Process control and instrumentation system: Includes the entire instrumentation system, the entire control system, and all of the Work specified in the Instrumentation and Control Specifications and depicted on the Instrumentation Drawings. This includes all the PCS and instruments and networking components as well as the various servers, workstations, thin clients, etc.
22. PCM: Process control module: An enclosure containing any of the following devices: PLC, RTU, or RIO.
23. PCS: Process Control System: A general name for the computerized system that gathers and processes data from equipment and sensors and applies operational controls to the process equipment. It includes the PLCs and/or RIOs, LOIs, HMIs, both LCPs, VCPs and all data management systems accessible to staff.
24. PJB: Power junction box: An enclosure with terminal blocks that distribute power to multiple instruments.
25. PLC: Programmable logic controller.
26. PS: Power supply.
27. RIO: Remote I/O device for the PLC consisting of remote I/O racks, or remote I/O blocks.
28. RTU: Remote telemetry unit: A controller typically consisting of a PLC, and a means for remote communications. The remote communications devices typically are radios, modems, etc.
29. SCADA: Supervisory control and data acquisition system: A general name for the computerized system that gathers and processes data from sensors and equipment located outside of the facility, such as wells, lift stations, metering stations, etc.
30. SPDT: Single-pole, double-throw.
31. SPST: Single-pole, single-throw.
32. UPS: Uninterruptible power supply.
33. VCP: Vendor control panel: Control panels that are furnished with particular equipment by a vendor other than the ICSC. These panels may contain PLCs, RIO, LOI, HMI, etc.
34. WAN: Wide area network: A control or communications network that extends beyond the physical boundaries of the facility.

1.04 SUBMITTALS

A. Furnish submittals as specified in Section 01330 - Submittal Procedures and this Section.

B. General:
   1. Instruct all equipment suppliers of submittals and operation and maintenance manuals of the requirements in this Section.
   2. Furnish the submittals required by each section in the Instrumentation Specifications.
   3. Adhere to the wiring numbering scheme specified in Section 16075 - Identification for Electrical Systems throughout the Project:
      a. Uniquely number each wire.
      b. Wire numbers must appear on all Equipment Drawings.
   4. Use equipment and instrument tags, as indicated on the Drawings, for all submittals.

C. Submittal preparation:
   1. During the period of preparation of submittals, the Contractor shall authorize direct, informal liaison between the ICSC and the Engineer for exchange of technical information. As a result of this liaison, certain minor refinements and revisions may be authorized informally by the Engineer, which do not alter the scope of Work or cause increase or decrease in the Contract price or times. During this informal exchange, no oral statement by the Engineer shall be construed to give formal approval of any component or method, nor shall any statement be construed to grant exception to, or variation from, these Contract Documents.
   2. In these Contract Documents, some items of Work are represented schematically, and are designated for the most part by numbers, as derived from criteria in ISA-5.1:
      a. Employ the nomenclature and numbers designated in this Section and indicated on the Drawings exclusively throughout shop drawings, data sheets, and similar submittals.
      b. Replace any other symbols, designations, and nomenclature unique to a manufacturer’s, suppliers, or subcontractor’s standard methods with those identified in this Section and indicated on the Drawings.

D. Specific submittal requirements:
   1. Shop drawings:
      a. Required for materials and equipment listed in this and other sections.
      b. Furnish sufficient information to evaluate the suitability of the proposed material or equipment for the intended use, and for compliance with these Specifications.
      c. Shop drawings requirements:
         1) Front, side, and, rear elevations, and top and bottom views, showing all dimensions.
         2) Locations of conduit entrances and access plates.
         3) Component layout and identification.
         4) Schematic and wiring diagrams with wire numbers and terminal identification.
         5) Connection diagrams, terminal diagrams, internal wiring diagrams, conductor size, etc.

6) Anchoring method and leveling criteria, including manufacturer's recommendations for the Project site seismic criteria.
7) Weight.
8) Finish.
9) Nameplates:
a) As specified in Section 16075 - Identification for Electrical Systems or as indicated on the Drawings.
10) Temperature limitations, as applicable.

d. Use equipment and instrument tags as depicted on the P&IDs for all submittals.
e. Adhere to wiring numbering scheme outlined in Section 16075 - Identification for Electrical Systems throughout the Project:
1) Uniquely number each wire per the Specifications.
f. Wire numbers must appear on all equipment drawings.
g. Organize the shop drawing submittals for inclusion in the Operation and Maintenance Manuals:
1) Furnish the initial shop drawing submittal bound in one or more standard size, 3-ring, D-ring, loose-leaf, vinyl plastic, hard-cover binders suitable for bookshelf storage.
2) Binder ring size: 2 inches.
h. Include the letterhead and/or title block of the firm responsible for the preparation of all shop drawings. Include the following information in the title block, as a minimum:
1) The firm's registered business name.
2) Firm's physical address, email address, and phone number.
3) Owner's name.
4) Project name and location.
5) Drawing name.
6) Revision level.
7) Personnel responsible for the content of the drawing.
8) Date.
i. The work includes modifications to existing circuits:
1) Clearly show all modifications to existing circuits.
2) In addition, show all existing unmodified wiring to clearly depict the functionality and electrical characteristics of the complete modified circuits.

2. Product data:
a. Submitted for non-custom manufactured material listed in this and other sections and shown on shop drawings.
b. Include:
1) Catalog cuts.
2) Bulletins.
3) Brochures.
4) Quality photocopies of applicable pages from these documents.
5) Identify on the data sheets the Project name, applicable specification section, and paragraph.
6) Identify model number and options for the actual equipment being furnished.
7) Neatly cross out options that do not apply or equipment not intended to be supplied.
c. Use equipment and instrument tags as depicted on the P&IDs for all submittals.

d. Adhere to wiring numbering scheme outlined in Section 16075 - Identification for Electrical Systems throughout the Project:
    1) Uniquely number each wire per the Specifications.
e. Wire numbers must appear on all equipment drawings.

3. Detailed sequence of operation for all equipment or systems.
4. Operation and maintenance manuals:
    a. As specified in Section 01782 - Operation and Maintenance Data.
    b. Operational Manual:
        1) Prepare and provide a simplified version of the standard manufacturer's HMI software and system operations manual that includes basic instructions in the application of the system as required for operators in day-to-day operations.
    c. Control System Software Record Documents:
        1) Include complete documentation of all the software programs provided for the entire control and PCS system, including:
            a) Listings of all application software on both hard copy and DVD, DVD-ROM, and CD-ROM.
            b) Database, both hard copy and DVD, DVD-ROM, and CD-ROM.
            c) Communication protocols.
            d) All documentation necessary to maintain, troubleshoot, modify, or update the software system.
    d. Organize the operation and maintenance manuals for each process in the following manner:
        1) Section A - Process and Instrumentation Diagrams.
        2) Section B - Control Descriptions.
        3) Section C - Loop Drawings.
        4) Section D - Instrument Summary.
        5) Section E - Instrument Data Sheets and Brochures.
        6) Section F - Sizing Calculations.
        7) Section G - Instrumentation Installation Details.
        8) Section H - Test Results.
        9) Section I - Operational Manual.
        10) Section J - Spare Parts List.
        11) Section K - Control System Software.
5. Material and equipment schedules:
    a. Furnish a complete schedule and/or matrix of all materials, equipment, apparatus, and luminaries that are proposed for use:
        1) Include sizes, names of manufacturers, catalog numbers, and such other information required to identify the items.
6. Itemized instrument summary:
    a. Submit a hard copy of the instrument summary.
    b. List all of the key attributes of each instrument including:
        1) Tag number.
        2) Manufacturer.
        3) Model number.
        4) Service.
        5) Area location.
        6) Calibrated range.
        7) Loop drawing number.
    c. Associated LCP, VCP, PCM, or PLC.

7. Instrument data sheets and cut sheets:
    a. Furnish fully completed data sheets, both electronically in Microsoft Word or Excel and in hard copy, for each instrument and component according to ISA-20 Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves. The data sheets provided with the instrument specifications are preliminary and are not complete. They are provided to assist with the completion of final instrument data sheets. Additional data sheets may be required. Include the following information on the data sheet:
        1) Component functional description specified in this Section and indicated on the Drawings.
        2) Manufacturers model number or other product designation.
        3) Tag number specified in this Section and indicated on the Drawings.
        4) System or loop of which the component is a part.
        5) Location or assembly at which the component is to be installed.
        6) Input and output characteristics, including digital bus communication.
        7) Scale range with units and multiplier.
        8) Requirements for electric supply.
        9) Requirements for air supply.
        10) Power consumption.
        11) Response timing.
        12) Materials of construction and of component parts that are in contact with, or otherwise exposed to, process media, and or corrosive ambient air.
        13) Special requirements or features, such as specifications for ambient operating conditions.
        14) Features and options that are furnished.
    b. Provide a technical brochure or bulletin (“cut sheet”) for each instrument on the project. Submit with the corresponding data sheets:
        1) Where the same make and model of instrument is used in 2 or more applications on the project, and the process applications are nearly identical, and the materials, features and options are identical submit one brochure or bulletin for the set of identical instruments.
        2) Include a list of tag numbers for which it applies with each brochure or bulletin.
        3) Furnish technical product brochures that are complete enough to verify conformance with all Contract Document requirements, and to reflect only those features supplied with the device.
        4) Cross out models, features, options, or accessories that are not being provided.
        5) Clearly mark and identify special options and features.
    c. Organization: Index the data sheets and brochures in the submittal by systems or loops.
8. Control panel hardware submittal:
    a. Submit the following in 1 submittal package.
    b. Complete and detailed bills of materials:
        1) Including quantity, description, manufacturer, and part number for each assembly or component for each control panel.
        2) Include all items within an enclosure.
    c. Complete grounding requirements for each system component including any requirements for PLCs, process LANs, and Control System equipment.

d. Requirements for physical separation between control system components and 120 VAC, 480 VAC, and medium-voltage power cables.
e. UPS and battery load calculations to show that the backup capacity and time meet the specified requirements.
f. Provide a data sheet for each control system component together with a technical product brochure or bulletin, which include:
    1) The manufacturer's model number or other identifying product designation.
    2) Tag and loop number.
    3) System to which it belongs.
    4) Site to which it applies.
    5) Input and output characteristics.
    6) Requirements for electric power.
    7) Device ambient operating requirements.
    8) Materials of construction.

9. Schedule of values:
    a. In addition to completing all items referred to in the schedule of values, Section 01292 - Schedule of Values, submit per unit instrument and labor costs used in developing the final bid for the PCS system, for the express purpose of pricing and cost justification for any proposed change orders. It is the responsibility of the ICSC subcontractor to prove to the Engineer’s satisfaction that said per unit costs were used in the development of the final Bid amount.
10. Installation recommendations:
    a. Submit the manufacturer’s printed recommendations for installation of instrumentation equipment.
11. Training submittals:
    a. Develop and submit for review a general training plan for approval by Owner within 14 calendar days from Notice to Proceed. Include complete descriptions of all planned training classes, a preliminary training schedule, a list of all proposed instructors along with resumes, examples of proposed training manuals, and a description of any special training tools to be used (simulators, self-paced modules, personal computer-based training, etc.).
    b. The Engineer will review the general training plan. Special emphasis will be placed on review of the qualifications of the proposed instructors and the timing of the individual courses to maximize their effectiveness. If, in the opinion of the Engineer, the proposed instructors are not sufficiently qualified to conduct the specified training courses, or lack experience, where required, on the specific configuration of the system, provide more qualified instructors.
    c. The general training plan and schedule shall be updated by the Contractor at the beginning of each Phase and approved by the Owner a minimum of 30 days prior to commencement of training.
    d. Training course plan submittals:
        1) For each training course or other training activity, submit a detailed, complete outline and agenda for each lesson as specified in Section 01756 - Commissioning.
        2) Describe any student pre-requisites for the course or training activity.
        3) Provide an updated schedule for all sessions of the course, including dates, times, durations, and locations.
        4) Submit training materials.

e. Incorporate all submittal review comments into the course.
f. Do not conduct training courses before review and acceptance of the Course Plan submittal for the course.

12. Project Record documents:
    a. Furnish as specified in Section 01770 - Closeout Procedures.
13. Loop Drawings:
    a. Submit loop drawings for every analog, discrete, and fieldbus signal and control circuit:
        1) Provide a loop drawing submittal that completely defines and documents the contents of each monitoring, alarming, interlock, and control loop on this Project.
        2) This requirement applies to all signal and control circuits associated with equipment on this Project including vendor supplied equipment packages and control panels.
        3) Provide loop drawings in the format indicated in the contract drawings. Provide all tagging in accordance with the Owner's standard.
    b. Show every instrument and I/O point on at least one loop diagram.
    c. Provide a complete index in the front of each bound volume:
        1) Index the loop drawings by systems or process areas.
    d. Provide drawings showing definitive diagrams for every instrumentation loop system:
        1) Show and identify each component of each loop or system using requirements and symbols from ISA-5.4.
        2) Furnish a separate drawing sheet for each system or loop diagram.
    e. In addition to the ISA-5.4 requirements, show the following details:
        1) Functional name of each loop.
        2) Reference name, drawing, and loop diagram numbers for any signal continuing off the loop diagram sheet.
        3) Show all terminal numbers, regardless of the entity providing the equipment.
        4) MCC panel, circuit, and breaker numbers for all power feeds to the loops and instrumentation.
        5) Designation of and, if appropriate, terminal assignments associated with, every manhole, pull-box, junction box, conduit, and panel through which the loop circuits pass.
        6) Show vendor control panel, instrument panel, conduit, junction box, equipment and PCS terminations, termination identification, wire numbers and colors, power circuits, and ground identifications.
        7) If a circuit is continued on another drawing, show the name and number of the continuation drawing on the loop drawing. Provide complete references to all continuation drawings whether vendor control panels, other loop drawings, existing drawings provided by the Owner, or other drawings.
    f. In addition to the above requirements, provide loop diagrams in accordance with the example loop diagram as indicated on the Drawings.
14. Instrument Installation Drawings:
    a. Submit, instrument installation, mounting, and anchoring details for all components and assemblies, including access requirements and conduit connection or entry details.
    b. Furnish for each instrument a dedicated 8 1/2-inch by 11-inch installation detail that pertains to the specific instrument by tag number.

c. For each detail, provide certification and the hard copies, by the instrument manufacturer, that the proposed installation is in accordance with the instrument manufacturer's recommendations and is fully warrantable.
d. For each detail, provide, as a minimum, the following contents:
    1) Necessary sections and elevation views required to define instrument location by referencing tank, building or equipment names and numbers, and geographical qualities such as north, south, east, west, basement, first floor, etc.
    2) Ambient temperature and humidity where the instrument is to be installed.
    3) Corrosive qualities of the environment where the instrument is to be installed.
    4) Hazardous rating of the environment where the instrument is to be installed.
    5) Process line pipe or tank size, service and material.
    6) Process tap elevation and location.
    7) Upstream and downstream straight pipe lengths between instrument installation and pipe fittings and valves.
    8) Routing of tubing and identification of supports.
    9) Mounting brackets, stands, anchoring devices, and sun shades.
    10) Conduit entry size, number, location, and delineation between power and signal.
    11) NEMA ratings of enclosures and all components.
    12) Clearances required for instrument servicing.
    13) List itemizing all manufacturer makes, model numbers, quantities, lengths required, and materials of each item required to support the implementation of the detail.

15. Control Panel Drawings:
    a. Layout Drawings:
        1) Submit panel, enclosure, console, furniture, and cabinet layout drawings for all items provided.
        2) As a minimum, include the following information:
            a) To scale front, side, and plan views.
            b) Dimensions.
            c) Interior and exterior arrangements.
            d) Mounting information, including conduit entrance location.
            e) Finish data.
            f) Tag number and functional name of items mounted in and on each panel, console, and cabinet.
            g) Nameplate legend including text, letter size, materials, and colors.
    b. Wiring and piping diagrams:
        1) Submit panel wiring and piping diagrams for every panel that contains wiring and/or piping.
        2) Include the following information:
            a) Name of panel.
            b) Wiring and piping sizes and types.
            c) Terminal strip numbers.
            d) Wire tags and labels.

e) Functional name and manufacturer's designation for items to which wiring and piping are connected.
f) Electrical control schematics in accordance with ANSI standards.

c. Installation drawings:
1) Provide site-specific installation drawings for all control equipment panels, including dimensions.
2) Provide scaled drawings and show the position of the equipment at its intended installation location.
3) Show the placement of all equipment being provided under this Contract and its spatial relationship to all other equipment located in the abutting and adjoining areas.
4) Show all required access and clearances associated with the equipment with a statement of compliance to manufacturer's recommendations, NEC, and other applicable codes.

16. Schematic Diagrams:
a. Submit schematic diagrams for all electrical equipment in ladder diagram format.
b. Include device and field connection terminal numbers on all schematic diagrams.
c. Incorporate equipment manufacturer’s shop drawing information into the schematic diagrams in order to document the entire control system.

17. Control System Diagram:
a. Submit a complete set of control system diagrams including the following information:
1) All PLCs, workstations, printers, communication devices, and communication links:
a) Show all PLCs with their current I/O allocation, and future I/O allocation, current plus spares provided, and maximum potential I/O based on available slots.
2) All cables required for communication requirements.
3) Show each component fully annotated with conduit size and number associated with the power source.

18. Process Control Software Submittal:
a. In accordance with Product Data and Shop Drawing general requirements.
b. Submit a complete description of the standard application software programs, operating system and utility programs, including modifications and explanation of how the specific functional requirements are met:
1) Provide a cross-reference between the Specification requirements and the software submittal, in order to provide the Engineer the ability to identify how each specified requirement or function is met.
c. A complete listing of the PCS system point I/O database:
1) Include for each data point, relevant parameters such as range, contact orientation, limits, incremental limits, I/O card byte, I/O hardware address, and PLC assignment.
2) Organize on a site-by-site basis, separate by point type.
3) In addition to the active I/O points, list the implemented spare I/O points and the available I/O points remaining on each card, as well as other defined future points specified or shown.

4) Upon completion of the Work, update all I/O lists to indicate the final as-built configuration of the systems:
a) Organize as-built I/O list on a site-by-site basis, separated by equipment and point type.

d. Detailed descriptions of procedures used to implement and modify control strategies and database construction.
e. Preliminary overview, screens, station graphic displays, and preliminary reports.

19. Instrumentation and Control System Contractor Statement of Qualifications:
a. Submit statement of qualifications of the proposed ICSC in accordance with subsequent requirements of this Section.
20. Control Descriptions:
a. For each control loop, provide a detailed functional description of the operation of the equipment, signals, and controls as shown on the P&IDs:
1) Include all functions depicted or described in the Contract Documents.
2) Include within the Control Description content:
a) All specific requirements.
b) All common requirements that pertain in general to all loops.
c) Listing all ranges, setpoints, timers, values, counter values, etc.
21. Test Procedure Submittals:
a. Submit the proposed procedures to be followed during tests of the PCS and its components in 2 parts:
1) Preliminary Submittal: Outline of the specific proposed tests and examples of proposed forms and checklists.
2) Detailed Submittal: After successful review of the Preliminary Submittal, submit the proposed detailed test procedures, forms, and checklists. Include a statement of test objectives with the test procedures.
22. Test reports:
a. As specified in Section 01330 - Submittal Procedures.

1.05 QUALITY ASSURANCE

A. Manufacture instruments at facilities certified to the quality standards of ISO 9001.

B. ICSC qualifications:
1. General information on the proposing company:
a. Document that the ICSC Company has been actively involved in the instrumentation, PLC-based control systems business for a minimum of five years and has adequate facilities, organization structure, manpower, and technical and managerial expertise to properly perform the Work as specified in these Specifications.
b. Submit a financial prospectus indicative of the corporation's financial state. This prospectus shall also include:
1) A letter from a financial institution indicating a current line of credit and bonding limit which can be applied to this Project.
2) Latest annual report or reviewed financial statement.
2. Document that the ICSC has a qualified permanent service facility:
a. Said facility shall be staffed with permanent employees and equipped with the tools and test equipment necessary to calibrate, test, and process start-up all of the instrumentation, control, telemetry, SCADA and control

systems hardware and software furnished under this Contract, including remote diagnostic capability.

b. Document in-house resource of permanent personnel experienced in the design and programming of equipment and systems as specified in these Specifications.

c. Document the existence of a training program staffed by qualified instructors, to provide proper training in the operation and maintenance of equipment as specified in these Specifications.

d. Document that the firm is a recognized or certified “system integrator partner” or similar designation for the control software and PLC system being supplied for this Project.

3. Similar project experience of the company:

a. Provide a list of at least 3 successfully completed projects for a water and/or wastewater system of similar scope and complexity in which the proposing firm used components the same as those intended for use on this Project. The proposing firm must have performed, for each listed project, system engineering, system fabrication and installation, documentation (including schematic, wiring and panel assembly drawings), software configuration and documentation, field testing, calibration and process start-up, operator instruction, and maintenance training. In addition, provide the following information for each project:

1) Name of plant or system owner, contact name, and current telephone number. Design engineer’s name, address, and telephone number. Failure to provide current contact information may result in the listed project being disqualified for use in meeting the minimum requirements for prequalification.

2) Manufacturer and model number(s) of the PLC based control system and the computer-based SCADA system used for both hardware and software.

3) Brief description of the system.

4) Approximate number of input and output signals: analog, digital, and fieldbus.

5) Brief application software description.

6) Contracted cost of the system, separate by base amount and any change orders for the completed projects.

7) Duration of the project and date of completion.

4. Information on the proposed Project team members:

a. Provide the name and resume of the individual persons who will be responsible for each of the following:

1) Office engineering and management of this Project.

2) Lead for software configuration/programming.

3) Individual who will be responsible for the hardware and hardware interface design.

4) Individual who will be responsible for field testing, calibration, and process start-up.

5) Individual who will be responsible for operator training.

b. All of these individuals must be permanent employees of the proposing firm.

5. Determination of the proposed ICSC qualifications is at the sole discretion of the Engineer.

C. Furnish all equipment listed by and bearing the label of UL or of an independent testing laboratory acceptable to the Engineer and the Authority Having Jurisdiction.

D. The ICSC must have their own operating UL listed panel fabrication facility. All panels must be fabricated at this facility and meet all UL 508/508A requirements.

E. ICSC:
   1. Contractor, through the use of a qualified ICSC, is responsible for the implementation of the PCIS and the integration of the system with other required instrumentation, control devices, and software.
   2. The ICSC assumes full responsibility, through the Contractor, to perform all work to select, furnish, install, test, calibrate, and place into operation all instrumentation, controls, telemetry equipment, control panels, and control system including application software, for a complete, integrated and functional PCIS system.
   3. Due to the complexities associated with the interfacing of numerous control system devices, it is the intent of these Specifications that the ICSC be responsible for the integration of the PCIS with existing devices and devices provided under the Contract Documents with the objective of providing a completely integrated control system.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 01600 - Product Requirements.

B. Special instructions:
   1. Securely attach special instructions for proper field handling, storage, and installation to each piece of equipment before packaging and shipment.

C. Tagging:
   1. Tag each component and/or instrument to identify its location, instrument tag number, and function in the system.
   2. Firmly attach a permanent tag indelibly machine marked with the instrument tag number, as given in the tabulation, on each piece of equipment constituting the PCS.
   3. Tag instruments immediately upon receipt in the field.
   4. Prominently display identification on the outside of the package.
   5. Utilize the Tag and Loop Number identifications shown on the P&IDs.

D. Delivery and inspection:
   1. Deliver products in undamaged condition, in manufacturer’s original container or packaging with identifying labels intact and legible. Include date of manufacture on label.

1.07 PROJECT OR SITE CONDITIONS

A. Site conditions:
   1. Provide a PCS, including all equipment, raceways, and any other components required for a complete installation that meets the environmental conditions for the Site as specified in the General Requirements and below.

2. Seismic classification:
    a. Provide all equipment and construction techniques suitable for the seismic requirements for the site, as specified in Section 01612 - Seismic Design Criteria.
3. Wind:
    a. Provide all equipment and construction techniques suitable for the site wind loading criteria, as specified in Section 01614 - Wind Design Criteria.
4. Altitude, temperature and humidity:
    a. As specified in Section 01610 - Project Design Criteria.
    b. Provide all equipment and instrumentation fully rated for continuous operation at this altitude, temperature and humidity conditions with no additional derating factors applied.
    c. Provide additional temperature conditioning equipment to maintain all equipment and instrumentation in non-conditioned spaces or outdoors subject to these ambient temperatures 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature as determined by the equipment manufacturer's guidelines:
        1) Provide all power wiring for these devices (e.g., heaters, fans, etc.), whether or not indicated on the Drawings.
5. Area classifications:
    a. Furnish enclosures that match the area classifications as specified in Section 16050 - Common Work Results for Electrical.
6. Site security:
    a. Abide by all security and safety rules concerning the Work on the Site, as specified in Section 01329 - Safety Plan.

1.08 SEQUENCING

A. General:
1. As specified in Section 01312 - Project Meetings and Section 01756 - Commissioning.
2. Testing requirements are specified in Section 01756 - Commissioning and Section 17950 - Commissioning for Instrumentation and Controls.
3. General scheduling requirements are specified in Section 01321 - Schedules and Reports.
4. Work restrictions and other scheduling requirements are specified in Section 01140 - Work Restrictions.
5. Commissioning requirements as specified in Section 01756 - Commissioning.

B. Pre-submittal conferences:
1. Before producing any submittals, schedule a pre-submittal conference for the purposes of reviewing the entire project, equipment, control philosophy, schedules, and submittal requirements.
2. The Contractor, instrumentation and control subcontractor, electrical subcontractor, and all manufacturers furnishing major pieces of equipment must attend, including but not limited to:
    a. Vendor control panels.
    b. Chemical feed systems.
    c. Motor control centers.
    d. Switchgear.
    e. Variable frequency drives.

f. Lighting.
g. Engine generators.

3. The Programmer shall be invited to attend the pre-submittal conference.

C. Control logic meetings:
1. Review the PLC programming with the Owner's Programmer, Engineer, and Owner on at least 3 half day meetings during development. Individuals responsible for programming PLCs and other programmable devices supplied by Contractor shall attend this meeting by telephone conference call:
a. Preliminary meeting: Meet before configuration work is begun on any PLCs programmed by the Contractor (including those provided through subcontractors and suppliers):
1) Contractor shall provide a list of each PLC and other programmable devices that will interface to the rest of the control system, including make, model, and a description of the interface; provide contact information for each individual responsible for programming each said PLC and device; and provide a listing of the submittals that will contain HMI/LOI interface information with a schedule for when each submittal will be provided.
b. Intermediate review meeting: Held after approximately one-half of the interface submittals identified in the Pre-submittal Conferences paragraph above have been submitted:
1) Individuals responsible for programming PLCs and other programmable devices supplied by Contractor shall attend this meeting.
2) Meet to discuss all control system interface submittals and their requirements.
c. Final review meeting: Held after all HMI/LOI interface submittals have been submitted:
1) Meet to discuss HMI/LOI interface submittals and requirements.
2. Vendor Equipment Meetings: Facilitate a meeting with each equipment supplier (including HVAC) who is providing equipment with a PLC and/or LOI. Meeting discussion point will include the following at a minimum:
a. Tag naming conventions.
b. PLC to PLC global data mapping.
c. All PLCs to HMI tags mapping.
d. LOI screen colors and navigation.
e. Interlock and permissive definitions.
f. Communication methods.
g. Standard code blocks for common control functionality.
h. Alarms: Clearing, formats, colors, and status.
3. Additional requirements as specified in Sections 17100 - Control Strategies, 17101 - Specific Control Strategies, and 17720 - Control Systems: Programmable Logic Controllers.

D. Source testing:
1. Before the delivery and installation of the PCS system to the job site, but after the procurement, assembly, and configuration of all components, perform the Source Test.
2. Schedule the Source Test after receiving approval of the Source Test procedures submittal.

3. Submit a copy of the test procedures including all forms at least 21 days before any scheduled test date.
4. Notify the Engineer of scheduled tests a minimum of 15 days before the date of the test.

E. General Field Start-Up and testing procedures:
   1. As specified in Section 01756 - Commissioning.

F. Installation testing:
   1. As specified in Section 01756 - Commissioning.
   2. Commence after acceptance of all training, wire test, calibration tests, and loop validation tests, and all inspections have demonstrated that the PCIS complies with all Contract requirements.
   3. Acceptance of the PCIS Installation testing must be provided in writing by the Owner before the performance testing may begin.

G. Training:
   1. As specified in Section 01756 - Commissioning.

H. Functional testing:
   1. Commence after acceptance of all training, wire test, calibration tests, and loop validation tests, and all inspections have demonstrated that the PCIS complies with all Contract requirements.
   2. Loop validation test.
   3. As specified in Section 17950 - Commissioning for Instrumentation and Controls:
      a. Notify the Owner of scheduled tests a minimum of 21 days before the estimated completion date of installation and wiring of the PCIS.
      b. Complete loop validation testing a minimum of 5 days before the pre-commissioning phase of the project.
      c. Loop validation certifications:
         1) After the field device loop tests have been successfully completed as specified in Section 17950 - Commissioning for Instrumentation and Controls for all individual instruments, all separate analog control networks, all valves, all VCPs, all motors, all local operator interface panels, all motor control centers, etc., submit a certified copy of all test forms signed by the Contractor, Vendor, and the Owner's representative with test data entered, together with a clear and unequivocal statement that all instrumentation, including all control and signal wiring, has been successfully calibrated, inspected, and tested:
            a) Acceptance of the PCIS Installation Testing must be provided in writing by the Engineer before the Process Operational Period may begin.
      d. The Programmer will assist with Functional Testing for PLCs programmed by the Programmer, as specified in Section 17950 - Commissioning for Instrumentation and Controls.
      e. The Programmer shall not be required to be on site, nor shall the Programmer be required to supply application software, until the loop validation tests are complete for a PLC and all prerequisites for the Process Operational Period are completed.

I. Provide all special tools and spare parts, as specified in the Maintenance paragraph of this Section, before Process Operational Period commences, suitably wrapped, and identified.

J. Process Operational Period:
   1. Upon completion of the Process Operational Period, conduct an Instrumentation and Controls Process Performance Test as a condition for Project final completion.

1.09 SCHEDULING (NOT USED)

1.10 WARRANTY

A. Provide additional warranty as specified in the individual Instrumentation and Control Specifications that extends beyond the Correction Period, as specified in General Conditions and Special Provisions.

1.11 SYSTEM PROCESS START-UP

A. Replace or modify equipment, software, and materials that do not achieve design requirements after installation in order to attain compliance with the design requirements:
   1. Following replacement or modification, retest the system and perform additional testing to place the complete system in satisfactory operation and obtain compliance acceptance from the Engineer.

1.12 OWNER'S INSTRUCTIONS (NOT USED)

1.13 MAINTENANCE

A. Before Substantial Completion, perform all maintenance activities required by the Contract Documents including any calibrations, final adjustments, component replacements or other routine service required before placing equipment or systems in service.

B. Furnish all spare parts as required by the Contract Documents.

C. Provide additional spare parts specified in other sections of the Instrumentation and Control Specifications.

D. Submit all special tools and spare parts, suitably wrapped and identified, before Process Operational Period commences.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide similar items from a single manufacturer throughout the PCIS portion of the Project.

B. Allowable manufacturers are specified in individual instrument and equipment specifications.

2.02 SYSTEM DESCRIPTION

A. General requirements:
   1. The Work includes everything necessary for and incidental to executing and completing the instrumentation and control system work indicated on the Drawings and specified in the Specifications and reasonably inferable there from including but not limited to:
      a. Preparing hardware submittals for field instrumentation.
      b. Design, develop, and draft loop drawings, control panel designs, and all other drawing submittals specified in the Instrumentation and Control Specifications.
      c. Prepare the test plan, the training plan, and the spare parts submittals.
      d. Procure all hardware.
      e. Fabricate panels.
      f. Perform factory tests on panels.
      g. Perform bench calibration and verify calibration after installation.
      h. Oversee and certify installation of the PCS system.
      i. Oversee, document, and certify loop testing.
      j. Oversee, document, and certify system.
      k. Installation Testing.
      l. Oversee and document Functional Testing.
      m. Conduct the Process Operational Period and the Instrumentation and Controls Process Performance Testing.
      n. Prepare operation and maintenance manuals.
      o. Conduct training classes.
      p. Integrate the PCS with instrumentation and control devices provided under other sections.
      q. Provide Record Drawings and Loop Drawings associated with Instruments and equipment:
         1) As specified in the Contract Documents.
         2) For Owner furnished items.
         3) For interfaces with existing equipment.
      r. Resolve signal, power, or functional incompatibilities between the PCS and interfacing devices.
      s. Perform all required corrective and preventative maintenance.
   2. It is the intent of these Specifications that the entire electrical power, instrumentation, and control system be complete and operable. Provide all necessary material and labor for the complete system from source of power to final utilization equipment, including all connections, testing, calibration of all equipment furnished by others, as well as equipment furnished by the Contractor, whether or not specifically mentioned but which are necessary for successful operation.
   3. The Owner, through the services of the Owner's Programmer, will provide the configuration and programming for parts of the PLC and PC based control system, as described below:
      a. The following PLCs will be programmed by the Owner's Programmer:
         1) PLC1, PLC2, PLC7.
      b. The CCS consisting of personal computers and software that will be configured by the Owner's Programmer.
      c. All other PLCs and other programmable devices shall be programmed by the Contractor, either directly or through the services of other entities such

as subcontractors, equipment suppliers, and packaged equipment suppliers (vendors).

d. The Owner's Programmer will assist with the testing of the software provided by the Programmer, as specified in this Section and in Section 17950 - Commissioning for Instrumentation and Controls.

4. Coordinate all aspects of the Work between Contractor and all subcontractors before bidding to ensure that all costs associated with a complete installation are included. The Owner is not responsible for any change orders due to lack of coordination of the Work between the Contractor, the ICSC, the other subcontractors, or suppliers.
5. Furnish detailed, complete, and thorough operations and maintenance documentation, including but not limited to operations manuals, maintenance manuals, as-built wiring drawings, training manuals, as-built software documentation, and all other documentation required to operate, modify, and maintain all parts of the PCS.
6. The Programmer will provide as-built software documentation for the PLCs and computers programmed by the Programmer. The Programmer will provide training on hardware and software items provided by the Programmer. All other documentation and training shall be by the Contractor.
7. Where demolition is indicated on the Drawings, the electrical subcontractor is responsible for disconnecting equipment electrical connections and rendering the equipment safe. The ICSC is responsible for physically removing all instrumentation to be demolished and return it either to the Owner or dispose of it as directed by the Owner's representative. The Programmer shall be responsible for any program modifications needed based on the demolition of the equipment, both for the loops directly and indirectly affected.
8. Portions of this Project involve installation in existing facilities and interfaces to existing circuits, power systems, controls, and equipment:
   a. Perform and document comprehensive and detailed field investigations of existing conditions (circuits, power systems, controls, equipment, etc.) before performing any Work.
   b. Provide and document interface with, modifications to, upgrade, or replacement of existing circuits, power systems, controls, and equipment.
9. Revise in a manner as directed by the Engineer all I/O and addressing that the Engineer determines to be unacceptable as a result of a lack of Contractor coordination between Contract Documents and all suppliers.

B. Existing system:
   1. Tertiary Feed Pumps 1-3.
   2. Tertiary Filter Cells 1-5.
   3. PLC1, and PLC2.

C. New system:
   1. Tertiary Feed Pumps 4 and 5.
   2. Tertiary Filter Cells 6 and 7 and associated VCPs.

D. Operating facility:
   1. As specified in Section 01140 - Work Restrictions.
   2. Portions of this existing facility must remain fully functional throughout the entire construction period. In consideration of this requirement, comply with the following guidelines:
      a. All outages must be of minimal duration and fully coordinated and agreed to by the Owner. Adjust the construction to meet the requirements of the Owner.
      b. As weather and facility demand conditions dictate, re-adjust the construction schedule to meet the demands placed upon Owner by its users.
      c. Where portions of the Work are in existing facilities and require interface to existing circuits, power systems, controls and equipment, perform comprehensive and detailed field investigations of existing conditions. Determine all information necessary to document, interface with, modify, upgrade, or replace existing circuits, power systems, controls, and equipment.
   3. According to individual circumstances and in compliance with the Drawings, extend or replace conduit and cable connections from existing locations.
   4. Where shown or specified, replace existing field instruments with new.
   5. Contractor is responsible for the integrity and measurement accuracy of all loops.
   6. Any defect found in existing equipment is the responsibility of the Owner. Contractor is not responsible for defects on existing Owner components.
   7. The standards of documentation, instrument tagging, cable and conductor termination, terminal identification and labeling that apply to the new installation apply equally to the existing installation.

2.03 EXISTING PRODUCTS (NOT USED)

2.04 MATERIALS

A. Furnish all materials under this Contract that are new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these devices and that bear all approvals and labels as required by the Specifications.

B. Provide materials complying with the applicable industrial standard as specified in the Contract Documents.

2.05 MANUFACTURED UNITS (NOT USED)

2.06 EQUIPMENT (NOT USED)

2.07 COMPONENTS

A. Furnish all meters, instruments, and other components that are the most recent field proven models marketed by their manufacturers at the time of submittal of the shop drawings unless otherwise specified to match existing equipment.

B. Unless otherwise specified, furnish individual instruments that have a minimum accuracy of within 0.5 percent of full scale and a minimum repeatability of within 0.25 percent of full scale.

C. Signal transmission:
   1. Analog signals:
      a. Furnish analog measurements and control signals that vary in direct linear proportion to the measured variable, unless otherwise indicated.
      b. Furnish electrical analog signals outside control panels that are 4-to-20 milliamperes 24 VDC, except as indicated.
      c. Electrically or optically isolate all analog signals from other signals.
      d. Furnish regulated analog signals that are not affected by changes in supply voltage or load resistance within the unit's rating.
      e. Maintain the total 4-to-20 milliamperes loop impedance to 10 percent below the published value at the loop operating voltage.
      f. Where necessary, reduce loop impedance by providing current-to-current (I/I) isolation amplifiers for signal re-transmission.
   2. Pneumatic signals:
      a. All pneumatic signals: 3-to-15 pounds per square inch gauge.
   3. Discrete input signals:
      a. As indicated in the controller hardware specification.
   4. Discrete output signals:
      a. Dry contacts or TRIAC outputs (with express written approval by the Engineer) as needed to coordinate with the field device.
      b. Provide external terminal block mounted fuse with blown fuse indication for all discrete outputs.
      c. Provide interposing relays for all discrete outputs for voltage and/or current compatibilities.
      d. Provide interposing relays as required for functionality of the control circuit.
   5. Signal performance and design criteria:
      a. Stability:
         1) After Controls have taken corrective action, oscillation of the final control element shall not exceed 2 cycles per minute or a magnitude of motion of 0.5 percent of full travel.
      b. Response:
         1) Any change in setpoint or controlled variable shall produce a corrective change in position of the final control element and stabilized within 30 seconds.
      c. Agreement:
         1) Setpoint indication of controlled variable and measured indication of controlled variable shall agree within 3 percent of full scale over a 6:1 operating range.
      d. Repeatability:
         1) For any repeated magnitude of control signal, from either an increasing or decreasing direction, the final control element shall take a repeated position within 0.5 percent of full travel regardless of force required to position the final element.
      e. Sensitivity:
         1) Controls shall respond to a setpoint deviations and measured variable deviations within 1.0 percent of full scale.
      f. Performance:
         1) All instruments and control devices shall perform in accordance with the manufacturers' specifications.

D. Discrete circuit configuration:
   1. Configure discrete control circuits to fail safe, on loss of continuity or loss of power.
   2. Alarm contacts: Fail to the alarm condition.
   3. Control contacts fail to the inoperative condition unless otherwise indicated on the Drawings.

E. Grounding:
   1. Analog signal cables shields shall only be grounded at a single point in the loop. Unless otherwise noted, ground signal cable shields at control panel.
   2. For communication and data line signal cable shields and drain wires should be grounded at both ends of the cable.
   3. Insulate the shielding and exposed drain wire for each signal cable with heat-shrink tubing.
   4. Terminate the signal cable shield on a dedicated grounding terminal block.
   5. Provide isolating amplifiers within control panels for field equipment possessing a grounded input or output, except when the panel circuit is galvanically isolated.

F. Instrument air:
   1. Where indicated on the Drawings, provide dry, filtered control air at 30 pounds per square inch gauge nominal pressure piped to all field instruments and instrument panels requiring air:
      a. Provide each field instrument with an integral, non-adjustable filter/regulator assembly to provide regulated air.
      b. Provide each instrument panel requiring air with an adjustable filter/regulator assembly with gauge and an air manifold to provide air to pneumatic instruments.
      c. Filter all air to 5-micron maximum particle size.
      d. Provide low pressure switch to alarm on insufficient air supply.

2.08 ACCESSORIES

A. Provide flow conditioning devices or other required accessories if necessary to meet the accuracy requirements in the Contract Documents.

B. Nameplates:
   1. Provide a nameplate for each controller, instrument transducer, instrument power supply, solenoid, or any other control device located either in the field or within panels.
   2. All nameplates shall be of identical style, color, and material throughout the facility.
   3. Device nameplates shall include:
      a. Designations as indicated on the Drawings and identified on the Process and Instrumentation Drawings.
         1) Device tag and loop number ID (e.g., FIT-60.011).
         2) PLC ID (e.g., PLC-11).
         3) Power information (e.g., PCM-11, 120 VAC).
      b. White lettering on a black background, laminated plastic.
   4. All instruments shall be equipped with Type 316 stainless steel nameplate with the instrument tag stamped in 3/8-inch letters and connected to the instrument using Type 316 stainless steel wire.

2.09 MIXES (NOT USED)

2.10 FABRICATION (NOT USED)

2.11 FINISHES (NOT USED)

2.12 SOURCE QUALITY CONTROL

A. Provide all equipment that is new, free from defects, and standard products produced by manufacturers regularly engaged in the production of these products that bear all approvals and labels as required by the Specifications.

B. Arrange with all manufacturers of the equipment and fabricators of panels and cabinets, to allow the Owner and Engineer to inspect and witness the testing of the equipment at the site of fabrication:
   1. Equipment includes the cabinets, special control systems, flow measuring devices, and other pertinent systems and devices.

C. Source Test is specified in Section 17950 - Commissioning for Instrumentation and Controls.

PART 3 EXECUTION

3.01 EXAMINATION

A. The ICSC is encouraged to visit the site and examine the premises completely before bidding. It is the ICSC's responsibility to be fully familiar with the existing conditions and local requirements and regulations.

B. Review the existing Site conditions and examine all shop drawings for the various items of equipment in order to determine exact routing and final terminations for all wiring and cables.

C. Provide a complete instrumentation and control system:
   1. Install all extra conduits, cables, and interfaces as may be necessary to provide a complete and operating electrical, and process control and instrumentation system.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. Equipment locations indicated on the Drawings may change due to variations in equipment size or minor changes made by others during construction:
   1. Verify all dimensions as indicated on the Drawings:
      a. Actual field conditions govern all final installed locations, distances, and levels.
   2. Review all information indicated on the Drawings, including architectural, structural, mechanical, instrumentation, and the accepted electrical,

instrumentation, and mechanical shop drawings, and coordinate Work as necessary to adjust to all conditions that arise due to such changes.

3. Make minor changes in location of equipment before rough in, as directed by the Owner or Engineer.

B. Perform all related Electrical Work in accordance with the applicable sections of the Electrical Specifications.

C. The PCIS configurations are diagrammatic:
   1. The locations of equipment are approximate unless dimensioned.
   2. Where Project conditions require, make reasonable changes in locations and arrangements.

D. Field instruments installation:
   1. Install field instruments as specified in the Contract Documents, API RP 550 and RP 551, and the manufacturer's instructions.
   2. Mount field instruments so that they can be easily read, readily approached, and easily serviced, and so they do not restrict access to mechanical equipment:
      a. Mount field instruments on a pipe stand or local panel, if they are not directly mounted, unless otherwise indicated on the Drawings.
      b. Provide sun shields for all field electronic instruments located outdoors.
   3. Make connections from rigid conduit systems to field instruments with PVC coated flexible conduit:
      a. Type of flexible conduit required for the area classification:
         1) Area classification as specified in Section 16050 - Common Work Results for Electrical.
      b. Maximum length of 18 inches.
   4. Connect field instruments with cable as specified in the Electrical Specifications, except when the manufacturer requires the use of special cable, or otherwise specified in this Section:
      a. Special cable applications shall be in accordance with the NEC.
   5. Verify the correctness of each installation:
      a. Polarity of electric power and signal connections.
   6. Ensure all process connections are free of leaks.

E. Process sensing lines and air tubing:
   1. Install individual tubes parallel and/or perpendicular to and near the surfaces from which they are supported.
   2. Provide supports for rigid tubing at intervals of not more than 3 feet.
   3. Slope horizontal runs of instrument tubing at a minimum of 1/16-inch per foot to allow for draining of any condensate.
   4. Bends:
      a. Make bends for parallel lines symmetrical.
      b. Make bends without deforming or thinning the walls of the tubing.
   5. Square-cut and clean all ends of tubing before being inserted in the fittings.
   6. Provide bulkhead fittings at all panels requiring pipe and/or tubing entries.

7. Use stainless steel tubing for all piping hard piped from the air header, unless otherwise indicated on the Drawings or not compatible with the fluids or atmosphere in the area:
    a. Use flexible connections only on moving equipment and under the constraint that the length shall be less than 1.5 times maximum travel of the equipment.

F. Equipment tie-downs:
1. Anchor all instruments, control panels, and equipment by methods that comply with seismic and wind bracing requirements, which apply to the Site.
2. All control panels, VCPs, LCPs, RTUs, PCMs, etc., shall be permanently mounted and tied down to structures.

G. Existing instrumentation:
1. Clean, recondition and re-calibrate each existing instrument to be reused, removed, or reinstalled using an authorized service facility of the instrument manufacturer.
2. Provide certification of this Work before reinstallation of each instrument.

H. Instrument tagging:
1. As specified in Section 16075 - Identification for Electrical Systems.
2. Provide all field-mounted instruments with nameplates:
    a. Nameplates engraved with the instrument's full tag number as indicated on the Drawings:
        1) Affix tags with stainless steel wire fasteners.
3. Provide all back of panel instruments with nameplates:
    a. Engraved with the instrument's full tag number as indicated on the Drawings.
4. Provide all front of panel instruments with a nameplate:
    a. Engraving to include the following:
        1) Instrument's full tag number.
        2) Service description.
    b. Nameplates:
        1) Secure nameplates to the panel with stainless steel screws.
        2) Use an accepted adhesive if screws would violate the NEMA or other ratings of the enclosure.

I. Cable and conductor termination:
1. Terminate all cables and conductors on terminal blocks.
2. Terminal block enclosures:
    a. Suitable for the area classification as specified in Section 16050 - Common Work Results for Electrical.

J. Surge protection:
1. Provide outdoor field instrument loops with voltage surge protection units installed on the instruments and the panel.
2. Individually fuse each 4 to 20 milliamperes direct current loop with a 1/2-ampere fuse between power supplies and receiver surge protectors.
3. Provide voltage surge protection for 4 wire transmitters and analyzers:
    a. Protect both power source and signal loop.

K. Scope and responsibilities:
   1. Refer to the following table for procurement and installation scope and responsibilities for the owner, design engineer, contractor, integrator, and programmer.

Item No.	Task	Responsible Parties					Service or Equipment Supplied By
		Owner (O)	Design Engineer (DE)	Contractor (C)	Integrator (I)	Programmer (P)	
1.00	**I&C Design Update**						
1.01	Owner-furnished equipment procurement.	L	A				O
1.02	Equipment and package system procurement.			L			C
1.03	Equipment and package system submittal preparation.			L			C
1.04	Equipment and package system submittal review.	A	L			A	DE/ O
1.05	Update I&C design to incorporate any changes, if changes approved by Owner during the submittal processes, for equipment and/or package systems.	A	L		A		DE
2.00	**HMI Application Programming**						
2.01	HMI software application programming.	A		A	A	L	P
2.02	Develop PLC/DCS interfaces to Vendor package systems (Vendor package system programmed by Vendor).	A		A	A	L	P
2.03	Digital field network interface and network configuration (ownership including calibration and setup).	A		A	A	L	P
2.04	HMI graphical user interface.	A		A	A	L	P
3.00	**Vendor Package and Auxiliary System Application Programming**						
3.01	Vendor Package PLC software application programming (procured by Contractor).			A	L	S	I
3.02	Configuration of auxiliary systems necessary to provide required functionality and connectivity for monitoring and control of auxiliary systems: HVAC, power monitors, lighting, and fire protection.			A	L		I

Item No.	Task	Responsible Parties					Service or Equipment Supplied By
		Owner (O)	Design Engineer (DE)	Contractor (C)	Integrator (I)	Programmer (P)	
4.00	**Integration**						
4.01	Instrumentation specifications and procurement.			A	L		I
4.02	Vendor-supplied package and auxiliary system coordination with plant PLC/DCS (communications, submittals, software development).			A	L	S	I
4.03	Vendor package systems and auxiliary system interface demonstration at FAT, where required.			S	L	S	I
4.04	Control system equipment, Vendor package system, and auxiliary system interface submittal review and preparation for formal Owner review.			S	L		I
4.05	I&C design update to reflect approved Vendor submittals (if required).	A	L	S	S		
5.00	**Equipment and Panels**						
5.01	***PLC/DCS Process Control System***						
5.02	PLC/DCS control panels and associated panel equipment procurement.			A	L		I
5.03	PLC/DCS control panels and associated panel equipment fabrication.			A	L		I
5.04	PLC/DCS control panels factory testing.	W	W	A	L	A	I
5.05	PLC/DCS installation.	W		A	L		I
5.06	PLC/DCS field testing OAT, SAT.	W	W	A	L	A	I
5.07	Operator interface stations (both in panel and desktop) related setup and configuration.	W		A	A	L	P
5.08	Field PLC/DCS interfaces (HMIs).			A	L	A	I
5.09	***Communications***						
5.10	Fiber patch panel procurement and installation.			A	L		I
5.11	Ethernet switch procurement and installation.			A	L		I

Item No.	Task	Responsible Parties					Service or Equipment Supplied By
		Owner (O)	Design Engineer (DE)	Contractor (C)	Integrator (I)	Programmer (P)	
5.12	Copper patch panel procurement and installation.			A	L		I
5.13	Uninterruptible power supply procurement and installation.			A	L		I
5.14	***Field Local Control Panels (LCPs)***						
5.15	LCP procurement and fabrication.			A	L		I
5.16	LCP installation.			A	L		I
5.17	***Local Operator Interfaces (LOIs)***						
5.18	LOI procurement and fabrication.			A	L		I
5.19	LOI installation.			A	L		I
5.20	LOI programming.			A	A	L	P
5.21	***Control Room***						
5.22	Workstation furniture procurement and installation.			A	L		I
6.00	**Instruments and Control Valves**						
6.01	Submittal and datasheets.			A	L		I
6.02	Procurement.			A	L		I
6.03	Installation.			A	L		I
6.04	Setup and/or calibration.			A	L		I
7.00	**Electrical and Mechanical for Process Control System**						
7.01	Building electrical provision and installation - cable/conduit/wire.			A	L		I
7.02	Building mechanical provision and installation - including process instruments related tubing.			L	A		C
7.03	Building wiring racks and supports (cable and/or conduit) - coordinated with Division 16 power contractor where applicable.			L	A		C

Item No.	Task	Responsible Parties					Service or Equipment Supplied By
		Owner (O)	Design Engineer (DE)	Contractor (C)	Integrator (I)	Programmer (P)	
7.04	Building internal fiber-optic backbone conduit installation (from building entrance/duct bank).			A	L		C
7.05	Building internal communication wiring - DeviceNet, Modbus, Ethernet, etc. from PLC/DCS and/or patch panel.			A	L		C
7.06	Electrical and mechanical installation inspection.	W	A	L	A		C
7.07	Vendor package - On/off skid-related electrical controls installation.			A	L		I
7.08	Vendor package - On/off skid-related mechanical controls installation.			L	A		C
7.09	Vendor package electrical and mechanical installation inspection.	W	A	L	A		C
7.10	Site fiber-optic backbone cable installation, termination, and certification testing.			A	L		I
7.11	Network testing.	W	A	A	L		I
8.00	**Process Start-Up**						
8.01	Pre-operation and component test.	W	A	A	L	A	I
8.02	Loop checkout.	W	A	A	L	A	I
8.03	System Acceptance Test (SAT).	W	A	A	L	A	I
8.04	Operational testing.	W	A	A	L	A	I
8.05	Commissioning testing.	L	A	A	A	A	O
9.00	**Process Closeout**						
9.01	Redline drawings and/or electronic files submittal to Owner.			A	L		I
9.02	As-builts (record set) - Update all drawings.			A	L		I
9.03	Operation and maintenance manuals.			A	L		I
9.04	Operational testing and commissioning sign-off forms.	W	W	A	L		I

Item No.	Task	Responsible Parties					Service or Equipment Supplied By
		Owner (O)	Design Engineer (DE)	Contractor (C)	Integrator (I)	Programmer (P)	
9.05	Training.	W		A	L	S	I
9.06	Commissioning (process performance testing).	L	A	A	A	S	O
Key: L – Lead, A – Assist, S – Support, W – Witness							

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. As specified in Section 01756 - Commissioning.

B. Owner Training:
   1. Demonstration requirements are specified in Section 17950 - Commissioning for Instrumentation and Controls.

3.08 FIELD QUALITY CONTROL

A. Inspection:
   1. Allow for inspection of PCIS installation as specified in Section 01450 - Quality Control.
   2. Provide any assistance necessary to support inspection activities.
   3. Engineer inspections may include, but are not limited to, the following:
      a. Inspect equipment and materials for physical damage.
      b. Inspect installation for compliance with Drawings and Specifications.
      c. Inspect installation for obstructions and adequate clearances around equipment.
      d. Inspect equipment installation for proper leveling, alignment, anchorage, and assembly.
      e. Inspect equipment nameplate data to verify compliance with design requirements.
      f. Inspect cable terminations.
      g. Inspect/witness instrument calibrations/verifications.
   4. Inspection activities conducted during construction do not satisfy inspection requirements specified in Section 17950 - Commissioning for Instrumentation and Controls.

B. Instrument Installation Inspection:
   1. Provide any assistance necessary to support inspection activities.
   2. Inspections may include, but are not limited to, the following:
      a. Inspect equipment and materials for physical damage.
      b. Inspect the installed arrangement, lay lengths, orientation, piping obstructions, etc., that could affect the instruments accuracy or repeatability.
      c. Inspect installation for compliance with Drawings and Specifications.
      d. Inspect installation for obstructions and adequate clearances around equipment.
      e. Inspect equipment installation for proper leveling, alignment, anchorage, and assembly.
      f. Inspect equipment nameplate data to verify compliance with design requirements.
      g. Inspect cable terminations.
      h. Inspect/witness instrument calibrations/verifications.
   3. Inspection activities conducted during construction do not satisfy inspection requirements specified in Section 17950 - Commissioning for Instrumentation and Controls.
   4. Field acceptance testing: (Functional Testing) is specified in Section 17950 - Commissioning for Instrumentation and Controls. Additional general requirements are specified in Section 01756 - Commissioning.

C. Installation supervision:
   1. Ensure that the entire PCIS is installed in a proper and satisfactory manner. At a minimum, the ICSC shall provide the following services:
      a. Installation resources:
         1) Coordinate with the Contractor regarding installation requirements of the Contract Documents.
      b. Provide technical assistance to installation personnel by telephone:
         1) Furnish installation personnel with at least 1 copy of the accepted submittals, including all installation details.
      c. Periodic inspections during the construction period.
      d. A complete check of the completed installation to ensure that it is in conformance with the requirements of the equipment manufacturer and the Contract Documents.
      e. Field verify accuracy and calibration of all instruments.

3.09 ADJUSTING

A. Control valves:
   1. Stroke all control valves, cylinders, drives and connecting linkages from the control system as well as local control devices and adjust to verify proper control action, hand switch action, limit switch settings, torque settings, remote control actions, and remote feedback of valve status and position.
   2. Check control valve actions and positioner settings with the valves in place to ensure that no changes have occurred since the bench calibration.

B. Make all revisions necessary to the control system software, as directed by the Engineer:
   1. It is understood that the Contractor knows and agrees that changes will be required in the control system software during the Source Testing, Functional

Testing, Process Operational Period, Process Start-Up, and during the Project Correction Period.

3.10 CLEANING

A. As specified in Section 01770 - Closeout Procedures.

B. Vacuum clean all control panels and enclosures before process start-up and again after final completion of the project.

C. Clean all panel surfaces.

D. Return to new condition any scratches and/or defects.

E. Wipe all instrument faces and enclosures clean.

F. Leave wiring in panels, manholes, boxes, and other locations in a neat, clean, and organized manner:
   1. Neatly coil and label all spare wiring lengths.
   2. Shorten, re-terminate, and re-label excessive spare wire and cable lengths, as determined by the Engineer.

G. As specified in other sections of the Contract Documents.

3.11 PROTECTION

A. Protect all Work from damage or degradation until date of Substantial Completion.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 17100

CONTROL STRATEGIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Contractor-developed loop description submittal requirements.
   2. General programming requirements.
   3. Common control functions:
      a. General control and monitoring functions to be provided throughout the PCS system:
         1) These requirements apply to all systems, and supplement the specific loop descriptions in Section 17101 - Specific Control Strategies and information indicated on the Drawings.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.03 DEFINITIONS

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Hardwired control: Control circuitry that does not utilize software to initiate functionality.

C. Hardwired interlocks: A safety or protective feature that will interrupt operation of the equipment in all operating modes with no required operator intervention.

D. Software interlocks: A safety or protective feature that will interrupt operation of the equipment when the PLC has control.

E. Slew rate: Rate of change in respect to time.

F. Clamp: Imposed upper and lower limits on setpoints to eliminate entries outside the allowable control parameters.

G. Watchdog timer: Timers imposed to test components such as discrete I/O to verify the health of the card.

1.04 SYSTEM DESCRIPTION (NOT USED)

1.05 SUBMITTALS

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.06 QUALITY ASSURANCE (NOT USED)

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS (NOT USED)

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION (NOT USED)

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. General programming requirements:
   1. Use variable names or aliases derived from tag and loop identification on the P&IDs for all process values:
      a. Submit names for Owner approval.
      b. Unless otherwise noted, utilize floating-point format for all PLC algorithms and calculations.
      c. Provide PLC logic to convert raw input values into engineering units in a floating-point format.
   2. Store all adjustable parameters in the PLC, and configure so that an operator with sufficient security access can change the parameters from the LOI or HMI. Update and display the current value at all locations, regardless of where the last change was made.
   3. Reusable PLC code blocks:
      a. Owner will provide standard user defined function blocks (UDFBs) and user-defined types (UDTs) for PLC programming. Utilize these standards wherever possible in PLC programming.
      b. Develop and use new standard user defined function blocks (UDFBs) and user defined types (UDTs) where appropriate. One instance of each standard code block shall reside in each PLC and shall be referenced in main routines and subroutines.
      c. New code blocks that the Contractor would like to use as a standard shall be submitted to Owner for review and approval.
   4. Documentation:
      a. All control logic shall be completely annotated including all rungs, instructions, and tags.
      b. Each routine shall have a title and a detailed description of the control strategy represented by the control logic. Where parameters are passed to the routine, all parameters shall be defined in the routine description.
      c. Analog tag descriptions representing process variables shall include the engineering unit range of the analog variable.
      d. Digital tag descriptions shall include the On and Off state labels.
      e. Complete, grammatically correct sentences and terminology, consistent with water treatment processes, shall be utilized in the development of rung and routine descriptions.
      f. All equations developed in the process logic shall be fully documented in the rung or routine description. A description of each constant and variable utilized in the equation shall be defined including engineering units.
   5. Program slew rates for setpoints as needed to limit the effect of updated setpoints on the process:
      a. Provide for control setpoints and manual speed and position selections.
      b. Store new setpoints in one register, and gradually ramp the actual setpoint register at the slew rate until it reaches the new value.
      c. Provide operator access to change slew rates from the HMI.

6. Saved setpoints:
    a. Provide an operator selection to save all setpoint values.
    b. Where possible use a DFB or AOI to provide an operator selection to restore all setpoints to the initial start-up value.
    c. Provide an operator selection to restore all setpoints to the last saved value.
7. Store a copy of all adjustable parameters and accumulated and integrated totals in PCS:
    a. Upon re-loading of the PLC program, re-load these values to the PLC from PCS or processor memory card.
    b. PLCs provide a minimum 2 week data storage to provide for data accumulation and later communication to the Historian in the event of a network interruption.
8. Calculated values:
    a. Program calculations such that division by zero errors cannot occur.
    b. Prevent calculations from generating values that exceed the limits of the equipment or data type structures (integers) internal to the PLC.
    c. Configure counting functions (start counts and operation counts) to allow a minimum of 10,000 counts, and to roll-over to zero at an even decimal interval (1 followed by 4 or more zeros).
    d. Configure integrating functions to accurately accumulate the maximum rate from the instrument/equipment (totalizers, run time meters) for 30 years. Utilize manufacturer AOI/DFBs etc. where possible.
9. Timers:
    a. Provide programmable settling and proving timers in control sequences as required for starting and stopping of equipment to allow the process to settle down before proceeding with any additional control functions:
        1) The settling timers may be overridden by setting the timer to 0 seconds.
10. Control Panel status:
    a. Design the PLC system to function as a stand-alone unit that performs all of the control functions described in this Section completely independent from the functions of the PCS system PC-based operator interfaces:
        1) Failure of the PCS system shall not impact data acquisition, control, scaling, alarm checking, or communication functions of the PLC.
    b. Furnish a minimum of 1 screen that depicts the status of all enclosures containing PLCs, communication equipment, UPS or I/O in the control system, including but not limited to the following:
        1) PLC cabinet over-temperatures from high temperature switch.
        2) Intrusion status on all enclosures equipped with intrusion switches.
        3) AC power failure:
            a) Monitor ahead of UPS.
        4) DC power supply failure:
            a) For redundant power supplies, alarm when either power supply or the diode bridge fails.
        5) UPS failure signal.
        6) UPS Low Battery signal.
        7) Digital bus network Coupler and or Gateway failure signal.
        8) Ethernet Switch failure signal.

11. PLC system communication status:
    a. Furnish a minimum of 1 screen to display all communication errors and status within the PCS:
        1) Communication between PCS and PLCs, PLC to PLC, PLC to RIO and PLC and or PCS to VCP.
        2) 4-20 mA HART interface cards.
        3) Digital bus network status:
            a) Profibus scanners.
        4) Modbus Gateway modules.
        5) Display status of each node, and summary of failures over the past 60 minutes.
    b. Generate a communications alarm if any communication fault is detected or there is no response from a node for more than a user specified time.
    c. In the event of communications loss:
        1) Continue normal operation at each PLC.
        2) Where control parameters are received over a communications link:
            a) If a link fails where process elements use the remote value for closed-loop control, hold operating status, speed and position, of the process elements at their last state before the communication alarm, unless other I/O local to that PLC indicates shutdown or over-ride conditions:
                (1) Ensure that the operator can control the process using PCI\S HAND mode at the local LOI.
            b) If a link fails where process elements use the remote value to determine setpoints, continue to operate using the last value received:
                (1) Provide a manual over-ride entry at the local LOI to allow an operator to enter a different value for any such remote signal.
                (2) Generate an alarm whenever an over-ride value is in use.
12. 4-20 mA Hart interface cards:
    a. Provide the following HART protocol information for each populated channel on the card:
        1) Process variable values:
            a) Primary process variable (analog): 4-20 mA current signal.
            b) Primary process variable (digital): Digital value in engineering units.
            c) Percent range: Primary process variable expressed as percent of calibrated range.
            d) Loop current: Loop current value in milliamps.
            e) Secondary process Variable 1: Digital value in engineering units available from multivariable devices (if applicable).
        2) Host commands:
            a) Set primary variable units.
            b) Set upper range.
            c) Set lower range.
            d) Set damping value.
            e) Set message.
            f) Set tag.
            g) Set date.
            h) Set descriptor.
            i) Perform loop test: Force loop current to specific value.

j) Initiate self-test: Start device self-test.
k) Get more status available information.

3) Status and diagnostic alerts:
   a) Device malfunction: Indicated device self-diagnostic has detected a problem in device operation.
   b) Configuration changed: Indicates device configuration has been changed.
   c) Cold start: Indicates device has gone through power cycle.
   d) More status available: Indicates additional devices status data available.
   e) Primary variable analog output fixed: Indicates device in fixed current mode.
   f) Primary variable analog output saturated: Indicates 4-20 mA signal is saturated.
   g) Secondary variable out of limits: Indicates secondary variable value outside the sensor limits.
   h) Primary variable out of limits: Indicates primary variable value outside the sensor limits.

4) Device identification:
   a) Instrument tag: User defined, up to 8 characters.
   b) Descriptor: User defined, up to 16 characters.
   c) Manufacturer name (code): Code established by HCF and set by manufacturer.
   d) Device type and revision: Set by manufacturer.
   e) Device serial number: Set by manufacturer.
   f) Sensor serial number: Set by manufacturer.

5) Calibration information:
   a) Date: Date of last calibration, set by user.
   b) Upper range value: Primary variable value in engineering units for 20 mA point, set by user.
   c) Lower range value: Primary variable value in engineering units for 4 mA point, set by user.
   d) Upper sensor limit: Set by manufacturer.
   e) Lower sensor limit: Set by manufacturer.
   f) Sensor minimum span: Set by manufacturer.
   g) PV damping: Primary process variable damping factor, set by user.
   h) Message: Scratch pad message area (32 characters), set by user.
   i) Loop current transfer function: Relationship between primary variable digital value and 4-20 mA current signal.
   j) Loop current alarm action: Loop current action on device failure (upscale/downscale).
   k) Write protect status: Device write-protect indicator.

C. Common control functions:
   1. Incorporate common control functions into all control loops and devices and into the control programming, whether or not specifically shown in the specific control descriptions or elsewhere in the Contract Documents.
   2. Alarms:
      a. Generate alarms within the PLC logic.

b. Indicate alarms at the LOI and HMI. Enable acknowledgement from either the HMI or the LOI.
c. Generate high, high-high, low, and low-low level alarms where indicated:
    1) Provide an alarm reset deadband for each analog value to prevent excessive repeated alarms.
    2) Provide logic and timers to inhibit analog alarms based on process events. For example, inhibit low flow alarms when a pump is stopped, or has not been running long enough to establish flow.
d. Flash all alarm and fail conditions and their respective indicators on the PCS graphic screens and local indicating lights until the condition is acknowledged by the operator, even if the alarm condition is no longer present.
e. Once the alarm is acknowledged by an operator, display alarm conditions in a steady state (not flashing) while the alarm condition is still present:
    1) Flash with a cycle rate of 1/2 second on and 1/2 second off.
f. Once the alarm has been cleared and the operator has acknowledged the alarm or fail condition, turn the graphic alarm indicator off.
g. For all alarms that do not have inherent timers, provide an operator-adjustable proving timer to limit nuisance alarms, continuously adjustable from zero seconds to 100 minutes. The initial setting of proving timers shall be zero seconds:
    1) The PLC shall start the timer when it first detects an alarm condition, and shall only activate the alarm after the timer has expired.
    2) If the alarm condition clears while the timer is running, the timer shall reset, and the alarm shall not be activated.
h. Use interlocks and proving timers to prevent alarms from operating due to power loss, except for loss of power alarms.
i. Furnish an alarm silence pushbutton at each PCM, LOI, or LCP with an audible alarm to signal the PLC to turn off the audible alarm until the next alarm occurs.
j. Lamp test: Furnish lamp test pushbuttons at each control panel with more than 10 pilot lights, that illuminates all pilot lights on the panel:
    1) The lamp test may sequence through blocks of lights.
    2) Minimum on time for each lamp during lamp test 15 seconds.
k. Horns and Beacons:
    1) Activate PCM horn and beacon on all critical alarms and on other alarms as defined by the Facility Alarm Philosophy.
    2) Deactivate PCM horn and beacon when PCM reset pushbutton is activated.
    3) Silence PCM horn when PCM silence pushbutton is activated.
l. Dual analog instruments:
    1) For applications where 2 or more analog instruments are measuring the same process variable:
        a) Generate an operator adjustable percent deviation alarm.
        b) Allow operator to take each instrument out of service when an instrument is out of service.

3. Where a reset is shown for counts, totals and times maintained in the PLC:
    a. Provide a reset selection on the HMI screen that displays the value.
    b. Provide a preset function on the HMI to allow an operator-entered value to become the current accumulated total.
    c. Limit access to the reset and preset functions to operators with suitable security level.

d. Log the value before reset, operator, time, and date of reset in the PCS archive.
e. Log the value before preset, preset value, operator, time, and date of preset in the PCS archive.

4. Where start counts are indicated on the Drawings, or required in this Section, count starts for each piece of equipment (off to on transitions of running status) in the PLC:
   a. Display total starts on PCS screens, and provide a reset function.
   b. Where indicated, calculate number of starts for each day:
      1) Display current day and previous day starts on PCS displays.
      2) Do not reset daily start count when overall count is reset.
      3) Archive starts for each day through PCS.
5. Where run time accumulation is indicated on the Drawings, or required in this Section, integrate accumulated run time to the nearest 0.1 hour whenever the running status input indicates that the equipment is running:
   a. Display total run time in hours on PCS screens.
   b. Where indicated, calculate total run time for each day:
      1) Display current day and previous day run time on the HMI to the nearest 0.1 hour.
      2) Do not reset daily run time when overall time is reset.
      3) Archive run time for each day through PCS.
6. For all monitored analog values:
   a. Convert all values to engineering units in floating-point format within the PLC.
   b. Maintain trends in PCS.
   c. Flows and Weights:
      1) Totalize flows in the PLC logic:
      2) Where totalized flows are input to a discrete input, count input pulses and multiply by the volume per pulse.
      3) Where no totalizer input is shown, integrate the analog input over time.
      4) Display totals on the HMI and LOI.
      5) Archive totals to the historical database through PCS.
   d. Generate an alarm whenever an over-ride value is in use.
   e. Calculate hourly, daily, and monthly averages:
      1) Calculations shall be performed by the PLC.
      2) Display averages on the HMI, and archive through PCS.
   f. Calculate minimum and maximum values each day, and month:
      1) Calculations may be performed by the PLC or PCS.
      2) Display minima and maxima on the HMI, and archive through PCS.
   g. Generate an alarm whenever an over-ride value is in use.
7. Analog data processing:
   a. Engineering units conversion:
      1) Use engineering units for all analog point values. Convert analog inputs to engineering units.
   b. Analog magnitude checking:
      1) Provide upper and lower limits to prevent operator-entered values (setpoints, etc.) from falling outside acceptable limits.

c. Analog value quality:
    1) Monitor analog values received at each PLC from analog inputs or communications from another PLC or RIO specific to critical analog values, and generate alarms for the following conditions:
        a) Rate of change in excess of acceptable limit:
            (1) Provide a separate rate limit for each value.
        b) Stale value:
            (1) For analog signals that come from analog inputs or calculations using analog inputs, which are expected to have some variation each time the input is read, alarm when there is no change in the value for 10 times the normal expected scan or communication update.

8. Tank and vessel levels:
    a. Display all tank and vessel levels as both a level (typically in feet) and a volume (typically in gallons):
        1) Some individual displays may be only level or volume, when agreed to by the Owner and Engineer during screen meetings.
    b. Monitor rate of change of volume on all tanks and vessels:
        1) Establish the maximum withdraw rate at which the volume should decrease (all pumps or feeders operating at maximum output). Generate an alarm whenever the volume decreases faster than this rate.
        2) Establish the minimum fill rate at which the volume should increase when filling. Generate an alarm whenever the volume increases faster than this rate. Verify tank and vessel level is fluctuating to verify the validity of the IO register. If it is determined the register is not active or failed in a manner that leaves a stagnant value generate an alarm.
9. I/O filtering and processing:
    a. Analog input filtering:
        1) For each analog input provide an adjustable first order filter, for the purpose of smoothing out spikes and other noise for analog transmitter input signals. By default, configure analog inputs with no filtering affect.
        2) Monitor analog input signal quality:
            a) Over range: The input value is above the normal range (typically over 21 mA).
            b) Under range: The input value is below the normal range (typically under 3 mA, indicating a probable broken connection).
            c) Generate alarms for over or under range inputs.
            d) Do not use over or under range values for control or calculation purposes:
                (1) Where a second instrument is provided to monitor the same condition (a redundant instrument, or additional instruments furnished for averaging or different operating modes), and has a valid signal, use that input for control.
                (2) Otherwise, hold all outputs affected by the signal at their last values before the signal went out of range.

3) Digital input filtering (proving timer):
a) Provide an adjustable time delay function (0-10 seconds) on discrete input for the purpose of de-bouncing.
b) By default, discrete inputs shall be configured with de-bounce timers set to zero seconds.

10. Instrument scaling (HMI/LOI):
    a. Provide 1 or more maintenance screens to display ranges and trigger points for all field instruments:
        1) For analog instruments, use input scaling values in the PLC to determine minimum and maximum calibration points.
11. PCS HAND-OFF-AUTO:
    a. Where indicated, provide HAND-OFF-AUTO and START-STOP selections in the PCS, accessed from an LOI or HMI for operators with sufficient security, to provide the following operating modes:
        1) PCS AUTO: The normal, automatic control mode of the strategy which allows full PLC control in response to process conditions and programmed sequences.
        2) PCS HAND: Enables PCS Manual control where control decisions are made by an operator through the PCS START-STOP, OPEN/CLOSE, or other selections as indicated.
        3) PCS OFF: Automated PCS control is disabled and PLC calls for all associated equipment to stop and valves to close or go to their identified safe state.
        4) Program the PLC so that switching a strategy between AUTO and HAND (either direction) occurs with a smooth transition. Keep running or position status unchanged when control is switched to HAND until a change is requested using the operator selections (START, STOP, OPEN, CLOSE). Keep running and position status unchanged when control is switched to AUTO until the control logic determines a change is required.
12. Interlocks:
    a. Implement software interlocks where indicated to place equipment in a safe condition in response to impending hazardous process conditions. Apply software interlocks when equipment is operating in PCS AUTO or PCS HAND:
13. Permissives:
    a. Implement software permissives where indicated to prevent equipment from starting in an unsafe condition.
    b. Apply software permissives when equipment is operating in PCS AUTO or PCS HAND.
14. Process control algorithms:
    a. Jog and hold: Unless otherwise indicated, use jog and hold control algorithms where possible:
        1) When the error between process variable and setpoint is beyond a setpoint deadband:
            a) Jog valve or ramp speed in the required direction for a preset “Jog Time” or until the process variable reaches or passes the setpoint.

b) Then hold speed or position through a setpoint “Hold Time.”
c) Continue alternating jog and hold until the error is less than the deadband.

2) Provide operator access to Jog Time and Hold Time setpoints from the HMI.

b. PID algorithms: Use where indicated, or where necessary to provide fast response:

1) Provide a PID faceplate with the following displays and functions for each PID control algorithm:
a) Display Output, CV.
b) Display Setpoint, SP.
c) Display Process Variable, PV.
d) Allow for operator selection of Automatic or Manual control of the output.
e) Under Manual control of output allow the operator to enter the desired output value.
f) Allow for input of the 3 Proportional, Integral, and Derivative tuning parameters.
g) Configure PID loops to prevent reset windup when controlled equipment is operating in Manual (local or PCS), or when the equipment has reached a physical limit.
h) When controlled equipment is being operated in remote PCS HAND, configure the PID function to track the process variable to provide a smooth transfer between Manual and Automatic modes.
i) Provide selectable slew rates with adjustable setpoints to allow the PID algorithm to slowly ramp to its final value to minimize system disturbance.

15. Equipment alternating and sequencing:
a. Distribute number of starts and run time equally between identical equipment.
16. Motor control:
a. Monitor the device’s LOCAL-OFF-REMOTE (LOR) switch (the hard-wired switch at the MCC, drive or equipment) to determine when the PLC has control of the associated equipment:
1) Display current REMOTE status on the PCS screens.
b. Monitor the device’s running status from the starter auxiliary or run status input:
1) Display the current status (running or stopped) on the PCS screens.
2) Use status to calculate total run time and daily run time, and to count total starts and daily starts.
3) Provide time stamp for each start.
4) For motors 200 HP and greater, provide software to prevent exceeding the manufacturer’s recommended maximum starts per hour.
c. When equipment control has been given to the PLC as reported by the LOCAL-OFF-REMOTE switch, allow selection of PCS AUTO or PCS HAND control modes based upon operator selection using the PCS screens.
d. Starting, stopping and running when the device LOR is in LOCAL:
1) With the LOR switch in the LOCAL position, the motor is controlled by the START and STOP pushbuttons.

2) With the LOR switch in the OFF position, the motor is prohibited from running.
3) With the LOR switch in the REMOTE position, the motor is controlled remotely.

e. Starting, stopping and running when the device LOR is in REMOTE:
1) When the motor is expected to be running (PLC has issued a START or RUN due to process conditions or operator selection), LOR is in REMOTE, and the device is not reported to be running, start an operator adjustable “Control Activation” timer:
a) Provide “Control Activation” timers for each piece of controlled equipment:
(1) If the LOR and required running status do not change, and the PLC does not receive running status within the “Control Activation” time period:
(a) De-activate the output.
(b) Place the device in a “Failed” state.
(c) Generate a “Failed to Respond” alarm.
2) When the motor is not expected to be running (PLC has issued a STOP or removed the RUN output), LOR is in REMOTE, and the device is reported to be running, start the “Control Activation” timer:
a) If the LOR and required stopped status do not change, and the PLC does not lose the running status within the “Control Activation” time period:
(1) Keep the RUN output off or the STOP output on.
(2) Place the device in a “Failed” state.
(3) Generate a “Failed to Respond” alarm.
3) Re-establish PLC control of a device in a “Failed” state only after the following:
a) An operator turns the device’s LOR switch out of REMOTE, and back to REMOTE (i.e., REMOTE input to the PLC cycles off and back on).

f. Where motor winding high temperature switches or RTD temperature elements are shown, generate an alarm when high temperature is sensed (contact opens or temperature above the high alarm setpoint), but do not stop the motor unless otherwise indicated.

g. Motor equipped with current detection shall shut down and report a “failed” status on detection of high current.

h. Control two-speed motors similar to other motors, except as listed below:
1) Motor states are RUN-FAST, RUN-SLOW, and STOP.
2) Start all two-speed motors in the RUN-SLOW state. If or when the high speed is required (RUN-FAST operator selection or process conditions), transition to RUN-FAST after a designated time.
3) When transitioning from RUN-FAST to RUN-SLOW, remove the RUN-FAST output or issue a STOP, then wait for a “Fast to Slow” time delay before energizing the RUN-SLOW or START-SLOW output.

i. Simultaneous starts:
1) Prevent more than one motor-driven load 25 HP or larger in the same facility from starting concurrently:
a) When starting one load, inhibit start logic for all other such equipment until the load being started is up to speed (RVSS or

VFD), or after a setpoint time delay (full-voltage starters and miscellaneous equipment).

j. Speed control:
   1) Modulate speed on VFD-driven motors using jog and hold, or PID control algorithms to maintain process conditions as described in the specific loop descriptions.
   2) Operate speed control within a pre-defined range:
      a) Minimum speed as determined by equipment manufacturer. The higher of:
         (1) Minimum motor speed to maintain adequate cooling for the type of load driven (constant or variable torque).
         (2) Minimum equipment speed, such as minimum speed to deliver flow or to deliver minimum flow for equipment cooling or lubrication.
      b) Maximum speed 100 percent (60 hertz) or as identified by equipment manufacturer.
   3) Where multiple equipment may operate together to maintain the same process condition:
      a) Provide an operator selection for starting sequence.
      b) Start the first equipment at a preset starting speed.
      c) When one or more equipment is running and the speed control algorithm reaches a preset “Start Next” speed value (initially 95 percent of speed range) through a preset time delay:
         (1) Start the next available equipment at the preset starting speed.
         (2) Ramp up the started equipment and ramp down the previously running equipment to the mid operating speed (adjustable in the PLC). Determine preset values for each condition based on equipment and system characteristics to provide approximately the same total flow or process condition with the new load running at the mid speed (for example if one pump is running and the second pump will be added, then the total flow of both pumps running at mid operating speed should be approximately the same as flow of one pump at Start Next speed).
         (3) Once both equipment reach the mid operating speed, resume the speed control algorithm for those equipment.
         (4) Operate all equipment at the same speed following the output of the speed control algorithm.
      d) When two or more pieces of equipment are running, monitor for a “Stop Next” condition:
         (1) Where flow rate is monitored, use a preset “Stop Next” flow rate for each possible number and combination of equipment:
            (a) Determine initial “Stop Next” speed based on the flow that can be provided with one fewer piece of equipment running at a speed slightly below the “Start Next” speed.
         (2) When the “Stop Next” condition exists through a preset time delay:
            (a) Ramp speed of running equipment except for the equipment to be stopped up to a preset value based

on the number of items running. Determine preset values for each condition based on equipment and system characteristics to provide approximately the same total flow or process condition with one fewer load running (typically slightly below the preset "Start Next" speed) while ramping speed of equipment to be stopped down to the preset minimum speed.

(b) Operate all remaining equipment at the same speed following the output of the speed control algorithm. Stop the load once it reaches minimum speed.

17. Gate and valve control:
    a. Monitor the device's LOCAL-STOP-REMOTE (LSR) switch(es) (the integral switch in the actuator or hard-wired switch at the local control station):
        1) Display current REMOTE status on PCS screens.
    b. Start an "Open Activation" timer whenever the device is expected to be open (PLC has issued an OPEN command in PCS AUTO, or OPEN was selected in PCS HAND):
        1) Initially set "Open Activation" time to twice the normal opening time.
        2) If the LSR position and open command do not change, and the PLC does not receive fully open status feedback within the "Open Activation" time period:
            a) De-activate the open output.
            b) Place the device in a "Failed" state.
            c) Generate a "Failed to Open" alarm.
    c. Start a "Close Activation" timer whenever the device is expected to be closed (PLC has issued a CLOSE command in PCS AUTO, or CLOSE was selected in PCS HAND):
        1) Initially set "Close Activation" time to twice the normal closing time.
        2) If the LSR position and close command do not change, and the PLC does not receive fully closed status feedback within the "Close Activation" time period:
            a) De-activate the close output.
            b) Place the device in a "Failed" state.
            c) Generate a "Failed to Close" alarm.
    d. Limit the number of open/close /commands so that it does not exceed the manufacturer requirements.
    e. For modulating valves (valves controlled from either a 4-20 mA signal or digital communications command) with position feedback, start a "Position Error" timer whenever the position feedback differs from the required position command by more than a setpoint error when the LSR is in REMOTE:
        1) For analog modulating devices, error is determined by position feedback differing from position command by more than the setpoint error.
        2) For discrete modulating devices, error is determined by feedback not changing in the correct direction, or changing at less than a setpoint rate, when the OPEN or CLOSE PLC output is active.
        3) Initially set the "Position Error" time to 60 seconds.

4) If the LSR position does not change, and position error stays outside of the setpoint error through the “Position Error” time period:
a) Place the device in a “Failed” state.
b) Generate a “Position Fail” alarm.

f. Provide separate time delay settings for each function and for each device.

g. If the valve position inputs indicate an invalid state (i.e., valve open and closed at the same time), place the device in a “Failed” state and generate an “Invalid State” alarm.

h. Re-establish PLC control of a device in a “Failed” state only after one of the following:
1) An operator turns the device’s LSR switch out of REMOTE and back to REMOTE (i.e., REMOTE input to the PLC cycles off and back on).

i. For all alarm conditions, control other devices (as stopping pumps, etc.) as stated in the individual loop descriptions to make the system safe.

j. For discrete modulating valves (valves positioned to intermediate positions to control process values through discrete OPEN and CLOSE outputs), count the number of actuations (OPEN or CLOSE commands) per hour in the PLC:
1) Display count on the HMI.

18. Chemical systems (LOI/HMI):
a. Provide the following chemical system screens:
1) Where one LOI manages more than one chemical system, a main menu screen that will allow the operator to access the individual chemical system screens using software keys.
2) One or more screens for each individual chemical system controlled at that location, containing:
a) All status displays (running, failed, etc.).
b) Selections (lead/lag, which process flow to pace to, etc.).
c) Setpoint entry and display.
d) Calculated feed requirement (result of flow pacing calculation) in engineering units (typically milligrams of chemical per minute).
e) Output signal to feeder in percent of full span.
f) Actual chemical flow rate from flowmeter (where shown).
g) Process flow rate(s) used to pace each chemical on the individual chemical screens (PROC FLOW):
(1) Where different process flows can be selected for flow pacing, display and identify the selected source.

b. Chemical system calculations: Perform calculations as indicated on the Drawings and in the individual loop descriptions. Use the following assumptions, unless otherwise noted:
1) Where chemical flow feedback is not used, assume feeder output is linear in response to control signal.
2) Zero signal (typically 4 milliamperes) produces zero flow.
3) Perform flow-pacing calculations using as indicated on the Drawings or described in the individual loop descriptions.

c. Provide the setpoints and selections indicated on the Drawings and in the individual loop descriptions. Typical setpoints include:
1) QMAX: Maximum calibration value:
a) Chemical flow rate measured from calibration column at maximum feeder output (typically in gallons of solution per hour or milliliters of solution per minute).

2) CONC: Chemical concentration:
    a) The concentration of the chemical in the solution to be fed, in engineering units (typically milligrams of chemical per liter of chemical solution).
3) DENSITY:
    a) Density of the chemical solution to be fed in engineering units or as a specific gravity.
    b) Used to calculate the concentration of the chemical in the solution.
4) DOSE: Desired dosage:
    a) Desired chemical concentration in the process stream in engineering units (typically milligrams of chemical per liter of process fluid).
5) FLOW SEL: Selection of process stream(s) for flow pacing.
6) OPEN/CLOSED LOOP:
    a) Selection of method of controlling chemical flow-paced feed rate.
    b) OPEN LOOP: Signal to feeder is based on feeder calibration (QMAX) to deliver calculated chemical solution feed rate. Chemical solution flowmeter is not used for control.
    c) CLOSED LOOP: Chemical feed rate is directly controlled using the calculated chemical solution feed rate as the setpoint, and the flow rate from the chemical solution flowmeter as the process variable.
7) TRIM FACTOR: Adjusts the desired impact of the trim multiplier. Adjustable from 0 to 1.
8) QAH: Desired setpoint for top of band for analyzer trim control.
    a) QAL: Desired setpoint for bottom of band for analyzer trim control.

d. Chemical control algorithms:
    1) Flow pacing algorithm: Operator selects a desired dose and the control system adjusts the chemical feed rate to dose based on process flow, chemical concentration, and feeder calibration. The calculation is as follows (units may vary from those shown in the calculation below):

$$FEEDER\ FLOW\ (gph) = \frac{34{,}897 * DOSE\left(\frac{mg}{L}\right) * PROCESS\ FLOW(MGD)}{CONC(\%)\ * DENSITY\left(\frac{lb}{gal}\right)}$$

$$FEEDER\ FLOW\ (\%) = \frac{FEEDER\ FLOW(gph)}{QMAX(gph)}$$

    2) Flow pacing with closed loop algorithm: Operator selects a desired dose and the control system adjusts the speed of the chemical feeder through a speed control signal to match the measured chemical feed rate to a flow rate setpoint. This flow rate setpoint shall be derived from the process flow and operator setpoints for dosage

and concentration. The calculation is as follows (units may vary from those shown in the calculation below):

$$\boldsymbol{FEEDER\ FLOW\ (gph)} = \frac{\boldsymbol{34,897 * DOSE\left(\frac{mg}{L}\right) * PROCESS\ FLOW(MGD)}}{\boldsymbol{CONC(\%)\ * DENSITY\left(\frac{lb}{gal}\right)}}$$

a) Adjust the speed of the chemical feeder using a PID control algorithm to maintain the calculated FEEDER FLOW:
   (1) SP = Calculated FEEDER FLOW.
   (2) PV = Chemical Flow.
   (3) CV = Speed of the Chemical Feeder.

3) Flow pacing with analyzer trim algorithm: Operator selects a desired dose and desired analyzer setpoint band and the control system adjusts the chemical feed rate to dose based on process flow, chemical concentration, process analyzer output, and feeder calibration. The calculation is as follows (units may vary from those shown in the calculation below):

$$\boldsymbol{PRE\ TRIM\ FLOW\ (gph)} = \frac{\boldsymbol{34,897 * DOSE\left(\frac{mg}{L}\right) * PROCESS\ FLOW(MGD)}}{\boldsymbol{CONC(\%)\ * DENSITY\left(\frac{lb}{gal}\right)}}$$

$$\boldsymbol{TRIM\ MULTIPLIER} = \frac{\boldsymbol{AI - \frac{1}{2}(QAH + QAL)}}{\boldsymbol{-\frac{1}{2}(QAH - QAL)}}$$

CLAMP THE TRIM MULTIPLIER OUTPUT TO A MAXIMUM OF 1 AND MINIMUM OF -1.

$$\boldsymbol{TRIM\ ADDER(gph) = TRIM\ FACTOR * TRIM\ MULTIPLIER * PRE\ TRIM\ FLOW(gph)}$$

$$\boldsymbol{FEEDER\ FLOW(gph) = PRE\ TRIM\ FLOW(gph) + TRIM\ ADDER(gph)}$$

$$FEEDER\ FLOW\ (\%) = \frac{FEEDER\ FLOW(gph)}{QMAX(gph)}$$

4) Flow pacing with closed loop and analyzer trim algorithm: Operator selects a desired dose and desired analyzer setpoint band and the control system adjusts the speed of the chemical feeder through a speed control signal to match the measured chemical feed rate to a

flow rate setpoint. An additional control algorithm is used in the calculation to fine-tune the feed based on an analytical measurement as measured by the process analyzer.

$$\boldsymbol{PRE\ TRIM\ FLOW\ (gph)} = \frac{\boldsymbol{34,897 * DOSE\left(\frac{mg}{L}\right) * PROCESS\ FLOW(MGD)}}{\boldsymbol{CONC(\%)\ * DENSITY\left(\frac{lb}{gal}\right)}}$$

$$\boldsymbol{TRIM\ MULTIPLIER} = \frac{\boldsymbol{AI - \frac{1}{2}(QAH + QAL)}}{\boldsymbol{-\frac{1}{2}(QAH - QAL)}}$$

CLAMP THE TRIM MULTIPLIER OUTPUT TO A MAXIMUM OF 1 AND MINIMUM OF -1.

$$\boldsymbol{TRIM\ ADDER(gph) = TRIM\ FACTOR *\ TRIM\ MULTIPLIER * PRE\ TRIM\ FLOW(gph)}$$

$$\boldsymbol{FEEDER\ FLOW(gph) = PRE\ TRIM\ FLOW(gph) + TRIM\ ADDER(gph)}$$

a) Adjust the speed of the chemical feeder using a PID control algorithm to maintain the calculated FEEDER FLOW:
   (1) SP = Calculated FEEDER FLOW.
   (2) PV = Chemical Flow.
   (3) CV = Speed of the Chemical Feeder.

19. Breaker status:
    a. Display the following data to the extent it is available from the specified device:
       1) Open.
       2) Closed.
       3) Tripped.
       4) Ground fault.
       5) Settings.
       6) Racked out.
20. Power Data:
    a. Retrieve data from:
       1) Power Quality Meters (PQMs) at 480V.
       2) Main Breaker Protective Relays on 12.47 kV Switchgear.
       3) Generator Master Control Panel.
       4) Digital bus networks, as indicated.
       5) Where available, use EtherNet IP communications.
    b. Display the following data (to the extent it is available) from the specified device.
       1) Current XXXX.X A:
          a) A-Phase.

b) B-Phase.
c) C-Phase.

2) Volts: XXXX.X V:
a) A-Phase.
b) B-Phase.
c) C-Phase.

3) Reactive power: XXXX.X kVAR.
4) Real power: XXXX.X kW.
5) Apparent power: XXXX.X kVA.
6) Power factor: 0.XX.
7) Energy: XXXXXXX kW*hr.
8) Demand peak: XXXX Amp.
9) Demand peak: XXXX kW.

c. For engine/generator system monitoring, also display percent of rated output.

21. Power Supply and Distribution displays Power Quality Meters display:
a. In addition to the Power Data listed above, display the following (where available) from PQMs, Protective Relays, and Generator Master Control Panel:
1) Frequency: Hertz.
2) THD (current and voltage): up to 31st harmonic.

b. Calculate, indicate, historize, and trend data in a 12.47 kV Meter Table that lists measurements from the following Protection Relays:
1) Protection Relay on 52-G1.
2) Protection Relay on 52-G2.
3) Protection Relay on 52-M1.
4) Protection Relay on 52-M2.
5) Protection Relay on 52-M3.
6) Display calculated values for "Load At 12.47 kV", which sums the current, kW, and kW-hr values for all five Protection Relays.
7) Display calculated values for "Load At 480V", which sums the current, kW, and kW-hr values for all PQM meters.
8) Display calculated values for "Transformer and Line Losses", which subtracts "Load at 480V" from "Load At 12.47 kV" for current, kW, and kW-hr values for all PQM meters.

c. Display the data in a 480V Meter Table that lists measurements from all power quality meters on the plant.

22. Digital bus Starters, RVSS and VFDs equipped with EtherNet IP communications:
a. Communicate and display all values listed in the equipment specifications, indicated on the Drawings, or listed below.
b. Communicate start and stop commands, and receive running feedback over the fieldbus network.
c. Provide data entry screen for the cost of electricity in dollars per (kw*hr), which will be used in calculations for display.
d. Monitor the following additional values, and display on the HMI:
1) Motor current, phase A, B, and C.
2) Over current alarm.
3) Under current alarm.
4) Running status.
5) Phase loss.
6) Stall.

7) Number of starts.
8) History of past 5 trips.

e. Calculate, indicate, historize, and trend, the following additional values:
1) Full Load Amps (static value, Engineer will provide).
2) Average Motor Operating Current.
3) Run Time (Hours).
4) Operating Hours (Hours/Year).
5) Average Load Factor (equals Average Motor Current Operating Current/Full Load Amps) - *display as a percentage.*
6) Annual Energy Use (kW*hr).
7) Annual Operating Cost (dollars).
8) Percent of Site Electric Use (equals Annual Energy Use/Sum of Annual Energy (kW*hr) values for all PQM meters).

f. For Variable Frequency Drives:
1) Speed command.
2) Speed feedback.

g. For RVSS, Variable Frequency Drives, and where otherwise shown or available, monitor the following over the digital bus network:
1) Line voltage.
2) Power.
3) Power factor.
4) Over voltage alarm.
5) Under voltage alarm.
6) Over current alarm.
7) Under current alarm.
8) Indicate, historize, trend, and alarm data as indicated in the ACS I/O Tables on the Drawings.

23. Calculate, indicate, historize, and trend plant-wide calculated values for kW by the following Groups.
a. Calculated values (summed from starter data for all equipment within the Groups identified below):
1) Demand peak: XXXX Amp.
2) Demand peak: XXXX kW.
3) Electric Power Consumption, by Process Group (kW): XXXX kW.
4) Electric Power Consumption, by Process Group (percent): XX.XX percent (equals Electric Power Consumption, by Process Group (kW)/Sum of Electric Power Consumption on all 480V Meters).
5) Electric Energy Consumption, by Process Group (kW*hr): XXXX kW*hr.
6) Electric Energy Consumption, by Process Group (percent): XX.XX percent (equals Electric Energy Consumption, by Process Group (kW)/Sum of Electric Energy Consumption on all 480V Meters).

b. Display a Process Energy Consumption Table that lists the calculated values for each of the identified Groups.
c. Display a Process Energy Pie Graph that portions wedges according to the values calculated in Electric Energy Consumption, by Process Group (5). Label wedges, (with numeric percentage), for Groups to cover at least 90 percent of the Pie Graph. The remainder wedge of Pie Graph area can be labelled as "Other" (with numeric percentage).

24. Instruments equipped with digital bus communications:
    a. Communicate and display all values listed in the equipment specifications, indicated on the Drawings, or listed below:
        1) Instrument diagnostics.
        2) Communications health.
        3) Process variable.
        4) Alarm summary.
        5) All totalizers (if applicable).
        6) Indicate, historize, trend, and alarm data as indicated in the ACS I/O Tables on the Drawings.
25. Calculate, indicate, historize, and trend calculated values for additional, process-specific measurements. Algorithms will be provided by the Engineer:
    a. Influent:
        1) Influent flows (diurnally) vs. time (mgd vs. hours for 2 weeks, running).
        2) Influent flows (daily vs. time (mgd vs. *day of the week* for 1 week, running).
        3) Influent flows (diurnally) vs. time (mgd vs. *month of the year* for the last 3 years, running).
    b. Aeration basins:
        1) BOD loading rate vs. time.
        2) MLSS in Aeration Basins vs. time.
        3) Solids retention time (total and aerobic) vs. time.
        4) Aerobic solids retention time and WW temperature vs. time.
        5) Aerobic solids retention time and WAS load vs. time.
        6) Aerobic solids retention time and MLSS vs. time.
        7) Sludge volume index vs. time.
        8) Effluent ammonia and nitrate, phosphorus vs. time.
    c. Secondary clarifiers:
        1) Surface overflow rate vs. time.
        2) Solids loading rate vs. time.
        3) Effluent TSS vs. time.
        4) Solids blanket depth vs. time.
        5) RAS flows and percent of influent vs. time.
    d. Effluent.
    e. Solids treatment.
    f. Plant-wide process measurements:
        1) Surface overflow rate vs. time.
        2) Solids loading rate vs. time.
        3) Effluent TSS vs. time.
        4) Solids blanket depths vs. time.
        5) RAS flows and percent of influent vs. time.
26. Valves and gate operators equipped with digital bus communications:
    a. Communicate and display all controls and data listed in the equipment specification, as indicated on the Drawings, or listed below:
        1) Open, close or direct position commands.
        2) Fully open and closed status.
        3) Position.

4) High torque, overload and other applicable alarms.
5) Indicate, historize, trend, and alarm data as indicated in the ACS I/O Tables on the Drawings.

b. Establish initial torque curves using manufacturer's software for performance tracking and wear.

27. Power failure:
    a. Retain all operating setpoints during power failure.
    b. Restore plant operation to the state it was before the power loss:
        1) Store the operating state of all major equipment and systems in the PLC, and retain the last state during a power loss.
    c. Provide an operator selection to permit the plant to re-start. Once re-start is selected:
        1) Allow plant loads to re-start, and allow loads to sequence on and ramp up following normal control logic. Where loads were operating in PCS HAND, restore their operation to the state before the power loss.
        2) Use the logic described above for preventing concurrent starts to provide necessary delays between each start.
    d. Operating on generator power:
        1) Include running and starting kW and kVA requirements for each major equipment and system in registers in the PLC:
            a) Where running load can vary due to speed, valve position, etc., use the normal starting value plus 25 percent of the difference between the maximum and minimum values.
        2) Inhibit starting of loads from process control logic and from operator selection (in PCS HAND) that will exceed generator capability.
        3) Generate the following alarms:
            a) Generator near capacity: When measured kW or kVA reaches 90 percent of the rating of running generators.
            b) Generator at capacity: When measured kW or kVA reaches 95 percent of the rating of running generators.
            c) Unable to start: When an operator selects a load that would exceed generator starting or running capacity.
            d) Insufficient capacity: When the control system needs to start a load, but is inhibited due to generator capacity.
        4) Whenever the Generator at Capacity alarm is active, inhibit starting of any loads, and inhibit increase in speed of all control loops, and other changes that would increase electrical load.
        5) Display the following power system data on the HMI and LOI in numerical and graphical formats:
            a) Available power.
            b) Current power demand.
            c) Capacity of the generator.
            d) Current power demand load as a percentage of capacity.
            e) Generator frequency.

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL (NOT USED)

3.08 ADJUSTING (NOT USED)

3.09 CLEANING (NOT USED)

3.10 DEMONSTRATION AND TRAINING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 17101

SPECIFIC CONTROL STRATEGIES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Loop descriptions:
      a. Specific control requirements and functional descriptions for individual control loops.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.03 DEFINITIONS

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SYSTEM DESCRIPTION (NOT USED)

1.05 SUBMITTALS (NOT USED)

1.06 QUALITY ASSURANCE (NOT USED)

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY (NOT USED)

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION (NOT USED)

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION

A. Tertiary Pump Station:
   1. References:
      a. Process Area: 06.
      b. P&ID Drawings: 06N01, 06N02.
      c. Programmable Logic Controller: PLC-2.
   2. Key Mechanical Equipment:
      a. 06-PMP-001 - Tertiary Feed Pump No. 1 (1800 gpm).
      b. 06-PMP-002 - Tertiary Feed Pump No. 2 (900 gpm).
      c. 06-PMP-003 - Tertiary Feed Pump No. 3 (1800 gpm).
      d. 06-PMP-6004 - Tertiary Feed Pump No. 4 (1800 gpm).
      e. 06-PMP-6005 - Tertiary Feed Pump No. 5 (1800 gpm).
      f. 06-GAT-001 - Tertiary Influent Gate.
   3. Instrumentation:
      a. 06-PI-604 - Pump 1 Discharge Pressure Gauge.
      b. 06-PE/PSH-604 - Pump 1 Discharge Pressure Switch.
      c. 06-XS-604 - Pump 1 Motor Moisture Detection Switch.
      d. 06-TSH-604 - Pump 1 Motor Temperature Switch.
      e. 06-PI-605 - Pump 2 Discharge Pressure Gauge.
      f. 06-PE/PSH -605 - Pump 2 Discharge Pressure Switch.
      g. 06-XS-605 - Pump 2 Motor Moisture Detection Switch.
      h. 06-TSH-605 - Pump 2 Motor Temperature Switch.
      i. 06-PI-606 - Pump 3 Discharge Pressure Gauge.
      j. 06-PE/PSH -606 - Pump 3 Discharge Pressure Switch.
      k. 06-XS-606 - Pump 3 Motor Moisture Detection Switch.
      l. 06-TSH-606 - Pump 3 Motor Temperature Switch.
      m. 06-PI-6004 - Pump 4 Discharge Pressure Gauge.
      n. 06-PE/PSH -6004 - Pump 4 Discharge Pressure Switch.
      o. 06-ME-6004 - Pump 4 Motor Moisture Sensor.
      p. 06-TE-6004 - Pump 4 Motor Temperature Sensor.
      q. 06-PI-6005 - Pump 5 Discharge Pressure Gauge.
      r. 06-PE/PSH -6005 - Pump 5 Discharge Pressure Switch.
      s. 06-ME-6005 - Pump 5 Motor Moisture Sensor.
      t. 06-TE-6005 - Pump 5 Motor Temperature Sensor.
      u. 06-LE/LIT-602 - Wet Well Level Transmitter.
      v. 06-FE/FIT-608 - Pump Station Discharge Flowmeter.
      w. 06-FI-609 - Pump Station Discharge Flow Indicator.
      x. 06-AE/AIT-609 - Pump Station Turbidity Meter.
   4. System Overview:
      a. The tertiary pump station pumps secondary effluent to the tertiary filtration system.
      b. The tertiary pump station has five feed pumps, each having a variable frequency drive. Tertiary Feed Pump 2 is operated to satisfy lower flow

rate requirements. Tertiary Feed Pumps 1, 3, 4, and 5 operate in a LEAD/LAG Mode to satisfy higher flow rate requirements.

c. Under normal circumstances, tertiary station feed pumps are operated in REMOTE-AUTO Mode to maintain a controlled station flow rate.

d. The operator enters in SCADA a Tertiary Flow Rate Requested setpoint. The PLC may reduce the value of the requested flow rate and calculate a Tertiary Flow Rate Resolved Setpoint to satisfy a number of process conditions, as described later in this Control Description. SCADA displays both “Tertiary Flow Rate Requested” and “Tertiary Flow Rate Resolved Setpoints.”

e. A flowmeter at the station discharge measures the flow rate. The PLC controls the number of pumps in operation and the speed of those pumps, as required to achieve the “Tertiary Flow Resolved Setpoint.”

f. An ultrasonic level transmitter measures level in the pump station wetwell. An alarm occurs on HIGH-HIGH, HIGH, LOW, or LOW-LOW level conditions.

g. The PLC monitors the filter system influent turbidity. At a HIGH-HIGH turbidity condition, the PLC will initiate an alarm and stop all station pumps operating in REMOTE-AUTO Mode.

5. Local Controls and Instrumentation:

a. Station Pumps (each pump):

1) Instruments and Protective Devices:

a) Pressure Gauge.

b) Pressure Switch.

c) Motor Moisture Sensor.

d) Motor Temperature Sensor.

2) LCP:

a) START pushbutton.

b) LOCKOUT STOP pushbutton.

3) Indicators and Alarms:

a) None.

4) Hardwired Interlocks:

a) None.

b. Wetwell Ultrasonic Level:

1) Instruments and Protective Devices:

a) Level Transmitter.

2) LCP:

a) None.

3) Indicators and Alarms:

a) Level Indication.

4) Hardwired Interlocks:

a) None.

c. Station Magnetic Flowmeter:

1) Instruments and Protective Devices:

a) Magnetic Flowmeter.

2) LCP:

a) None.

3) Indicators and Alarms:

a) Flow Indication.

4) Hardwired Interlocks:

a) None.

d. Station Turbidity Analyzer:
    1) Instruments and Protective Devices:
        a) Turbidity Meter.
    2) LCP:
        a) None.
    3) Indicators and Alarms:
        a) Turbidity Indication.
    4) Hardwired Interlocks:
        a) None.

6. MCC Controls and Instrumentation:
    a. Station Pump VFD (each pump):
        1) Instruments and Protective Devices:
            a) None.
        2) VFD:
            a) LOCAL-OFF-REMOTE switch.
            b) START pushbutton.
            c) STOP pushbutton.
            d) RESET pushbutton.
            e) SPEED potentiometer.
        3) Indicators and Alarms:
            a) RUNNING indication.
            b) VFD FAILED alarm.
            c) Motor HIGH TEMPERATURE alarm.
            d) Motor HIGH MOISTURE alarm.
            e) Discharge HIGH PRESSURE alarm.
        4) Hardwired Interlocks: When a pump is locked out, it will not start until the alarm condition is cleared and the RESET pushbutton on the VFD is pressed:
            a) Motor HIGH TEMPERATURE: Stop and latch out motor and activate Motor High Temperature alarm.
            b) Motor HIGH MOISTURE: Stop and latch out motor and activate Motor Moisture Detection alarm.
            c) Discharge HIGH PRESSURE: Stop and latch out motor and activate Discharge High Pressure alarm.
            d) VFD FAILED: Shut down and latch out the pump and generate VFD FAIL alarm.
        5) Control Logic:
            a) In LOCAL Mode, the pumps are controlled by the START-STOP pushbuttons on the VFD or the START-LOCKOUT-STOP pushbuttons at the local control station.
            b) In REMOTE Mode, the pumps are controlled by the PLC.
    b. Wetwell Ultrasonic Level:
        1) None.
    c. Station Magnetic Flowmeter:
        1) None.
    d. Station Turbidity Analyzer:
        1) None.

7. PLC Functions:
    a. Station Pump (each pump):
        1) Remote Manual Mode:
            a) START-STOP and manual speed control of individual pumps through OIS control graphics buttons.

b) The range of manual speed adjustment for the jockey pump is 50 percent to 100 percent speed.
c) The Tertiary Feed Pumps operate at a minimum speed of 40 percent when one pump is ON, or a minimum speed of 60 percent if two pumps are ON.

2) Remote Auto Mode:
a) Tertiary Feed Pumps 1, 2, 4 and 5 operate in a LEAD/LAG Mode. The operator selects either MANUAL or AUTO pump CALL ORDER.
b) Tertiary Feed Pumps 1, 2, 4 and 5 operate in a speed range of 40 percent to100 percent when one pump is ON, or in a speed range of 60 percent to 100 percent when two or more pumps are ON.
c) The Jockey Pump operates within a speed range of 50 percent to 100 percent.
d) When the Tertiary Flow Rate Setpoint is reduced to 0.5 mgd or less (minimum flow of the Jockey Pump), all pumps will be stopped. Wintertime flow set point is 0.63 mgd.
e) The Tertiary Feed Pumps operate at a minimum speed of 40 percent when one pump is ON, or a minimum speed of 60 percent if two or more pumps are ON.
f) Under automatic control, individual pump speeds will be limited to a minimum speed of 40 percent and maximum speed of 100 percent.
g) The operator enters the “Tertiary Flow Rate Requested” (0.5 to 7.6 mgd) in the OIS. The PLC evaluates a number of process parameters, as described below, and may reduce the “Tertiary Flow Rate Requested” to a lesser value called the “Tertiary Flow Rate Resolved.” Both the Requested and Resolved flow rates are shown in the OIS.
h) Tertiary Flow Rate Resolved Setpoint is defined as Tertiary Flow Rate Requested, less reductions that may be applied according to the following reduction rules. The range of Tertiary Flow Rate Resolved is 0.0 to 7.6 mgd.
i) Reduction 1: The maximum value of Tertiary Flow Rate Resolved is limited to the total rated capacity of on-line filters according to the following formula, sum of the following:
(1) New Filters: Tertiary Flow Rate Resolved ≤ (#On-Line Filters x 7.6/2) mgd.
(2) Existing Filters: Tertiary Flow Rate Resolved ≤ (#On-Line Filters x 1.07) mgd.
(3) A filter is “online” when the filter influent valve is OPEN, and the FILTER is IN SERVICE or in FILTER to WASTE.
j) Reduction 2: Reduce Tertiary Flow Rate Resolved Setpoint from Reduction 1 if the level in the pump wetwell (LIT-602) approaches the LOW alarm setpoint. If the level of the wetwell reaches a point above the LOW alarm setpoint and below the LOW Alarm Setpoint plus an offset value, as determined in the PLC, then reduce the Flow Rate Resolved Setpoint in proportion

to the proximity of the wetwell level to the wetwell LOW alarm setpoint:

(1) Reduction 2 Correction Factor: (LIT-602) - (LIT-602 LOW alarm setpoint) / (offset value). Reduction 2 Correction Factor is limited to the range of 0.0 to 1.0.

(2) Applied Correction Factor 2: Tertiary Flow Setpoint Reduction 2 x Tertiary Flow Setpoint from Reduction 1 x Reduction 2 Correction Factor.

k) Reduction 3: Reduce Tertiary Flow Rate Resolved Setpoint from Reductions 1 and 2 if the level in the Recycled Water Storage Basin (LIT-904) approaches the HIGH Alarm Setpoint. Recycled Water Storage Basin Level is provided to PLC2 by PLC7 via PLC-to-PLC communications. If the level in the Recycled Water Storage Basin reaches a point below the HIGH Alarm Setpoint and above the HIGH Alarm Setpoint less an offset value, as determined in the PLC, then reduce the Flow Rate Resolved Setpoint in proportion to the proximity of the Recycled Water Storage Basin level to the Recycled Water Storage Basin HIGH Alarm Setpoint:

(1) Determine Reduction 3 Correction Factor: (LIT-904 HIGH Alarm Setpoint) - (LIT-904) / (Offset Value). Reduction 3 Correction Factor is limited to the range of 0.0 to 1.0.

(2) Apply Reduction 3: Tertiary Flow Setpoint Resolved = Tertiary Flow Setpoint from Reduction 1 x Reduction 2 Correction Factor x Reduction 3 Correction Factor.

l) Reduction 4: Reduce Tertiary Flow Rate Resolved Setpoint from Reductions 1, 2, and 3 if the level in the Flash Mix Structure (LIT-612) approaches the HIGH Alarm Setpoint. Flash Mix Structure Level is provided to PLC2 by PLC1 via PLC-to-PLC communications. If the level in the Flash Mix Structure reaches a point below the HIGH Alarm Setpoint and above the HIGH Alarm Setpoint less an offset value, as determined in the PLC, then reduce the Flow Rate Resolved Setpoint in proportion to the proximity of the Flash Mix Structure level to the Flash Mix Structure HIGH Alarm Setpoint:

(1) Determine when to use Reduction 4: If LIT-612 is greater than or equal to the HIGH Alarm Setpoint less the offset value, then use Reduction 4.

(2) Determine Reduction 4 Correction Factor: (LIT-612 HIGH Alarm Setpoint)-(LIT-612)/(Offset Value). Reduction 4 Correction Factor is limited to the range of 0.0 to 1.0.

(3) Reduction 4: Tertiary Flow Setpoint Resolved = Tertiary Flow Rate Setpoint from Reduction 1 x Reduction 2 Correction Factor x Reduction 3 Correction Factor x Reduction 4 Correction Factor.

m) Reduction 5: Reduce Tertiary Flow Rate Resolved Setpoint from Reductions 1, 2, 3, and 4 if the level in the Cloth Media Disk Filters (LIT-6631/6731) approaches the HIGH Alarm Setpoint, applicable only if one or both Cloth media Disk filters is on-line. If the level in Filters 6 or 7 reaches a point below the HIGH Alarm Setpoint and above the HIGH Alarm Setpoint less an offset value, as determined in the PLC, then reduce the Flow

Rate Resolved Setpoint in proportion to the proximity of the Filter level to the Filter HIGH Alarm Setpoint.

(1) Determine when to use Reduction 4: If LIT-6631/6731 is greater than or equal to the HIGH Alarm Setpoint less the offset value, then use Reduction 4.
(2) Determine Reduction 4 Correction Factor: (LIT-6631/6731 HIGH Alarm Setpoint) - (LIT-6631/6731) / (Offset Value). Reduction 4 Correction Factor is limited to the range of 0.0 to 1.0.
(3) Reduction 5: Tertiary Flow Setpoint Resolved = Tertiary Flow Rate Setpoint from Reduction 1 x Reduction 2 Correction Factor x Reduction 3 Correction Factor x Reduction 4 Correction Factor.

n) Reduction of flow setpoints for any of the reasons outlined above will be instantaneous. As the setpoint reducing conditions become relieved, the setpoint reduction(s) are removed accordingly. Resulting increase of the resolved setpoint will be velocity limited (adjustable in PLC) to prevent the possibility of resonance of the control loop.
o) Any reduction below operator requested setpoints will be indicated on OIS screen by continuously showing the operator requested setpoint and the Tertiary Flow Rate Resolved Setpoint.
p) If Tertiary Flow (FIT-608) is not equal to Tertiary Flow Resolved Setpoint, plus or minus 10 percent (adjustable in PLC) for a period exceeding a (adjustable in PLC) time of 10 minutes, an alarm will be issued. Alarm text, “Tertiary Flow Resolved Setpoint not achieved.” This alarm will be inhibited if none of the pumps are operating in REMOTE-AUTO Mode.
q) If filter influent turbidity reaches 10 NTU (adjustable in the PLC), a HIGH turbidity alarm will be issued. Alarm text, “Tertiary Influent Turb HIGH.”
r) When Tertiary Flow Setpoint is less than 0.5 mgd, any tertiary pumps running in REMOTE-AUTO Mode will stop. An alarm will be issued. Alarm text, “All Tertiary Pumps Off.” This alarm will be inhibited if all five tertiary feed pumps are not in REMOTE-AUTOMATIC Mode.
s) When Tertiary Flow Rate Resolved Setpoint is in the range of 0.5 to 1.3 mgd and the Jockey Pump is not available, an alarm will be issued. Alarm text, “Tertiary Jockey Pump not available.”
t) When Tertiary Flow Rate Resolved Setpoint is in the range of 0.5 to 1.3 mgd and Jockey Pump is available, the Jockey Pump will start at minimum speed and ramp at VFD-controlled acceleration rate to a speed necessary to maintain as measured by Tertiary Pump Station Effluent Flow FIT-608, Tertiary Flow Resolved Setpoint. LEAD or LAG pumps, if running, will stop.
u) When Tertiary Flow Rate Resolved Setpoint is greater than 1.3 mgd and LEAD pump is available, the LEAD pump will start; the Jockey Pump, if running under REMOTE-AUTO Mode, will stop. The LEAD pump will ramp up at VFD-controlled acceleration rate to a speed necessary to maintain Tertiary Flow

Resolved Setpoint as measured by Tertiary Pump Station Effluent Flow FIT-608.

v) When Tertiary Flow Resolved Setpoint is in the range greater than 1.3 mgd and the LEAD pump is unavailable, the LAG pump will start; the Jockey Pump, if running, will stop. The LAG pump will ramp up at VFD-controlled acceleration rate to a speed necessary to maintain Tertiary Flow Setpoint as measured by Tertiary Pump Station Effluent Flow FIT-608. LAG pump will become LEAD pump.

w) If the Tertiary Flow is less than Tertiary Flow Rate Resolved Setpoint with only the LEAD pump running for a period (adjustable in the PLC) of 1 minute, the LAG pump will be called. Both LEAD and LAG pumps will be commanded initially to minimum speed. When the LAG pump RUNNING feedback is received, both LEAD and LAG pumps will be controlled at the same speed to achieve Tertiary Flow Setpoint. Similar controls for Lag II and Lag III pumps.

x) If the Tertiary Flow is greater than Tertiary Flow Rate Resolved Setpoint, with both LEAD and LAG pumps running for a period (adjustable in the PLC) of 1 minute, the LEAD pump speed will be increased to maximum (100 percent), and simultaneously the LAG pump will be commanded OFF. When the LAG pump ON feedback is lost, LEAD pump speed will be controlled to achieve Tertiary Flow Resolved Setpoint.

y) If filter influent turbidity reaches 15 NTU (adjustable in the PLC) for a period exceeding 5 minutes (adjustable in the PLC), a HIGH-HIGH turbidity alarm will be issued. Alarm text, “Tertiary Influent Turb HIGH-HIGH Pump Stop.” Pumps running in REMOTE-AUTO Mode will stop and be placed in REMOTE-MANUAL Mode.

z) If Tertiary Effluent Bypass Valve (08-VLV-002) is open and Tertiary Effluent Valve (08-VLV-001) is closed for a period of 60 minutes (adjustable in PLC), an alarm will be issued. Alarm text, “Tertiary Bypass Shutdown.” Pumps running in REMOTE-AUTO Mode will stop and be placed in REMOTE-MANUAL Mode. Pumps running in REMOTE-MANUAL Mode will stop.

aa) Sustained HIGH-HIGH or LOW-LOW level alarms that last for 1 minute or more (operator adjustable) will cause a smooth and orderly filtration shutdown. Pumps running in REMOTE-AUTO Mode will stop and be placed in REMOTE-MANUAL Mode. Pumps running in REMOTE-MANUAL Mode will stop. Shutdown conditions shall include:
   (1) No filters online.
   (2) LIT-602 LOW-LOW (Tertiary Pump Station Wetwell).
   (3) LIT-904 HIGH-HIGH (on-site reservoir).
   (4) LIT-612 HIGH-HIGH (flash mix). Alarm text, “Flash Mix HIGH-HIGH Pump Stop.”

3) Screen Selectors, Indicators, and Alarms:
   a) LEAD/LAG selector.
   b) MANUAL-AUTO selector.
   c) START-STOP selector.

d) ON indication.
e) RUNTIME indication.
f) LOCAL-REMOTE indication.
g) Pump SPEED indication.
h) Tertiary Flow requested indication.
i) Tertiary Flow setpoint.
j) Tertiary Flow Reduced alarm.
k) Tertiary Flow Setpoint Not Achieved alarm.
l) Jockey Pump Not Available indication.
m) VFD FAIL alarm.
n) Motor HIGH TEMPERATURE alarm.
o) Motor HIGH MOISTURE alarm.
p) Discharge HIGH PRESSURE alarm.
q) FAIL TO START alarm.
r) Tertiary Bypass Shutdown alarm.
s) All Tertiary Pumps OFF alarm.
t) Flash Mix HIGH HIGH LEVEL Pump Shutdown alarm.
u) Tertiary Wetwell LOW LOW LEVEL Pump Shutdown alarm.

4) Inter-PLC Communications:
a) PLC2 obtains Flash Mix Structure level information from PLC1. No control action is taken should communication be lost.
b) PLC2 obtains quantity of filters online information from PLC1.
c) PLC2 obtains recycled water storage basin level information from PLC7.
d) PLC2 obtains Parshall Flume and Bypass Flow information from PLC4.

b. Wetwell Ultrasonic Level:
1) Remote Manual Mode:
a) None.
2) Remote Auto Mode:
a) None.
3) Screen Selectors, Indicators, and Alarms:
a) LEVEL indication.
b) HIGH LEVEL alarm.
c) LOW LEVEL alarm.
4) Inter-PLC Communications:
a) None.

c. Station Magnetic Flowmeter:
1) Remote Manual Mode:
a) None.
2) Remote Auto Mode:
a) None.
3) Screen Selectors, Indicators, and Alarms:
a) FLOW indication.
b) LOW FLOW alarm.
4) Inter-PLC Communications:
a) None.

d. Station Turbidity Analyzer:
1) Remote Manual Mode:
a) None.
2) Remote Auto Mode:
a) None.

3) Screen Selectors, Indicators, and Alarms:
   a) TURBIDITY indication.
   b) HIGH TURBIDITY alarm.
   c) HIGH HIGH TURBIDITY alarm.
4) Inter-PLC Communications:
   a) None.

B. Tertiary Filters Combination of two Cloth Media Disk and five Continuous Backwash Sand Media:
   1. References:
      a. Process Area: 06.
      b. P&ID Drawings: 06N03, 06N04, 06N05, 06N06, 06N07, 06N08, 06N09.
      c. Programmable Logic Controller: PLC-1.
   2. Key Mechanical Equipment:
      a. 06-FLT-6600 - Filter Cell No. 6 Drive Motor.
      b. 06-FLT-6700 - Filter Cell No. 7 Drive Motor.
      c. 06-PMP-6640 - Filter Cell No. 6 Backwash Pump A.
      d. 06-PMP-6645 - Filter Cell No. 6 Backwash Pump B.
      e. 06-PMP-6740 - Filter Cell No. 7 Backwash Pump A.
      f. 06-PMP-6745 - Filter Cell No. 7 Backwash Pump B.
      g. 06-VLV/EDM-631 – Filter Cell No. 1 Inlet Valve
      h. 06-VLV/EDM-635 – Filter Cell No. 1 Inlet Valve
      i. 06-VLV/EDM-651 – Filter Cell No. 1 Inlet Valve
      j. 06-VLV/EDM-655 – Filter Cell No. 1 Inlet Valve
      k. 06-VLV/EDM-660 – Filter Cell No. 1 Inlet Valve
      l. 06-VLV/EDM-6601 - Filter Cell No. 6 Inlet Valve.
      m. 06-VLV /EDR-6602 - Filter Cell No. 6 Effluent Valve.
      n. 06-VLV /EDR-6603 - Filter Cell No. 6 Filter To Waste Valve.
      o. 06-VLV /EDM-6701 - Filter Cell No. 7 Inlet Valve.
      p. 06-VLV /EDR-6702 - Filter Cell No. 7 Effluent Valve.
      q. 06-VLV /EDR-6703 - Filter Cell No. 7 Filter To Waste Valve.
      r. 06-VLV /EDR-6611, -6621 - Filter Cell No. 6 Solids Waste Valves.
      s. 06-VLV /EDR-6612, -6613, -6614, -6615 - Filter Cell No. 6 Backwash A Valves.
      t. 06-VLV /EDR-6622, -6623, -6624, -6625 - Filter Cell No. 6 Backwash B Valves.
      u. 06-VLV /EDR-6711, -6721 - Filter Cell No. 7 Solids Waste Valves.
      v. 06-VLV /EDR-6712, -6713, -6714, -6715 - Filter Cell No. 7 Backwash A Valves.
      w. 06-VLV /EDR-6722, -6723, -6724, -6725 - Filter Cell No. 7 Backwash B Valves.
   3. Instrumentation:
      a. 06-ZSOC-6601 - Filter Cell No. 6 Inlet Valve Position Switch.
      b. 06- ZSOC-6602 - Filter Cell No. 6 Effluent Valve Open/Close Position Switch.
      c. 06- ZSOC-6603 - Filter Cell No. 6 Filter To Waste Valve Open/Close Position Switch.
      d. 06- ZSOC-6701 - Filter Cell No. 7 Inlet Valve Position Switch.
      e. 06- ZSOC-6702 - Filter Cell No. 7 Effluent Valve Open/Close Position Switch.
      f. 06- ZSOC-6703 - Filter Cell No. 7 Filter To Waste Valve Open/Close Position Switch.

g. 06-AE/AIT-6604 - Filter Cell No. 6 Effluent Turbidity Meter.
h. 06-AE/AIT-6704 - Filter Cell No. 7 Effluent Turbidity Meter.
i. 08-AE/AIT-801 - Combined Filter Effluent Turbidity Meter.
j. 06-LE/LT-6631 - Filter Cell No. 6 Backwash Header A Level Transmitter.
k. 06-LE/LSHH-6632 - Filter Cell No. 6 Backwash Header A Level Switch.
l. 06-LE/LT-6731 - Filter Cell No. 7 Backwash Header A Level Transmitter.
m. 06-LE/LSHH-6732 - Filter Cell No. 7 Backwash Header A Level Switch.
n. 06-PI-6633 - Filter Cell No. 6 Backwash Header B Pressure Gauge.
o. 06-PI-6634 - Filter Cell No. 6 Backwash Header A Pressure Gauge.
p. 06-PE/PIT-6734 - Filter Cell No. 7 Backwash Header A Pressure Transmitter.
q. 06-PI-6733 - Filter Cell No. 7 Backwash Header B Pressure Gauge.
r. 06-PI-6734 - Filter Cell No. 7 Backwash Header A Pressure Gauge.
s. 06-PE/PIT-6634 - Filter Cell No. 6 Backwash Header A Pressure Transmitter.
t. 06-PI-6641 - Filter Cell No. 6 Backwash Pump A Pressure Gauge.
u. 06-PI-6646 - Filter Cell No. 6 Backwash Pump B Pressure Gauge.
v. 06-PI-6741 - Filter Cell No. 7 Backwash Pump A Pressure Gauge.
w. 06-PI-6746 - Filter Cell No. 7 Backwash Pump B Pressure Gauge.
x. 06-FE/FIT-6002 – Cloth Media Disk Filter Effluent flow meter
y. 06-FE/FIT-6001- Continuous Backwash Sand Media Effluent flow meter
z. 06-FE/FIT-6651 - Filter Cell No. 6 Backwash Flowmeter.
aa. 06-FE/FIT-6751 - Filter Cell No. 6 Backwash Flowmeter.

4. System Overview:
   a. Filter Mode: The influent pipe (1) routes flow to the filter basin (2), where filtration occurs. The filter basin contains a series of circular disks covered with a unique pile cloth media. As water passes through the media via an outside-in flow path, some particulates are removed and stored within the depth of the pile cloth media while others are deposited on the pile cloth media surface. Filtered water, or filtrate, is collected in a center tube (3) and flows, via gravity, over the effluent weir and into the effluent chamber (4) prior to discharge. It is important to note that during filtration, the disks do not rotate.
   b. Backwash Mode: As the amount of particulates on and within the pile cloth media increases, the static pressure required to pass water through the pile cloth media increases. This results in an increased water level within the filter basin and increased differential pressure on the pile cloth media. Upon reaching a specific basin level or elapsed time period, the backwash mode will be automatically initiated to clean the pile cloth media. Solids are backwashed from the pile cloth media surface by liquid suction through backwash shoes (5) positioned on both sides of each disk. These spring loaded backwash shoes contact the pile cloth media to provide the necessary suction for optimum cleaning efficiency. During backwash, disks are cleaned in groups. The number of disks in each group will depend on the size of the unit. Disks rotate slowly while a backwash/waste pump (not shown) draws filtered water from the center tube through the pile cloth media on an inside-to-outside, or reversed, flow path. This provides effective cleaning of the pile cloth media over the entire disk. By the end of the backwash cycle, the basin water level returns to its normal operating level. Backwash water is typically directed to the headworks. Filtration continues while the filter is in backwash mode. This feature allows continuous filtration while maintaining efficient filter

performance. A quiescent environment during filtration, combined with the outside-in filtration flow path, allows heavier particulates to settle to the bottom of the filter basin. Upon reaching a specific number of backwash cycles performed, or an elapsed time, the solids waste mode will be automatically initiated. The solids waste mode utilizes the backwash/waste pump to provide suction of the settled solids through a perforated solids collection manifold (6). Since solids wasting occurs immediately after a backwash cycle is completed, the backwash/waste pump remains on during the backwash-to-solids waste mode transition. The solids are pumped on an intermittent basis, to the storm drain. Filtration continues while the filter is in solids waste mode. This feature allows continuous filtration while maintaining efficient filter performance.

c. Summary of Operation:
    1) Secondary clarified effluent flows is pumped to the filter flash mixer, then flows by gravity through the flocculation basins to the filter influent channel. Flow continues from the influent channel through valves to each disk filter Cell. Filter aid coagulant may be added in the flash mix, and chlorine solution can be added to each individual filter.
    2) Use of Filters 6 and 7 is preferred over Filters 1 to 5. The operator may select any combination of filters to be which filter is on-line. The DEFAULT is filters 6 and 7.
    3) Under normal operation the inlet valve on filters 6 or 7 will be opened 100 percent if either filter is on-line.
    4) Under normal operation the inlet valve on filters 1 to 5 will be modulated to a set opening point that equates to approximately 0.5 mgd per filter that is online. The operating set point will be developed during startup and commissioning of the new filters. The filter flow for filters No. 1 to 5 is determined by flow meter 06-FE/FIT-6001.
    5) Under normal operation, the disks are stationary and completely submerged by the secondary effluent in the filter basin; flow permeates through the filter media by gravity. Filtrate enters the internal portion of the disks and is directed to effluent chamber/channel through the center shaft.
    6) Solids are retained on and within the disk media while the filtrate flows into the center tube of the disks. As solids accumulate on the media, a mat is formed and the liquid level in the filter basin increases. At a predetermined level or time, the backwash cycle is initiated. Solids are backwashed from the surface by liquid suction from both sides of each disk. During backwash, the media disks remain fully submerged and rotate slowly, driven by a single-chain drive mechanism, allowing each segment to be cleaned. Backwash water is pumped to the plant storm drain system.
    7) The tertiary treatment process is equipped with five existing filter modules and two new filter Cells. Each filter Cell is equipped with 16 cloth filter disks mounted on a shaft, and a manual influent gate. Each filter operates independently of the other filter Cells.
    8) Each filter has eight backwash valves, two sludge waste valve, two backwash waste pumps, and one filter drive.
    9) Each filter comes equipped with a vendor supplied PLC based control panel.

10) Turbidity is monitored in the Tertiary Pump Station discharge, each individual Filter Cell Effluent, and Common UV process Inlet.
11) The filter system removes particulate matter from the secondary effluent.
12) The filtered water turbidity is monitored at the effluent of each individual filter (AIT-6604/6704).
13) The combined filter effluents are monitored for filtered water turbidity (AIT-801) at the UV Disinfection influent channel.
14) If the turbidity of the combined filter effluent does not meet effluent standards (adjustable in SCADA, default value less than 2 NTU), then the PLC initiates a filter-to-waste sequence for the IN-SERVICE filter, selected REMOTE-AUTO, having the highest effluent turbidity.
15) Filtered water from the selected filter is directed to the FILTER-TO-WASTE stream, which is controlled by each filter-to-waste valve.
16) Filter waste valve control is based on effluent turbidity. If the effluent turbidity meter senses turbidity above the set point, it will open the waste valve, then close the effluent valve.
17) Total tertiary filter effluent flow is the combination of flow meters 06-FE/FIT-60011 and 6002.

5. Local Controls and Instrumentation:
   a. Filter Cell Influent and Effluent Valves (each valve):
      1) Instruments and Protective Devices:
         a) Valve OPENED limit switch.
         b) Valve CLOSED limit switch.
      2) Valve Actuator:
         a) LOCAL-OFF-REMOTE switch.
         b) OPEN-STOP-CLOSE switch.
      3) Indicators and Alarms:
         a) OPENED indication.
         b) CLOSED indication.
      4) Hardwired Interlocks:
         a) None.
      5) Control Logic:
         a) In LOCAL Mode, the valves are controlled by the OPEN-STOP-CLOSE switch on the valve actuator.
         b) In REMOTE Mode, the valves are controlled by the PLC.
   b. Cloth Media Filter Cell Vendor Package (each cell):
      1) Instruments and Protective Devices:
         a) Valve OPENED limit switch (each valve).
         b) Valve CLOSED limit switch (each valve).
         c) Level Transmitter.
         d) High Level Switch.
         e) Pressure Gauges (4).
         f) Pressure Transmitter.
      2) Cloth Media VCP:
         a) Refer to Section 11366B.
      3) Indicators and Alarms:
         a) OPENED indication (each valve).
         b) CLOSED indication (each valve).
         c) Pressure Indications (5).
         d) Refer to Section 11366B for additional indicators and alarms.

4) Hardwired Interlocks:
a) Refer to Section 11366B.

c. Backwash Flowmeter (each meter):
1) Instruments and Protective Devices:
a) Magnetic Flowmeter.
2) LCP:
a) None.
3) Indicators and Alarms:
a) Flow Indication.
4) Hardwired Interlocks:
a) None.

d. Filter Effluent Turbidity Analyzer (each analyzer):
1) Instruments and Protective Devices:
a) Turbidity Meter.
2) LCP:
a) None.
3) Indicators and Alarms:
a) Turbidity Indication.
4) Hardwired Interlocks:
a) None.

6. MCC Controls and Instrumentation:
a. None.

7. PLC Functions:
a. Filter Cell Influent and Effluent Valves (each valve):
1) Remote Manual Mode:
a) OPEN-CLOSE of valves through OIS control graphic buttons.
2) Remote Auto Mode:
a) A cloth media disk filter is considered ONLINE if its influent valve is fully opened for Filters 6 and 7. A continuous backwash filter is considered ONLINE if its influent valve is opened to the valve open set point for Filters 1 to 5. A filter is considered OFFLINE if its influent valve is fully closed.
b) A filter is considered IN-SERVICE if it is ONLINE and its filter to waste valve is fully closed and its filter effluent valve is fully opened.
c) A filter is placed IN-SERVICE under REMOTE-AUTO Mode as follows:
(1) The collective mode selector for the Filter Influent, Filter Effluent ,and Filter-To-Waste valves must be set to REMOTE-MANUAL Mode.
(2) The Filter Influent valve must be selected REMOTE-MANUAL and proven OPENED.
(3) The Filter Effluent valve must be selected REMOTE-MANUAL and proven OPENED.
(4) The Filter To Waste valve must be selected REMOTE-MANUAL and proven CLOSED.
(5) The mode selector for the Filter Influent, Filter Effluent, and Filter-To-Waste valves must be set to REMOTE-AUTO Mode. The valves will not accept REMOTE-AUTO Mode selection unless Conditions (2), (3), and (4) above are true.
d) The PLC monitors filtered water turbidity at the effluent of each filter that is IN-SERVICE. If the turbidity exceeds an adjustable

value (range 0-5 NTU, default 2 NTU) for an adjustable duration (range 0-60 seconds, default 60 seconds), then an alarm is generated.

e) The PLC monitors the combined filtered water turbidity at the UV disinfection influent channel (AIT-801). If the turbidity exceeds an adjustable value (range 0-5 NTU, default 2 NTU) for an adjustable duration (range 0-60 seconds, default 60 seconds), then the PLC selects the in-service filter, selected REMOTE-AUTO, with the highest effluent turbidity, and initiates a Filter-To-Waste operating sequence for that filter.

f) The Filter-To-Waste operating sequence takes a filter OUT OF SERVICE as follows:
   (1) The Filter-To-Waste valve is commanded OPEN.
   (2) When the opening of the Filter-To-Waste valve is confirmed, then the Filter Effluent valve is commanded CLOSE.
   (3) When the closing of the Filter Effluent valve is confirmed, a Filter-To-Waste alarm is generated for the subject filter.
   (4) If the Filter-To-Waste operating sequence is not completed and confirmed as outlined above, then a Fail To Achieve Filter-To-Waste alarm is generated, and the Filter-To-Waste and Filter Effluent valves for the selected filter are automatically placed in REMOTE-MANUAL Mode. Operator intervention is required to place the subject filter IN-SERVICE under REMOTE-AUTO Mode.

g) After a Filter-To-Waste sequence has been initiated, the PLC will wait for an adjustable time period before another Filter-To-Waste sequence can be initiated.

3) Screen Selectors, Indicators, and Alarms:
   a) MANUAL-AUTO selector.
   b) OPEN-CLOSE selector.
   c) LOCAL-REMOTE indication.
   d) Valve OPENED indication.
   e) Valve CLOSED indication.

4) Inter-PLC Communications:
   a) PLC1 receives combined effluent turbidity information from PLC7. There is no automatic action if communication is lost and Filter-To-Waste sequences cannot be initiated until communication is restored.

b. Filter Cell Vendor Package (each cell):
   1) Remote Manual Mode:
   2) Remote Auto Mode:
   3) Screen Selectors, Indicators, and Alarms:
      a) .Refer to original filter project for existing filter selections, indicators and alarms
      b) Refer to Drawing 00N02 for additional selectors, indications, and alarms.
   4) Inter-PLC Communications:

c. Backwash Flowmeter (each meter):
   1) Remote Manual Mode:
      a) None.

2) Remote Auto Mode:
    a) None.
3) Screen Selectors, Indicators, and Alarms:
    a) FLOW indication.
    b) FLOW totalization indication.
    c) LOW FLOW alarm.
    d) HIGH FLOW alarm.
4) Inter-PLC Communications:
    a) None.

d. Filter Effluent Turbidity Analyzer (each analyzer):
1) Remote Manual Mode:
    a) None.
2) Remote Auto Mode:
    a) None.
3) Screen Selectors, Indicators, and Alarms:
    a) TURBIDITY indication.
    b) HIGH TURBIDITY alarm.
    c) HIGH HIGH TURBIDITY alarm.
4) Inter-PLC Communications:
    a) None.

e. Filter Effluent Flowmeter (each meter):
1) Remote Manual Mode:
    a) None.
2) Remote Auto Mode:
    a) None.
3) Screen Selectors, Indicators, and Alarms:
    a) FLOW indication, each meter and summation.
    b) FLOW totalization indication.
    c) LOW FLOW alarm.
    d) HIGH FLOW alarm.
4) Inter-PLC Communications:
    a) None.

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL (NOT USED)

3.08 ADJUSTING (NOT USED)

3.09 CLEANING (NOT USED)

3.10 DEMONSTRATION AND TRAINING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 17206

LEVEL MEASUREMENT: ULTRASONIC

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Ultrasonic level instruments.

B. Provide all instruments identified in the Contract Documents.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.03 DEFINITIONS

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Specific definitions:
   1. FDT: Field Device Tool.
   2. DTM: Device Type Manager.

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide complete documentation covering the traceability of all calibration instruments.

1.05 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

D. Manufacture instruments facilities certified to the quality standards of ISO Standard 9001 - Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
   1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

1.08 WARRANTY

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.09 MAINTENANCE

A. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
   1. Ultrasonic level sensor with 4-wire remote transmitter:
      a. Endress+Hauser, Prosonic S FDU Series Sensor with FMU Series Transmitter.
      b. Siemens, Echomax Series sensor with HydroRanger 200 Series Transmitter.
      c. Pulsar, dB Series Sensor with Ultra 3 transmitter.

2.02 MANUFACTURED UNITS

A. Ultrasonic level measurement with 4-wire remote transmitter:
   1. General:
      a. Continuous non-contact level measurement device with remote transmitter using ultrasonic echo sensing. The transducer generates an ultrasonic pulse in the range of 12 to 50 kHz and measures the time required for the pulse to travel to the process surface and return. The

distance is calculated from the send and receive times. Each 4-wire level transmitter system includes, but is not limited to:
1) Ultrasonic transducer.
2) Signal cable.
3) Transmitter.

2. Performance requirements:
   a. Accuracy:
      1) 0.25 percent of range.
   b. Repeatability:
      1) 0.1 percent of range.
3. Ultrasonic transducer:
   a. Encapsulated in chemical- and corrosion-resistant material as indicated on the Instrument Data Sheet or Instrument Index.
   b. Class I Division 1 for transducer only.
   c. Operating temperature range: -5 to 122 degrees Fahrenheit (-20 to 50 degrees Celsius).
   d. Operating relative humidity range: 5 to 95 percent.
   e. Functions:
      1) Temperature compensation.
   f. Mounting: As indicated in the Contract Documents.
   g. Sensors shall be rated for NEMA 6P submergence. Sensors shall have mechanical decoupling between sensor membrane and outer housing. Sensors shall be provided with automatic build up compensation to provide self-cleaning when condensation may occur. Sensors shall be provided with internal heating elements and separate power supplies for these elements when freezing condensation may occur.
4. Transmitter:
   a. Level-indicating transmitter:
      1) Indicator: Liquid crystal display with approximately 0.50-inch display scaled to read in engineering units.
      2) Sensitivity: Able to ignore momentary level spikes or momentary loss of echo and indicate loss of echo condition on indicating transmitter unit.
      3) Ability to allow for signal profiles and echo mapping:
         a) Provide manufacturer's software for re-mapping the signal.
   b. Functions:
      1) Level measurement.
      2) Tank volume.
      3) Flow measurement.
   c. Power supply:
      1) 120 VAC.
      2) Power consumption: 36 VA maximum.
   d. Outputs:
      1) Isolated 4 to 20 milliamperes DC.
      2) Relay outputs:
         a) Minimum 6 Form A or Form C contacts.
         b) Rated 5 amps at 250 VAC.
         c) Programmable.
      3) Enclosure: NEMA Type 4X.
      4) Mounting: As indicated in the Contract Documents.
      5) Operating temperature range from -5 to 122 degrees Fahrenheit (-20 to 50 degrees Celsius); relative humidity of 10 to 100 percent.

6) Power supply shall be 90-253 VAC, or 10.5-32 VDC.
7) The transmitter shall have automatic volume calculation for horizontal or vertical tanks with 32 point linearization; pre-programmed linearization tables for flumes and weirs; back water detection for submerged flow conditions; sludge detection; synchronization of pulses between two ultrasonic units used in same tank; automatic sensor detection; alternating pump control; rake/screen control.
8) There shall be at least 3 integral totalizers and 3 daily counters with the ability for simultaneous measurement of level and flow in storm water overflow basin with only 1 sensor; EE prom memory backup; temperature compensation; average, difference and sum calculations.

2.03 ACCESSORIES

A. Mounting brackets: As indicated on the Drawings.

B. Provide sunshades for outdoor installations.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Factory calibrate each instrument with a minimum 3-point calibration or according to manufacturer's standard at a facility that is traceable to NIST:
   1. Submit calibration data sheets to the Engineer at least 30 days before shipment of the instruments to the project site.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed:
   1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of instruments.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.05 ADJUSTING

A. As specified in Section 17950 - Commissioning for Instrumentation and Controls.

B. Turn on turbulent surface software feature for all installations measuring surfaces lacking a placid surface. This would include but not be limited to level measurements in mixed media filters and potentially wet wells.

3.06 CLEANING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.08 PROTECTION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.09 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be as indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

SECTION 17206A

ULTRASONIC (LEVEL TRANSMITTER)

Level Transmitter

PROJECT INFORMATION

PLANT	ELLIS CREEK WRF	**CUSTOMER**	CITY OF PETALUMA
PROJECT	7310L10	**LOCATION**	

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

SPECIFICATION NUMBER	17206	**MEASURING PRINCIPLE**	ULTRASONIC
DRAWING NUMBER	06N001	**PLC**	PLC-2
SERVICE	4-WIRE ULTRASONIC	**TYPICAL DETAILS**	[*]

CONNECTION

PROCESS CONNECTION	N/A

FLUID

LEVEL RANGE	0-15 FT	**TEMPERATURE**	N/A

ELEMENT

ELEMENT TAG NO.	LE-602	**ENCLOSURE CLASS**	NEMA 4X
ELEMENT HAZ. MATERIALS	N/A	**ELEMENT MATERIAL**	MFR. STD.
SUBMERGENCE DETECTION	NO	**TEMPERATURE COMP.**	NO
HEATED ELEMENT	NO		

TRANSMITTER

TRANSMITTER TAG NO.	LIT-602	**HAZARDOUS APPROVALS**	N/A
MOUNTING	REMOTE	**ENCLOSURE CLASS**	NEMA 4X
POWER	120VAC-1P	**OUTPUT**	4-20 MA
AMBIENT TEMPERATURE	-5 TO 122 DEG F	**MEASUREMENT APPL**	LEVEL
SURGE PROTECTION	NO		

NOTES

[*]

SECTION 17302

FLOW MEASUREMENT: MAGNETIC FLOWMETERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Full-body magnetic flowmeters.

B. Provide all instruments identified in the Contract Drawings.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. International Organization for Standardization (ISO):
   1. 9000 - Quality management systems - Fundamentals and vocabulary.
   2. 17025 - General requirements for the competence of testing and calibration laboratories.

C. National Institute of Standards and Technology (NIST).

D. NSF International (NSF).

1.03 DEFINITIONS

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Include sizing information from the manufacturer that includes:
   1. Chart of the measurement error from zero to maximum measured volumetric flow range indicated in data sheets.
   2. Indication of all input parameters and their values used in the calculations.

1.05 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.

2. Physical conditions:
    a. Installation and mounting requirements.
    b. Location within the process.
    c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.08 WARRANTY

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.09 MAINTENANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
    1. Endress+Hauser:
        a. Promag W flowtube with 300/500 series transmitter.
        b. Promag H flowtube with 300/500 series transmitter.
    2. Emerson, Rosemount 8750W.
    3. Krohne, IFC.
    4. Yokogawa, AXF.
    5. ABB, Watermaster.

2.02 MANUFACTURED UNITS

A. Magnetic flowmeter:
    1. General:
        a. Magnetic flowmeters obtain the flow velocity by measuring the changes of induced voltage of the conductive fluid passing across a controlled magnetic field.
        b. Complete zero stability shall be an inherent characteristic of the flowmeter system.

c. Include for each magnetic flow metering system:
    1) A metering tube with electrodes (sensor).
    2) Signal cable.
    3) Transmitter integral or remote as indicated on the Drawings.
    4) Flowmeter grounding rings.

2. Performance requirements:
    a. Accuracy:
        1) 0.25 percent of flow rate from 10 to 100 percent of full-scale for velocities ranging between 1.9 to 10 feet per second.
    b. Repeatability:
        1) 0.25 percent of rate.

3. Element:
    a. Metering tube:
        1) Constructed of carbon steel or Type 304 stainless steel (unless specifically noted otherwise in the instrument data sheets) with flanged connections to match with piping material.
        2) Liner material in conformance with:
            a) Manufacturer's recommendations for the intended service.
            b) NSF certified for all drinking water applications.
        3) Electrodes type and material in conformance with:
            a) Manufacturer's recommendations for the intended service.
            b) Utilize a minimum of 2**,** self-cleaning electrodes.
        4) Meter terminal housing NEMA Type 4X, unless installed in locations such as vaults that will experience submergence. In those applications NEMA 6P is required:
            a) Unless specifically noted otherwise in the instrument data sheets.
        5) Meter coating consisting of epoxy painted finish.
        6) Components:
            a) 2 grounding rings:
                (1) Which are in conformance with the manufacturer's bore and material recommendation for the meter's intended service.
                (2) Designed to protect and shield from abrasion of the liner's edge interface at the meter's end.

4. Transmitter:
    a. Power supply:
        1) As indicated in the data sheets.
        2) Power consumption: 60 VA maximum.
    b. Outputs:
        1) Isolated 4 to 20 milliamperes DC.
    c. Microprocessor-based signal converter/transmitter.
    d. Utilize DC pulse technique to drive flux-producing coils.
    e. Contain a 6-digit display for flow rate, percent of span, and totalizer.
    f. Operator keypad interface.
    g. Integral zero return to provide consistent zero output signals in response to an external dry contact closure.
    h. Integral low flow cut-off zero return.
    i. Programmable parameters including:
        1) Meter size.
        2) Full-scale flow rate.
        3) Magnetic field frequency.
        4) Time constant.

j. Data retention for a minimum of 5 years without auxiliary main or battery power.
k. Self-diagnostics and automatic data checking.
l. Protected terminals and fuses in a separate compartment which isolates field connection from electronics.
m. Ambient operating temperature limits of -5 to 140 degrees Fahrenheit (-20 to 60 degrees Celsius).

2.03 ACCESSORIES

A. Provide stainless steel tags for each instrument. Tags shall be labeled as specified in the Contract Documents.

B. Provide sunshades for all transmitters located outdoors.

C. Provide galvanic isolation gaskets, nylon/Teflon™ flange bolt insulation bushings and nylon washers on all meters installed on pipes with cathodic protection.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Factory calibrate each flow metering system at a facility that is traceable to the NIST. ISO-17025 accredited test facility with certified accuracy traceable to NIST.

C. Evidence of accreditation shall originate from a national verification agency such as A2LA.

D. A real-time computer generated printout of the actual calibration date indication actual velocities and as read values of the flow tube:
1. Flow calibration report of the manufacturers flow lab calibration procedure shall be shipped with the meter system.
2. Minimum calibration shall be a 3 point calibration including 1, 3, and 10 feet per second velocities for every meter and transmitter system.
3. Manufacturer shall archive all calibration reports for future reference.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. For instruments located outdoors or where instrument elements and transmitters are separated by conduit located outside the building envelope, provide surge protection devices at the transmitters.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide manufacturer's services to perform installation inspection.

3.05 ADJUSTING

A. Field Verification:
   1. Verify factory calibration of all instruments in accordance with the manufacturer's instructions.
   2. The transmitter and sensor to include a method to verify flow meter performance to the original manufacturer specifications.
   3. Verification should be traceable to factory calibration using a third party, attested onboard system pursuant to ISO standards.
   4. The verification report should be compliant to common quality systems such as ISO 9000 to prove reliability of the meter specified accuracy.
   5. Return factory calibrated devices to the factory if they do not meet the field verification requirements for calibration.

3.06 CLEANING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Demonstrate performance of all instruments to the Engineer before commissioning.

3.08 PROTECTION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.09 SCHEDULES

A. Instrument Data Sheets included in this Section.

B. The provided information does not necessarily include all required instruments.

C. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

SECTION 17302A

FLOW MEASUREMENT: MAGNETIC FLOWMETERS (MAGNETIC FLOW TRANSMITTER)

Magnetic Flow Transmitter

PROJECT INFORMATION

PLANT	ELLIS CREEK WRF	**CUSTOMER**	CITY OF PETALUMA
PROJECT	7310L10	**LOCATION**	

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

SPECIFICATION NUMBER	17302	**MEASURING PRINCIPLE**	MAGNETIC
DRAWING NUMBER	06N009	**PLC**	PLC-1
SERVICE	MAGNETIC FLOWMETER	**POWER LOCATION**	07-LPD
		TYPICAL DETAIL(S)	[*]

CONNECTION

LINE SIZE	24"	**PROCESS CONNECTION**	ANSI 150
LINE MATERIAL	STEEL	**PROCESS CONN. MATERIAL**	STEEL

FLUID

FLUID	FILTERED WATER	**PRESSURE**	125 PSI
NOMINAL FLOW	1 MGD	**TEMPERATURE**	N/A
FLOW RANGE	0-5.2 MGD	**VISCOSITY**	N/A
		CONDUCTIVITY	N/A

ELEMENT

ELEMENT TAG NO.	FE-6001	**PROCESS CONNECTION**	ANSI 150
ENCLOSURE CLASS	NEMA 4X	**LINER MATERIAL**	HARD RUBBER
HAZARDOUS APPROVALS	N/A	**VACUUM POSSIBILITY**	NO
TUBE SIZE	18"	**ELECTRODE TYPE**	MFR. STD.
TUBE MATERIAL	MFR. STD.	**ELECTRODE MATERIAL**	316 SST

TRANSMITTER

TRANSMITTER TAG NO.	FIT-6001	**HAZARDOUS APPROVALS**	N/A
MOUNTING	INTEGRAL	**EMPTY PIPE DETECTION**	YES
ENCLOSURE CLASS	NEMA 4X	**BI DIRECTIONAL FLOW**	NO
POWER	120VAC-1P	**PULSE OUTPUT**	NO
AMBIENT TEMPERATURE	-5 TO 122 DEG F	**RELAY OPTIONS**	YES
OUTPUT	4-20 MA	**POTTED ELECTRONICS**	NO
SURGE PROTECTION	NO	**CATHODIC PROT. LINE**	NO

NOTES

[*]

Engineers...Working Wonders With Water®

Magnetic Flow Transmitter

RESERVOIR

PROJECT INFORMATION

PLANT	ELLIS CREEK WRF	**CUSTOMER**	CITY OF PETALUMA
PROJECT	7310L10	**LOCATION**	

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

SPECIFICATION NUMBER	17302	**MEASURING PRINCIPLE**	MAGNETIC
DRAWING NUMBER	06N009	**PLC**	PLC-1
SERVICE	MAGNETIC FLOWMETER	**POWER LOCATION**	07-LPD
		TYPICAL DETAIL(S)	[*]

CONNECTION

LINE SIZE	24"	**PROCESS CONNECTION**	ANSI 150
LINE MATERIAL	STEEL	**PROCESS CONN. MATERIAL**	STEEL

FLUID

FLUID	FILTERED WATER	**PRESSURE**	125 PSI
NOMINAL FLOW	5 MGD	**TEMPERATURE**	N/A
FLOW RANGE	0-8 MGD	**VISCOSITY**	N/A
		CONDUCTIVITY	N/A

ELEMENT

ELEMENT TAG NO.	FE-6002	**PROCESS CONNECTION**	ANSI 150
ENCLOSURE CLASS	NEMA 4X	**LINER MATERIAL**	HARD RUBBER
HAZARDOUS APPROVALS	N/A	**VACUUM POSSIBILITY**	NO
TUBE SIZE	18"	**ELECTRODE TYPE**	MFR. STD.
TUBE MATERIAL	MFR. STD.	**ELECTRODE MATERIAL**	316 SST

TRANSMITTER

TRANSMITTER TAG NO.	FIT-6002	**HAZARDOUS APPROVALS**	N/A
MOUNTING	INTEGRAL	**EMPTY PIPE DETECTION**	YES
ENCLOSURE CLASS	NEMA 4X	**BI DIRECTIONAL FLOW**	NO
POWER	120VAC-1P	**PULSE OUTPUT**	NO
AMBIENT TEMPERATURE	-5 TO 122 DEG F	**RELAY OPTIONS**	YES
OUTPUT	4-20 MA	**POTTED ELECTRONICS**	NO
SURGE PROTECTION	NO	**CATHODIC PROT. LINE**	NO

NOTES

[*]

Magnetic Flow Transmitter

PROJECT INFORMATION

PLANT	ELLIS CREEK WRF	**CUSTOMER**	CITY OF PETALUMA
PROJECT	7310L10	**LOCATION**	

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

SPECIFICATION NUMBER	17302	**MEASURING PRINCIPLE**	MAGNETIC
DRAWING NUMBER	06N002	**PLC**	PLC-2
SERVICE	MAGNETIC FLOWMETER	**POWER LOCATION**	20-LPA
		TYPICAL DETAIL(S)	[*]

CONNECTION

LINE SIZE	14"	**PROCESS CONNECTION**	ANSI 150
LINE MATERIAL	STEEL	**PROCESS CONN. MATERIAL**	STEEL

FLUID

FLUID	FILTER INFLUENT	**PRESSURE**	125 PSI
NOMINAL FLOW	2400 GPM	**TEMPERATURE**	N/A
FLOW RANGE	0-5600 GPM	**VISCOSITY**	N/A
		CONDUCTIVITY	N/A

ELEMENT

ELEMENT TAG NO.	FE-608	**PROCESS CONNECTION**	ANSI 150
ENCLOSURE CLASS	NEMA 4X	**LINER MATERIAL**	HARD RUBBER
HAZARDOUS APPROVALS	N/A	**VACUUM POSSIBILITY**	NO
TUBE SIZE	14"	**ELECTRODE TYPE**	MFR. STD.
TUBE MATERIAL	MFR. STD.	**ELECTRODE MATERIAL**	316 SST

TRANSMITTER

TRANSMITTER TAG NO.	FIT-608	**HAZARDOUS APPROVALS**	N/A
MOUNTING	INTEGRAL	**EMPTY PIPE DETECTION**	YES
ENCLOSURE CLASS	NEMA 4X	**BI DIRECTIONAL FLOW**	NO
POWER	120VAC-1P	**PULSE OUTPUT**	NO
AMBIENT TEMPERATURE	-5 TO 122 DEG F	**RELAY OPTIONS**	YES
OUTPUT	4-20 MA	**POTTED ELECTRONICS**	NO
SURGE PROTECTION	NO	**CATHODIC PROT. LINE**	NO

NOTES

[*]

Magnetic Flow Transmitter

PROJECT INFORMATION

PLANT	ELLIS CREEK WRF	**CUSTOMER**	CITY OF PETALUMA
PROJECT	7310L10	**LOCATION**	

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

SPECIFICATION NUMBER	17302	**MEASURING PRINCIPLE**	MAGNETIC
DRAWING NUMBER	06N005	**PLC**	PLC-1
SERVICE	MAGNETIC FLOWMETER	**POWER LOCATION**	07-LPD
		TYPICAL DETAIL(S)	[*]

CONNECTION

LINE SIZE	3"	**PROCESS CONNECTION**	ANSI 150
LINE MATERIAL	STAINLESS STEEL	**PROCESS CONN. MATERIAL**	STAINLESS STEEL

FLUID

FLUID	FILTER BACKWASH	**PRESSURE**	125 PSI
NOMINAL FLOW	100 GPM	**TEMPERATURE**	N/A
FLOW RANGE	0-150 GPM	**VISCOSITY**	N/A
		CONDUCTIVITY	N/A

ELEMENT

ELEMENT TAG NO.	FE-6651	**PROCESS CONNECTION**	ANSI 150
ENCLOSURE CLASS	NEMA 4X	**LINER MATERIAL**	HARD RUBBER
HAZARDOUS APPROVALS	N/A	**VACUUM POSSIBILITY**	NO
TUBE SIZE	3"	**ELECTRODE TYPE**	MFR. STD.
TUBE MATERIAL	MFR. STD.	**ELECTRODE MATERIAL**	316 SST

TRANSMITTER

TRANSMITTER TAG NO.	FIT-6651	**HAZARDOUS APPROVALS**	N/A
MOUNTING	INTEGRAL	**EMPTY PIPE DETECTION**	YES
ENCLOSURE CLASS	NEMA 4X	**BI DIRECTIONAL FLOW**	NO
POWER	120VAC-1P	**PULSE OUTPUT**	NO
AMBIENT TEMPERATURE	-5 TO 122 DEG F	**RELAY OPTIONS**	YES
OUTPUT	4-20 MA	**POTTED ELECTRONICS**	NO
SURGE PROTECTION	NO	**CATHODIC PROT. LINE**	NO

NOTES

[*]

Magnetic Flow Transmitter

PROJECT INFORMATION

PLANT	ELLIS CREEK WRF	**CUSTOMER**	CITY OF PETALUMA
PROJECT	7310L10	**LOCATION**	

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

SPECIFICATION NUMBER	17302	**MEASURING PRINCIPLE**	MAGNETIC
DRAWING NUMBER	06N008	**PLC**	PLC-1
SERVICE	MAGNETIC FLOWMETER	**POWER LOCATION**	07-LPD
		TYPICAL DETAIL(S)	[*]

CONNECTION

LINE SIZE	3"	**PROCESS CONNECTION**	ANSI 150
LINE MATERIAL	STAINLESS STEEL	**PROCESS CONN. MATERIAL**	STAINLESS STEEL

FLUID

FLUID	FILTER BACKWASH	**PRESSURE**	125 PSI
NOMINAL FLOW	100 GPM	**TEMPERATURE**	N/A
FLOW RANGE	0-150 GPM	**VISCOSITY**	N/A
		CONDUCTIVITY	N/A

ELEMENT

ELEMENT TAG NO.	FE-6751	**PROCESS CONNECTION**	ANSI 150
ENCLOSURE CLASS	NEMA 4X	**LINER MATERIAL**	HARD RUBBER
HAZARDOUS APPROVALS	N/A	**VACUUM POSSIBILITY**	NO
TUBE SIZE	3"	**ELECTRODE TYPE**	MFR. STD.
TUBE MATERIAL	MFR. STD.	**ELECTRODE MATERIAL**	316 SST

TRANSMITTER

TRANSMITTER TAG NO.	FIT-6751	**HAZARDOUS APPROVALS**	N/A
MOUNTING	INTEGRAL	**EMPTY PIPE DETECTION**	YES
ENCLOSURE CLASS	NEMA 4X	**BI DIRECTIONAL FLOW**	NO
POWER	120VAC-1P	**PULSE OUTPUT**	NO
AMBIENT TEMPERATURE	-5 TO 122 DEG F	**RELAY OPTIONS**	YES
OUTPUT	4-20 MA	**POTTED ELECTRONICS**	NO
SURGE PROTECTION	NO	**CATHODIC PROT. LINE**	NO

NOTES

[*]

SECTION 17402

PRESSURE/VACUUM MEASUREMENT: INSTRUMENT VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Valve manifolds and instrument valves.

B. Provide all valves identified in the Contract Documents.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.03 DEFINITIONS

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Additional requirements:
   1. Product data:
      a. Valve type.
      b. Body material.
      c. Size.
      d. Options.
   2. Shop drawings:
      a. Mounting details for all manifold valves.

1.05 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the valves are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the Engineer if any installation condition does not meet the valve manufacturer's recommendations or specifications.

D. Provide valves manufactured at facilities certified to the quality standards of ISO 9001.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Protect valve manifolds and protective coatings from damage during handling and installation. Repair coating where damaged.

1.07 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
   1. Provide valves suitable for the installed site conditions including, but not limited to, material compatibility, process, and ambient temperatures.

1.08 WARRANTY

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.09 MAINTENANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Valve manifold:
   1. One of the following or equal:
      a. Anderson Greenwood.
      b. Hex Valve.
      c. Noshok.
      d. Emerson, Rosemount.

B. Block and bleed valve:
   1. One of the following or equal:
      a. Anderson Greenwood.
      b. Hex Valve.

C. Gauge valve:
   1. One of the following or equal:
      a. Anderson Greenwood.
      b. Hex Valve.

D. Level sensor isolation valve:
   1. One of the following or equal:
      a. Indu-Tech, Level Sensor Isolation Valve.
      b. DeZURIK, Level Sensor Isolation Valve.
      c. Tyco, Rovalve Isolation Knife Gate Valve.

2.02 MANUFACTURED UNITS

A. Valve manifolds:
   1. General:
      a. Provide 2-valve, 3-valve, blowdown type 5-valve, or metering type 5-valve manifolds as indicated on the Drawings.
      b. Valve manifolds shall have one piece bonnet with a metal to metal seal to the valve body below the bonnet threads.
   2. Requirements:
      a. Bonnet lock pin to prevent accidental loosening.
      b. Gas leak tested metal-to-metal hard seat design for hard seat valves.
      c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
      d. Manifold valves shall have straight through portion for bi-directional flow and easy roddable cleaning.
      e. Manifold valves shall allow for direct or remote instrument mounting.
      f. Shall be able to withstand pressures up to 6,000 psi for soft seat valves and 10,000 psi for hard seat valves at maximum 200 degrees Fahrenheit.
      g. Materials of construction:
         1) Body material: Type 316 stainless steel.
         2) O-Ring: Teflon.
      h. 2-Valve manifolds:
         1) 1 isolation valve and 1 drain/vent and calibration valve.
      i. 3-Valve manifolds:
         1) 2 isolation valves and 1 equalizing valve for differential pressure applications.
         2) Plugged vent connections used for vent/drain or calibration.
      j. Blowdown 5-valve manifold:
         1) 2 isolation valves, 1 equalizing valve, 2 blowdown valves for differential pressure applications.
      k. Metering 5-valve manifold:
         1) 2 isolation valves, 2 equalizing valves, 1 vent/drain and calibration valve for differential pressure applications.

B. Block and bleed valves:
   1. General:
      a. Valve shall provide process isolation and venting/draining capabilities.
      b. Gas leak tested metal-to-metal hard seat design for hard seat valves.
      c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
      d. Valve shall not be used with fluids with high solids content, such as raw wastewater or sludge.

2. Requirements:
    a. Materials of construction:
        1) Body material: Type 316 stainless steel.
        2) O-Ring: Teflon.

C. Gauge valves:
1. General:
    a. Valve shall provide process isolation from pressure instrument.
    b. Gas leak tested, metal-to-metal hard seat design for hard seat valves.
    c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
2. Requirements:
    a. Materials of construction:
        1) Body material: Type 316 stainless steel.
        2) O-Ring: Teflon.

D. Level sensor isolation valves:
1. General:
    a. Valve shall provide process isolation from level diaphragm.
    b. Gas leak tested, metal-to-metal hard seat design for hard seat valves.
    c. Gas leak tested soft seat design with replaceable seat for soft seat valves.
2. Requirements:
    a. Materials of construction:
        1) Body material: Type 316 stainless steel.
        2) Flange diameter size: 3 inches.

2.03 ACCESSORIES

A. Provide tube fitting, female NPT, or pipe butt weld connections if necessary.

B. Provide stainless steel concentric or eccentric pipe nipples when necessary.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location and verify it will work properly when installed:
1. Notify the Engineer promptly if any installation condition does not meet the manufacturer’s recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of all valves.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.05 ADJUSTING

A. As specified in Section 17950 - Commissioning for Instrumentation and Controls.

3.06 CLEANING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Demonstrate performance of all valves to the Engineer before commissioning.

3.08 PROTECTION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.09 SCHEDULES (NOT USED)

END OF SECTION

SECTION 17403

PRESSURE/VACUUM MEASUREMENT: SWITCHES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Pressure/vacuum switches.

B. Provide all instruments specified in the Contract Documents.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.03 DEFINITIONS

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Additional requirements:
   1. Product data:
      a. Accessories such as diaphragm seals, valve manifold, snubbers, and pulsation dampeners.

1.05 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.
      b. Location within the process.
      c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the Engineer if any installation condition does not meet the instrument manufacturer’s recommendations or specifications.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems:
   1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

1.08 WARRANTY

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.09 MAINTENANCE

A. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Mechanical type pressure switch: One of the following or equal:
   1. Ashcroft, B Series Type 400.
   2. United Electric Controls Series 400.
   3. ASCO, S-Series.

2.02 MANUFACTURED UNITS

A. Mechanical type pressure switches:
   1. General:
      a. Pressure switch shall be diaphragm or diaphragm-sealed piston type.
   2. Performance requirements:
      a. Pressure range:
         1) As specified in data sheets following this Section.
      b. Accuracy:
         1) Within 1.0 percent of range.
      c. Repeatability:
         1) Within 1.0 percent of range.
   3. Element:
      a. Type: Diaphragm, diaphragm-sealed piston, or bourdon tube.
      b. Overpressure:
         1) Minimum 130 percent of maximum range pressure without damage to switch or sensing element.
         2) Minimum 400 percent of nominal range without leakage or rupture.
      c. Sensing element shall not require ambient temperature compensation.

d. Wetted materials: Stainless steel.
e. Setpoint:
    1) Single.
    2) Switch shall activate at setpoint on increasing pressure for high-pressure alarm applications and on decreasing pressure for low-pressure alarm applications.
f. Adjustable deadband.
g. Switch elements:
    1) Snap acting.
    2) Single-pole double-throw (SPDT).
    3) Rated at 5 A, 125/250 VAC.
    4) Automatic reset type.
h. Enclosure: Epoxy coated:
    1) NEMA Type 4X.
i. Switch mounting:
    1) Process connection: 1/2-inch NPT.

4. Components:
    a. Provide all necessary hardware for pressure switch mounting.

2.03 ACCESSORIES

A. Provide diaphragm seals as specified in data sheets or as indicated on the Drawings:
    1. Diaphragm seal and pressure switch shall be assembled by manufacturer and shipped as an assembly.

B. Furnish block and bleed valves as specified in Section 17402 - Pressure/Vacuum Measurement: Instrument Valves.

C. Provide stainless steel tags for each instrument. Tags shall be labeled as specified in the Contract Documents.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Factory calibrate each instrument with a minimum 3-point calibration or according to Manufacturer’s standard at a facility that is traceable to the NIST.
    1. Submit calibration data sheets to the Engineer at least 30 days before shipment of the instruments to the project site.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of instruments.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.05 ADJUSTING

A. Verify factory calibration of all instruments in accordance with the manufacturer's instructions:
   1. Return factory calibrated devices to the factory if they do not meet the field verification requirements for calibration.

3.06 CLEANING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.08 PROTECTION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.09 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments specified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications or both.

END OF SECTION

SECTION 17403A

PRESSURE SWITCHES

Pressure Switch

SPECIFICATION: 17403

PROJECT INFORMATION

PLANT ELLIS CREEK WRF
PROJECT 7310L10
CUSTOMER CITY OF PETALUMA
LOCATION

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

Tag:	P&ID						
PSH-6004	06N001	**SERVICE:**	PRESSURE SWITCH HIGH				
PE-6004		**FLUID:**	FILTER INFLUENT	**HAZARDOUS APP:**	N/A	**POWER:**	[*]
		MEASURING PRINCIPLE:	PRESS SW	**ELEM. ENCL. CLASS:**	NEMA 4X	**POWER LOCATION:**	LOOP
		SET POINT:	26 PSIG OPEN	**ELEMENT MATERIAL:**	MFR. STD.	**OUTPUT:**	RELAY
		MOUNTING:	INTEGRAL	**SWITCH ENCL. CLASS:**	NEMA 4X	**RELAY FORM:**	SPDT
		TYPICAL DETAILS:	[*]	**ENCL. MATERIAL:**	MFR. STD.	**PLC:**	PLC-2
		PRESSURE:	0-60 PSI	**SURGE PROTECTION:**	NO	**MANUAL RESET:**	NO
		TEMPERATURE:	N/A	**BOTT. HOUSING MAT.:**	MFR. STD.	**SEAL TYPE:**	N/A
		CONN. MOUNTING:	BOTTOM	**INSTRUMENT VALVES:**	BLOCK AND BLEED	**DIAPHRAGM/WET MAT:**	MFR. STD.

Tag:	P&ID						
PSH-6005	06N001	**SERVICE:**	PRESSURE SWITCH HIGH				
PE-6005		**FLUID:**	FILTER INFLUENT	**HAZARDOUS APP:**	N/A	**POWER:**	[*]
		MEASURING PRINCIPLE:	PRESS SW	**ELEM. ENCL. CLASS:**	NEMA 4X	**POWER LOCATION:**	LOOP
		SET POINT:	26 PSIG OPEN	**ELEMENT MATERIAL:**	MFR. STD.	**OUTPUT:**	RELAY
		MOUNTING:	INTEGRAL	**SWITCH ENCL. CLASS:**	NEMA 4X	**RELAY FORM:**	SPDT
		TYPICAL DETAILS:	[*]	**ENCL. MATERIAL:**	MFR. STD.	**PLC:**	PLC-2
		PRESSURE:	0-60 PSI	**SURGE PROTECTION:**	NO	**MANUAL RESET:**	NO
		TEMPERATURE:	N/A	**BOTT. HOUSING MAT.:**	MFR. STD.	**SEAL TYPE:**	N/A
		CONN. MOUNTING:	BOTTOM	**INSTRUMENT VALVES:**	BLOCK AND BLEED	**DIAPHRAGM/WET MAT:**	MFR. STD.

Tag:	P&ID						
PSH-604	06N002	**SERVICE:**	PRESSURE SWITCH HIGH				
PE-604		**FLUID:**	FILTER INFLUENT	**HAZARDOUS APP:**	N/A	**POWER:**	[*]
		MEASURING PRINCIPLE:	PRESS SW	**ELEM. ENCL. CLASS:**	NEMA 4X	**POWER LOCATION:**	LOOP
		SET POINT:	26 PSIG OPEN	**ELEMENT MATERIAL:**	MFR. STD.	**OUTPUT:**	RELAY
		MOUNTING:	INTEGRAL	**SWITCH ENCL. CLASS:**	NEMA 4X	**RELAY FORM:**	SPDT
		TYPICAL DETAILS:	[*]	**ENCL. MATERIAL:**	MFR. STD.	**PLC:**	PLC-2
		PRESSURE:	0-60 PSI	**SURGE PROTECTION:**	NO	**MANUAL RESET:**	NO
		TEMPERATURE:	N/A	**BOTT. HOUSING MAT.:**	MFR. STD.	**SEAL TYPE:**	N/A
		CONN. MOUNTING:	BOTTOM	**INSTRUMENT VALVES:**	BLOCK AND BLEED	**DIAPHRAGM/WET MAT:**	MFR. STD.

Pressure Switch

SPECIFICATION: 17403

PROJECT INFORMATION

PLANT ELLIS CREEK WRF
PROJECT 7310L10
CUSTOMER CITY OF PETALUMA
LOCATION

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

Tag:	P&ID	SERVICE: PRESSURE SWITCH HIGH			
PSH-605	06N002	**FLUID:** FILTER INFLUENT	**HAZARDOUS APP:** N/A	**POWER:** [*]	
PE-605		**MEASURING PRINCIPLE:** PRESS SW	**ELEM. ENCL. CLASS:** NEMA 4X	**POWER LOCATION:** LOOP	
		SET POINT: 26 PSIG OPEN	**ELEMENT MATERIAL:** MFR. STD.	**OUTPUT:** RELAY	
		MOUNTING: INTEGRAL	**SWITCH ENCL. CLASS:** NEMA 4X	**RELAY FORM:** SPDT	
		TYPICAL DETAILS: [*]	**ENCL. MATERIAL:** MFR. STD.	**PLC:** PLC-2	
		PRESSURE: 0-60 PSI	**SURGE PROTECTION:** NO	**MANUAL RESET:** NO	
		TEMPERATURE: N/A	**BOTT. HOUSING MAT.:** MFR. STD.	**SEAL TYPE:** N/A	
		CONN. MOUNTING: BOTTOM	**INSTRUMENT VALVES:** BLOCK AND BLEED	**DIAPHRAGM/WET MAT:** MFR. STD.	

Tag:	P&ID	SERVICE: PRESSURE SWITCH HIGH			
PSH-606	06N002	**FLUID:** FILTER INFLUENT	**HAZARDOUS APP:** N/A	**POWER:** [*]	
PE-606		**MEASURING PRINCIPLE:** PRESS SW	**ELEM. ENCL. CLASS:** NEMA 4X	**POWER LOCATION:** LOOP	
		SET POINT: 26 PSIG OPEN	**ELEMENT MATERIAL:** MFR. STD.	**OUTPUT:** RELAY	
		MOUNTING: INTEGRAL	**SWITCH ENCL. CLASS:** NEMA 4X	**RELAY FORM:** SPDT	
		TYPICAL DETAILS: [*]	**ENCL. MATERIAL:** MFR. STD.	**PLC:** PLC-2	
		PRESSURE: 0-60 PSI	**SURGE PROTECTION:** NO	**MANUAL RESET:** NO	
		TEMPERATURE: N/A	**BOTT. HOUSING MAT.:** MFR. STD.	**SEAL TYPE:** N/A	
		CONN. MOUNTING: BOTTOM	**INSTRUMENT VALVES:** BLOCK AND BLEED	**DIAPHRAGM/WET MAT:** MFR. STD.	

SECTION 17404

PRESSURE/VACUUM MEASUREMENT: GAUGES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Pressure/vacuum gauges.

B. Provide all instruments specified in the Contract Documents.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. American Society of Mechanical Engineers (ASME):
   1. B40.100 - Pressure Gauges and Gauge Attachments.

1.03 DEFINITIONS

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Additional requirements:
   1. Product data:
      a. Accessories such as diaphragm seals, valve manifold, snubbers, and pulsation dampeners.

1.05 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
   2. Physical conditions:
      a. Installation and mounting requirements.

b. Location within the process.
c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.08 WARRANTY

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.09 MAINTENANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
1. Ashcroft:
a. Maximum pressure less than 10 pounds per square inch: Model 1188.
b. Maximum pressure greater than or equal to 10 pounds per square inch: Model 1279.
2. Wika.
3. Ametek U.S. Gauge.

2.02 MANUFACTURED UNITS

A. General:
1. Pressure gauge assembly shall include pressure sensing element, gauge case, and dial mechanism.

B. Performance requirements:
1. Pressure range:
a. As specified in the Contract Documents.
2. Accuracy:
a. Grade 2A, as defined by ASME B40.100.

b. Within 1.0 percent of span after friction errors are eliminated by tapping or vibration.
c. Maximum allowable friction inaccuracy: Within 1.0 percent of span.

3. Element:
   a. Where the maximum pressure is less than 10 pounds per square inch, provide socket and bellows; for all other pressure ranges, employ a Bourdon® tube.
   b. Socket tips for bellows and Bourdon® tube:
      1) Materials: Type 316 stainless steel.
   c. Overpressure: Minimum 130 percent of maximum range pressure without damage to gauge or sensing element.
   d. Wetted materials: Type 316 stainless steel.
4. Dial gauge:
   a. Dial size: 4-1/2 inches.
   b. Dial case material:
      1) Maximum pressure less than 10 pounds per square inch:
         a) Phenolic.
      2) Maximum pressure greater than or equal to 10 pounds per square inch:
         a) Phenolic.
   c. Provide safety gauge with safety blow out through the back or top of the unit.
   d. Dial face: Gasketed shatterproof glass or polycarbonate.
   e. Provide gauge locks on all pressure gauges directly connected to diaphragm seals.
   f. Provide gauge locks where possible.
   g. Connection and mounting:
      1) Direct mounted and suitable for outdoor installation.
      2) 1/2-inch NPT.
      3) Connection material: Stainless steel.
   h. Pointer: Externally adjustable.

2.03 ACCESSORIES

A. Pulsation dampeners and snubbers:
   1. Provide pulsation dampener or snubber with each pressure gauge installed on discharge of positive displacement type pump.
   2. Provide piston-type snubber if pressure spikes will exceed 130 percent of gauge maximum range.
   3. Materials: Type 316 stainless steel.
   4. Mount pulsation dampener or snubber integrally to the pressure gauge.
   5. Connection: 1/2-inch NPT.

B. Provide means for gauge isolation as specified in Section 17402 - Pressure/Vacuum Measurement: Instrument Valves:
   1. Mount valve manifold integrally to the gauge.
   2. Valve manifold and pressure gauge shall be assembled by manufacturer and shipped as an assembly.

C. Provide stainless steel tags for each instrument. Tags shall be labeled as specified in the Contract Documents.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Factory calibrate each pressure gauge at a facility that is traceable to the NIST.

C. Provide complete documentation covering the traceability of all calibration instruments.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc., for proper installation of instruments.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.05 ADJUSTING

A. Verify factory calibration of all instruments in accordance with the manufacturer's instructions:
   1. Return factory calibrated devices to the factory if they do not meet the field verification requirements for calibration.

3.06 CLEANING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.08 PROTECTION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.09 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:
   1. Instruments may be indicated on the Drawings, specified in the Specifications or both.

END OF SECTION

SECTION 17404A

PRESSURE GAUGES

Pressure Gauge

SPECIFICATION: 17404

PROJECT INFORMATION

PLANT ELLIS CREEK WRF
PROJECT 7310L10
CUSTOMER CITY OF PETALUMA
LOCATION

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

Tag:	P&ID						
PI-6004	06N001	**SERVICE:**	PRESSURE INDICATOR				
		FLUID:	FILTER INFLUENT	**CONNECTION TYPE:**	1/2 IN NPT	**BOTT. HOUSING MAT.:**	MFR. STD.
		TEMPERATURE:	N/A	**ISOLATION SEALS:**	N/A	**INSTRUMENT VALVES:**	BLOCK AND BLEED VALVE
		MEASURING PRINCIPLE:	DIRECT	**CASE MATERIAL:**	PHENOLLIC	**DIAPHRAGM MAT.:**	MFR. STD.
		TYPICAL DETAILS:	[*]	**DIAL SIZE:**	4-1/2"	**AMBIENT TEMP:**	-5 TO 122 DEG F
		GAUGE RANGE:	0-60 PSI	**OPTIONS:**	N/A		
Tag:	**P&ID**	**SERVICE:**	PRESSURE INDICATOR				
PI-6005	06N001	**FLUID:**	FILTER INFLUENT	**CONNECTION TYPE:**	1/2 IN NPT	**BOTT. HOUSING MAT.:**	MFR. STD.
		TEMPERATURE:	N/A	**ISOLATION SEALS:**	N/A	**INSTRUMENT VALVES:**	BLOCK AND BLEED VALVE
		MEASURING PRINCIPLE:	DIRECT	**CASE MATERIAL:**	PHENOLLIC	**DIAPHRAGM MAT.:**	MFR. STD.
		TYPICAL DETAILS:	[*]	**DIAL SIZE:**	4-1/2"	**AMBIENT TEMP:**	-5 TO 122 DEG F
		GAUGE RANGE:	0-60 PSI	**OPTIONS:**	N/A		
Tag:	**P&ID**	**SERVICE:**	PRESSURE INDICATOR				
PI-604	06N002	**FLUID:**	FILTER INFLUENT	**CONNECTION TYPE:**	1/2 IN NPT	**BOTT. HOUSING MAT.:**	MFR. STD.
		TEMPERATURE:	N/A	**ISOLATION SEALS:**	N/A	**INSTRUMENT VALVES:**	BLOCK AND BLEED VALVE
		MEASURING PRINCIPLE:	DIRECT	**CASE MATERIAL:**	PHENOLLIC	**DIAPHRAGM MAT.:**	MFR. STD.
		TYPICAL DETAILS:	[*]	**DIAL SIZE:**	4-1/2"	**AMBIENT TEMP:**	-5 TO 122 DEG F
		GAUGE RANGE:	0-60 PSI	**OPTIONS:**	N/A		
Tag:	**P&ID**	**SERVICE:**	PRESSURE INDICATOR				
PI-605	06N002	**FLUID:**	FILTER INFLUENT	**CONNECTION TYPE:**	1/2 IN NPT	**BOTT. HOUSING MAT.:**	MFR. STD.
		TEMPERATURE:	N/A	**ISOLATION SEALS:**	N/A	**INSTRUMENT VALVES:**	BLOCK AND BLEED VALVE
		MEASURING PRINCIPLE:	DIRECT	**CASE MATERIAL:**	PHENOLLIC	**DIAPHRAGM MAT.:**	MFR. STD.
		TYPICAL DETAILS:	[*]	**DIAL SIZE:**	4-1/2"	**AMBIENT TEMP:**	-5 TO 122 DEG F
		GAUGE RANGE:	0-60 PSI	**OPTIONS:**	N/A		

Pressure Gauge

SPECIFICATION: 17404

PROJECT INFORMATION

PLANT ELLIS CREEK WRF
PROJECT 7310L10
CUSTOMER CITY OF PETALUMA
LOCATION

ELEMENT/SWITCH

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

Tag:	P&ID						
PI-606	06N002	**SERVICE:**	PRESSURE INDICATOR				
		FLUID:	FILTER INFLUENT	**CONNECTION TYPE:**	1/2 IN NPT	**BOTT. HOUSING MAT.:**	MFR. STD.
		TEMPERATURE:	N/A	**ISOLATION SEALS:**	N/A	**INSTRUMENT VALVES:**	BLOCK AND BLEED VALVE
		MEASURING PRINCIPLE:	DIRECT	**CASE MATERIAL:**	PHENOLLIC	**DIAPHRAGM MAT.:**	MFR. STD.
		TYPICAL DETAILS:	[*]	**DIAL SIZE:**	4-1/2"	**AMBIENT TEMP:**	-5 TO 122 DEG F
		GAUGE RANGE:	0-60 PSI	**OPTIONS:**	N/A		

SECTION 17509

ANALYZERS: TURBIDITY

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Turbidity analyzers (turbidimeters).

B. Provide all instruments identified in the Contract Documents.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. CSA International (CSA).

C. United States Environmental Protection Agency (USEPA):
   1. Method 180.1 - Determination of Turbidity by Nephilometry.

1.03 DEFINITIONS

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide complete documentation covering the traceability of all calibration instruments.

1.05 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
   1. Process conditions: Fluids, pressures, temperatures, flows, materials etc.
   2. Physical conditions:
      a. Installation and mounting requirements.

b. Location within the process.

c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.

C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

D. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems:

1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

1.08 WARRANTY

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.09 MAINTENANCE

A. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all of these supplies before project substantial completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Low range turbidimeters: LED type:
1. Lovibond PTV Series.
2. GLI T53 Analyzer with 8320T Sensor (Accu4 System).
3. Endress Hauser CUE21-NIR.
4. Endress Hauser CUS52D–NIR sensor with CM44x transmitter.

B. Turbidimeters: Laser type:
1. HACH - TU5300/5400.

2.02 MANUFACTURED UNITS

A. Low range turbidimeters: LED type:
   1. General:
      a. The turbidimeter shall be a microprocessor-based, continuous-reading, on-line nephelometric instrument utilizing a 4-beam radiometric measurement. Each turbidity system shall consist of a 1 sensor and 1 transmitter.
   2. Performance requirements:
      a. Range:
         1) 0 to 10 NTU.
      b. Accuracy:
         1) Within 2 percent of reading or within 0.020 NTU (whichever is greater) from 0 to 40 NTU.
         2) Within 5 percent of reading from 40 to 100 NTU.
      c. Resolution: 0.001 NTU.
      d. Repeatability: Better than within 0.1 percent of span or better.
      e. Response time:
         1) Initial response in 1 minute.
         2) 9.5 seconds with internal bubble trap.
      f. Sample flow required: 0.19 to 1.8 milliliter per minute (0.05 to 0.5 gallon per hour).
      g. Storage temperature: -20 degrees Celsius to 60 degrees Celsius (4 degrees Fahrenheit to 140 degrees Fahrenheit).
      h. Operating temperature: 0 degrees Celsius to 40 degrees Celsius (32 degrees Fahrenheit to 104 degrees Fahrenheit).
      i. Operating humidity: 5 to 95 percent non-condensing.
      j. Pressure:
         1) Low pressure kit: 0 to 50 pounds per square inch gauge at 68 degrees Fahrenheit.
         2) High pressure kit - 0 to 150 pounds per square inch gauge at 68 degrees Fahrenheit.
   3. Element:
      a. Light sources shall be emitted by 2 separate LED sources one shall illuminate and measure both the transmittance (reference) and 90 degree scatter (active) through the sample, once measured the second LED illuminates and same measurements are made with the exception that the Reference becomes the Active. The transmitter shall use both measurements and a comparison algorithm to calculate the NTU.
      b. Optical components shall be mounted in a sealed head assembly that can be removed easily for calibration/service, without disturbing sample flow.
      c. The turbidimeter body shall be constructed of corrosion-resistant polystyrene, and shall include an internal bubble trap to vent entrained air from the sample stream.
      d. The turbidimeter shall offer the choice of Formazin-based (20 or 1 NTU) or instrument comparison-based calibration methods and the quartz calibration cube.
      e. Unit shall be capable of signal averaging.
   4. Transmitter:
      a. The transmitter unit shall be a microprocessor-based device capable of functioning with a single sensor, and as a digital interface link between

turbidimeters and other communication devices through a digital bus communications.

b. Interface module:
   1) The interface unit shall allow operators to control sensor and network functions with user-friendly, menu-driven software, and shall provide data logging of measurement data, and the capability to transfer data to a computer or printer via an RS232 serial input/output device.
   2) The interface unit and power supply shall be housed in NEMA Type 4X industrial plastic enclosures.
c. Power supply:
   1) 120 VAC.
   2) Power consumption: 40 VA maximum.
d. Outputs:
   1) Isolated 4 to 20 milliamperes DC.
   2) Relay outputs:
      a) 2 Form C contact.
      b) Rated 5 amps at 230 VAC.
      c) Programmable.
   3) Output span programmable over any portion of the 0 to 10 NTU range.
e. Piping connections:
   1) Sample inlet fitting 1/2-inch NPT female, adaptable to 3/8-inch or 1/4-inch barb or tube fittings.
   2) Drain fitting 1/2-inch NPT female.
f. Enclosures NEMA Type 4X/IP66.
g. Certification:
   1) Certified in accordance with CSA type 4.
   2) CE compliant.
   3) Class I Division 2 Groups A, B, C and D.
   4) Class II Division 2 Groups E, F and G.

B. Low range turbidimeters: Laser type:
   1. General:
      a. The turbidimeter shall be a microprocessor-based, continuous-reading, on-line nephelometric instrument with predictive diagnostics, meeting all design and performance criteria in accordance with USEPA method 10258. Each turbidity system shall consist of a 1 sensor and 1 transmitter.
      b. Optical components shall be mounted in a sealed head assembly that can be removed easily for calibration/service, without disturbing sample flow.
      c. The turbidimeter body shall be constructed of corrosion-resistant metal and shall include an internal bubble trap to vent entrained air from the sample stream.
   2. Performance requirements:
      a. Range: 0.002 to 700 NTU.
      b. Accuracy:
         1) Within 2 percent of reading within 0.01 NTU from 0 to 40 NTU based on Formazin primary standard at 25 degrees Celsius.
         2) Within 10 percent of reading from 40 to 1,000 NTU based on Formazin primary standard at 25 degrees Celsius
      c. Resolution: 0.0001 NTU.

d. Repeatability: Within 1 percent of reading or 0.002 NTU, whichever is greater based on Formazin primary standard at 25 degrees Celsius.
e. Sample flow required: 100 to 1,000 mL/min; optimal flow rate 200 to 500 mL/min.
f. Sample pressure: Maximum of 87 pounds per square inch.

3. Element:
   a. The low range online laser turbidimeter consists of a Class 1 650 nanometer (EPA) or 850 nanometer (ISO) laser light source and 360 degrees by 90 degrees detection system with predictive diagnostics designed to continuously monitor turbidity in a sample stream.
4. Transmitter:
   a. The graphical interface unit shall be a microprocessor-based device capable of functioning with a single sensor, and as a digital interface link between turbidimeters and other communication devices through a digital bus communications.
   b. The interface unit shall allow operators to control sensor and network functions with user-friendly, menu-driven software, and shall provide data logging of measurement data, and the capability to transfer data to a computer or printer via an RS-232 serial input/output device.
   c. The interface unit shall be housed in NEMA Type 4X (indoor) industrial plastic enclosure. Operating humidity: 5 to 95 percent non-condensing.
   d. All turbidimeters on the network shall have RS-232 serial input/output capability for 2-way communication to a computer or 1-way communication to a printer to record or print real-time turbidity data, calibration history and current set points.
   e. Enclosures: NEMA Type 4X
   f. Certification:
      1) USEPA - Federal Register Vol 67 No. 209.
   g. Power supply:
      1) 120 VAC.
      2) Power consumption: 75 VA maximum.
   h. Outputs:
      1) Isolated 4 to 20 milliamperes DC.
      2) Relay outputs:
         a) 4 Form C contacts.
         b) Rated 5 amps at 120 VAC.
         c) Programmable.

2.03 ACCESSORIES

A. Mounting brackets as required or as indicated on the Drawings.

B. Provide sunshades for outdoor installations.

C. Flushing solenoids for cleaning the probe as recommended by the manufacturer.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Factory calibrate each instrument with a minimum 3-point calibration or according to manufacturer's standard at a facility that is traceable to the NIST.

1. Submit calibration data sheets to the Engineer at least 30 days before shipment of the instruments to the project site.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.

1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Coordinate the installation with all trades to ensure that the mechanical system has all necessary appurtenances including weld-o-lets, valves, etc. for proper installation of instruments.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide manufacturer's services to perform installation inspection, start-up and calibration/verification.

3.05 ADJUSTING

A. As specified in Section 17950 - Commissioning for Instrumentation and Controls.

3.06 CLEANING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.08 PROTECTION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.09 SCHEDULES

A. The provided information does not necessarily include all required instruments. Provide all instruments identified in the Contract Documents:

1. Instruments may be indicated on the Drawings, specified in the Specifications, or both.

END OF SECTION

SECTION 17509A

ANALYZER: TRANSMITTER

Analyzer Transmitter

PROJECT INFORMATION

PLANT	ELLIS CREEK WRF	**CUSTOMER**	CITY OF PETALUMA
PROJECT	7310L10	**LOCATION**	

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

SPECIFICATION NUMBER	17509	**MEASURING PRINCIPLE**	NEPHELOMETRIC
DRAWING NUMBER	06N003	**PLC**	PLC-1
SERVICE	TURBIDITY PROBE	**TYPICAL DETAILS**	[*]
POWER LOCATION	07-LPD		

FLUID

FLUID	FILTER EFFLUENT	**PRESSURE**	N/A
MEASUREMENT RANGE	0-10 NTU	**TEMPERATURE**	N/A
SAMPLE FLOW	N/A	**SAMPLE TEMPERATURE**	40 - 80 DEG F
SAMPLE pH	1-14		

ELEMENT

ELEMENT TAG NO.	AE-6604	**PROCESS CONNECTION**	INSERTION
ENCLOSURE CLASS	NEMA 4X	**HAZARDOUS APPROVALS**	N/A
CLEANING APPARATUS	YES	**ELEMENT MOUNTING KIT**	HOT TAP

TRANSMITTER

TRANSMITTER TAG NO.	AIT-6604	**SIGNAL OUTPUT**	AI
ENCLOSURE CLASS	NEMA 4X	**OUTPUT**	4-20 MA
TRANS. MOUNTING	REMOTE	**TRANS. HAZ APPROVALS**	N/A
POWER	120VAC-1P	**RELAY OPTIONS**	YES
SURGE PROTECTION	NO	**AMBIENT TEMPERATURE**	-5 TO 122 DEG F
AIR CLEANING SYSTEM	NO		

NOTES

[*]

Analyzer Transmitter

PROJECT INFORMATION

PLANT	ELLIS CREEK WRF	**CUSTOMER**	CITY OF PETALUMA
PROJECT	7310L10	**LOCATION**	

GENERAL NOTE: FIELDS SHOWN WITH THE [*] SYMBOL ARE NOT SHOWN ON THE DATASHEET BUT MAY BE REQUIRED BY THE CONTRACT DOCUMENTS. THE CONTRACTOR SHALL SUBMIT COMPLETE ISA DATASHEETS FOR EACH INSTRUMENT PER ALL SPECIFIED REQUIREMENTS.

GENERAL

SPECIFICATION NUMBER	17509	**MEASURING PRINCIPLE**	[*]
DRAWING NUMBER	06N006	**PLC**	PLC-1
SERVICE	TURBIDITY PROBE	**TYPICAL DETAILS**	[*]
POWER LOCATION	07-LPD		

FLUID

FLUID	FILTER EFFLUENT	**PRESSURE**	N/A
MEASUREMENT RANGE	0-10 NTU	**TEMPERATURE**	N/A
SAMPLE FLOW	N/A	**SAMPLE TEMPERATURE**	40 - 80 DEG F
SAMPLE pH	1-14		

ELEMENT

ELEMENT TAG NO.	AE-6704	**PROCESS CONNECTION**	INSERTION
ENCLOSURE CLASS	NEMA 4X	**HAZARDOUS APPROVALS**	N/A
CLEANING APPARATUS	YES	**ELEMENT MOUNTING KIT**	HOT TAP

TRANSMITTER

TRANSMITTER TAG NO.	AIT-6704	**SIGNAL OUTPUT**	AI
ENCLOSURE CLASS	NEMA 4X	**OUTPUT**	4-20 MA
TRANS. MOUNTING	REMOTE	**TRANS. HAZ APPROVALS**	N/A
POWER	120VAC-1P	**RELAY OPTIONS**	YES
SURGE PROTECTION	NO	**AMBIENT TEMPERATURE**	-5 TO 122 DEG F
AIR CLEANING SYSTEM	NO		

NOTES

[*]

SECTION 17710

CONTROL SYSTEMS: PANELS, ENCLOSURES, AND PANEL COMPONENTS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Design, fabrication and assembly of all instrumentation enclosures, control panels and components provided under this contract, including but not limited to:
      a. Custom built instrumentation and control panels, including all enclosures for hand stations controllers, low voltage power distribution and marshalling panels.
      b. Control panels furnished as part of equipment systems specified in other Divisions, such as vendor control panels (VCPs) and chemical feed panels.
      c. Control components.
      d. Control panel installation.

B. Provide all control panels identified in Contract Documents.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Institute of Electrical and Electronics Engineers (IEEE):
   1. C62.41.1 - Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.
   2. 802.3af - Standard for Information Technology Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Specific Requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.
   3. 802.3at - Standard for Information Technology - Local and Metropolitan area networks - Specific requirements - Part 3: CSMA/CD Access Method and Physical Layer Specifications Amendment 3: Data Terminal Equipment (DTE) Power via the Media Dependent Interface (MDI) Enhancements.

C. International Electrotechnical Commission (IEC):
   1. 61643-11 - Low-Voltage Surge Protective Devices - Part 11: Surge Protective Devices Connected to Low-Voltage Power Systems - Requirements and test methods.
   2. 61643-21 - Low-Voltage Surge Protective Devices - Part 21: Surge Protective Devices Connected to Telecommunications and Signaling Networks - Performance Requirements and Testing Methods.

D. Underwriters Laboratories Inc. (UL):
   1. 248-14 - Low-Voltage Fuses - Part 14: Supplemental Fuses.

2. 497B - Standard for Protectors for Data Communications and Fire-Alarm Circuits.
3. 508 - Standard for Industrial Control Equipment.
4. 508A - Standard for Industrial Control Panel.
5. 698A - Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.
6. 1077 - Standard for Supplementary Protectors for Use in Electrical Equipment.
7. 1283 - Standard for Electromagnetic Interference Filters.
8. 1449 - Standard for Surge Protective Devices.

1.03 DEFINITIONS

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Specific definitions:
   1. The term “panel” in this Section is interchangeable with the term “enclosure.”

1.04 SUBMITTALS

A. Provide submittals as specified in Section 01330 - Submittal Procedures and Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide a control panel hardware submittal for each control panel and enclosure being provided on this project, including but not limited to:
   1. Product data:
      a. Enclosure construction details and NEMA type.
      b. Manufacturer's literature and specification data sheets for each type of equipment to be installed within or on the panel or enclosure.
   2. Shop drawings:
      a. Scaled, detailed exterior panel (front and side views) and interior panel layout showing equipment arrangement and dimensional information:
         1) Provide draft for review and approval by Engineer. The Engineer has the authority to substantially alter initial panel layouts.
      b. Complete nameplate engraving schedule.
      c. Structural details of fabricated panels.
   3. Calculations:
      a. Provide installation details based on calculated shear and tension forces:
         1) Calculations shall be signed and sealed by a Professional Engineer licensed in the state where the cabinets and panels will be installed.
      b. For assembled enclosures and other equipment with a weight of 200 pounds or more, provide calculations for:
         1) Weight including panel internal components.
         2) Seismic forces and overturning moments.
         3) Shear and tension forces in connections.
      c. Cooling calculations, including but not limited to:
         1) Highest expected ambient temperature for the enclosure's location.
         2) Internal heat load.
         3) Exposure to direct sunlight.

4) Dimensions of the enclosure in inches.
5) Maximum allowable temperature inside the enclosure, based on the lowest operating temperature limit of the installed components.

C. Seismic design:
1. Seismic panel construction:
a. Seismic anchorage: Provide seismic design calculations and installation details for anchorage of all panels, enclosures, consoles, etc. to meet seismic requirements in Section 01612 - Seismic Design Criteria:
1) Stamped by a Professional Engineer registered in the state where the project is being constructed.
b. For floor-mounted freestanding panels weighing 200 pounds or more (assembled, including contents), submit calculations, data sheets, and other information to substantiate that panel, base, and framing meet minimum design strength requirements and seismic requirements as specified in Section 01612 - Seismic Design Criteria. Calculations shall be signed and sealed by a Professional Engineer licensed in the state where the cabinets and panels will be installed.

1.05 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Assemble panels, enclosures, and rack systems along with all internal and external devices, wiring, equipment, and materials in a facility that is recognized by UL to assemble and certify UL-labeled control panels:
1. Provide all components and equipment with UL 508 listing.
2. All control panels shall be UL 508A labeled, unless the equipment in the panel and the design in the contract documents cannot be reasonably modified to meet the requirements for UL 508A labeling:
3. Provide fuses for all equipment that is not UL or UR listed.
4. Install all intrinsically safe circuits and equipment in accordance with UL698A.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Project environmental conditions as specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation.

1.08 SEQUENCING (NOT USED)

1.09 SCHEDULING (NOT USED)

1.10 WARRANTY

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.11 SYSTEM START-UP (NOT USED)

1.12 OWNER'S INSTRUCTIONS (NOT USED)

1.13 COMMISSIONING (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. As listed below in the individual component paragraphs.

B. Provide instruments and other components performing similar functions of the same type, model, or class, and from 1 manufacturer.

2.02 SYSTEM DESCRIPTION

A. Panel dimensions:
   1. Minimum dimensions are scalable from or as indicated on the Drawings and are based upon manufacturer's non-certified information. It is the responsibility of the Contractor or manufacturer to design and size all panels:
      a. Size panels to provide space for all equipment, wiring, terminations, and other items in the panel, including space for future build out.
      b. Panel sizes that substantially deviate (within 3 inches in any dimension) from the sizes indicated on the Drawings must be approved by the Engineer.
      c. Maximum panel depth: 30 inches, unless otherwise indicated.

B. Structural design:
   1. Completed and installed panel work shall safely withstand seismic requirements at the project site as specified in Section 16050 - Common Work Results for Electrical. Enclosures and internal equipment shall be braced to prevent damage from specified forces.

2.03 EXISTING PRODUCTS

A. Provide labor and materials for complete modifications to existing panels as required.

2.04 MATERIALS

A. Construct and finish enclosures using materials capable of withstanding the mechanical, electrical, and thermal stresses, as well as the effects of humidity and corrosion that are likely to be encountered in normal service:
   1. Enclosures shall have the following properties:
      a. NEMA Type 1: Steel.
      b. NEMA Type 4: Steel with gasketed door, raintight.
      c. NEMA Type 4X: Type 316 stainless steel (unless Type 304 is indicated on the Drawings).
      d. NEMA Type 4X: Polycarbonate or fiberglass reinforced polyester (FRP) in corrosive areas where stainless steel is incompatible.
      e. NEMA Type 12: Steel with gasketed door, dusttight.
      f. NEMA Type 7: Cast aluminum.

B. Bolting material:
   1. Commercial quality 1/2-inch diameter, stainless steel hex-head Grade 5 bolts, nuts, and washers, with unified coarse (UNC) threads.
   2. Carriage bolts for attaching end plates.
   3. All other bolted joints shall have S.A.E. standard lock washers.

2.05 MANUFACTURED UNITS

A. Panels/enclosures:
   1. Manufacturers: One of the following or equal:
      a. Rittal.
      b. nVent/Hoffman.
      c. Saginaw Control & Engineering.
   2. Panel assembly:
      a. General guidelines for panel fabrication include:
         1) Continuous welds ground smooth.
         2) Exposed surfaces free of burrs and sharp edges.
         3) Base formed of heavy channel iron, either galvanized or powder coated, minimum 1/2-inch holes at 12-inch spacing to accommodate anchoring of freestanding enclosures to floor.
      b. Construct enclosure and mounting panel using stretcher-level quality sheet metal having minimum thickness not less than the following sizes (U.S. Standard Gauge):

Enclosure Height (inches)	Minimum Enclosure Steel Thickness (gauge)	Minimum Back Mounting Panel Thickness (gauge)
Wall-mounted up to 48	14	14
Up to 57	12	12
57 - 69	12	10
69 - 82	12, except 10 on back	10
82 or more	10	10

         1) Use heavier sheet metal to meet seismic requirements at the project site or when required due to equipment requirements.

c. Construct supporting frame structure with angled, channeled, or folded rigid section of sheet metal, rigidly attached to and having essentially the same outer dimensions as the enclosure surface and having sufficient torsional rigidity to resist the bending moments applied via the enclosure surface when it is deflected.
d. Provide stiffeners for back mounting panels in enclosures larger than 4 feet. In addition, secure the panels in place by collar studs welded to the enclosure.
e. Door construction:
    1) Turned-back edges suitably braced and supported to maintain alignment and rigidity without sagging.
    2) Sufficient width to permit door opening without interference with rear projection of flush-mounted instruments.
    3) Heavy-gauge stainless steel hinges.
    4) For NEMA Type 12, Type 4, and Type 4X, provide oil-resistant neoprene sealing gasket and adhesive to seal cover to enclosure.
    5) Gasket installed to seal against roll lip on the enclosure opening.
f. Latches:
    1) For panels, provide each door with a 3-point latching mechanism and locking handle with rollers on the ends of the latch rods. Latch rods shall be connected to a common door handle, hold doors securely, and form a compressed seal between door and gasket, at the top, side, and bottom.
        a) Provide padlock for each enclosure with padlock provisions.
    2) Include an oiltight key-locking, 3-point latching mechanism on each door:
        a) Provide 2 keys per panel.
        b) All locks keyed alike.
    3) For large NEMA Type 4 and NEMA Type 4X cabinets not available with 3-point latching hardware, provide multiple clips and padlock hasps.
g. Panel cut-outs:
    1) Cut, punch, or drill cutouts for instruments, devices, and windows. Smoothly finish with rounded edges.
    2) Allow a minimum of 3-inch envelope around all displays, controllers, and monitors.
    3) Reinforce around cut-outs with steel angles or flat bars for the following:
        a) Large panel cutouts; for example, openings for local operator interfaces.
        b) Pilot device groupings, where the removed metal exceeds 50 percent of the available metal.

3. In addition to the requirements specified above, the following requirements for NEMA Type 4X powder coated stainless steel enclosures apply:
    a. Minimum 14-gauge, Type 304 stainless steel.
    b. Captive stainless steel cover screws threaded into sealed wells.
    c. Inside finish: White polyester powder coating.
    d. Specifically designed for use with flange-mounted disconnect handles where required or as indicated on the Drawings.

4. Outdoor panels. Supplementary requirements for panels located outdoors are as follows:
    a. All enclosures located outdoors shall be explicitly designed and rated for outdoor service by the manufacturer.
    b. Door hardware: Stainless steel.
    c. Provide factory installed rain canopy and sun shield for all enclosures with operator interface panels.
    d. Bases: Heavy channel, gasketed stainless steel bases, flanges up, for anchoring to pad.

B. Arrangement of components:
    1. Arrange panel internal components for external conduit and piping to enter into panel either from above or below.
    2. Arrange panel instruments and control devices in a logical configuration, associating pushbutton and selector switches with related readout devices, or as indicated on the Drawings.
    3. Mount internal control components on an internal back panel. Devices may be mounted on the side panel only by special permission from the Engineer.
    4. All control panel mounted operator interface devices shall be mounted between 3 feet and 5 feet above finished floor.

C. Overcurrent protection:
    1. Main overcurrent device:
        a. Where the electrical power supply voltage to the control panel is more than 120 VAC, provide the panel with a flange-mounted disconnect handle operating a molded-case circuit breaker and provide a control power transformer for 120-VAC circuits:
            1) Door-mounted disconnect handles are not acceptable.
            2) Mechanically interlock the disconnect switch with the control enclosure doors so that no door can be opened unless the power is disconnected, and the disconnect switch cannot be closed until all doors are closed.
            3) Provide means to defeat the interlock.
            4) Lockable in the off position.
        b. Control panels supplied with 120 VAC:
            1) Provide an internal breaker with the line side terminals covered by a barrier.
            2) Provide a nameplate prominently positioned on the control panel identifying the location of the power source and a warning statement requiring the source to be disconnected before opening the door to the enclosure.
    2. Provide circuit breakers as specified in Section 16412 - Low Voltage Molded Case Circuit Breakers.
    3. Selection and ratings of protective devices:
        a. Interrupting ratings: Not less than the system maximum available fault current at the point of application.
        b. Voltage rating: Not less than the voltage of the application.
        c. Select current rating and trip characteristics to be suitable for:
            1) Maximum normal operating current.
            2) Inrush characteristics.
            3) Coordination of the protective devices to each other and to the source breaker feeding the panel.

d. Circuit breakers, fuses, and motor overcurrent protection devices used for branch circuit protection must be UL 508A compliant.
    1) Circuit breakers listed under UL 1077 Standard for Supplementary Protectors that do not comply with UL 508A requirements are not acceptable.
    2) Miscellaneous, miniature, and micro fuses listed under UL 248 Part 14 that do not comply with UL 508A requirements are not acceptable.
    3) Manual motor controllers provided with an instantaneous-trip overcurrent mechanism listed under UL 508 that do not comply with UL 508A requirements are not acceptable.

4. Provide a separate protective device for each powered electrical device:
    a. An individual circuit breaker for each 120-VAC instrument installed within its respective control panel and clearly identified for function.
    b. An individual fuse for each PLC discrete output. Provide with individual blown fuse indication external of the I/O card:
        1) Size external fuse to open before any I/O-card-mounted fuses.
    c. Individual discrete inputs shall use a 1/2-ampere fuse.
        1) Control loops shall use a 5-ampere fuse.
    d. Install protective devices on the back mounting panel and identify by a service nameplate in accordance with the wiring diagrams.
5. Fuses for 4-to-20 milliamperes signals:
    a. Provide durable, readily visible label for each fuse, clearly indicating the correct type, size, and ratings of replacement fuse:
        1) Label shall not cover or interfere with equipment manufacturer's instructions.
    b. An individual 1/2-ampere fuse for each 4-to-20 milliamperes analog loop powered from the control panel.
    c. Provide fuses rated for the voltage and available short-circuit current at which they are applied.
    d. Manufacturers: One of the following or equal:
        1) Ferraz Shawmut.
        2) Littelfuse.
        3) Bussmann.
6. Fuse holders:
    a. Modular type:
        1) DIN rail mounting on 35-millimeter rail.
        2) Touch-safe design: All connection terminals to be protected against accidental touch.
        3) Incorporates blown-fuse indicator.
        4) Plug-in style fuse terminals and fuse plugs are not acceptable.
    b. Provide nameplate identifying each fuse:
        1) As specified in Section 16075 - Identification for Electrical Systems.
    c. Manufacturers: One of the following or equal:
        1) Phoenix Contact, UT4-HESI Series.
        2) Allen-Bradley, 1492-FB Series B.
7. Control circuit breakers:
    a. DIN rail mounting on 35-millimeter rail.
    b. Manual OPEN-CLOSE toggle switch.
    c. Rated for 250 VAC.
    d. Interrupting rating: 10 kiloampere (kA) or available fault current at the line terminal, whichever is higher.

e. Current ratings: As required for the application.
f. Provide nameplate identifying each circuit breaker:
1) As specified in Section 16075 - Identification for Electrical Systems.
g. Manufacturers: One of the following or equal:
1) Phoenix Contact, TMC Series.
2) ABB.
3) Allen-Bradley.
4) Square D.

8. Electronic circuit protectors:
a. Used where equipment is equipped with a NEC Class 2 power supplies requiring 100 watts to 8 amps.
b. DIN rail mounting on 35-millimeter rail.
c. Rated for 24 VDC.
d. 4 channels to feed 4 independent power feeds to separate devices.
e. Output current ratings: As required for the application.
f. LED input status indication.
g. LED failure status of each channel indication.
h. Fail contacts.
i. Provide nameplate identifying each circuit breaker:
1) As specified in Section 16075 - Identification for Electrical Systems.
j. Manufacturers: One of the following or equal:
1) Rockwell Automation 1692-TD014.
2) Puls PISA11 series.

D. Conductors and cables:
1. Power and control wiring:
a. Materials: Stranded, soft annealed copper.
b. Insulation: 600 volts type MTW.
c. Minimum sizes:
1) Primary power distribution: 12 AWG.
2) Secondary power distribution: 14 AWG.
3) Control: 16 AWG.
d. Color:
1) AC power (line and load): Black.
2) AC power (neutral): White.
3) AC control: Red.
4) AC control: Orange for foreign voltages.
5) DC power and control (ungrounded): Blue.
6) DC power and control (grounded): White with Blue stripe.
7) Ground: Green.

2. Signal cables:
a. Materials: Stranded, soft annealed copper.
b. Insulation: 600 volts, PVC outer jacket.
c. Minimum size: 18 AWG paired triad.
d. Overall aluminum shield (tape).
e. Copper drain wire.
f. Color:
1) 2-Conductor:
a) Positive (+): Black.
b) Negative (-): White and red.
2) 3-Conductor:
a) Positive (+): Black.

b) Negative (-): Red.
c) Signal: White.

g. Insulate the foil shielding and exposed drain wire for each signal cable with heat-shrink tubing.

E. Conductor identification:
1. Identify each conductor and cable with unique wire numbers as specified in Section 16075 - Identification for Electrical Systems.
2. Readily identified without twisting the conductor.

F. General wiring requirements:
1. Wiring methods: Wiring methods and materials for panels shall be in accordance with the NEC requirements for General Purpose (no open wiring) unless otherwise specified.
2. Install all components in accordance with the manufacturer's instructions included in the listing and labeling.
3. Provide a nameplate on the cover of the control panel identifying all sources of power supply and foreign voltages within the control panel.
4. Provide transformers, protective devices, and power supplies required to convert the supply voltage to the needed utilization voltage.
5. Provide power surge protection for all control panels.
6. Provide signal surge protection within control panels for each analog I/O, discrete I/O, and data line (Copper Ethernet, Coax, Fieldbus signals) that originates from outdoor devices.
7. Provide non-metallic ducts for routing and organization of conductors and cables:
   a. Provide wiring separation plan.
   b. Size ducts for ultimate build-out of the panel, or for 20-percent spare, whichever is greater.
   c. Provide separate ducts for signal and low-voltage wiring from power and 120-VAC control wiring:
      1) 120 VAC: Grey colored ducts.
      2) 24 VDC: White colored ducts.
8. Cables shall be fastened with cable-mounting clamps or with cable ties supported by any of the following methods:
   a. Screw-on cable tie mounts.
   b. Hammer-on cable-tie mounting clips.
   c. Fingers of the nonmetallic duct.
9. Wire ties:
   a. No wire ties inside wire duct.
   b. Use Panduit Cable tie installation tool, with tension control/cutoff.
   c. Verify cut ends are cut flush filed smooth after installed.
10. Provide supports at the ends of cables to prevent mechanical stresses at the termination of conductors.
11. Support panel conductors where necessary to keep them in place.
12. Wiring to rear terminals on panel-mount instruments shall be run in nonmetallic duct secured to horizontal brackets run adjacent to the instruments.
13. Conductors and cables shall be run from terminal to terminal without splice or joints. Exceptions:
   a. Factory-applied connectors molded onto cables shall be permitted. Such connectors shall not be considered as splices or joints.

14. The control panel shall be the source of power for all 120-VAC devices interconnected with the control panel including, but not limited to:
    a. Solenoid valves.
    b. Instruments both mounted in the control panel and remotely connected to the control panel.

G. Provide power circuits for all Contractor and Vendor-furnished PLC cabinets in accordance with the PLC and Instrument Power wiring diagrams Indicated on the Drawings or as specified.

2.06 EQUIPMENT (NOT USED)

2.07 COMPONENTS

A. Thermal management:
1. Provide heating, cooling, and dehumidifying devices in order to maintain all instrumentation and control devices to within a range as specified in Section 17050 - Common Work Results for Process Control and Instrumentation.
2. Air conditioner:
    a. Provide solid-state cabinet coolers or air conditioning units on all outdoor panels containing electronic components such as local operator interfaces, panel instruments, programmable logic controllers, or remote I/O.
    b. Provide filters on intake and exhaust openings.
    c. Increase panel sizes as needed to accommodate cooling units.
    d. Enclosure rating: NEMA Type 4X.
    e. Closed-loop design.
    f. Manufacturers: The following or equal:
        1) Kooltronic, GuardianX DP Series.
        2) ICEqube, Blade series or IECEx/ATEX for Zone 1 and 2.
3. Heating:
    a. Provide all panels located in areas that are not climate controlled with thermostatically controlled strip heaters, except where all of the following conditions apply:
        1) The panel is not supplied with 120 VAC power.
        2) There are no electronics or moisture-sensitive devices in the enclosure.
        3) The panel is smaller than 38 inches high.
4. Heat exchanger:
    a. Closed-loop design ensuring separation of ambient air and clean air inside the cabinet.
    b. Filterless design to facilitate easy cleaning of the core.
    c. Mounting: As indicated on the Drawings.
    d. Manufacturers: The following or equal:
        1) Noren, CC Series.
        2) ICEqube, Blade series.
5. Enclosure temperature switch:
    a. Provide wall-mounted bimetallic switch transmitter (to measure internal cabinet temperature in all enclosures) containing electrical components such as PLCs, RTUs, RIO, and VFDs.
    b. Sensor and electronic enclosure.

c. Accuracy: Within 2 degrees Fahrenheit.
d. Single contact:
1) Manufacturers: One of the following or equal:
a) nVent/Hoffman ATEMNC.
b) Pfannenberg FLZ.
e. Dual contact:
1) Manufacturers: The following or equal:
a) nVent/Hoffman ADLTEMP.
6. Status relays and discrete inputs for switches, power supplies, and fieldbus devices (if applicable):
a. Provide as indicated on the Drawings or as specified.
7. Fan ventilation:
a. Provide nVent/Hoffman fan speed control:
1) Provide 2 door/cabinet-mounted vent fans for every 72 inches of cabinet width.
2) Provide finger-guard kit.
3) Filter kit with 2 spare filters for each intake fan.
4) Provide bezel and gasket kit.
5) Provide fan shroud.
6) Automatically adjust fan speed depending on remote temperature sensor input.
7) 120 VAC, 60 hertz.
8) NEMA Type 5-15R cord connections.

B. Panel meters:
1. Pointer type:
a. Suitable for panel mounting.
b. Minimum scale length: 3 inches.
c. Calibrated in engineering units.
d. Accuracy: Within 2 percent of span.
e. NEMA Type 4/IP65 sealed front metal bezel.
f. Manufacturers: One of the following or equal:
1) Yokogawa.
2) Red Lion.
2. Digital process indicators:
a. General:
1) Integral provisions for scaling.
2) Scale to process engineering units.
3) Switch-programmable decimal points.
4) NEMA Type 4/IP65 sealed front bezel.
b. Current and voltage indicators:
1) 3-1/2-digit minimum.
2) Minimum character height: 0.5 inches.
3) Accuracy:
a) AC/DC volts: Within 0.1 percent of reading plus 2 digits.
b) DC current: 4-to-20 milliamperes; within 0.1 percent of reading plus 1 digit.
c) DC voltage: 0 to 10 volts; within 0.1 percent of reading plus 1 digit.
c. Operating voltage: 120 VAC.

d. Operating temperature: 32 degrees to 140 degrees Fahrenheit.
1) Manufacturers: One of the following or equal:
a) Red Lion.
b) Action Instruments, Visipak.

3. Digital bar graph meter:
a. Self-contained instruments that display process signals directly in engineering units, both in decimal format and as a bar graph display.
b. Suitable for panel mounting.
c. LED display:
1) Not less than 3 decimal digits.
2) Not less than a 101-segment LED bar graph.
d. Input signal:
1) All conventional current loops and voltage control signals.
e. Minimum sample rate of once per second.
f. Provisions for field-adjustable scaling and/or offset.
g. Accuracy shall be within 1 least-significant digit.
h. Manufacturers: One of the following or equal:
1) Ametek Dixson.
2) Yokogawa.
3) Weschler Instruments.

4. Counters:
a. 6 digits.
b. Switch-selectable inputs:
1) Switch contacts.
2) CMOS.
3) TTL.
4) Magnetic pickup.
5) RLC sensors.
c. Selectable up/down control via external signal.
d. Remote reset.
e. Remote inhibit to prevent accumulating counts.
f. Programmable to enable or disable front panel reset.
g. Non-volatile memory to retain all data upon loss of supply power.
h. Sunlight readable.
i. Operating temperature: 32 degrees to 122 degrees Fahrenheit.
j. Manufacturers: The following or equal:
1) Red Lion, PAX Series.

C. Pilot devices:
1. General:
a. Provide operator pushbuttons, switches, and pilot lights, from a single manufacturer.
b. Size:
1) 30.5 millimeters.
c. Heavy duty.
d. Pushbuttons:
1) Contacts rated:
a) NEMA Type A600.
2) Furnish 1 spare normally open contact and normally closed contact with each switch.

e. Selector switches:
    1) Contacts rated:
        a) NEMA Type A600.
        b) Knob type.
    2) Furnish 1 spare normally open contact and normally closed contact with each switch.
    3) Provisions for locking in the OFF position where lockout provisions are indicated on the Drawings.
f. Pilot lights:
    1) Type:
        a) LED for interior installations.
    2) Push to test.
    3) Lamp color:
        a) On/Running/Start: Red.
        b) Off/Stop: Green.
        c) Power: White.
        d) Alarm: Amber.
        e) Status or normal condition: White.
        f) Opened: Red.
        g) Closed: Green.
        h) Failure: Red.

2. Indoor and outdoor areas:
    a. NEMA Type 4/13.
    b. Manufacturers: One of the following or equal:
        1) Allen-Bradley, Type 800T.
        2) Schneider Electric, Class 9001, Type K.
        3) General Electric, Type CR104P.
        4) IDEC, TWTD Series.
3. Corrosive areas:
    a. NEMA Type 4X.
    b. Corrosion resistant.
    c. Exterior parts of high-impact strength fiberglass-reinforced polyester or multiple-layer epoxy-coated zinc.
    d. Manufacturers: One of the following or equal:
        1) Cutler Hammer, Type E34.
        2) Schneider Electric, Class 9001, Type SK.
        3) Allen-Bradley Type 800H.
        4) IDEC, TWTD Series.
4. Hazardous (Classified) Areas/Class I Division 2:
    a. NEMA Type 4X.
    b. Corrosion resistant.
    c. Exterior parts of high-impact strength fiberglass-reinforced polyester or multiple-layer epoxy-coated zinc:
        1) All contacts contained within a hermetically sealed chamber:
            a) Pushbuttons.
            b) Selector switches.
            c) Push-to-test contacts on pilot lights.
        2) UL listed and labeled for Class I Division 2 areas.
    d. Manufacturers: One of the following or equal:
        1) Cutler Hammer, Type E34.
        2) Allen-Bradley, Type 800H.

D. Potentiometer and slidewire transmitters:
   1. Provide a DC output in proportion to a potentiometer input.
   2. Potentiometer input:
      a. 100 ohms to 100 K ohms.
      b. Impedance Greater or equal to 1 M ohms.
      c. Zero turn-up: 80 percent of full-scale input.
      d. Span turn-down: 80 percent of full-scale input.
   3. Field-configurable output:
      a. Voltage and current: All conventional current loops and voltage control signals.
   4. Accuracy including linearity and hysteresis within 0.1 percent maximum at 77 degrees Fahrenheit.
   5. Operating temperature: 32 degrees to 131 degrees Fahrenheit.
   6. Supply power: 9 to 30 VDC.
   7. Manufacturers: The following or equal:
      a. Phoenix Contact, Mini Analog Pro.

E. Signal isolators and converters:
   1. Furnish signal isolators that provide complete isolation of input, output, and power input:
      a. Minimum isolation level: 1.0 kilovolts AC/50 hertz for at least 1 minute.
      b. Adjustable span and zero.
      c. Accuracy: Within 1.0 percent of span.
      d. Ambient temperature range: -4 degrees to 149 degrees Fahrenheit.
   2. Manufacturers: One of the following or equal:
      a. Phoenix Contact, Mini Analog Pro.
      b. Acromag, 1500, 600T, 800T, Flat Pack, or ACR Series.
      c. Action Instruments, Q500 Series or Ultra SlimPakII.
      d. AGM Electronics, Model TA-4000.
      e. Moore Industries, MIT 4-Channel.

F. Relays:
   1. General:
      a. For all types of 120-VAC relays, provide surge protection across the coil of each relay.
      b. For all types of 24-VDC relays, provide a free-wheeling diode across the coil of each relay.
      c. For plug in type relays, provide a relay base from the same manufacturer as the relay manufacturer.
   2. General purpose:
      a. Magnetic control relays.
      b. NEMA ratings:
         1) 300 volts.
         2) 10 Amps thermal continuous test current.
         3) 60 Amps make.
         4) 6 Amps break.
      c. Plug-in type.
      d. LED indication for energization status.
      e. Coil voltages: As required for the application.
      f. Minimum poles: DPDT.
      g. Touch-safe design: All connection terminals to be protected against accidental touch.

h. Enclose each relay in a clear plastic heat and shock-resistant dust cover.
i. Quantity and type of contact shall be as indicated on the Drawings or as needed for system compatibility.
j. Relays with screw-type socket terminals.
k. Provide additional (slave/interposing) relays when the following occurs:
    1) The number or type of contacts shown exceeds the contact capacity of the specified relays.
    2) Higher contact rating is required in order to interface with starter circuits or other equipment.
l. DIN rail mounting on 35-millimeter rail.
m. Ice-cube-type relays with retainer clips to secure relay in socket.
n. Integrated label holder for device labeling.
o. Manufacturers: One of the following or equal:
    1) Potter and Brumfield: Type KRP or KUP.
    2) IDEC: R* Series (* = H, J, R, S, U).
    3) Allen-Bradley: Type 700 HC.
    4) Square D: Type K.

3. Terminal block relays:
    a. Magnetic control relays.
    b. For use as an interposing relay for PLC based discrete I/O signals.
    c. NEMA ratings:
        1) 250 volts.
        2) 6 Amps continuous.
        3) 1,500 volt-amperes make.
    d. Plug-in type.
    e. LED indication for energization status.
    f. Coil voltages: As required for the application.
    g. Minimum poles: SPDT.
    h. Touch-safe design: All connection terminals to be protected against accidental touch.
    i. Quantity and type of contact shall be as indicated on the Drawings or as needed for system compatibility.
    j. Relays with screw-type socket terminals.
    k. DIN rail mounting on 35-millimeter rail.
    l. Integrated label holder for device labeling.
    m. Manufacturer: One of the following or equal:
        1) Phoenix Contact PLC Series.
        2) Eaton XR TBR Series.
        3) IDEC RV8H Series.
        4) Allen-Bradley Type 700 HL TBR Series.
4. Latching:
    a. Magnetic-latching control relays.
    b. NEMA ratings:
        1) 300 volts.
        2) 5 Amps continuous.
        3) 360 volt-amperes make.
        4) 320 volt-amperes break.
    c. Plug-in type.
    d. DIN rail mounting on 35-millimeter rail.
    e. Coil voltage: As required for the application.
    f. Minimum poles: 2 PDT; as required for the application. Plus 1 spare pole.

g. Touch-safe design: All connection terminals to be protected against accidental touch.
h. Clear cover for visual inspection.
i. Provide retainer clip to secure relay in socket.
j. Manufacturers: One of the following or equal:
1) Square D, 8501, Type K.
2) IDEC, RR2KP Series.

5. Time delay:
a. Provide time-delay relays to control contact transition time.
b. Contact rating:
1) 240 volts.
2) 10 Amps continuous.
3) 3,600 volt-amperes make.
4) 360 volt-amperes break.
c. Coil voltage: As required for the application.
d. Provide pneumatic or electronic type with on-delay, off-delay, and on/off-delay:
1) For off-delay, use true power-off time-delay relays. Where the required timing range exceeds capability of the off-delay relay use, signal off-delay where power loss will not cause undesirable operation or pneumatic time-delay relays.
e. Minimum poles: 2 PDT.
f. Units include adjustable dial with graduated scale covering the time range in each case.
g. Minimum timing range: 0.1 seconds to 10 minutes, or as required for the application.
h. Manufacturers: One of the following or equal:
1) IDEC, RTE Series.
2) Tyco Electronics, Agastat 7000 Series (pneumatic).
3) Allen-Bradley, Type 700-HR.

G. Terminal blocks:
1. DIN rail mounting on 35-millimeter rail.
2. Rated for 15 amperes at 600 volts.
3. Screw terminal type.
4. Provide mechanism to prevent wire connection from loosening in environments where vibration is present. This mechanism shall not cause permanent deformation to the metal body.
5. Finger-safe protection for all terminals for conductors.
6. Construction: Polyamide insulation material capable of withstanding temperature extremes from -40 degrees to 221 degrees Fahrenheit.
7. Terminals: Plainly identified to correspond with markings on the diagrams:
a. Permanent machine-printed terminal identification.
8. Disconnect-type field signal conductor terminals with socket/screw for testing.
9. Identify terminals suitable for use with more than 1 conductor.
10. Position:
a. So that the internal and external wiring does not cross.
b. To provide unobstructed access to the terminals and their conductors.
11. Provide minimum 25-percent spare terminals.
12. Manufacturers: One of the following or equal:
a. Phoenix Contact, UT4 Series.
b. Allen-Bradley, 1492 Series.

H. DIN rail grounding:
   1. Grounding terminal blocks used exclusively for bonding each DIN rail section to panel grounding busbar shall:
      a. Mount to DIN rail via grounding foot with mounting screw.
      b. Connect to the panel grounding busbar shall be via a green insulated conductor sized in accordance with NEC.
      c. Not be used for grounding signal cable shields.
   2. Screw terminal type.
   3. DIN rail mounting on 35-millimeter rail.
   4. Provide mechanism to prevent wire connection from loosening in environments where vibration is present. This mechanism shall not cause permanent deformation to the metal body.
   5. Finger-safe protection for all terminals for conductors.
   6. Terminals: Plainly identified to correspond with markings on the diagrams:
      a. Permanent machine-printed terminal identification.
   7. Manufacturers: One of the following or equal:
      a. Phoenix Contact, USKLG Series.
      b. Allen-Bradley, 1492-JG Series.

I. Wire duct:
   1. Provide flame retardant plastic wiring duct, slotted with dust cover.
   2. Type:
      a. Wide slot.
      b. Narrow slot.
      c. Round hole.
   3. Manufacturers: The following or equal:
      a. Panduit.
      b. Phoenix Contact.
      c. Thomas & Betts.
      d. Iboco.

J. DIN rail:
   1. Perforated steel.
   2. 35 mm width.
   3. 15 mm deep.
   4. Provide 2-inch offset using one of the following:
      a. Offset brackets.
      b. Preformed standoff DIN Rail Channel.

K. Surge protection devices (SPD):
   1. 120 VAC control panel power SPD:
      a. Provide SPD for panel 120 VAC power entrances:
         1) Non-faulting and non-interrupting design.
         2) Provide line to neutral and neutral to ground surge protection.
      b. Provide surge protection at secondary of main circuit breaker:
         1) Surge protection is not required for 120 VAC circuits that are only used for panel lights and receptacles.
         2) For panels receiving power at 480 VAC, provide surge protection on the 120 VAC control power transformer secondary.
      c. DIN rail mounting.

d. Attach wiring to the SPD by means of a screw-type cable-clamping terminal block:
    1) Gastight connections.
    2) Visual status indication of MOV status on the input and output circuits.
    3) Dry contact rated for remote status indication.
e. Approvals:
    1) Tested in accordance with IEC 61643-11.
    2) Tested in accordance with UL 1283.
    3) Tested in accordance with UL 1449.
    4) Surge protection minimum requirements: Withstand a minimum 10-kA test current of an 8/20 µs waveform in accordance with IEEE C62.41.1 Category C Area.
f. Manufacturers: One of the following or equal:
    1) Phoenix Contact, Type SFP Filter.
    2) ASCO, Model 277.

2. 24 VDC control panel power SPD:
    a. Provide SPD for 24VDC power circuits.
    b. Provide surge protection at DC power supply output.
    c. DIN rail mounting.
    d. Attach wiring to the SPD by means of a screw-type cable clamping terminal block:
        1) Optical status indicator.
        2) Dry contact rated for remote status indication.
    e. Approvals:
        1) Tested in accordance with IEC 61643-11.
    f. Manufacturers: One of the following or equal:
        1) Phoenix Contact, Plugtrab PLT-SEC-T3-24-FM-UT.
3. Panel mounted control, signal, and data line SPD:
    a. General:
        1) This section applies to SPD located in a control panel, field panel, network junction box, or marshalling panel.
        2) Approvals:
            a) Tested in accordance with IEC 61643-21.
            b) Tested in accordance with UL 497B.
        3) SPD shall consists of 2 parts:
            a) Base module:
                (1) DIN rail mounting.
                    (a) Grounded to DIN rail via mounting rail foot.
            b) Plug protection module:
                (1) Replacing a plug shall not require the removal of any wires nor interrupt the signal.
        4) Provide indirect shield ground style SPD unless otherwise noted.
        5) Provide ability to locally identify and indicate SPD health.
        6) SPD shall be provided with controller module with dry contact for remote status monitoring of SPD device health.
        7) SPD modules shall be compatible with signal, communication bus type, data type, or control power being protected.
        8) Provide dedicated SPD for each signal, communication bus type, or data line being protected.

b. Manufacturers: One of the following or equal:
1) Phoenix Contact, Plugtrab PT-IQ Series.
2) Dehn, Blitzductor XTU Series.

4. Copper Ethernet SPD:
a. Protects network equipment from lightning or other surge events.
b. Suitable for Gigabit networks.
c. Compatible with shielded Cat 6 cabling with shielded RJ-45 ports.
d. Compliant with PoE standards IEEE 802.3af and 802.3at.
e. Nominal discharge surge current: 10 kA.
f. Approvals:
1) Tested in accordance with IEC 61643-21.
2) Tested in accordance with UL 497B.
g. Manufacturers: One of the following or equal:
1) Phoenix Contact, DT-LAN-CAT6+.
2) Weidmuller, VDATA CAT6.
3) Eaton/MTL, ZoneBarrier.

5. Field device mounted SPD:
a. Conduit entry mounting.
1) Provide parallel or through wiring configurations as required by the application.
a) Use parallel wiring configuration if there is an available cable gland at the device.
b) Use through wiring configuration if there is no available cable gland at the device.
2) Provide Screw connections compatible with field device.
b. NEMA 4X stainless steel material housing.
c. Approvals:
1) Tested in accordance with IEC 61643-21.
d. 4-wire field device:
1) Module shall provide simultaneous protection of signal cable, communication bus, or data line, and power supply line.
a) Maximum continuous voltage:
(1) DC:
(a) Signal: 32 VDC.
(b) Power supply: 255 VDC.
(2) AC:
(a) Signal: 22.6 VAC.
(b) Power supply: 255 VAC.
2) Manufacturers: The following, engineer knows of no equal:
a) Endress+Hauser, HAW569-CB2C.
e. 2-wire or 3-wire field device:
1) Module shall provide protection for the signal cable, communication bus or data line.
2) Manufacturers: One of the following or equal:
a) Endress+Hauser, HAW569 Series.
b) Phoenix Contact, Surgetrab S-PT Series.
c) Eaton/MTL, TP Series.

L. Horns and beacons:
1. Beacons/horn combination units:
a. Manufacturers: The following or equal:
1) Edwards, Multi-Status LED 108i with tone module.

b. LED Colors: Red, Green, and Amber.
c. Power: 120VAC.
d. Provide accessories such as pipe mount flange, pipe extensions, corner mount brackets, or wall mount brackets as needed.
e. Horn rated 80 dB minimum at 10 feet.

2. Dedicated beacon unit:
   a. Manufacturers: One of the following or equal:
      1) Federal Signal Corp., Starfire Series.
      2) Allen-Bradley, 855 B *-* 10 Series.
      3) Edwards, 102 Series.
3. Dedicated horn unit:
   a. Electromechanical:
      1) Manufacturers: One of the following or equal:
         a) Federal Signal, 350 or 31X Series.
         b) Edwards, 878EX or 879EX Series.
   b. Electronic:
      1) Manufacturers: One of the following or equal:
         a) Federal Signal, 300GCX or 300X Series.
         b) Allen-Bradley, 855H or 855XH Series.
         c) Edwards, 5530M or 5533MD Series.
   c. Rated for 80 dB minimum at 10 feet.

M. Power supplies:
1. Design power supply system so that either the primary or backup supply can be removed, repaired or replaced, and returned to service without disrupting the system operation.
2. Convert 120 VAC to 24-volt DC or other DC voltages required or as required for the application.
3. Provide redundant backup 24 VDC power supply units to automatically supply the load upon failure of the primary supply.
4. Provide power supply arrangement that is configured with several modules to supply adequate power in the event of a single module failure in either a 1+1 or N+1 configuration as required:
   a. Provide automatic switchover upon module failure.
   b. Alarm contacts monitored by the PLC.
5. Provide protective isolation between power supply units either by means of Diodes, Diode Modules, MOSFET Modules, or use power supplies with built in redundancy. Power supplies with built in redundancy must actively isolate each power supply and be designed as such.
6. Sized to provide 40-percent excess rated capacity.
7. UL 508C listed to allow full-rated output without de-rating.
8. Provide fuse or short-circuit protection.
9. Provide a minimum of 1 set of dry contacts for each power supply configured to change state on failure for monitoring and signaling purposes.
10. Output regulation: Within 0.05 percent for a 10-percent line change or a 50-percent load change.
11. Operating temperature range: 32 degrees to 140 degrees Fahrenheit.
12. Touch-safe design: All connection terminals to be protected against accidental touch.

13. DIN rail mounting on 35-millimeter rail:
    a. Mount the power supply in the proper orientation as recommended by the manufacturer to ensure adequate thermal dispersion without derating the power supply.
14. Provide self-protecting power supplies with a means of limiting DC current in case of short circuit.
15. Manufacturers: One of the following or equal:
    a. Fully redundant:
        1) Phoenix Contact, Quint Power Supply with SFB technology.
            a) Phoenix Contact, Quint.
        2) IDEC, PS5R Series:
        3) Sola.
        4) PULS.
    b. Redundancy module:
        1) Phoenix contact, o-ring redundancy module.

N. Limit switches:
1. NEMA Type 4X.
2. AC contact rating 120 volts, 10 A.
3. DC contact rating 125 volts, 0.4 A.
4. Provide robust actuation mechanism not prone to degradation.
5. Provide complete actuator mechanism with all required hardware.
6. Allows for contact opening even during contact weld condition.
7. UL approved.
8. Operating temperature range: 0 degrees to 230 degrees Fahrenheit).
9. Manufacturers: One of the following or equal:
    a. Allen-Bradley, 802 Series.
    b. Honeywell, HDLS Series.
    c. Omron, D4 Series.
    d. Eaton, E47, E49, E50.
    e. ABB.

O. Current switches:
1. Operate from 120-VAC supply voltage.
2. 1 normally open and normally closed contacts.
3. Adjustable current setting.
4. Manufacturers: The following or equal:
    a. Zelio®, RM35.
    b. Phoenix Contact, EMD Series.

P. Current transmitters:
1. Input current range: As indicated on Drawings.
2. Output: 4-20 mA.
3. Operate from 24 VDC supply voltage.
4. Output overload protected.
5. Accuracy: Within 0.5 percent Full-Scale.
6. Ripple and Noise: 1 percent Max., peak to peak.
7. Frequency: 50/60 hertz.
8. Manufacturer:
    a. Phoenix Contact: Mini Analog Pro Series.
    b. CR Magnetics: CR4320 series.
    c. American Aerospace: 1070 Series.

Q. Panel mount quick connector:
   1. Keyed insertion plug.
   2. Threaded cap to protect connection when not in use.
   3. Material: Stainless steel.
   4. Pre-wired pigtails.
   5. Indoor/Outdoor:
      a. Rating: Meets or exceeds panel rating.
      b. Manufacturers: One of the following or equal:
         1) Amphenol.
         2) Sealcon.
   6. Hazardous (Classified) Areas:
      a. UL listed and labeled for area as indicated on the Drawings.
      b. Manufacturers: The following or equal:
         1) Amphenol HDE Series.

2.08 ACCESSORIES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide panels with an inside protective pocket to hold the panel drawings. Ship panels with 1 copy of accepted Shop Drawings including, but not limited to, schematic diagram, connection diagram, and layout drawing of control wiring and components in a sealed plastic bag stored in the panel drawing pocket.

C. Provide 15-inch floor stands or legs where needed or as indicated on the Drawings.

D. Provide a folding shelf for enclosures that contain programmable controllers. The shelf shall be mounted on the inside surface of the door, capable of supporting a laptop computer.

E. Provide nameplate to each panel as indicated on the Drawings:
   1. Provide as specified in Section 16075 - Identification for Electrical Systems on all internal and external instruments and devices.
   2. Provide a nameplate with the following markings that is plainly visible after installation:
      a. Manufacturer’s name, trademark, or other descriptive marking by which the organization responsible for the panel can be identified.
      b. Supply voltage, phase, frequency, and full-load current.
      c. Power source or circuit ID.
      d. Short-circuit current rating of the panel based on one of the following:
         1) Short-circuit current rating of a listed and labeled assembly.
         2) Short-circuit current rating established utilizing an approved method.

F. Provide a window kit where indicated on the Drawings or where a transmitter with display is mounted inside a control panel. The window shall meet the following requirements:
   1. Safety plate glass.
   2. Secured by rubber locking seal.
   3. Allow full viewing of devices issuing visual process data or diagnostics.

G. Lighting:
   1. Provide 1 luminaire for each section, on the interior of the panel, spaced evenly along the top-front of the enclosure door opening(s):
      a. Covered or guarded.
      b. Provide On-Off door-activated switches where indicated on the Drawings.
      c. 120-volt, single-phase, 15-amp style plug.
      d. Provide 4,000 K, 900 Lumens - LED fixture.
         1) Provide additional fixtures for every 36 inches of width.

H. Receptacles:
   1. Provide 1 duplex receptacle located every 6 feet of enclosure width, spaced evenly along the back mounting panels.
   2. GFCI, 120-volt, single-phase, 15-amp style plug.
   3. Provide circuit breaker or fuse to limit receptacle draw to 5 amperes.

I. Grounding:
   1. Provide the following:
      a. Grounding strap between enclosure doors and the enclosure.
      b. Equipment grounding conductor terminals.
      c. Provide equipment grounding busbar with lugs for connection of all equipment grounding wires.
      d. Bond multi-section panels together with an equipment grounding conductor or an equivalent grounding busbar.
   2. Identify equipment grounding conductor terminals with the word “GROUND,” the letters “GND,” the letter “G,” or the color green.
   3. Signal cable shields shall only be grounded at a single point in the loop. Unless otherwise noted, ground signal cable shields at control panel.
   4. Ensure the continuity of the equipment grounding system by effective connections through conductors or structural members.
   5. Design so that removing a device does not interrupt the continuity of the equipment-grounding circuit.
   6. Provide an equipment-grounding terminal for each incoming power circuit, near the phase conductor terminal.
   7. Size ground wires in accordance with NEC and UL Standards, unless noted otherwise.
   8. Unless otherwise noted, connect all exposed, noncurrent-carrying conductive parts, devices, and equipment to the equipment-grounding circuit.
   9. Connect the door stud on the enclosures to an equipment-grounding terminal within the enclosure using an equipment-bonding jumper.

J. Provide sunshades and insulation for all outdoor installations.

K. Automatic Transfer Switch:
   1. Manufacturer:
      a. TSI Power Corporation.
   2. Redundant 120VAC power feeds to a single 120VAC output.
      a. Capable of handling out-of-phase and/or asynchronous AC sources.
      b. Selectable transfer time 20ms, 40ms or 1 sec.
      c. Built in circuit breakers.
      d. Audible alarms.
      e. LED status indicators.
      f. DB9 communication interface.

3. Power:
    a. 3600VA max.
4. Voltage:
    a. 95-135VAC (both sources).
    b. 47-63 hertz.
    c. Nominal voltage better than 2 percent from no load to full load.
5. Alarm contacts (through DB9):
    a. Loss of primary voltage source.
    b. Loss of secondary voltage source.
6. Mounting:
    a. Shelf.
    b. Rack.
    c. Wall.

2.09 MIXES (NOT USED)

2.10 FABRICATION (NOT USED)

2.11 FINISHES

A. Finishes:
    1. Metallic (non-stainless):
        a. Metal surfaces of panels shall be prepared by chemical cleaning and mechanical abrasion in accordance with the finish manufacturer's recommendations to achieve a smooth, well-finished surface.
        b. Scratches or blemishes shall be filled before finishing. One coat of zinc phosphate shall be applied per the manufacturer's recommended dry-film thickness and allowed to dry before applying the finish coat.
        c. Finish coat shall be a baked polyester-urethane powder, aliphatic air-dry polyurethane, or epoxy enamel to meet NEMA rating specified application.
        d. Exterior of enclosures located outdoors shall be UV-resistant polyester powder coating. Total dry film thickness shall be 3 mils, minimum.
    2. Stainless steel:
        a. Stainless enclosures shall be provided with a Number 4 brushed finish - not painted.

B. Colors:
    1. Exterior color of panels mounted indoors shall be manufacturer's standard light gray.
    2. Exterior of panels mounted outdoors shall be manufacturer's standard white.
    3. Panel interiors shall be manufacturer's standard white.

2.12 SOURCE QUALITY CONTROL

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine the installation location for the instrument and verify that the instrument will work properly when installed.
   1. Notify the Engineer promptly if any installation condition does not meet the instrument manufacturer's recommendations or specifications.

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. Install enclosures so that their surfaces are plumb and level within 1/8-inch over the entire surface of the panel; anchor securely to wall and structural supports at each corner, minimum. Direct attachment to drywall is not permitted.

B. Install the enclosure per guidelines and submitted installation instructions to meet the seismic requirements at the project site.

C. Provide floor stand kits for wall-mounted enclosures larger than 48 inches high.

D. Provide concrete housekeeping pads for freestanding enclosures:
   1. Refer to the structural typical details.

E. Install gasket and sealing material under panels with floor slab cutouts for conduit:
   1. Undercoat floor-mounted panels.

F. Provide a full-size equipment-grounding conductor in accordance with NEC included with the power feeder. Terminate to the incoming power circuit-grounding terminal.

G. All holes for field conduits, etc. shall be cut in the field. There shall be no additional holes, factory cut holes, or hole closers allowed. Incorrect holes, additional holes, or miscut holes shall require that the entire enclosure be replaced.

H. Protect all wiring from sharp edges and corners.

I. Control panels that are adjacent to motor control centers shall be fully wired to the motor control centers using wireways integral to the motor control center or additional conduits as needed. These interconnections are not shown or reflected on the Conduit Schedule but shall be shown on the Loop Drawings prepared by the Contractor.

J. Provide individually fused analog input module points with blown-fuse indicator lights, mounted external of the module on the output terminal strip.

K. Side panels:
   1. Side panels shall be kept free off all control equipment and devices. Any deviation must be sent to the engineer in writing asking for a deviation.

3.04 ERECTION, INSTALLATION, APPLICATION, AND CONSTRUCTION (NOT USED)

3.05 REPAIRS/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.10 DEMONSTRATION AND TRAINING (NOT USED)

3.11 PROTECTION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 17720

CONTROL SYSTEMS: PROGRAMMABLE LOGIC CONTROLLERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Programmable logic controller (PLC) based control systems hardware.
   2. Development software to be used with the specified PLC hardware.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Institute of Electrical and Electronics Engineers (IEEE).

1.03 DEFINITIONS

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Specific definitions:
   1. CPU: Central processing unit.
   2. I/O: Input/Output.

C. Specific definitions:
   1. Development operating software: The software provided by the PLC manufacturer for use in programming the PLC.
   2. Application software: The software that is programmed specifically for the Project.

1.04 SYSTEM DESCRIPTION

A. Provide all PLC hardware as indicated on the Drawings and as specified in this Section.

1.05 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Product data:
   1. CPU:
      a. Processor type.
      b. Processor speed.
      c. Memory.
      d. Internal processor battery backup time.

2. I/O modules:
    a. Type.
    b. Standard wiring diagram.

C. Calculations:
1. Submit calculations or documented estimate to verify that memory requirements of this Section are met, including spare requirements. If possible, use PLC manufacturer's calculation or estimating worksheet.
2. Submit calculations to verify that spare I/O requirements of this Section are met.
3. Submit calculations to verify that PLC power supply requirements of this Section are met.

D. Product data:
1. Programming languages.
2. Operating system requirements.

E. Control logic:
1. Fully annotated copy of programmed PLC logic.
2. Cross-referenced index of all PLC registers or points.

F. Provide application software for the specific Project process requirements.
1. Fully annotated copy of programmed PLC logic in its native format.
2. Cross-referenced index of all PLC registers or points.

1.06 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide PLC hardware manufactured at facilities certified to the quality standards of ISO 9001.

C. Additional requirements:
1. Provide PLC system components by a single manufacturer:
    a. Third-party communication modules may be used only for communication or network media functions not provided by the PLC manufacturer.
2. Use PLC manufacturer approved hardware, such as cable, mounting hardware, connectors, enclosures, racks, communication cable, splitters, terminators, and taps.
3. All PLC hardware, CPUs, I/O devices, and communication devices shall be new, free from defects, and produced by manufacturers regularly engaged in the manufacture of these products.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 COMMISSIONING (NOT USED)

1.15 MAINTENANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. In addition to the spare parts requirements specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems
   1. CPU: 1 spare for each type of CPU in the system.
   2. I/O cards: 3 spares for each type of I/O card in the system.
   3. Power supplies: 2 spares for every power supply in the system.
   4. Network/communications cards: 1 spare for every network or communications card in the system.
   5. Remote adapter: 1 spare for every remote adaptor in the system.
   6. Chassis: 1 spare for each chassis size in the system.
   7. Communication cable: 1 spare for each type of cable used in the system.

C. Installed spare requirements:
   1. I/O points:
      a. Provide total of 25 percent spare I/O capacity for each type of I/O at every PLC and remote inputs and outputs (RIO).
      b. Wire all spare I/O points to field terminal blocks in the same enclosure the PLC resides in.
   2. PLC backplane capacity:
      a. Provide 25-percent or 3 spare backplane slots, whichever is greater, in all racks containing I/O.
   3. PLC memory:
      a. Provide 50-percent spare program volatile memory.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following no equal:
   1. Modicon:
      a. Plant PLCs:
         1) Quantum Components.

b. Vendor PLC:
1) M580.
2) M340.
3) Momentum.

B. The PLC programming software system shall be manufactured by PLC hardware manufacturer:
1. Modicon:
a. Unity Pro XL Version II.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. Programmable logic controller:
1. Construction:
a. Furnish plug-in modular system.
b. Provide PLCs capable of operating in a hostile industrial environment without fans, air conditioning, or electrical filtering:
1) Temperature: 0 to 60 degrees Celsius.
2) RFI: 80 to 1,000 MHz.
3) Vibration: 10 to 500 hertz.
4) Humidity: 0 to 95 percent.
c. Provide internal power supplies designed to protect against overvoltage and frequency distortion characteristics frequently encountered with the local power utility.
d. Design the PLC system to function as a standalone unit that performs all of the control functions described in this Section completely independent from the functions of the HMI system PC-based operator interfaces:
1) Failure of the HMI system shall not impact data acquisition, control, scaling, alarm checking, or communication functions of the PLC.
2. CPU:
a. Configure each CPU so that it contains all the software relays, timers, counters, number storage registers, shift registers, sequencers, arithmetic capability, and comparators necessary to perform the specified control functions.
b. Capable of interfacing with all discrete inputs, analog inputs, discrete outputs, analog outputs, and communication cards to meet the specified requirements.
c. Capable of supporting and implementing closed-loop floating-point math and PID control that is directly integrated into the CPU control program.
3. Memory:
a. Supply with sufficient memory to implement the specified control functions plus a reserve capacity as specified with the requirements of this Section:
1) Reserve capacity:
a) Totally free from any system use.
2) Programmed in a multi-mode configuration with multiple series or parallel contacts, function blocks, counters, timers, and arithmetic functions.

4. Programming:
    a. Provide a system where processors are programmed by:
        1) Portable laptop computer both locally and via the PLC control network.
5. PLC power supply:
    a. Input: 120 VAC.
    b. Mounted in the PLC housing or as indicated on the Drawings.
    c. Sized to power all modules mounted in that housing including an average module load for any empty housing slots plus 50 percent above that total.
6. PLC input/output, I/O modules:
    a. General:
        1) Compatible with all of the PLCs being furnished under the contract and by the same manufacturer as the PLCs.
        2) Provide I/O modules that:
            a) Isolate in accordance with IEEE Surge Withstand Standards and NEMA Noise Immunity Standards.
            b) Provide A/D and D/A converters with optically or galvanically isolated inputs and outputs.
            c) Accept dual-ended inputs.
        3) The use of common grounds between I/O points is not acceptable.
        4) Provide modules that are removable without having to disconnect wiring terminals:
            a) Utilize a swing-arm or plug-in wiring connector.
        5) Provide at each PLC the I/O modules for the following:
            a) Designated future I/O points contained in the I/O Lists and/or shown on the P&IDs, control schematics, or described in the control strategies.
            b) Installed spare capacity in accordance with the requirements of this Section.
            c) Wire all spares provided to the field terminal strip.
        6) Condition, filter, and check input signals for instrument limit conditions.
        7) Filter, scale, and linearize the raw signal into an engineering-units-based measurement.
        8) Alarm measurements for high, low, rate-of-change limits, and alarm trends.
        9) Provide external fuses mounted on the field connection terminal block for all discrete input, discrete output, and analog input I/O points.
        10) When multiple cards of the same I/O type are provided and parallel equipment, instrumentation, or redundant processes exist, distribute I/O among cards to ensure that a single card failure will not render an entire process unavailable.
    b. Discrete input modules:
        1) Discrete input module model number for Plant PLCs: 140DAI54000.
        2) Defined as contact closure inputs from devices external to the input module.
        3) Provide inputs that are optically isolated from low-energy common-mode transients to 1,500 volts peak from users wiring or other I/O modules.
        4) Individually isolated inputs.
        5) With LEDs to indicate status of each discrete input.

6) Input voltage: 120VAC.
7) Provide input module points that are individually fused with blown-fuse indicator lights, mounted external of the module on the output terminal strip:
a) Coordinate external fuse size with the protection located on the module, so that the external fuse opens first under a fault condition.

c. Discrete output modules:
1) Discrete output module model number for Plant PLCs: 140DAO84210.
2) Defined as contact closure outputs for ON/OFF operation of devices external to the output module:
a) Triac outputs may be used, with the permission of the Engineer. Care must be used in applying this type of module to ensure that the leakage current through the output device does not falsely signal or indicate an output condition.
3) Optically isolated from inductively generated, normal mode and low-energy common-mode transients to 1,500 volts peak.
4) LEDs to indicate status of each output point.
5) Output voltage: 120VAC.
6) Individually isolated outputs.

d. Analog input modules:
1) Analog input module model number for Plant PLCs: 140ACI03000.
2) Signal type: Provide 4-20 mA for most applications; other levels are acceptable to interface to vendor control panels.
3) Analog-to-digital conversion: Minimum 12-bit precision with the digital result entered into the processor.
4) The analog-to-digital conversion updated with each scan of the processor.
5) Individually isolated each input.
6) Coordinate the size of the external fuse with the protection located on the module, so that the external fuse opens first under a fault condition.

e. Analog output modules:
1) Discrete output module model number for Plant PLCs: 140ACO13000.
2) Signal type: Provide 4-20 mA for most applications; other levels are acceptable to interface to vendor control panels.
3) Individual isolated output points each rated for loads of up to 1,000 ohms.

7. Communications modules:
a. Remote I/O adapter module:
1) For any PLC location requiring more than 1 housing to mount all of the I/O modules or that is identified as a RIO, provide the appropriate remote I/O adapter module for communication with the secondary housing(s).
2) Install the RIO adapter module in the PLC backplane and the RIO backplane.
3) Provide adapter modules that support all available types of I/O modules required.

4) Provide all network taps, connectors, termination resistors, drop cables, and trunk cables necessary for remote I/O communications.
5) Complete diagnostic LEDs.

b. Network communications modules:
1) General:
a) Install communications modules in the PLC backplane.
2) Ethernet:
a) Ports: 1 RJ-45.
b) Communication rate: 10/100 Mbit/s.
3) Modbus:
a) Ports: 2.
b) Each port individually configurable as Modbus Master or Slave.
4) Provide all network taps, connectors, termination resistors, drop cables, and trunk cables necessary for remote I/O communications.

8. PLC backplane housing:
a. Mount the PLC power supply, CPU, communications module, and I/O modules in a suitable standard PLC backplane or housing.
b. Provide spare slots in each PLC and RIO location in accordance with the requirements of this Section.
c. Provide a blank slot filler module for each spare slot.

B. PLC programming software:
1. Furnish operating software capable of monitoring and/or controlling the PLCs via the PLC data network:
a. Contain diagnostics to collect troubleshooting and performance data and display it in easy to understand graphs and tables.
b. Monitor devices at each drop on the PLC data network for proper communications.
c. Provide the ability to program all PLCs on the PLC data network from the Engineer’s console.
2. PLC programming laptop/desktop operating system:
a. Microsoft Windows 10.
3. The PLC programming software shall be suitable for the PLCs specified above.
4. PLC programming software for all programming, monitoring, searching, and editing:
a. Usable both on-line, while connected to the PLC, and off-line.
b. The operating software shall display multiple series and parallel contacts, coils, timers, counters, and mathematical function blocks.
c. Capable of disabling/forcing all inputs, outputs, and coils to simulate the elements of the ladder logic; forced elements shall be identifiable by means of color change.
d. Include a search capability to locate any address or element and its program location.
e. Display at the EC, PLC status information, such as faults and communication errors and amount of memory remaining.
5. The PLC programming software shall support the following programming languages:
a. Ladder Diagram.
b. Function Block Diagram.

6. Generate a PLC program printout, which is fully documented, through the PLC programming software:
    a. Fully documented program listings include, as a minimum, appropriate rungs, address, and coils shown with comments to clarify to a reader what that segment of the program accomplishes on an individual line-by-line basis.
    b. Include a sufficient embedded comment for every rung of the program explaining the control function accomplished in said rung.
    c. Use a mnemonic associated with each contact, coil, etc. that describes its function.
    d. Utilize the tag and loop identification as contained in the P&IDs:
        1) If additional internal coils, timers, etc. are used for a loop, they shall contain the loop number.
    e. Provide a cross-reference report of program addresses.
7. Software functions automatically without operator intervention, except as required to establish file names and similar information:
    a. Furnish the operating system software that is the standard uncorrupted product of the PLC manufacturer with the following minimum functions:
        1) Respond to demands from a program request.
        2) Dynamic allocation of the resources available in the PLC. These resources include main memory usage, computation time, peripheral usage, and I/O channel usage.
        3) Allotment of system resources based on task priority levels such that a logical allocation of resources and suitable response times are ensured.
        4) Queuing of requests in order of priority if one or more requested resources are unavailable.
        5) Resolution of contending requests for the same resource in accordance with priority.
        6) Service requests for execution of one program by another.
        7) Transfer data between programs as requested.
        8) Management of all information transfers to and from peripheral devices.
        9) Control and recovery from all program fault conditions.
        10) Diagnose and report real-time hardware device errors.
8. Program execution:
    a. Application software - program execution scheduled on a priority basis:
        1) A multilevel priority interrupt structure is required.
        2) Enter into a list of pending programs a program interrupted by a higher priority program:
            a) Resume its execution once it becomes the currently highest priority program.
        3) Schedule periodic programs.
        4) Base the allocation of resources to a time-scheduled program on its relative priority and the availability of resources.
9. Start-up and restart:
    a. Provide software that initializes and brings a PLC or any microprocessor-based hardware unit from an inactive condition to a state of operational readiness.

b. Initialization:
    1) Determination of system status before start-up of initializing operating system software and initializing application software.
    2) Loading of all memory-resident software, initializing timers, counters, and queues, and initialization of all dynamic database values.

10. Shutdown:
    a. Where possible, provide orderly shutdown capability for shutdowns resulting from equipment failure, including other PLC processor failures, primary power failure, or a manually entered shutdown command.
    b. Upon loss of primary power, a high-priority hardware interrupt initiates software for an immediate, orderly shutdown.
    c. Hardware is quickly and automatically commanded to a secure state in response to shutdown command or malfunction.
    d. Alarm PLC failure at the operator interface level.
11. Diagnostics:
    a. Furnish diagnostic programs with the PLC software package to detect and isolate hardware problems and assist maintenance personnel in discovering the causes for system failures.
    b. Use the manufacturer's standard diagnostic routines as much as possible.
    c. Furnish diagnostic software and test programs for each significant component in the control system.
    d. As a minimum, provide diagnostic routines to test for power supply, central processing unit, memory, communications, and I/O bus failures.
12. Calendar/time program:
    a. The calendar/time program to update the second, minute, hour, day, month, and year and transfer accurate time and date information to all system-level and application software.
    b. Variations in the number of days in each month and in leap years must be handled automatically by the program.
    c. The operator must be able to set or correct the time and date from any operator interface, only at the highest security level.
13. Algorithms:
    a. Implementation of algorithms for the determinations of control actions and special calculations involving analog and discrete data.
    b. Algorithms must be capable of outputting positional or incremental control outputs or providing the product of calculations.
    c. Algorithms must include alarm checks where appropriate.
    d. Provide, as a minimum, the following types of algorithms:
        1) Performs functions such as summing several variables, raising to a power, roots, dividing, multiplying, and subtracting.
        2) A switch algorithm, which reads the current and value from its input address and stores it as the value of its output address. 2 types of switches shall be accommodated: 2 outputs with 1 input and 1 output with 2 inputs.
        3) A 3-mode proportional-integral-derivative, PID, controller algorithm, with each of the 3 modes independently adjustable, supports both direct and reverse-acting modes.
        4) Lead, lag, dead time, and ratio compensators.
        5) Integration and totalization of analog process variables.
14. Furnish a comprehensive database for the analog inputs, calculated values, control modules, and outputs:
    a. In addition, provide spare database points for future expansion.

15. One integrated database can be utilized for all types of analog points or separate databases for each type; in either case, the database for each point must include all specified aspects.
16. All portions of the database must be available for use by the display, report, and other specified software modules.
17. All of the data fields and functions specified below must be part of the point definition database at the operator interface. Provide the capability to define new database points through the point display specified below as well as modifying defined points through these displays. This point definition and modification must include all of the features and functions defined below. The analog database software must support the following functions and attributes:
    a. Analog input signal types:
        1) Provide software at the remote terminal units (RTUs) and PLCs to read variable voltage/current signals and pulse duration/frequency type analog input signals.
    b. Input accuracy:
        1) Inputs must be read with an accuracy of within 0.05-percent full-scale or better.
        2) Data conversion errors must be less than 0.05-percent full-scale.
        3) Pulse accumulation error less than or equal to 1 count of actual input count at a scan rate of once per minute.
        4) Maintain for a minimum of 1 year the system accuracy stated above without adjustments.
    c. Blocking:
        1) Provide mechanisms to inhibit or block the scanning and/or processing of any analog input through the operator interface.
        2) For any input so blocked, the operator may manually enter a value to be used as the input value.
    d. Filtering:
        1) For each analog input, provide a first order lag digital filter with an adjustable filter factor.
    e. Linearizing:
        1) Where analog inputs require square root extraction or other linearization, provide a mechanism to condition the filtered data before the process of scaling and zero suppression takes place.
    f. Calculated values:
        1) Provide means to allow for pseudo-inputs calculated by algebraic and/or Boolean expressions utilizing real inputs, other calculated values, constants, etc.
        2) These values must be handled the same as real inputs in terms of record-keeping, alarming, etc.
    g. Scaling and zero suppression:
        1) Provide a conversion program to convert input values into engineering units in a floating-point format.
    h. Alarms:
        1) Provide an alarm program to check all analog variables against high-high, high, low, and low-low alarm limits.
        2) When an analog value exceeds a set limit, it must be reported as an alarm based on individually set priority level for each alarm point.

3) Provide an adjustable hysteresis band in order to prevent excessive alarms when a variable is hovering around an alarm limit.
4) Must be possible to inhibit alarms based on external events, e.g., lock-out low pump flow alarm when the pump is off.

i. Averages:
1) Provide a program to calculate and store hourly, daily, and monthly averages of analog variables.
2) Continuously compute averages, e.g., the average for the current period to the present point in time must be stored in memory and available for use in displays, etc.
3) Update hourly averages each minute or at the polling interval for the selected variable.
4) Update daily averages at least once each hour and calculate using the results of the hourly averages.
5) Update monthly averages at least once each day and calculate using the results of the daily averages.
6) At the end of each averaging period, store the average values for the period on the hard disk for historical record-keeping and reset the present period average register to the present value of the variable.
7) The active database must include the present period average and previous period average for each variable and averaging period.

j. Totals:
1) Provide a program to calculate and store hourly, daily, and monthly totalization of analog variables.
2) Assign a scaling factor to each variable to convert to the appropriate units based on a 1-minute totalizing interval.
3) Assign a separate factor for each totalizing interval.
4) Variables for which totalization is inappropriate must have scaling factors of zero.
5) At the end of each totalizing period, store the totalized values for the period on the hard disk for historical record-keeping and reset the present period totalization register to zero.
6) The active database must include the present period total and previous period total for each variable and totalizing period.

k. Engineering units:
1) Provide software to allow the system and the operator to convert all the measured analog variables to any desired engineering units.
2) The operator must be able to view displays and generate reports of any measured variable in one or more engineering units such as flow in gpm, mgd, cfs, and acre-feet per day.
3) Pre-program the conversion of the engineering units, and, if not pre-programmed, the operator must be able to program new engineering unit conversions by using simple methods, e.g., multiplication of the database attributes by a constant.
4) The programming method must be at a level and compatible with the specified training of the operator and the Owner's personnel.
5) New conversions must not require the services of a special programmer and/or special, high-level, programming training.

l. Control modules:
1) For each control function configured, whether processed at the RTU, PLC, or operator interface, maintain a file of necessary data including

input values, setpoints, constants, intermediate calculated values, output value and limit clamps, etc.
2) Input and output assignments, setpoints, and constants must be adjustable by the operator through the operator interface.
3) Provide control algorithms for manual control with output values adjustable by the operator.

m. Analog outputs:
1) Analog outputs must be maintained as part of the database.
2) These outputs must be adjustable manually by the operator through the operator interface or through automatic control algorithms.

18. Some of the above functions may be better accomplished in the data acquisition and graphic display software package; it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.

C. General control functions:
1. Analog control functions:
a. PID, lead/lag, signal select, alarm, limit, delay, and time base.
b. Furnish the control system complete with a library of mathematical/calculation software to support averaging, weighted average, addition, subtraction, multiplication, division, square root extraction, exponential, AND, OR, NAND, NOR, XOR, and NXOR functions.
c. All math utilities must be linkable to process data points or manual inputs via control block configuration.
d. By linking control blocks to data points, the math library must support system unit conversion and calculation requirements.

2. Discrete control functions:
a. AND, OR, NOT, EXCLUSIVE OR, comparators, delays, and time base.

3. Software support:
a. Retain in firmware all control and logic functions at each RTU and PLC and in RAM at the operator interface.
b. Call each function as required by the configured controls to perform the intended function.

4. Control and status discrepancies:
a. Generate a discrepancy/fail alarm for any pump, valve, or final control element if a discrepancy exists between a system or operator command and the device status.
1) For example, the system commands to start (call), and the pump fails to start (run status report back), within predetermined operator-programmable time delay (time disagree), then a discrepancy (fail) alarm shall be generated.

b. Involuntary change in the device's status must also generate an alarm:
1) For example, a pump starts when not commanded to do so, or a pump shuts down while running even though it still has a command to run.

c. Each command, status, and alarm must cause the color of the symbol to change.
d. Because many discrete final control elements have a cycle time in excess of the scan interval, provide each control output with an associated delay

period selected to be longer than the operating period of the control element:
1) Delay periods for each final control element must be adjustable at the operator interface.
2) List all time delays in the final documentation.

5. Some of the above functions may be better accomplished in the data acquisition and graphic display software package; it is the responsibility of the ICSC to optimize the location of the various functions between all software packages.

D. Control configuration:
1. Provide software to allow control strategies to be developed, and their operation initiated through the operator interface.
2. Provide standardized control point displays for defining the control functions including the function type, input/output addresses, setpoints, tuning constants, etc.
3. Provide a mechanism to link separate control functions together into an integrated control strategy.
4. Provide a mechanism to download operational/control setpoints developed at any operator interface to any PLC or RTU for operational implementation.
5. Provide a mechanism to define and implement operational/control setpoints locally at the PLC or RTU, and to upload them to the operator interface for operational record-keeping.
6. Perform control configurations on-line at the operator interface; the PLC or RTU may be taken off-line when being configured or downloaded.

E. Remote inputs and outputs (RIOs):
1. Compatible with all of the PLCs being furnished under this Contract, shall be by the same manufacturer as the PLCs, and, as a minimum, include:
a. Power supply.
b. Rack.
c. Backplane.
d. Communications module.
e. I/O modules.
f. Enclosure.
2. Provide all cables and software needed for a complete and operational RIO system as specified in the Contract Documents.
3. Provide a group of pre-assigned diagnostic registers to report RIO system faults to the driver PLC.
4. The control system must continue operation should a fault occur on a single RIO drop:
a. Upon clearing the fault, restart communications to that drop automatically.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES (NOT USED)

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Utilize personnel to accomplish or supervise the physical installation of all elements, components, accessories, or assemblies:
   1. Employ installers who are skilled and experienced in the installation and connection of all elements, components, accessories, and assemblies.

C. All components of the control system including all data network cables are the installation responsibility of the ICSC unless specifically noted otherwise.

D. General:
   1. The control system logic program shall reside at the PLC level.

E. Use the tag and loop identifications found on the P&IDs for all tags used and/or assigned as part of the application software work provided by the ICSC.

F. Program the PLC logic using the following language(s):
   1. Ladder Diagram.
   2. Function Block Diagram.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION

A. Provide a minimum of 4 CD/DVD copies of the following:
   1. Application software:
      a. Finalized fully annotated copy of programmed PLC logic in its native format.
      b. Cross-referenced index of all PLC registers or points.

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.08 ADJUSTING (NOT USED)

3.09 CLEANING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.10 DEMONSTRATION AND TRAINING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Tailor training specifically for this Project that reflects the entire control system installation and configuration.

C. Perform training by pre-approved and qualified representatives of the ICSC and/or manufacturer of the PLC hardware and programming software:
   1. A representative of the ICSC may perform the PLC hardware training only if the representative has completed the manufacturer's training course for the PLC hardware.
   2. A representative of the ICSC may perform the PLC programming software training only if the representative has completed the manufacturer's training course for the PLC programming software.

3.11 PROTECTION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 17733

CONTROL SYSTEMS: NETWORK MATERIALS AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Materials and equipment used in process control and LAN networks including:
      a. Network switches.
      b. Media converters.
      c. Patch panels and other data network hardware.
      d. Related accessories.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Institute of Electrical and Electronics Engineers (IEEE):
   1. 802.1X - Standard for Local and Metropolitan Area Networks - Port-Based Network Access Control.
   2. 802.3 - Standard for Ethernet.
   3. 802.3ab - Standard for Information Technology - Telecommunications and information exchange between systems - Local and Metropolitan Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications - Physical Layer Parameters and Specifications for 1000 Mb/s Operation over 4 pair of Category 5 Balanced Copper Cabling, Type 1000BASE-T.
   4. 802.3u - Standards for Local and Metropolitan Area Networks: Supplement - Media Access Control (MAC) Parameters, Physical Layer, Medium Attachment Units, and Repeater for 100Mb/s Operation, Type 100BASE-T (Clauses 21-30).
   5. 802.11b - Standard for Information Technology - Telecommunications and information exchange between systems - Local and Metropolitan networks - Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) specifications: Higher Speed Physical Layer (PHY) Extension in the 2.4 GHz band.

C. Telecommunications Industry Association/Electronics Industry Association (TIA/EIA):
   1. 568-C.3 - Optical Fiber Cabling Components Standard.

D. Underwriters Laboratories, Inc. (UL).

1.03 DEFINITIONS

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SUBMITTALS

A. Furnish submittals as specified in Sections 01330 - Submittal Procedures and 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Product data:
   1. Include information on all network equipment.
   2. Manufacturer’s operation and installation instructions.

C. Shop drawings:
   1. Complete set of drawings including but not limited to:
      a. System block diagram showing relationship and connections between devices provided under this Contract. Include manufacturer and model information, and address settings.
      b. Network riser diagram.
      c. Network port diagram, which physically locates all ports within the facility, and identifies their patch panel and switch port.
      d. Construction drawings for all equipment cabinets, including dimensions, identification of all components, preparation and finish data, and nameplates.
      e. Electrical connection diagrams.
      f. Complete grounding requirements.
   2. Furnish data sheets for each component together with a technical product brochure or bulletin:
      a. Manufacturer's model number.
      b. Project equipment tag.
   3. Complete and detailed bills of materials broken up by each cabinet. Each bill of material item will include the following:
      a. Quantity.
      b. Description.
      c. Manufacturer.
      d. Part numbers.

D. Test reports:
   1. As specified in Sections:
      a. 16125 - Fiber Optic Cable and Appurtenances.
      b. 17950 - Commissioning for Instrumentation and Controls.
   2. Signed test results as described in this Section.
   3. Test results shall include:
      a. Narrative describing the test procedures followed.
      b. Block diagram of test set up.
      c. Manufacturer’s information on test equipment used.
      d. Detailed test results.
      e. A narrative summarizing the results of the testing and identifying any further action required.

E. Operating manuals:
   1. Complete installation, operation, calibration, and testing manuals as specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

F. Record drawings:
   1. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.
   2. Electrical connection diagrams shall be revised to reflect any changes made in the field and submitted as record drawings.

1.05 QUALITY ASSURANCE

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.08 SEQUENCING (NOT USED)

1.09 SCHEDULING (NOT USED)

1.10 WARRANTY

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.11 SYSTEM START-UP (NOT USED)

1.12 OWNER'S INSTRUCTIONS (NOT USED)

1.13 COMMISSIONING (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS (NOT USED)

2.02 SYSTEM DESCRIPTION

A. Provide all network equipment identified in the Contract Documents.

2.03 EXISTING PRODUCTS (NOT USED)

2.04 MATERIALS (NOT USED)

2.05 MANUFACTURED UNITS

A. Ethernet switches:
   1. Managed Process Floor Ethernet switches:
      a. Manufacturers: One of the following, no equal:
         1) Hirschmann, BRS-40.
         2) Red Lion, N-Tron, 7000.
         3) Rockwell, Stratix 5700.
         4) Cisco, IE2000.
      b. Properties:
         1) Hardware:
            a) Power supply:
               (1) Provide redundant power supplies.
               (2) 24 VDC, 170 watts per power supply.
            b) No fans or moving parts.
         2) Performance:
            a) Enclosure:
               (1) All metal housing.
               (2) 15g Shock for 11ms minimum.
            b) 10/100BASE-TX RJ-45 Copper Ports (quantity as indicated on the Drawings).
            c) 100BASE-FX SC or ST Fiber Duplex Ports (quantity as indicated on the Drawings).
            d) 1,000BASE-T RJ-45 Copper Ports (quantity as indicated on the Drawings).
            e) 1,000Base-SX LC Duplex Fiber Ports (quantity as indicated on the Drawings).
            f) Capable of performing basic switching without special programming or configurations. Additional features available through software setup includes but not limited to:
               (1) SNMP.
               (2) VLAN.
               (3) QoS.
               (4) Port Mirroring.
               (5) DHCP Server
            g) IGMP Snooping with Ethernet I/P plug and play compatibility.
            h) 802.1d, 802.1w, 802.1D RSTP.
         3) Environment:
            a) Operating temperature range: 32 to 140 Degrees Fahrenheit.
            b) Humidity:10 to 95 percent, non-condensing.
         4) Connector type:
            a) Fiber: LC.
            b) Copper: RJ-45:
               (1) Quantity of copper and fiber ports as required to provide connections as indicated on the Drawings: As required to provide the number of connections required plus 20 percent spare ports of each type used.
         5) Mounting:
            a) DIN Rail mounting.

B. Media converters:
1. Copper to fiber transceiver:
a. Manufacturers: One of the following or equal:
1) N-Tron.
2) Transition Networks.
3) Phoenix Contact.
b. Transceiver shall be used to convert from Half/Full Duplex Ethernet to multimode fiber Ethernet 100BASE-FX:
1) Meets requirements of IEEE 802.3 Ethernet standard.
2) Supports Half/Full Duplex.
3) Connector type:
a) Fiber: SC.
b) Copper: RJ-45.
4) Power supply:
a) 110 VAC, 60 hertz.
b) 24 VDC, 6 watts.
5) Mounting:
a) Provide mounting hardware.
b) DIN rail mounting, unless otherwise indicated on the Drawings.
2. Copper to fiber transceiver: 3:
a. Manufacturers: The following, no equal:
1) Phoenix Digital, Optical Communication Module for Ethernet Network.
b. Use to connect a network device in a fiber optic ring connection.
c. Fiber ports:
1) Multimode fiber connection: 850 nanometer.
2) Real time diagnostics.
3) SC style connectors.
d. Ethernet port:
1) 10/100BASE-T.
e. Power:
1) 120 VAC, 22 VA.
3. Modular media converter systems:
a. Manufacturers: The following or equal:
1) Transition Networks.
b. Use for the installation of multiple media converters into a standard 19-inch EIA rack.
c. Provide 8-slot chassis for the installation of media conversion modules.
d. Provide power supply to support media converter modules from 120 VAC power supply.
e. Provide mounting hardware for installation into standard electronic equipment rack.
f. Chassis height: 2U Rack Units.
g. Media converter module:
1) Port 1:
a) 100BASE-FX.
b) SC for Multimode Fiber.
2) Port 2:
a) 10/100BASE-TX.
b) RJ-45.
3) Power:
a) From main chassis.

4) Diagnostics:
a) Power Indicating LED.
b) Port Activity Indicating LED.

C. Patch panels:
1. General:
a. Fiber:
1) All optical fibers shall be provided with strain relief and terminated at a fiber patch panel. Final connections between the patch panel and the fiber optic network equipment shall be made via fiber optic patch cords.
2) All fibers, active and dark, shall be terminated at the patch panels.
3) Interconnect and patch panel housings shall provide space for excess fiber and provide strain relief for the fiber cable.
4) Fiber cables shall be installed such that the outer sheath of the cable is carried into the interconnect enclosure or patch panels before breaking out buffer tubes.
b. Copper:
1) Final connections between the patch panel and network equipment shall be by patch cords.
2) All premises cables shall be terminated at the patch panels.
3) Cables shall be installed such that the outer sheath of the cable is carried into the interconnect enclosure or patch panels before breaking out conductors.
4) Maintain twist of broken out conductors per EIA/TIA standards.
2. Cabinet style fiber patch panels:
a. Wall mounted interconnect:
1) Use for the termination of a single cable outside of cabinets, in small enclosures or as indicated on the plans.
2) Wall mounted fiber interconnects shall be provided as complete units including the housing, the connector panels and the fiber connectors.
3) Wall mounted fiber interconnects shall provide physical protection for both the incoming cable and the outgoing patch cords.
4) Capacity:
a) As shown on the plans, minimum 6 connections.
5) Accessories:
a) Door lock.
b) Blanks for unused connector panels.
6) Manufacturers: The following or equal:
a) Leviton 5W110-N.
b) Corning Cable Systems, Wall-Mountable Interconnect Center.
b. DIN rail mounted:
1) Use for the termination of a single cable inside of cabinets, in small enclosures or as indicated on the plans.
2) DIN rail mounted cable interconnects shall be provided as complete units including the housing, the connector panels and the fiber connectors.
3) DIN rail mounted cable interconnects shall provide physical protection for both the incoming cable and the outgoing patch cords.
4) Capacity:
a) As shown on the plans, minimum 6 connections.

5) Accessories:
   a) Blanks for unused connector panels.
6) Manufacturers: One of the following or equal:
   a) Hirschmann, MIPP.
   b) DINSpace, SNAP XL.

2.06 EQUIPMENT (NOT USED)

2.07 COMPONENTS (NOT USED)

2.08 ACCESSORIES

A. Provide duplex patch cords to connect the interface cards provided with the associated patch panels.

2.09 MIXES (NOT USED)

2.10 FABRICATION (NOT USED)

2.11 FINISHES (NOT USED)

2.12 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide installation and configuration for the new and existing managed Ethernet switches. Provide configuration of the Ethernet switch network for a complete, functioning plant control system as indicated on the Drawings and as specified in this Section:
   1. Refer to SCADA block diagrams for all new network connections.
   2. Provide configurations for all managed Ethernet switches and other components including but not limited to VLAN (virtual local area network), additional Plant PLC communication cards and separate managed Ethernet switches as required, such that there is isolation of the following networks:
      a. Field and PLC I/O network: This includes the connections between the Plant PLC and:
         1) Plant PLC expansion racks.
         2) Plant PLC remote I/O (RIO) racks.
         3) Field Networks.
         4) HMI(s) part of a Plant PLC.
         5) Vendor furnished Ethernet network components.
      b. Valve Actuator network: This includes the connections between the Plant PLC and the valve master stations.

c. Process Control network: This includes the connections between the Plant PLC and other Plant PLCs.
d. SCADA network: This includes the connections between the various SCADA equipment including but not limited to servers (existing), workstations and printers.
e. Security network: This includes any security hardware with Ethernet communication as provided by the security/telephone/internet sub-contractor.

3. The process floor managed Ethernet switches for the process control network shall be configured and programmed for rapid fail over protection.
4. The enterprise level managed Ethernet switches shall be configured for a communication protocol that is compatible with the process control network's rapid fail over protocol.

C. All racks shall be level and plumb.

D. Install Velcro wrap on all cable bundles within the network rack/enclosure.

E. All cables and equipment shall be installed in strict conformance with the manufacturer's recommendations:
1. Cables shall be installed avoiding sharp bends.
2. Install cable using lubricant designed for cable pulling.
3. Cable ties or other cable supports shall be installed without crimping the LAN cables.
4. Install LAN cables without splices.
5. Installed bend radii shall not exceed 4 times the cable diameter.
6. Terminated all pairs at the jack and the patch panel.

F. Install cables a minimum of 40 inches away from electrical motors and transformers.

G. Install cables a minimum of 12 inches away from fluorescent lighting.

H. Individual pairs will be untwisted less than 1/2-inch at termination points.

I. All cables and terminations shall be labeled with cable designations as specified in Section 16075 - Identification for Electrical Systems.

J. Each data port shall be individually labeled with its patch panel/switch port ID:
1. Labeling must be printed - no handwritten labels will be allowed.

K. At the completion of the wiring installation, provide the following documentation:
1. A plan-view of the premise(s) showing the jack numbering scheme.
2. A printed certification report for the entire wiring installation showing compliance with all EIA/TIA specifications for data cable.
3. Reports such as those generated by Fluke DSP cable certification equipment meet this requirement.
4. Each device with a unique IP address shall be individually labeled with its IP address. The labeling must be printed; handwritten labels will not be allowed.

L. Managed Ethernet switches:
1. Configure switches to prevent broadcast storms.
2. Installations utilizing Rockwell PLCs and multicast messaging shall employ IGMP and snooping on all Rockwell components.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 FIELD QUALITY CONTROL (NOT USED)

3.08 ADJUSTING

A. Perform all firmware installations, configuration and other set up, as required, to place the network into proper operation.

3.09 CLEANING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.10 DEMONSTRATION AND TRAINING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. After completion of the cable system tests and before placing the system in operation, power up all devices installed on the LAN and verify communication between the devices.

C. Verify that all equipment is operable on the network simultaneously. Confirm that all network device communications settings are properly configured.

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 17903

SCHEDULES: I/O LIST

PART 1 GENERAL

1.01 SUMMARY

A. The I/O list is not a take-off list. Additional information is as indicated on the Drawings and specified in the Contract Documents. Where any discrepancies between this list and the P&ID drawings arise, the P&ID shall govern.

B. Abbreviations used in the I/O list are defined on the Drawings.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 I/O LIST

A. I/O list attached.

END OF SECTION

SECTION 17903A

PLC I/O LISTING

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PLC I/O Listing for PLC-1

Drawing	Tag	I/O	Location	Description	Service	(E/F)*
06N003	A-6604	AI	PLC-1	TURB	TURBIDITY PROBE	
06N006	A-6704	AI	PLC-1	TURB	TURBIDITY PROBE	
06N009	F-6001	AI	PLC-1		MAGNETIC FLOWMETER	
06N009	F-6002	AI	PLC-1		MAGNETIC FLOWMETER	
06N005	F-6651	AI	PLC-1		MAGNETIC FLOWMETER	
06N008	F-6751	AI	PLC-1		MAGNETIC FLOWMETER	
06N009	Z-631	AI	PLC-1	POSITION	FILTER CELL 1 INLET VALVE	
06N009	Z-635	AI	PLC-1	POSITION	FILTER CELL 2 INLET VALVE	
06N009	Z-651	AI	PLC-1	POSITION	FILTER CELL 3 INLET VALVE	
06N009	Z-655	AI	PLC-1	POSITION	FILTER CELL 4 INLET VALVE	
06N009	Z-660	AI	PLC-1	POSITION	FILTER CELL 5 INLET VALVE	
06N003	Z-6601	AI	PLC-1	POSITION	FILTER 6 INLET VALVE	
06N006	Z-6701	AI	PLC-1	POSITION	FILTER 7 INLET VALVE	
PLC-1	**Total AI Points = 13**					

* E/F = Existing/Future I/O

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PLC I/O Listing for PLC-1

Drawing	Tag	I/O	Location	Description	Service	(E/F)*
07N001	AUX1-7001	DI	PLC-1	RUNNING	FILTER SUPPORT BLDG EF	
07N001	AUX2-7001	DI	PLC-1	FAILED	FILTER SUPPORT BLDG EF	
06N009	HSAR-631	DI	PLC-1	REMOTE	FILTER CELL 1 INLET VALVE	
06N009	HSAR-635	DI	PLC-1	REMOTE	FILTER CELL 2 INLET VALVE	
06N009	HSAR-651	DI	PLC-1	REMOTE	FILTER CELL 3 INLET VALVE	
06N009	HSAR-655	DI	PLC-1	REMOTE	FILTER CELL 4 INLET VALVE	
06N009	HSAR-660	DI	PLC-1	REMOTE	FILTER CELL 5 INLET VALVE	
06N003	HSAR-6601	DI	PLC-1	REMOTE	FILTER 6 INLET VALVE	
06N003	HSAR-6602	DI	PLC-1	REMOTE	FILTER 6 OUTLET VALVE	
06N003	HSAR-6603	DI	PLC-1	REMOTE	FILTER 6 FTW VALVE	
06N006	HSAR-6701	DI	PLC-1	REMOTE	FILTER 7 INLET VALVE	
06N006	HSAR-6702	DI	PLC-1	REMOTE	FILTER 7 OUTLET VALVE	
06N006	HSAR-6703	DI	PLC-1	REMOTE	FILTER 7 FTW VALVE	
06N009	ZSC-631	DI	PLC-1	CLOSED	FILTER CELL 1 INLET VALVE	
06N009	ZSC-635	DI	PLC-1	CLOSED	FILTER CELL 2 INLET VALVE	
06N009	ZSC-651	DI	PLC-1	CLOSED	FILTER CELL 3 INLET VALVE	
06N009	ZSC-655	DI	PLC-1	CLOSED	FILTER CELL 4 INLET VALVE	
06N009	ZSC-660	DI	PLC-1	CLOSED	FILTER CELL 5 INLET VALVE	
06N003	ZSC-6601	DI	PLC-1	CLOSED	FILTER 6 INLET VALVE	
06N003	ZSC-6602	DI	PLC-1	CLOSED	FILTER 6 OUTLET VALVE	
06N003	ZSC-6603	DI	PLC-1	CLOSED	FILTER 6 FTW VALVE	
06N006	ZSC-6701	DI	PLC-1	CLOSED	FILTER 7 INLET VALVE	
06N006	ZSC-6702	DI	PLC-1	CLOSED	FILTER 7 OUTLET VALVE	

* E/F = Existing/Future I/O

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PLC I/O Listing for PLC-1

Drawing	Tag	I/O	Location	Description	Service	(E/F)*
06N006	ZSC-6703	DI	PLC-1	CLOSED	FILTER 7 FTW VALVE	
06N009	ZSO-631	DI	PLC-1	OPENED	FILTER CELL 1 INLET VALVE	
06N009	ZSO-635	DI	PLC-1	OPENED	FILTER CELL 2 INLET VALVE	
06N009	ZSO-651	DI	PLC-1	OPENED	FILTER CELL 3 INLET VALVE	
06N009	ZSO-655	DI	PLC-1	OPENED	FILTER CELL 4 INLET VALVE	
06N009	ZSO-660	DI	PLC-1	OPENED	FILTER CELL 5 INLET VALVE	
06N003	ZSO-6601	DI	PLC-1	OPENED	FILTER 6 INLET VALVE	
06N003	ZSO-6602	DI	PLC-1	OPENED	FILTER 6 OUTLET VALVE	
06N003	ZSO-6603	DI	PLC-1	OPENED	FILTER 6 FTW VALVE	
06N006	ZSO-6701	DI	PLC-1	OPENED	FILTER 7 INLET VALVE	
06N006	ZSO-6702	DI	PLC-1	OPENED	FILTER 7 OUTLET VALVE	
06N006	ZSO-6703	DI	PLC-1	OPENED	FILTER 7 FTW VALVE	
PLC-1	**Total DI Points = 35**					

* E/F = Existing/Future I/O

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PLC I/O Listing for PLC-1

Drawing	Tag	I/O	Location	Description	Service	(E/F)*
07N001	MS-7001	DO	PLC-1	RUN	FILTER SUPPORT BLDG EF	
06N009	ZCC-631	DO	PLC-1	JOG CLOSE	FILTER CELL 1 INLET VALVE	
06N009	ZCC-635	DO	PLC-1	JOG CLOSE	FILTER CELL 2 INLET VALVE	
06N009	ZCC-651	DO	PLC-1	JOG CLOSE	FILTER CELL 3 INLET VALVE	
06N009	ZCC-655	DO	PLC-1	JOG CLOSE	FILTER CELL 4 INLET VALVE	
06N009	ZCC-660	DO	PLC-1	JOG CLOSE	FILTER CELL 5 INLET VALVE	
06N003	ZCC-6601	DO	PLC-1	JOG CLOSE	FILTER 6 INLET VALVE	
06N003	ZCC-6602	DO	PLC-1	CLOSE	FILTER 6 OUTLET VALVE	
06N003	ZCC-6603	DO	PLC-1	CLOSE	FILTER 6 FTW VALVE	
06N006	ZCC-6701	DO	PLC-1	JOG CLOSE	FILTER 7 INLET VALVE	
06N006	ZCC-6702	DO	PLC-1	CLOSE	FILTER 7 OUTLET VALVE	
06N006	ZCC-6703	DO	PLC-1	CLOSE	FILTER 7 FTW VALVE	
06N009	ZCO-631	DO	PLC-1	JOG OPEN	FILTER CELL 1 INLET VALVE	
06N009	ZCO-635	DO	PLC-1	JOG OPEN	FILTER CELL 2 INLET VALVE	
06N009	ZCO-651	DO	PLC-1	JOG OPEN	FILTER CELL 3 INLET VALVE	
06N009	ZCO-655	DO	PLC-1	JOG OPEN	FILTER CELL 4 INLET VALVE	
06N009	ZCO-660	DO	PLC-1	JOG OPEN	FILTER CELL 5 INLET VALVE	
06N003	ZCO-6601	DO	PLC-1	JOG OPEN	FILTER 6 INLET VALVE	
06N003	ZCO-6602	DO	PLC-1	OPEN	FILTER 6 OUTLET VALVE	
06N003	ZCO-6603	DO	PLC-1	OPEN	FILTER 6 FTW VALVE	
06N006	ZCO-6701	DO	PLC-1	JOG OPEN	FILTER 7 INLET VALVE	
06N006	ZCO-6702	DO	PLC-1	OPEN	FILTER 7 OUTLET VALVE	
06N006	ZCO-6703	DO	PLC-1	OPEN	FILTER 7 FTW VALVE	

* E/F = Existing/Future I/O

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PLC I/O Listing for PLC-1

Drawing	Tag	I/O	Location	Description	Service	(E/F)*
PLC-1	Total DO Points = 23					

* E/F = Existing/Future I/O

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PLC I/O Listing for PLC-2

Drawing	Tag	I/O	Location	Description	Service	(E/F)*
06DN002	FIC-608	AI	PLC-2		EX. MAGNETIC FLOWMETER	E
06N002	FIC-608	AI	PLC-2		MAGNETIC FLOWMETER	E
06DN001	LI-602	AI	PLC-2		EX. ULTRASONIC LEVEL TRANSMITTER	E
06N001	LI-602	AI	PLC-2		4-WIRE ULTRASONIC	E
06N001	SB-6004	AI	PLC-2	SPEED IN	TERTIARY FEED PUMP 4	
06N001	SB-6005	AI	PLC-2	SPEED IN	TERTIARY FEED PUMP 5	
PLC-2 Total AI Points = 6						
06N001	SS-6004	AO	PLC-2	SPEED OUT	TERTIARY FEED PUMP 4	
06N001	SS-6005	AO	PLC-2	SPEED OUT	TERTIARY FEED PUMP 5	
PLC-2 Total AO Points = 2						
06N001	AUX1-6004	DI	PLC-2	RUNNING	TERTIARY FEED PUMP 4	
06N001	AUX1-6005	DI	PLC-2	RUNNING	TERTIARY FEED PUMP 5	
06N001	AUX2-6004	DI	PLC-2	FAILED	TERTIARY FEED PUMP 4	
06N001	AUX2-6005	DI	PLC-2	FAILED	TERTIARY FEED PUMP 5	
06N001	HSAR-6004	DI	PLC-2	REMOTE	TERTIARY FEED PUMP 4	
06N001	HSAR-6005	DI	PLC-2	REMOTE	TERTIARY FEED PUMP 5	
06N001	MAH-6004	DI	PLC-2	MOISTURE	TERTIARY FEED PUMP 4	
06N001	MAH-6005	DI	PLC-2	MOISTURE	TERTIARY FEED PUMP 5	
06N001	PSH-6004	DI	PLC-2	PRESS	PRESSURE SWITCH HIGH	
06N001	PSH-6005	DI	PLC-2	PRESS	PRESSURE SWITCH HIGH	
06N001	TAH-6004	DI	PLC-2	TEMP	TERTIARY FEED PUMP 4	
06N001	TAH-6005	DI	PLC-2	TEMP	TERTIARY FEED PUMP 5	
PLC-2 Total DI Points = 12						

* E/F = Existing/Future I/O

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PLC I/O Listing for PLC-2

Drawing	Tag	I/O	Location	Description	Service	(E/F)*
06N001	MS-6004	DO	PLC-2	RUN	TERTIARY FEED PUMP 4	
06N001	MS-6005	DO	PLC-2	RUN	TERTIARY FEED PUMP 5	
PLC-2	**Total DO Points = 2**					

* E/F = Existing/Future I/O

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PLC I/O Listing for PLC-7

Drawing	Tag	I/O	Location	Description	Service	(E/F)*
08N001	A-801	AI	PLC-7	TURB	EX. TURBIDITY PROBE	E
08N001	FI-806	AI	PLC-7		MAGNETIC FLOWMETER	E
PLC-7 Total AI Points = 2						
22N001	AUX1-2201	DI	PLC-7	RUNNING	MAINTENANCE BLDG EF	
22N001	AUX2-2201	DI	PLC-7	FAILED	MAINTENANCE BLDG EF	
PLC-7 Total DI Points = 2						

* E/F = Existing/Future I/O

SECTION 17950

COMMISSIONING FOR INSTRUMENTATION AND CONTROLS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Testing requirements that apply to process control and instrumentation systems for the entire Project.
   2. The programming for the plant control system (PCS) is being done by a third party contracted directly to the Owner. The third party contractor will be referred to as the “Programmer” in this specification.
      a. The Programmer shall assist in testing, calibration, and commissioning of the PCS.

1.02 REFERENCES

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Electronics Industries Alliance (EIA).

C. Telecommunications Industry Association (TIA).

1.03 DEFINITIONS

A. As specified in Sections 01756 - Commissioning and 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Specific definitions:
   1. Complete End-to-End Testing (CEET) - Signals are tested from the field device through the PLC program, the network, and all the way to the operator’s HMI graphic screens.
   2. Loop Validation Tests - Signals are tested from the field device to the PLC.
   3. Platform Testing: Testing of the PLC and SCADA/HMI at the manufacturer’s or programmer's shop to demonstrate the program’s functionality based upon specified and designed control requirements.
   4. PTO: Profibus Trade Organization.

1.04 SYSTEM DESCRIPTION (NOT USED)

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 01330 - Submittal Procedures.

B. General:
   1. Reference additional detailed test submittal scheduling and prerequisite requirements as specified in the Sequencing article of Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

C. Overall test plan:
   1. Develop the PCIS system test submittals in consultation and cooperation with all applicable subcontractors.
   2. Develop and submit an overall testing plan for the PCIS. The overall test plan to be reviewed and approved by the Engineer before detailed test plans, procedures, and forms will be reviewed.
   3. Describe the test phases as they apply specifically to this Project and each process system.
   4. Provide a preliminary testing schedule to show the sequence of tests and commissioning as they apply to each process system and each PLC.
   5. Provide a description of factory tests. Describe what equipment will be included, what testing equipment will be used, and the simulator that will be used.
   6. Provide examples of proposed forms and checklists.

D. Test procedures:
   1. Develop and submit detailed test procedures to show that the integrated SCADA system hardware and software is fully operational and in compliance with the requirements specified in the Contract Documents.
   2. Provide a statement of test objectives for each test.
   3. Prepare specific procedures for each process system.
   4. Describe sequentially the steps to be followed in verifying the correct operation of each process system, including all features described in the loop descriptions, control strategies, and shown in the P&IDs. Implied or generic test procedures are not acceptable.
   5. Specify who will perform the tests, specifically what testing equipment will be used (including serial numbers and NIST-traceable calibration), and how the testing equipment will be used.
   6. Describe the expected role of the Engineer, as well as any requirements for assistance from Owner's staff.
   7. Provide the forms and checklists to be used.

E. Test forms:
   1. Submit completed calibration forms, test forms, and checklists.
      a. Test forms shall include the detailed test procedures, or shall include clear references to separate pages containing the complete test procedure applicable to each form. If references to procedures are used, the complete procedure shall be included with each test binder.
      b. Every page of each test form shall include project name, date, time, name of person conducting the test, signature of person conducting the test, and for witnessed tests, place for signature of person (Engineer and Owner) witnessing the test.
      c. Sample test forms at the end of this Section show the minimum required content.
         1) The sample test forms have not been customized for this Project.
         2) Contractor shall develop and submit test forms customized for the Project and meeting the specified test and submittal requirements.

F. FAT procedure additional minimal requirements:
   1. Prepare and submit a FAT procedure which includes:
      a. Control system testing block diagram.
      b. Estimated test duration.

G. Details on the simulator construction, components, and operation. Testing binders:
   1. Sub-system to be tested, provide and submit a test binder containing all test procedures and individual test forms for the test. References to other documents for test procedures and requirements are not acceptable.
   2. Fill out in advance headings and all other information known before the test.
   3. Include applicable test plan information, as well as a list of all test prerequisites, test personnel, and equipment.
   4. Include or list reference material and provide separately at the time of the test.
   5. Record test results and verify that all test requirements and conditions have been met.

H. Test reports:
   1. At the conclusion of each test, submit a complete test report, including all test results and certifications.
   2. Include all completed test binders, forms, and checklists.
   3. Submission, review, and acceptance of each test report is required before the start of the sub-system.

1.06 QUALITY ASSURANCE

A. Test personnel:
   1. Furnish qualified technical personnel to perform all calibration, testing, and verification. The test personnel are required to be familiar with this Project and the equipment, software, and systems before being assigned to the test program.

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

1.11 WARRANTY (NOT USED)

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

B. Installation supervision:
   1. Provide as specified in Section 17050 - Common Work Results for Process Control and Instrumentation Systems.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING

A. Commissioning as specified in Section 01756 - Commissioning.

B. Testing and training phase:
   1. Source testing:
      a. Manufacturer services: Provide as specified in the table below.

Table 1

Section Number	Section Title	Source Testing (Witnessed or Non-Witnessed)
17100 - Control Strategies	Control Strategies	Non-Witnessed
17101 - Specific Control Strategies	Specific Control Strategies	Non-Witnessed
17710 - Control Systems - Panels, Enclosures, and Panel Components.	Control Systems - Panels, Enclosures, and Panel Components	Witnessed
17950 - Commissioning for Instrumentation and Controls	Commissioning for Instrumentation and Controls	Witnessed

      b. Prerequisite requirements:
         1) Engineer approval of the hardware and equipment source testing submittal, Manufacturer Certificate of Source Testing, is required before proceeding to Preliminary FAT.
         2) The Programmer shall assist in testing.

c. Preliminary FAT (Pre-FAT):
    1) The purpose of the Pre-FAT is to provide assurance that the HMI/SCADA system is ready for the full, witnessed FAT, in terms of both stability and functionality.
        a) Debugging of software and troubleshooting of hardware shall occur during and before the pre-FAT, not during the FAT.
        b) Contractor shall fully test the HMI/SCADA system and fix all deficiencies found before the FAT.
    2) Conduct utilizing test procedures approved by Engineer
    3) Owner shall have the right to witness any or all of the Pre-FAT testing and shall be notified in writing 20 days before the start of the pre-FAT.
    4) Submit a letter, signed by the Contractor's project manager or company officer, certifying that integrated system hardware and software has been tested and confirmed to be fully operational and in compliance with the requirements specified in the Contract Documents and is fully ready for the full, witnessed FAT.
        a) Attach the completed pre-FAT test forms, signed by the Contractor's staff.
    5) Engineer approval of the pre-FAT submittal is required before proceeding to FAT.
d. FAT hardware and communications testing:
    1) Perform tests to show that the integrated system hardware and software is fully operational and in compliance with the requirements specified in the Contract Documents.
    2) The complete PCIS system including operator stations, servers, network equipment, printers, PCMs, PLCs, RTUs, LCPs, CCS, peripherals, communications equipment, and other HMI/SCADA equipment, shall be assembled, connected, and software loaded for a fully functional FAT of the integrated system.
    3) Testing simulation:
        a) Inputs and outputs shall be simulated and proper control and system operation shall be validated.
        b) FAT shall make use of simulators that contain switches, pilot lights, variable analog signal generators, and analog signal level displays, which shall be connected to the I/O points within the HMI/SCADA system.
            (1) The use of jumper wires, terminal block mounted pilot lights, and loose meters to act as or supply the functionality of a simulator shall not be allowed.
            (2) The simulator may consist of a PLC, operating under a HMI/SCADA software package, or other approved software that has its I/O points wired to PLC's I/O points.
            (3) Software operating on a PC may then act as the switches, pilot lights, variable analog signal generators, and analog signal level displays.
    4) Additional source tests are specified in other sections of the Instrumentation and Control Specifications.
    5) Owner shall have the right to witness any or all of the FAT testing and shall be notified in writing 20 days before the start of the FAT.

6) Verify communications between the hardware and the programmer's software comply with specified requirements.
    a) For systems that contain RTUs or remote communications with other devices, the complete communications system must be factory tested, including actual interfacing with telephone company equipment and/or the actual radios used for radio based telemetry systems.
7) Panel inspections:
    a) Engineer will inspect each control panel for completeness, workmanship, fit and finish, and compliance with the Contract Documents and the accepted shop drawings.
        (1) Inspection to include, as a minimum: Layout, mounting, wire and data cable routing, wire tags, power supply, components and wiring, I/O components layout (including terminals, wiring and relays), device layout on doors and front panels, and proper ventilation operation.
    b) Inspection forms:
        (1) Provide panel inspection forms as part of the FAT procedures submittal.
        (2) A sample FAT control panel form has been provided at the end of this Section.
8) I/O test:
    a) Engineer will verify that I/O is properly wired to field terminals and is properly mapped into the PLC and the rest of the SCADA system, including all operator interface devices.
    b) Test methodology:
        (1) Discrete inputs:
            (a) Apply appropriate input from simulator at panel terminal, observe input card indicator, observe data value at each indicated data address, and observe data received at field wiring terminals or operator interface screen.
        (2) Discrete outputs:
            (a) Issue commands from operator interface screen or PLC, verify output card indicator light, and measure response at field wiring terminals or multimeter.
        (3) Analog inputs:
            (a) Apply appropriate analog input signal at panel terminals on simulator, observe data value at each indicated data address, and observe data properly received at field wiring terminals or operator interface screen.
            (b) Check each point at 0 percent, 50 percent, and 100 percent of scale.
        (4) Analog outputs:
            (a) Enter scaled values in the output buffer file, observe the output data file value, and measure appropriate response at field wiring terminals or multimeter.
            (b) Check each point at 0 percent, 50 percent, and 100 percent of scale.

c) Test forms to include, but not be limited to the following data:
(1) PLC and panel number.
(2) I/O type.
(3) I/O tag name.
(4) Rack/slot/number of I/O point.
(5) Check-off for correct response for each I/O point.
(6) Comments field.
(7) Initials of individual performing test.
(8) Date test was performed.
(9) Witness signature lines.

9) System configuration test:
a) Demonstrate and test the setup and configuration of operator stations, servers, development stations, and peripherals.
b) Demonstrate utility software and functions, such as virus protection, backup, optical drive burning, network monitoring, etc.
c) Demonstrate the proper operation of peripheral hardware.
d) Demonstrate general HMI/SCADA functions.
e) Demonstrate proper operation of log-on and other security access functions.
f) Demonstrate the proper operation of all historical data storage, trend, display, backup, and report functions.
g) Test automatic fail over of redundant equipment.
h) Demonstrate the proper operation of the alarm display and acknowledgement functions.
i) Test forms:
(1) For each test, list the specification page and paragraph of the function demonstrated, and provide a description of the function.
(2) List the specific tests and steps to be conducted.
(3) For each function, list all of the different sub-functions or ways the function can be used, and provide a test check-off for each:
(a) Include signature and date lines.

10) Engineer approval of the FAT Communication Testing activities is required before proceeding to FAT Platform Testing.

e. FAT Platform Testing - Control logic test:
1) Verify the PLC, HMI and SCADA, provides monitoring and control functionality based upon specified and designed control requirements.
2) Testing requirements:
a) Demonstrate each function described in the Control Strategies.
b) Demonstrate in detail how each function operates under a variety of operating scenarios.
(1) Test to verify the application of each general control strategy function to each specific control strategy or loop description.
c) Demonstrate the proper operation of the programming and configuration for each control strategy or loop description.
(1) Test each strategy or loop description on a sentence by sentence and function by function basis.

(2) Loops with similar or identical logic must each be tested individually.
(3) Test the boundaries of each numeric operator input by entering values outside of the allowable range.

d) Demonstrate the proper operation of all digital communication links and networks.
(1) Verify each digital communication I/O point.

e) Failure testing: Demonstrate how the system responds to and recovers from abnormal conditions including, but not limited to: equipment failure, operator error, communications subsystem error, communications failures, simulated/forced software lockups, power failure (both utility power and power to HMI and/or SCADA hardware), process equipment failure, and high system loading conditions.

3) Test forms:
a) Submit completed test forms for each loop including but not limited to the fully revised and approved control strategy.
b) Identify the cause and effect as each I/O point is toggled through the simulator.
(1) Identify and track proper and/or improper operation of the loop.
c) Note any deficiencies or operational changes on the forms for correction and documentation:
(1) Include signature and date lines.

4) Engineer approval of the FAT submittal is required prior to shipment of system components.

2. Owner training:
a. Demonstration requirements are specified in this Section.

Table 2

Course Title	Minimum Course Length (hours per session)	Personnel (Estimated Number of Students)	Minimum Number of Sessions
System Overview	8	10	1
Operator Training - Basic	24	10	2
Operator Training - Advanced	16	5	2
CIS (Computer) Equipment Maintenance	16	4	1
HMI Software	40	3	1
Historian System Training	24	5	1
Reports Training	8	5	2
PLC Hardware	16	4	1
PLC Software	32	6	1
LOI Hardware and Software	16	5	1
Network Equipment	16	4	1

Table 2			
Course Title	**Minimum Course Length (hours per session)**	**Personnel (Estimated Number of Students)**	**Minimum Number of Sessions**
Follow-Up Training	8	5	5
Instrument Training	24	3	1
Analytical Instrument Training	8	3	3

3. Training course requirements:
    a. Instrumentation training:
        1) Furnish training covering all instruments and control panels.
        2) Furnish the specified quantity of training, allocated to cover new instruments and hardwired controls as specified in this Section and specifically determined in the accepted training plan.
        3) Train maintenance staff in the use, cleaning, calibration, maintenance, and troubleshooting of all the instruments furnished within this Project.
        4) Furnish training on the operation of new hardwired controls.
    b. Analytical instrument training:
        1) Furnish training covering all analytical instruments.
        2) Furnish the specified quantity of training, allocated to cover new analytical instruments as specified in this Section and specifically determined in the accepted training plan.
        3) Train maintenance staff in the use, cleaning, calibration, maintenance, and troubleshooting of all the analytical instruments furnished within this Project.
        4) Provide training by manufacturer.
4. Recording training sessions:
    a. Record all training.
    b. Furnish digital video disk (DVD) format.
    c. These disks become the property of the Owner and cover, in detail, the training for the specific hardware and software of all the systems provided for the Project.
    d. Provide all the necessary cameras and recording equipment.
5. Installation testing:
    a. Calibration:
        1) Performed by Contractor and ICSC.
        2) Calibrate and adjust all instruments, devices, valves, and systems, in conformance with the component manufacturer's instructions and as specified in these Contract Documents.
        3) Replace either individually or within a system, defective elements that cannot achieve proper calibration or accuracy.
            a) Calibration for discrete devices:
                (1) Calibrate and adjust devices for reliable operation and to avoid nuisance tripping.

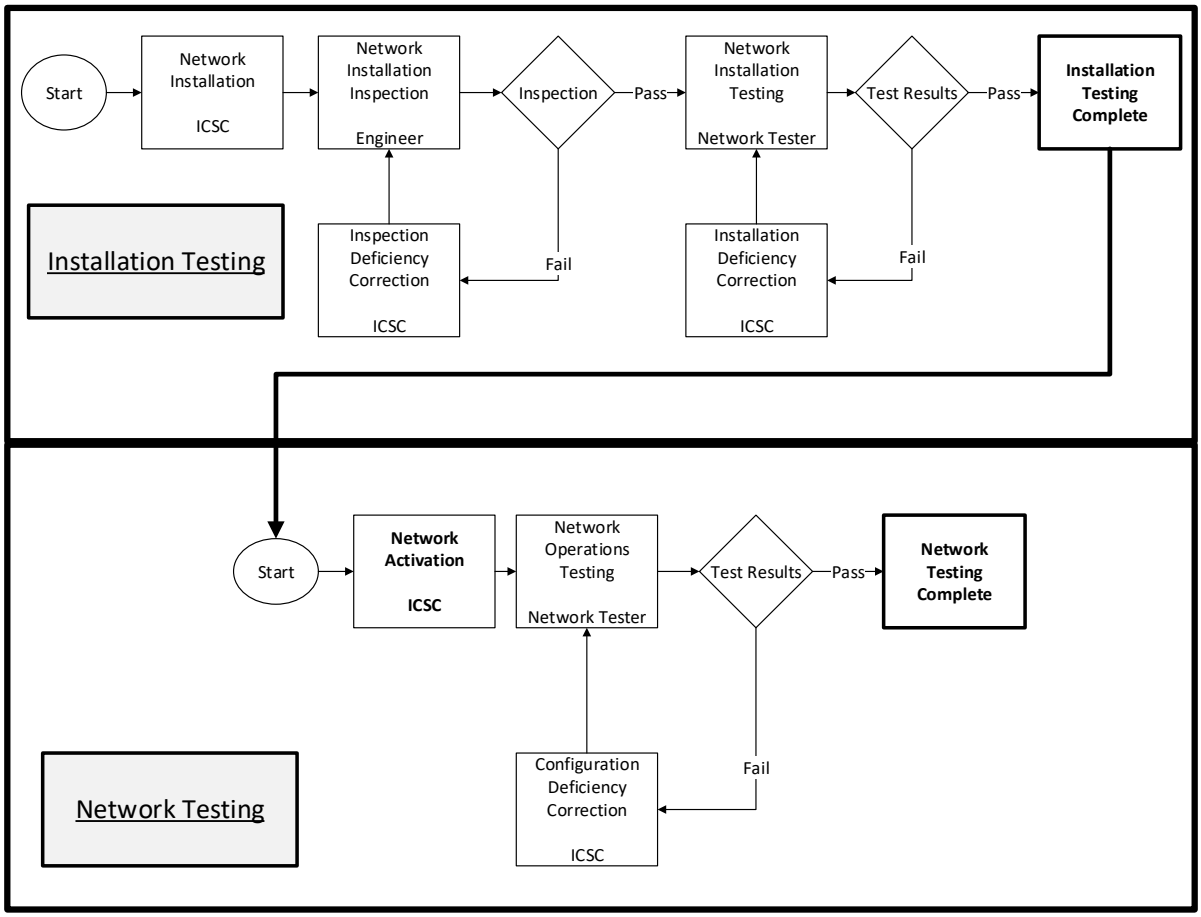
b) Calibration for ultrasonic and radar level devices:
(1) Provide Echo Transmission and signal quality on level transmitters including guided and unguided units.
(a) Submit printout of the actual transmission and parameters.
(2) Adjust mounting, as required, to obtain accurate readings.
(3) Post mounting: Provide any additional calibration required by manufacturer.
c) Calibrating analog transmitters:
(1) Components having adjustable features are to be set accurately for the specific conditions and applications of this installation.
(2) Test and verify that components and/or systems are within the specified limits of accuracy.
(3) Calibration points:
(a) Calibrate each analog instrument at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of span, using test instruments with accuracies traceable to NIST.
(4) Field verify calibration of instruments including units that have been factory-calibrated to determine whether any of the calibrations are in need of adjustment.
d) Analyzer calibration:
(1) Calibrate and test each analyzer system as a workable system after installation. Follow the testing procedures directed by the manufacturers' technical representatives.
(2) Submit completed instrument calibration sheets for every field instrument and analyzer.
(3) Calibration tags:
(a) Attach a calibration and testing tag to each instrument, piece of equipment, or system.
(b) Sign the tag when calibration is complete.
e) Calibration for industrial networking test equipment:
f) Submit calibration documentation.

b. Loop check:
1) Performed by the Contractor.
2) Cabling installed, terminated, and labeled.
3) Perform continuity check of wiring to each field device through intermediate devices to field terminals in the cabinet.
4) Complete loop check form for each device.
5) Submit loop check test results before proceeding to the next step.

c. Loop validation tests:
1) Performed by the Contractor, ICSC, and manufacturer's representative, working together, and witnessed by the Owner or Owner's representative.
2) Perform tests on the signal from each field device through intermediate devices to the I/O module on the PLC.
a) The PLC may or may not be connected to the network.
3) Engineer approval of the loop validation test submittal is required before proceeding to CEET.

d. LAN cable post-testing:
    1) Performed by Contractor and ICSC.
    2) After installing the cable and connectors, test all cables using the LAN certification to confirm the installation meets the requirements of the specification.
    3) Provide test documentation that includes the cable number, total length of cable, a permanent hard copy, as well as a USB or CD copy of all traces.
        a) After installing connectors:
        b) Perform cable end-to-end testing on all installed cables from both ends of the cable. Test shall include cable system performance tests and confirm the absence of wiring errors.
        c) Submit a signed test report presenting the results of the cable testing.
        d) Repair or replace any portions of the system not meeting TIA/EIA standards for installed cabling. Repaired sections shall be retested.
    4) Submit final documentation (including traces), using the approved test form, to the Engineer upon successful completion of the testing.
    5) Engineer approval of the LAN cable post-testing submittal is required before proceeding to CEET.
e. Industrial network testing:
    1) General test requirements:
        a) Contractor will hire a ‘Network Tester’ who is a Certified Profibus Installer for testing for the proper installation and operation of the Profibus network.
        b) Provide necessary components and labor required to address changes required to bring the network into compliance.
        c) Personnel shall be available at the time of network inspection and testing to address network deficiencies.
        d) Before commencing any network inspection or testing activities:
            (1) Verify that network segments and nodes are in their final installed condition.
                (a) Network node devices installed.
                (b) Field devices physically disconnected from the network.
            (2) Process and process equipment is not dependent on operation of the network.
            (3) Inspect network components and deficiencies addressed.
            (4) Manufacturer’s data and specifications for installed network components, available on-site for use by the network testing firm.
            (5) A complete set of Contract Documents included addenda and change orders are available on-site for use by the network testing firm.
        e) Network operation may be interrupted for inspection and testing.
        f) Figure 1, Network Test Sequence and Responsibilities, defines the general test sequence.

Figure 1 - Network Test Sequence and Responsibilities



2) Test equipment:
   a) Use the following test equipment:
      (1) Network line analyzer: ProfiTrace v1.6 or equivalent.
      (2) Oscilloscope: Fluke Scopemeter Series 190 or equivalent.
      (3) Digital VOM: Fluke 87 Multimeter or equivalent.
      (4) Network bus monitor, ProfiTrace v1.6 or equivalent.
3) Network installation testing:
   a) Performed by Contractor/ICSC, Network Tester, and Owner's representative working together.
   b) This activity focuses on the physical media and its installation.
   c) Conduct a physical inspection to establish the network configuration as indicated on the Drawings:
      (1) Validate the node type and quantity.
      (2) Identify improper installation and damaged components.
   d) Validate integrity of cables and connectors via a physical media test to confirm the signal propagation capabilities of the network media using visual and mechanical inspection:
      (1) Compare network devices nameplate data with drawings and specifications.
      (2) Confirm network components are PTO compliant.
      (3) Verify labeling of trunk cables.
      (4) Confirm permissible cable length.
      (5) Confirm correct cable type.

(6) Verify the presence/absence of stub lines.
(7) Verify network terminators are in place.
(8) Verify power supply source and connections for active terminations.
(9) Verify total network node count.
(10) Verify power supply specifications including quantity, ratings, locations, and configuration. Verify power supply source of supply location, conductor size, and rating.
(11) Inspect accessible network cabling for adherence to specified installation practices:
(a) Cable installed in conduit or protective raceway.
(b) Cable proximity to high voltage wiring.
(c) Exposure to extreme temperatures, shock, vibration, chemicals, or moisture.
(d) Bend radius.
(12) Inspect cable and conductor terminations for adherence to specified installation practices.
(13) Check all accessible components for evidence of physical damage.
(14) Check grounding techniques including ground conductor sizes and termination points.
(15) Eliminate signal reflections.

e) Electrical tests:
(1) Measure total network resistance.
(2) Cable length and configuration evaluation:
(a) Confirm the network cable topology (length and configuration) does not exceed data rate limitations.
(b) Confirm total stub length (if required by design) does not exceed data rate limitations.
(c) Calculate spare trunk length for the specified data rate.
(3) Line analysis for the following conditions:
(a) Short circuit between signal lines A and B.
(b) Short circuit between signal lines A and B and the cable shield.
(c) Shield continuity.
(d) Cross-wired signals lines.
(e) Terminator installed in wrong position.
(f) Poor transmission or reception levels.
(g) Non-permissible stub line.
(4) Examine the data traffic between the master and each slave device.
(5) Verify baud rate meets specified requirements.
(6) Confirm signal level meets specified requirements.
(7) Verify network cycle time meets specified requirements.
(8) Generate slave device list.
(9) Verify and record scanner diagnostic data including node status and error codes.
(10) Monitor and capture network waveform.
(11) Measure and record power supply voltage at active terminations.

f) Submit corrective measures recommendations based on the results of the inspections and testing.
g) Engineer approval of the network installation validation and testing submittal is required before proceeding to network operations validation and testing.

4) Network Operations Testing:
   a) Performed by Contractor/ICSC, Network Tester, Owner's representative, and Programmer working together.
   b) General requirements:
      (1) The network performance is monitored and measured using non-intrusive test equipment and procedures in accordance with the Referenced standards:
         (a) Profibus networks.
      (2) Modifications required as a result of network operations validation and shall be in conformance with the applicable standards from Profibus organization, North America, PTO.
   c) Online evaluation:
      (1) Confirm specified slave devices appear on the live list.
      (2) Evaluate data traffic between master and each slave to confirm proper slave configuration and performance.
      (3) Inspect waveform capture for evidence of excessive noise.
      (4) Evaluate and report any failed or questionable network tests.
      (5) Evaluate and report network error codes and related symptoms.
   d) Network Operations Validation and Testing Report:
      (1) Prepare a report that documents the results of the qualification and testing activities include, but not limited to, the following:
         (a) Document the installed condition of the network and provide baseline values for future network maintenance and testing activities.
         (b) Executive summary for each network including the following:
            - Inspection and test results for each network.
            - Calculated network parameters.
            - Recommendations.
            - Description of test procedures and required test equipment.
            - Network agency specifications.
         (c) Manufacturer's specifications and guidelines:
            - Include applicable manufacturer's specifications and guidelines.
            - Manufacturer's specifications and guidelines may supersede the specifications of the applicable governing body for the associated network but at a minimum must meet the governing body's requirements.
   e) Submit final report of the industrial network testing to the Engineer upon successful completion of the testing.

5) Engineer approval of the industrial network testing submittals is required before proceeding to CEET.

f. Complete End-to-End Testing (CEET):
    1) Performed by Contractor, ICSC, manufacturer's representative, and Programmer working together, with assistance from the OWNER or the inspection staff, as needed.
        a) The participants need to be dedicated full-time to CEET.
        b) ICSC will provide staff to verify input signals at, and create output signals from, an HMI or Engineering Workstation.
        c) Contractor and ICSC will be responsible for creating field signals and verifying proper operation of final control elements.
    2) Prerequisites:
        a) CEET cannot begin until the successful completion of the preceding tests:
            (1) Calibration.
            (2) Loop check.
            (3) Loop validation tests.
            (4) LAN cable post-testing.
            (5) Industrial network testing.
    3) Testing description:
        a) This testing is to ensure all I/O signals operate to the intent of the design from the field device to the HMI and all other auxiliary controls and indicators in the PCS.
        b) Connect PLC to the network to test signals from the field device through the PLC program, the network, and to the operator’s HMI graphic screens. The outputs will be energized for a duration long enough to verify proper operation of the final control element.
        c) SCADA screens:
            (1) Test and record operator commands and signal readouts to each operator device where there is more than one operator interface point.
            (2) For each signal, perform separate tests for SCADA computer screens, local operator interface (LOI) screens, and local control panels.
            (3) Retest any loop following any necessary corrections.
    4) Check control loops under simulated operating conditions by causing a range of input signals at the primary control elements and observing appropriate responses of the respective control and monitoring elements, final control elements, and the graphic displays associated with the HMI/SCADA system.
        a) Use actual process inputs wherever available.
        b) Issue commands from the HMI/SCADA system and verify proper responses of field devices.
            (1) Test SCADA system inputs from field device to SCADA system operator workstations.
                (a) Track responses through trend charts in the HMI/SCADA system.
            (2) Test SCADA system outputs from SCADA operator workstations to field devices and equipment.

5) Discrete device testing:
    a) Exercise each field device providing a discrete input to the HMI/SCADA system in the field and observe the proper operation shall be observed at the operator workstation:
        (1) Test limit switches, set limits mechanically, and observe proper operation at the operator workstation.
        (2) Exercise starters, relay contacts, switch contacts, and observe proper operation.
        (3) Calibrate and test instruments supplying discrete inputs, and observe proper operation.
    b) Test each device accepting a discrete output signal from the HMI/SCADA. Perform the appropriate operator action at the SCADA operator stations (including LOIs, if present) and confirm the proper operation of the field device:
        (1) Stroke valves through outputs from the HMI/SCADA system, and confirm proper directional operation. Confirm travel limits and any feedback signals to the HMI/SCADA system.
        (2) Exercise motors starters from the HMI/SCADA system and verify proper operation through direct field observation.
        (3) Exercise solenoids and other field devices from the HMI/SCADA system and verify proper operation through direct field observation.
6) Analog device testing:
    a) Apply continuously variable up and down analog inputs to verify the proper operation and setting of discrete devices (signal trips, etc.).
    b) Apply provisional settings on controllers and alarm setpoints.
7) Analog input:
    a) Exercise each field device monitoring the analog signal, through the HMI/SCADA system.
        (1) Apply simulated sensor inputs corresponding to 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent of span for networks that incorporate analog elements, and monitor the resulting outputs to verify compliance to accuracy tolerance requirements.
8) Analog output:
    a) Exercise each field device requiring an analog command signal, through the HMI/SCADA system.
        (1) Vary the output from the PLC HMI/SCADA system and measure the end device position, speed, etc. to confirm the proper operation of the device for the supplied analog signal.
        (2) Manually set the output from the HMI/SCADA screen at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent and measure the response at the final device and at any intermediate devices.
9) Submit completed test forms.
    a) Discrete instrument input devices:
        (1) Switch setting, contact action, and dead band.

(2) Valve position switches:
(a) Response in the PLC as the valve is stroked from the PLC.
(b) Field observed actual valve position, and valve indicator position as the valve is stroked from the PLC.
(3) Operator interface switches (control stations and other pilot devices) and associated response.
(4) Starter and drive auxiliary device contact response.
(5) Response of all other discrete inputs to the PLC.
(6) Test equipment used and associated serial numbers.

b) Discrete output devices:
(1) Observed response of field device to the discrete output from the PLC.
(2) Observe the proper operation of Open, Close, Start, Stop, On, Off, etc.
(3) Test equipment used and associated serial numbers.

c) Analog input devices:
(1) Calibration range.
(2) Calibration data: Input, output, and error at each test value.
(3) Analog input associated PLC register address.
(4) Value in PLC register at each test point.
(5) Value displayed at each operator interface station (local operator interface displays and SCADA workstations).
(6) Test equipment used and associated serial numbers.

d) Analog output devices:
(1) Calibration range.
(2) Test value at each test point.
(3) Analog output associated PLC register address.
(4) Control variable value at field device at each test point.
(5) Physical device response at each test point:
(a) Response to be actual valve position, or motor speed, etc.
(6) Test equipment used and associated serial numbers.

10) Failure testing:
a) Demonstrate how the system reacts and recovers from abnormal conditions including, but not limited to:
(1) Equipment failure.
(2) Communications sub-system error.
(3) Power failure.
(4) Process equipment failure.
(5) High system loading conditions.

11) Engineer approval of the CEET submittals is required before proceeding to Functional Testing.

6. Functional testing:
a. General:
1) Testing to demonstrate proper operation of systems with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.
2) Performed by Contractor, ICSC, manufacturer's representative, and Programmer working together, with assistance from the OWNER or the inspection staff, as needed.

3) Additional tests are specified in other Instrumentation and Control Sections.
4) Follow approved detailed test procedures and check lists for Functional Test activities.

b. Control logic operational validation:
1) The purpose of control logic validation is to field test the operation of the complete control system, including all parts of the HMI/SCADA system, all control panels (including vendor control panels), all control circuits, all control stations, all monitored/controlled equipment, and final control elements.
2) Demonstrate control functionality shown on the P&IDs, control schematics, and other drawings, and specified in the loop descriptions, control strategies, Electrical Specifications, and Mechanical Equipment Specifications.
3) Test in detail on a function-by-function and sentence-by-sentence basis.
4) Thoroughly test hardware and software functions:
5) Including all hardwired and software control circuit interlocks and alarms.
6) Test final control elements, controlled equipment, control panels, and ancillary equipment under startup, shut down, and steady-state operating conditions to verify all logic and control is achieved.
7) Control logic validation tests to include, but not limited to: a repeat of all control logic tests from the FAT, modified and expanded to include all field instruments, control panels, circuits, and equipment.

c. Loop tuning:
1) Optimally tune all electronic control stations and software control logic incorporating proportional, integral, or derivative control. Apply control signal disturbances at various process variable levels and adjusting the gain, reset, or rate settings as required to achieve proper response.
2) Verify the transient stability of final control elements operating over the full range of operating conditions, by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates. As a minimum, achieve 1/4-wave amplitude decay ratio damping (subsidence ratio of 4) under the full range of operating conditions.
3) If excessive oscillations or system instability occur, as determined by the Engineer, continue tuning and parameter adjustments, or develop and implement any additional control algorithms needed to achieve satisfactory control loop operation.
4) Functional validation sheets:
a) Document each Functional test on an approved test form.
b) Document loop tuning with a report for each loop, including two-pen chart recordings showing the responses to step disturbance at a minimum of 3 setpoints or process rates approved by the Engineer. Show tuning parameters on the charts, along with time, date, and sign-off by Contractor and Engineer.

c) Include on the form, functions which can be demonstrated on a loop-by-loop basis:
(1) Loop number and P&ID number.
(2) Control strategy, or reference to specification tested.
(3) Test procedures: Where applicable, use the FAT function-by-function, sentence-by-sentence loop test checklist forms modified to meet the requirements of the Functional test. Otherwise, create new forms.

d) For functions that cannot be demonstrated on a loop-by-loop basis (such as overall plant power failure), include on the test form a listing of the specific steps and tests to be conducted. Include with each test description the following information:
(1) Specification page and paragraph of function demonstrated.
(2) Description of function and/or text from specification.
(3) Test procedures: use the FAT loop test checklist forms modified to meet the specific testing conditions of the Functional test.

5) Functional certification:
a) Provide Manufacturer's Certificate of Installation and Functionality Compliance as specified in Section 01756 - Commissioning.
(1) Including all test forms with test data entered, submitted to the Engineer with a clear and unequivocal statement that all Functional test requirements have been satisfied.

C. Process Start-up Phase:
1. Process Start-up:
a. Programmer shall be onsite to support Process Start-up activities and provide functional changes as required.
1) ICSC shall be available as needed.
2. Process Operation Period:
a. Programmer shall be available to support Process Operational Period and provide functional changes as required.
1) ICSC shall be available as needed.
3. Instrumentation and Controls Fine-Tuning:
a. General:
1) After the Process Operational Period, test PCIS system for additional 60 days as specified in this Section to identify issues and make corrections, as needed.
2) The performance test is part of the Work that must be completed as a condition of substantial completion and final completion for the entire Project.
3) The complete PLC control and HMI/SCADA system must run continuously for the duration of the performance test.
4) Test and use the entire process control system under standard operating conditions.
5) Exercise all system functions.

6) Log failure, any system interruption and accompanying component, subsystem, or program failure including time of occurrence, duration of each failure, failure classification, and cause:
    a) Provide a competently trained technician or programmer on call for the Project Site during all normal working days and hours from the start of the performance test until final acceptance of the system.
        (1) Response time to the Project Site: 24 hours or less, for a major failure.

b. SCADA system testing:
    1) Exercise each system function, e.g., status report, alarms, logs, and displays several times at a minimum, and in a manner that approximates "normal" system operation.
    2) Failure of the HMI/SCADA system during testing shall be considered as indicating that the programs and operating system do not meet the requirements of the specifications.
        a) Corrective action is required before restarting the performance test.
    3) Only those components, sub-systems, and systems covered in this Section and supplied under this Contract shall be considered for this acceptance test. Problems and failures of other systems shall not be considered as part of this test, except as they display the capabilities of this system to detect failures.
    4) Failures:
        a) Classify failures as either major or minor:
            (1) Minor failure:
                (a) A small and non-critical component failure or software problem that can be corrected by the Owner's operators.
                (b) Log this occurrence but this is not a reason for stopping the test and is not grounds for non-acceptance.
                (c) Should the same or similar component failure occur repeatedly, this may be considered as grounds for non-acceptance.
                (d) Failure of one printer or operator station is considered a minor failure providing all functions can be provided by backup equipment, i.e., alternate printers and operator station, and repairs can be made and equipment returned to service within 3 working days.
            (2) Major failure:
                (a) Considered to have occurred when a component, subsystem, software control, or program fault causes a halt in or improper operation of the system and/or when a technician's work is required to make a repair or to re-initiate operation of the system.
                (b) Cause termination of the performance test.
                (c) Start a new acceptance test when the causes of a major failure have been corrected.
                (d) A failure is also considered major when failure of any control system that results in an overflow, underflow, overdose, or underdose condition occurs.

5) Technician report:
   a) Each time a technician is required to respond to a system malfunction, they must complete a report, which includes details concerning the nature of the complaint or malfunction and the resulting repair action required and taken.
   b) If a malfunction occurs which clears itself or which the operator on duty is able to correct, no report is required or logged as specified above.
   c) If a technician has performed work but no report is written, then a major failure is considered to have occurred.
   d) Each report shall be submitted within 24 hours to the Engineer and the Owner, or its representative.

3.08 FIELD QUALITY CONTROL (NOT USED)

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES

A. Example test forms:
   1. Example test forms are attached at the end of this Section. They may be used as a starting point for the development of Project-specific test forms for this Project.
   2. The example test forms are not intended to be complete or comprehensive. Edit and supplement the forms to meet the requirements for testing and test forms specified in this Section and other Contract Documents.

END OF SECTION

	FACTORY ACCEPTANCE TEST - CONTROL PANELS	

1. GENERAL INSPECTION

A. Structural Inspection

- ☐ Verify Lifting Lugs Installed
- ☐ Verity enclosure has lock and lock is functional
- ☐ Confirm that seismic bracing components are provided per manufacturer's installation instructions

B. Exterior Inspection

- ☐ Cabinet exterior is clean, scratch, and dent free
- ☐ Inspect externally for corrosion and damage
- ☐ Verify enclosure door opens and closes easily
- ☐ Verify enclosure has a 3-point latch
- ☐ Verify enclosure has a flange mounted disconnect (where voltages greater than 120 VAC enter the cabinet)
- ☐ Verify enclosure has the appropriate NEMA rating (1, 1G, 12, 3R, 4, 4X, etc.)
- ☐ Verify enclosure is the appropriate size (not grossly larger than design, and will still fit in the plant)

Nameplates

- ☐ Cabinet has identification nameplate
- ☐ All door labels are straight, spelled correctly, and match the tagging defined in the Contract
- ☐ Cabinet has a nameplate that includes the following:
  - ☐ Power source(s)
  - ☐ Circuit ID(s)
  - ☐ Integrator's Logo
  - ☐ Short Circuit KAIC ratings
- ☐ If labels are screwed to door, silicone was utilized to cover screw holes (Labels screwed to the door of a NEMA 4/4X panel technically violates the NEMA rating.)

Door Devices

- ☐ All devices penetrating the outside of panel have gaskets, silicone or both
- ☐ All door devices are installed (HMIs, Pilot Devices, etc.)
- ☐ Door mounted equipment is mounted straight and square
- ☐ All exterior or door mounted equipment present and accounted for, installed and securely fastened
- ☐ NEMA classification has not been violated due to penetrations
- ☐ Door mounted equipment has the same NEMA rating as the panel
- ☐ All door mounted equipment installed at the correct height
- ☐ All door mounted equipment installed in the correct positions and order (layout of door mounted equipment is grouped properly and in a logical manner)
- ☐ Doors with multiple penetrations have adequate bracing (if needed)
- ☐ Visually check condition of indicators , controllers and annunciators
- ☐ Check that pilot lights illuminate correctly
- ☐ Check the Push-To-Test function
- ☐ Ensure correct pilot light color

Peripheral Devices

- ☐ Horn / Beacon is installed (where required)
- ☐ Silence and Reset pushbutton

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1. GENERAL INSPECTION (continued)

C. Interior Inspection

- ☐ Cabinet is cleaned of marks and dirt.
- ☐ Inspect internally for corrosion and damage.
- ☐ Back panel is clean of marks and dirt.
- ☐ Interior of panel vacuumed and shall be free of all debris.
- ☐ Check that the panel roof is clean and clear of foreign materials.
- ☐ Bottom of panel has been cut out (where bottom entry is required), with angle iron welded around the bottom perimeter. Re-painting has been performed.
- ☐ If internal light door limit switch is provided, ensure the light automatically turns "on" when the doors are open.
- ☐ Check that a document pocket has been provided.
- ☐ Intrusion alarms (where required).

Interior Labeling

- ☐ All panel mounted equipment has identification labeling, by using either a Brothers or Phenolic type tags.
- ☐ Verify that door mounted components are mounted square and symmetrical.
- ☐ Verify that nameplates are straight, legible, and spelled correctly.
- ☐ All terminal blocks are identified/labeled with permanent labels including tight end blocks and caps.
- ☐ All wiring shrink labeled and or phased correctly to the specifications.
- ☐ All wire labels shrunk completely rotated and aligned alike for easy identification.
- ☐ All fuses and circuit breakers are labeled with ID and current rating.
- ☐ System Integrator's label or labels installed on door.
- ☐ Panel manufacturer model/serial number tag is present.
- ☐ All required safety/warning tags installed and straight.
- ☐ Correct UL (typically UL 508) or cUL tag installed and registered and all other associated tags installed and straight (the UL tag might not be installed in the panel at the factory test. If the panel is modified due to changes during the factory test or a punch list generated from the factory test, the UL labeling would need to be re-applied. Some UL shops do not apply the UL label until the panel is released to be shipped.).

Wireways

- ☐ Plastic wire way covers installed properly.
- ☐ Plastic wireways have no sharp edges.
- ☐ No wire Ties inside the wireways.
- ☐ No sharp edges on wire ties.
- ☐ Separation: White duct is used for DC voltages, Gray duct is used for AC voltages.
- ☐ Ensure wiring duct is not over-full, includes provision for 20% more wiring and the cover may easily be installed. Panduit recommends 50% duct fill, but 40% is a better practice.

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1. GENERAL INSPECTION (continued)

C. Interior Inspection (continued)

Wiring

- ☐ Visually check terminals and condition of internal wirings
- ☐ Verify that the control panel has been assembled and wired as designed
- ☐ Verify that all components are operational and perform the functions intended
- ☐ Verify that all components are sized appropriately for the application
- ☐ Verify that equipment control circuits function as intended
- ☐ Back of door wiring is labeled and neatly formed
- ☐ Back panel to door wiring has sufficient bending radius with spiral wrap
- ☐ Wire connection has been verified wired to correct points within the panel
- ☐ Individual wires have been given a pull test to verify a good terminal connection
- ☐ Wire and cable minimum bending radius have not been violated
- ☐ All equipment installed straight and square to back panel
- ☐ Wire colors are correct:
  - ☐ Black and White > AC hot and neutral, respectively
  - ☐ Red > AC control signals
  - ☐ Blue > DC power and control (Blue w/White stripe for DC ground)
  - ☐ Yellow > Foreign voltages (those still present when panel power is disconnected)
  - ☐ Green > AC equipment ground
  - ☐ Black > TSP (+)
  - ☐ White> TSP(-)
- ☐ Analog wiring shields are continuous (connected by a dedicated terminal block for such shields)
- ☐ Analog shield wires are grounded within the panel, where not otherwise grounded at the transmitter itself
- ☐ Discrete inputs are separately fused or protected by a circuit breaker on a “per loop” basis
- ☐ Intrinsic Safety Wiring
  - ☐ Ensure wiring associated with intrinsic safety circuits or intrinsic safety barriers is kept away from all other wiring by UL minimum distances or by a physical (grounded metal) barrier preventing non-intrinsically safe wiring from coming in contact with intrinsically safe circuits or wiring
- ☐ Verify all spare terminals are installed according to the percentage listed in the specifications

Grounding

- ☐ Equipped with “Blackburn” or other grounding type lug
- ☐ Lug is securely fastened to the panel structure
- ☐ Verify Grounding bar is installed
- ☐ Verify Isolated ground bar is installed

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2. POWER TEST

A. AC Power

- ☐ AC Power is routed correctly within the panel, and is isolated from DC and network wiring.
- ☐ All fuses are installed and sized properly.
- ☐ All breakers are installed and sized properly.
- ☐ 24 VDC Power Supplies are functional.
- ☐ 24 VDC Power fail contacts are functional.
- ☐ 24 VDC power supplies are redundant, and have diode modules enabling the hot swap-over between supplies.
  - ☐ 24 VDC supplies are equipped with dry contact failure alarms, wired as PLC inputs to signal failure of any DC power supply. Such alarm inputs to the PLC have been tested as being functional.
- ☐ Dedicated receptacle is wired to receive a dedicated AC supply.
- ☐ Verify continuity for all DC commons, ground and AC neutrals.
- ☐ Verify that the CP temporary input power is connected correctly and is the correct voltage.
- ☐ Close the CP main circuit breaker(s).
- ☐ Verify that voltages at subsequent circuit breakers are correct.
- ☐ Close circuit breakers.
- ☐ Verify that power feeding interruptible and uninterruptible power supplies is correct.
- ☐ Turn on power supplies if they are not already on.
- ☐ Verify that voltages at distribution terminals are correct.
- ☐ Energize any remaining hardware such as the PLC.

B. Uninterruptible Power Supply (UPS)

- ☐ Mounted appropriately within the cabinet, on a dedicated shelf, or rear of a swing-out sub panel.
- ☐ Is equipped with maintenance bypass switch (or at least plug/receptacle means for bypassing the unit).
- ☐ Test all UPS alarms (on inverter, failure, battery failure etc.)
- ☐ Turn off the AC power supply and verify that the UPS will be switched on to supply the designated vital loads in the control panel.

3. CONTROLS & AUXILIARY DEVICES TEST

- ☐ Verify all interposing and auxiliary relays are functioning.
- ☐ Verify panel lights are functioning.

Ventilation and Heating

- ☐ If ventilation fans are fitted, check the fans operate correctly any associated air filters are clean and not blocked.
- ☐ Verify components are installed in the correct orientation for proper air flow.

4. HARDWIRED INTERLOCK AND SAFETY TEST

- ☐ Verify that hardwired interlocks through the control panel as shown on schematic drawings are functioning. For example, outlet high pressure switch interlock to a pump.
- ☐ Verify that all hardwired safety devices through the control panel is functioning. For example, the pull cord emergency stops of conveyors.

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5. PLC TEST

A. Components

☐ PLC interior High Temperature alarm is installed, wired to the PLC, and is shown to be functional.

☐ Relays have transient suppression across their coils. This is particularly important for DC coil relays, where diodes in reverse polarity are often used.

☐ TVSS is installed across the main incoming 120 VAC.

PLC and PLC Rack

- ☐ Verify all cards are securely seated.
- ☐ Ensure clearance around PLC rack has been met, such that convective heat transfer is not impeded by devices erroneously mounted in the “no encroachment” area. Confirm with manufacturer clearance recommendations.

B. PLC I/O Test

☐ Furnish **I/O test forms** and test all the listed input and output points as follows:

- ☐ Discrete Inputs: Simulate a field contact closure by “shorting” across the appropriate terminal blocks. Observe the transition between a logical “0” and “1” in the PLC software.
- ☐ Discrete Outputs: Force the output bit to toggle between logical “0” and logical “1” using the PLC software. Measure contact resistance at the wired terminal blocks using a digital meter selected for the “ohms” setting.
- ☐ Analog Inputs: Connect a signal generator to the appropriate terminal blocks. Tailor the connection depending on whether a 2-wire or 4-wire simulation is required. Modulate the 4-20mA signal. Observe the associated PLC internal memory register to transition between 0-65535 or if scaled in engineering units, between 0 and the maximum scaled engineering unit. The latter method is preferred.
- ☐ Analog Outputs: Force the output register to a value between 0-65535 or 0-100%, if the scaling block can be manipulated. Observe the measured 4-20mA value increment and decrement using a digital ammeter.

C. Redundant Controllers (where required) Test

☐ Remove Communication cable from primary PLC to verify switching to backup PLC

☐ Remove Communication cable from backup PLC to verify switching back to primary PLC

☐ Remove Power cable from primary PLC to verify switching to backup PLC

☐ Remove Power cable from backup PLC to verify switching back to primary PLC

D. PLC Control Logic Verification

☐ The PLC control strategy is verified by following the Control Logic Verification Form based on the specifications. Each control strategy will be verified by simulating the process and checking the state or value of PLC outputs. The results of equipment status and alarms and process instrument values and trends shall also be verified on the Plant SCADA graphic screens stored in a temporary SCADA computer. Since all PLC input and output wiring has been verified and some field devices are not available during Factory Acceptance Testing, certain inputs will be simulated either by means of additional hardware and/or software as described below.

- ☐
- ☐ DI states are either simulated by hardwired switches or forced inputs using a programming terminal.
- ☐ For example, when starters and drives are not provided as part of the contract, jumpers may be installed from the output call relays to the running confirmation inputs to simulate the running state of the motors.

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5. PLC TEST (continued)

D. PLC Control Logic Verification (continued)

Typical Fault Logic

- ☐ If the fault input is high and the disable (if applicable) for the fault is not high and the common disable (if applicable) is not high begin timing. If any of these conditions changes, stop timing and reset the timer. If the timer reaches its preset, activate the alarm output. If the fault alarm is a shutdown alarm stop the associated motor and latch the alarm so that it remains present even if the condition clears.
- ☐ The fault condition must return to normal and the alarm must be reset for a latched alarm to clear.

Typical Fail to Start Logic

- ☐ If the motor is called to run (call output high) and no running feedback is received (running input is low) and the fail to start and common alarm disables (if applicable) are not high start timing. If any of these conditions changes, stop timing and reset the timer. If the timer reaches its preset, activate the alarm output, stop calling the motor and latch the alarm.

6. HMI OR OIT TEST

HMI / OIT Functionality

- ☐ Communication with PLC
- ☐ Screen Layouts
- ☐ Screen Navigation
- ☐ Set Point Entry
- ☐ Animation
- ☐ Color Correctness (Green=Run, Red=Off, Amber=Alarm, or the agreed upon convention)
- ☐ Alarms
- ☐ Acknowledge and Reset
- ☐ Security / Access Levels / Passwords

7. NETWORK COMMUNICATION TEST

A. Network Components

- ☐ Fiber optic cabling terminates in a patch panel
- ☐ Media converters are installed and functional
- ☐ Terminating resistors have been installed for trunk/tap topologies or where required
- ☐ Wire and cable bending limitations have not been violated

B. Networking Functions

- ☐ Verify data transfer via the network to different PLCs as shown on the Network Block Diagrams
- ☐ Verify network traffic rate and error margin is acceptable

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8. FAT DOCUMENTATION AND RECORD

Panel Documentation

- ☐ As-built panel drawings showing actual panel construction and devices arrangement and c/w Bill of Material.
- ☐ Panel schematic and interconnection drawings.
- ☐ P&ID drawings and schematic drawings for the process area controlled by the panel that is to be tested.
- ☐ I/O list test forms of the process area to be tested.
- ☐ FAT procedure of the process area to be tested.
- ☐ Test record forms of the process area to be tested. Forms shall include area for signature of responsible test personnel.
- ☐ Hard copy of the PLC application program of the process area to be tested.
- ☐ Hard copy of the HMI/OIT graphic screens of the process area to be tested.

9. FAT TOOLS AND SOFTWARE

- ☐ Simulation software if required
- ☐ Digital volt meter Fluke 87
- ☐ Process meter Fluke 787
- ☐ Laptop computer with PLC application program
- ☐ Temporary SCADA computer with HMI software and applicable graphic screens
- ☐ Jumper wires

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	INSTALLATION AND CERTIFICATION CHECKLIST DOCUMENTATION	

INSTRUMENT LOOP NO. _____

SERVICE DESCRIPTION _____

A COPY OF LATEST ISSUE OF THE FOLLOWING DOCUMENTS ARE INCLUDED IN THIS INSTRUMENT INSTALLATION CERTIFICATION FILE:

- ☐ INSTRUMENT SPECIFICATION SHEETS (FOR ALL INSTRUMENTS IN THE LOOP)
- ☐ INSTRUMENT INSTALLATION DETAILS (FOR ALL INSTRUMENTS IN THE LOOP)
- ☐ INSTRUMENT LOOP WIRING DIAGRAMS
- ☐ INSTRUMENT INSTALLATION CERTIFICATION CHECKLIST
- ☐ SIZING CALCULATIONS
- ☐ INSTRUMENT INSTALLATION SCHEDULE (APPLICABLE PART)
- ☐ NAMEPLATE SCHEDULE (APPLICABLE PART)
- ☐ VENDOR LITERATURE CALIBRATION INFORMATION

	☐ No	☐ Yes
INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS?		

REMARKS: _____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

	SWITCHES INSTALLATION AND CALIBRATION CHECKLIST	

INSTRUMENT LOOP NO. _____

SERVICE DESCRIPTION _____

CHECK BELOW, WHEN COMPLETED:

☐ BENCH CALIBRATED PER SPECIFICATION SHEET NO. _____

☐ VERIFIED PER P&ID NO. _____

☐ CORRESPONDS TO SPECIFICATION SHEET NO. _____

☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO. _____

☐ INSTALLATION CORRECT PER DETAIL NO. _____

☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED

☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL

☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

	☐ No	☐ Yes
INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS?		

FIELD CALIBRATION CHECK

CONTACT NO.	FUNCTION	FOR SIGNAL	CONTACT IS TO	AT SPECIFIED VALUE FOR		ACTUAL TRIP POINT WAS	
1	☐ ALARM	☐ INCR	☐ OPEN	SET PT =		SET PT =	
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET =		RESET =	
2	☐ ALARM	☐ INCR	☐ OPEN	SET PT =		SET PT =	
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET =		RESET =	
3	☐ ALARM	☐ INCR	☐ OPEN	SET PT =		SET PT =	
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET =		RESET =	
4	☐ ALARM	☐ INCR	☐ OPEN	SET PT =		SET PT =	
	☐ S/D PERM	☐ DECR	☐ CLOSE	RESET =		RESET =	

NOTE: PERM IS ABBREVIATION FOR PERMISSIVE

	SWITCHES **INSTALLATION AND CALIBRATION CHECKLIST**	

REMARKS: _____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

	TRANSMITTER/CONTROLLER/INDICATOR INSTALLATION AND CALIBRATION CHECKLIST	

☐ ☐

INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS? No Yes

INSTRUMENT TYPE INDICATOR ☐ TRANSMITTER ☐ CONTROLLER ☐

☐ OTHER DESCRIPTION _____

INSTRUMENT TAG NO. _____ SERIAL NO. _____

SERVICE DESCRIPTION _____

BENCH CALIBRATION CHECK

INPUT RANGE = _____ OUTPUT RANGE = _____

HEAD CORRECTION = _____ ☐ LINEAR

CALIBRATED SPAN = _____ ☐ SQUARE ROOT

% CALIB SPAN	DESIRED VALUE	ACTUAL VALUE	EXPECTED VALUE	ACTUAL VALUE
0				
50				
100				

CHECK BELOW, WHEN COMPLETED:

☐ BENCH CALIBRATED PER SPECIFICATION SHEET NO. _____

☐ VERIFIED PER P&ID NO. _____

☐ CORRESPONDS TO SPECIFICATION SHEET NO. _____

☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO. _____

☐ INSTALLATION CORRECT PER DETAIL NO. _____

☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED

☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL

☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

FIELD CALIBRATION CHECK

INPUT RANGE = _____ OUTPUT RANGE = _____

% CALIB SPAN	DESIRED VALUE	ACTUAL VALUE	EXPECTED VALUE	ACTUAL VALUE
0				
50				
100				

	TRANSMITTER/CONTROLLER/INDICATOR INSTALLATION AND CALIBRATION CHECKLIST	

☐ DIRECT ☐ REVERSE

☐ ACTION VERIFIED AT 50% SPAN

☐ ACTION VERIFIED AT _____ SPAN

CONTROLLER SETTINGS								
SETTING	**GAIN**	**PB**	**RESET (INTEGRAL)**	**DERIV. (RATE)**	**HIGH LIMIT**	**LOW LIMIT**	**ELEV. ZERO**	**ZERO SUPP**
PRE-TUNE								
POST-TUNE								

PRE-TUNE SETTINGS					
	GAIN	**PB**	**RESET (REPEAT/MIN)**	**RESET (MIN/REPEAT)**	**DERIVATION (MINUTES)**
FLOW	1.0	100	10	0.1	N/A
LEVEL	1.0	100	MIN.	MAX.	N/A
PRESSURE	2.0	50	2.0	0.5	N/A
TEMP.	4.0	25	0.1	10	OFF

REMARKS _____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

	ANALYZERS INSTALLATION AND CALIBRATION CHECKLIST	

☐ No ☐ Yes

INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS?

TYPE OF INSTRUMENT _____

INSTRUMENT TAG NO. _____ SERIAL NO. _____

SERVICE DESCRIPTION _____

CHECK BELOW, IF TRUE

☐ BENCH CALIBRATED PER SPECIFICATION SHEET NO. _____

☐ VERIFIED PER P&ID NO. _____

☐ CORRESPONDS TO SPECIFICATION SHEET NO. _____

☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO. _____

☐ INSTALLATION CORRECT PER DETAIL NO. _____

☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED

☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL

☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

REMARKS _____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

	CONTROL VALVES INSTALLATION AND CALIBRATION CHECKLIST	

☐ ☐

INSTRUMENT LOOP IS PART OF EQUIPMENT START-UP/SHUTDOWN INTERLOCKS? No Yes

☐ VALVE TAG NO. _____ SERIAL NO. _____

☐ TRANSDUCER TAG NO. _____ SERIAL NO. _____

☐ SOLENOID TAG NO. _____ SERIAL NO. _____

☐ VOLUME BOOSTER TAG NO. _____ SERIAL NO. _____

☐ POSITIONER _____ SERIAL NO. _____

SERVICE DESCRIPTION _____

TRANSDUCER CHECK					
INPUT RANGE =			OUTPUT RANGE =		
CALIBRATED SPAN =			CALIBRATED SPAN =		
BENCH					
SPAN	DESIRED	ACTUAL	SPAN	EXPECTED	ACTUAL
0%			0%		
50%			50%		
100%			100%		
FIELD					
SPAN	DESIRED	ACTUAL	SPAN	EXPECTED	ACTUAL
0%			0%		
50%			50%		
100%			100%		

CHECK BELOW, IF TRUE:

☐ BENCH CALIBRATED PER ABOVE _____

☐ VERIFIED PER P&ID NO. _____

☐ CORRESPONDS TO SPECIFICATION SHEET NO. _____

- ☐ VALVE SPECIFICATION NO. _____
- ☐ TRANSDUCER SPECIFICATION NO. _____
- ☐ SOLENOID SPECIFICATION NO. _____

☐ WIRING CORRECT PER INSTRUMENT LOOP DRAWING NO. _____

☐ INSTALLATION CORRECT PER INSTRUMENT INSTALLATION DETAILS _____

- ☐ VALVE DETAIL NO. _____
- ☐ TRANSDUCER DETAIL NO. _____
- ☐ SOLENOID DETAIL NO. _____

	CONTROL VALVES INSTALLATION AND CALIBRATION CHECKLIST	

☐ ACCESSORIES ARE PRESENT AND PROPERLY INSTALLED

☐ INSTRUMENT IS ACCESSIBLE FOR MAINTENANCE OR REMOVAL

☐ ENGRAVED LAMINATED NAMEPLATE (NO SPELLING ERRORS) PERMANENTLY INSTALLED

VALVE CHECK			
FLOW CHECK	☐ PROCESS FLOW DIRECTION THROUGH THE VALVE IS CORRECT		
SAFETY CHECK	ON LOSS OF AIR VALVE FAILS ☐ OPEN ☐ CLOSE	ON LOSS OF POWER SOLENOID FAILS ☐ TO VENT ☐ TO VALVE	
TRAVEL CHECK	FULL OPEN AT _____ PSI	FULL CLOSED AT _____ PSI	MEASURED TRAVEL _____ INCHES
SEATING CHECK	☐ ON BENCH ☐ IN-LINE	RESULTS	ACTUATOR BENCH SET
POSITIONER CHECK			
VALVE FULL OPEN AT _____ PSI TO POSITIONER			
VALVE FULL CLOSED AT _____ PSI TO POSITIONER			
VOLUME BOOSTER CHECK			
BYPASS VALVE (GAIN) ADJUSTING SCREW BACKED OUT _____ TURNS FROM CLOSED TO ENSURE QUICK BUT STABLE OPERATION (TYPICALLY 1-1/2 TO 2 TURNS)			

REMARKS _____

CHECKED BY (COMPANY) _____ ACCEPTED BY (COMPANY) _____

SIGNATURE _____ SIGNATURE _____

DATE _____ DATE _____

SECTION V

CONSTRUCTION AGREEMENT

CONSTRUCTION AGREEMENT

FY _____ Fund _____ Cost Center _____ Object Code _____ Project # _____ Amount $_____

For multi-year contracts or contracts with multiple accounts:

FY _____ Fund _____ Cost Center _____ Object Code _____ Project # _____ Amount $_____

FY _____ Fund _____ Cost Center _____ Object Code _____ Project # _____ Amount $_____

FY _____ Fund _____ Cost Center _____ Object Code _____ Project # _____ Amount $_____

THIS AGREEMENT is dated as of the _____ day of _____ in the year 20____, by
(city use only)

and between CITY OF PETALUMA (hereinafter called "CITY") and _____ (hereinafter called "CONTRACTOR").

CITY and CONTRACTOR, in consideration of the mutual covenants hereinafter set forth, agree as follows:

ARTICLE 1. WORK

CONTRACTOR shall complete the WORK as specified or indicated in the CITY'S Contract Documents entitled _____.

ARTICLE 2. COMPLETION OF WORK

The WORK shall be completed to the satisfaction of CITY within _____ (_____) working days from the commencement date stated in the Notice to Proceed. In no event, however, shall the WORK to be performed under this contract be considered to be complete until all construction items called for on the drawings, and specifications have been completed and the contract price paid in full.

ARTICLE 3. LIQUIDATED DAMAGES

A. CITY and the CONTRACTOR recognize that time is of the essence of this Agreement and that the CITY will suffer financial loss if the WORK is not completed within the time specified in Article 2 herein, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions. It is hereby understood and agreed that it is and will be difficult and/or impossible to ascertain and determine the actual damage which the CITY will sustain in the event of and by reason of the CONTRACTOR's failure to fully perform the WORK or to fully perform all of its contract obligations that have accrued by the time for completion as specified in Article 2 herein and/or as specified for completion of any scheduled operations or works described in the Special Provisions. It is, therefore, agreed in accordance with California Government Code Section 53069.85 that the CONTRACTOR will forfeit and pay to the CITY liquidated damages in the sum of _____ Dollars ($_____) per day for each and every calendar day that expires after the time for completion specified in Article 2 herein and/or as specified for completion of any scheduled operations or works described in the Special Provisions except as

otherwise provided by extension of time pursuant to Article 12 of the General Conditions. It is further understood and agreed in accordance with California Government Code Section 53069.85 that the liquidated damages sum specified in this provision is not manifestly unreasonable under the circumstances existing at the time this contract was made, and that the CITY may deduct liquidated damages sums in accordance with this provision from any payments due or that may become due the CONTRACTOR.

B. Liquidated damages will continue to accrue at the stated rate until final completion of the WORK. Accrued liquidated damages may be deducted by the CITY from amounts due or that become due to the CONTRACTOR for performance of the WORK. Liquidated damages may not be waived or reduced by CITY unless expressly waived or reduced in writing by the ENGINEER.

ARTICLE 4. PREVAILING WAGES

A. Pursuant to California Labor Code Section 1771, CONTRACTOR and any subcontractor shall pay all workers employed in execution of the WORK in accordance with the general rate of per diem wages specified for each craft, classification, or type of worker needed to execute the WORK. Copies of the prevailing rates of per diem wages are on file at the City Clerk's office and shall be made available to any interested party on request.

B. CONTRACTOR is required to pay all applicable penalties and back wages in the event of violation of prevailing wage law, and CONTRACTOR and any subcontractor shall fully comply with California Labor Code Section 1775, which is incorporated by this reference as though fully set forth herein.

C. CONTRACTOR and any subcontractor shall maintain and make available for inspection payroll records as required by California Labor Code Section 1776, which is incorporated by this reference as though fully set forth herein. CONTRACTOR is responsible for ensuring compliance with this section. CONTRACTOR and any subcontractor shall maintain and make available for inspection payroll records as required by California Labor Code Section 1776, which is incorporated by this reference as though fully set forth herein. CONTRACTOR is responsible for ensuring compliance with this section. In addition, CONTRACTOR and any subcontractor shall submit certified payroll records to the Labor Commissioner online: http://www.dir.ca.gov/Public-Works/Certified-Payroll-Reporting.html.

D. CONTRACTOR and any subcontractor shall fully comply with California Labor Code Section 1777.5, concerning apprentices, which is incorporated by this reference as though fully set forth herein. CONTRACTOR is responsible for ensuring compliance with this section.

E. In accordance with California Labor Code Section 1810, eight (8) hours of labor in performance of the WORK shall constitute a legal day's work under this Agreement. CONTRACTOR and any subcontractor shall pay workers overtime pay as required by California Labor Code Section 1815. CONTRACTOR and any subcontractor shall, as a penalty to the CITY, forfeit Twenty-Five Dollars ($25) for each worker employed in the

execution of the contract by the respective contractor or subcontractor for each calendar day during which the worker is required or permitted to work more that 8 hours in any one calendar day and 40 hours in any one calendar week in violation so the provisions of Article 3 of Chapter 1 of Part 7, Division 2 of the California Labor Code, which is incorporated by this reference as though fully set forth herein.

ARTICLE 5. CONTRACT PRICE

A. CITY shall pay CONTRACTOR for completion of the WORK the sum of _____ Dollars ($_____), based on the bid price of same and in accordance with the Contract Documents.

B. Notwithstanding any provisions herein, CONTRACTOR shall not be paid any compensation until such time as CONTRACTOR has on file with the City Finance Department a current W-9 form available from the IRS website (www.irs.gov) and has obtained a currently valid Petaluma business license pursuant to the Petaluma Municipal Code.

C. In no case shall the total contract compensation exceed _____ Dollars ($_____) without the prior written authorization by the City Manager. Further, no compensation for a section or work program component attached with a specific budget shall be exceeded without the prior written authorization of the City Manager.

ARTICLE 6. BONDS

A. Before entering upon the performance of the WORK, the CONTRACTOR shall furnish Performance and Labor and Materials Bonds, each in the amount of one hundred percent (100%) of the contract price, as security for the faithful performance and payment of all the CONTRACTOR's obligations under the Contract Documents. These Bonds shall remain in effect at least until one year after the date of Completion, except as otherwise provided by Law or Regulation or by the Contract Documents. The CONTRACTOR shall also furnish such other Bonds as are required by the Supplementary General Conditions.

B. The CONTRACTOR shall guarantee the WORK to be free of defects in material and workmanship for a period of one (1) year following the CITY's acceptance of the WORK. The CONTRACTOR shall agree to make, at the CONTRACTOR's own expense, any repairs or replacements made necessary by defects in material or workmanship which become evident within the one-year guarantee period. The CONTRACTOR's guarantee against defects required by this provision shall be secured by a Maintenance Bond, in the amount of ten percent (10%) of the contract price, which shall be delivered by the CONTRACTOR to the CITY prior to acceptance of the WORK. The Maintenance Bond shall remain in force for one (1) year from the date of acceptance of the contracted WORK. The CONTRACTOR shall make all repairs and replacements within the time required during the guarantee period upon receipt of written order from the ENGINEER. If the CONTRACTOR fails to make the repairs and replacements within the required time, the CITY may do the work and the CONTRACTOR and the

CONTRACTOR's surety for the Maintenance Bond shall be liable to the CITY for the cost. The expiration of the Maintenance Bond during the one-year guarantee period does not operate to waive or void the one-year guarantee, as set forth herein.

C. The form of the Performance, Labor and Materials, and Maintenance Bonds are provided by the CITY as part of the Contract Documents. Only such bond forms provided by the CITY are acceptable and shall be executed by such sureties as are named in the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (amended) by the Audit Staff, Bureau of Government Financial Operations, U.S. Treasury Department. All Bonds signed by an agent must be accompanied by a certified copy of such agent's authority to act.

D. If the surety on any Bond furnished by the CONTRACTOR is declared a bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the WORK is located, the CONTRACTOR shall within 7 days thereafter substitute another Bond and surety, which must be acceptable to the CITY.

E. All Bonds required by the Contract Documents to be purchased and maintained by CONTRACTOR shall be obtained from surety companies that are duly licensed or authorized in the State of California to issue Bonds for the limits so required. Such surety companies shall also meet such additional requirements and qualifications as may be provided in the Supplementary General Conditions.

ARTICLE 7. PAYMENT PROCEDURES

CONTRACTOR shall submit Applications for Payment in accordance with Article 14 of the General Conditions. Applications for Payment will be processed by ENGINEER as provided in the General Conditions.

ARTICLE 8. RETENTION

A. Pursuant to Section 22300 of the California Public Contract Code, the CONTRACTOR may substitute securities for any money withheld by the CITY to ensure performance under the Contract. At the request and expense of the CONTRACTOR, securities equivalent to the amount withheld shall be deposited with the CITY or with a state or federally chartered bank in California as to the escrow agent, who shall return such securities to the CONTRACTOR upon satisfactory completion of the Contract.

B. Alternatively, the CONTRACTOR may request and the CITY shall make payment of retentions earned directly to the escrow agent at the expense of the CONTRACTOR. At the expense of the CONTRACTOR, the CONTRACTOR may direct the investment of the payments into securities and the CONTRACTOR shall receive the interest earned on the investments upon the same terms provided for in this section for securities deposited by the CONTRACTOR. The CONTRACTOR shall be responsible for paying all fees for the expenses incurred by the escrow account and all expenses of the CITY. These expenses and payment terms shall be determined by the CITY's Finance Director of his/her designee and the escrow agent. Upon satisfactory completion of the Contract, the

CONTRACTOR shall receive from the escrow agent all securities, interest, and payments received by the escrow agent from the CITY, pursuant to the terms of this section. The CONTRACTOR shall pay to each subcontractor, not later than 20 days of receipt of the payment, the respective amount of interest earned, net of costs attributed to retention withheld from each subcontractor, on the amount of retention withheld to ensure the performance of the CONTRACTOR.

C. Securities eligible for investment under Section 22300 shall be limited to those listed in Section 16430 of the Government Code and to bank or savings and loan certificates of deposit, interest-bearing demand deposit accounts, standby letters of credit, or any other security mutually agreed to by the CONTRACTOR and the CITY.

ARTICLE 9. CONTRACT DOCUMENTS

The Contract Documents which comprise the entire agreement between the CITY and the CONTRACTOR concerning the WORK consist of this Agreement and the following attachments to this Agreement:

- Notice Inviting Bids
- Instructions to Bidders
- Bid Forms including the Bid, Bid Schedule(s), Information Required of Bidder, Bid Bond, and all required certificates and affidavits
- Labor and Materials Bond
- Performance Bond
- Maintenance Bond
- General Conditions
- Supplementary General Conditions (if any)
- Specifications
- Special Provisions
- Drawings
- Federal Wage Rates dated _____ (if applicable)
- Form FHWA-1273 (if applicable)
- Addenda (if any)
- Change Orders which may be delivered or issued after Effective Date of the Agreement and are not attached hereto.

There are no Contract Documents other than those listed in this Article 9. The Contract Documents may only be amended by Change Order as provided in Paragraph 3.5 of the General Conditions.

ARTICLE 10. INSURANCE

The applicable insurance requirements, as approved by the City's Risk Manager, are set forth in **Exhibit B**, attached hereto and incorporated by reference herein. *[City use: check one.]*

ARTICLE 11. INDEMNIFICATION

A. CONTRACTOR shall indemnify, defend with counsel acceptable to CITY, and hold harmless to the full extent permitted by law, CITY and its officers, officials, employees, agents and volunteers from and against any and all alleged liability, loss, damage, claims, expenses and costs (including, without limitation, attorney fees and costs and fees of litigation) (collectively, "Liability") of every nature arising out of or in connection with CONTRACTOR's performance of the WORK or its failure to comply with any of its obligations contained in this Agreement, except such Liability caused by the active negligence, sole negligence or willful misconduct of the CITY. Such indemnification by the CONTRACTOR shall include, but not be limited to, the following:

1. Liability or claims resulting directly or indirectly from the negligence or carelessness of the CONTRACTOR, its subcontractors, employees, or agents in the performance of the WORK, or in guarding or maintaining the same, or from any improper materials, implements, or appliances used in its construction, or by or on account of any act or omission of the CONTRACTOR, its employees, or agents;
2. Liability or claims arising directly or indirectly from bodily injury, occupational sickness or disease, or death of the CONTRACTOR's, or Supplier's own employees, or agents engaged in the WORK resulting in actions brought by or on behalf of such employees against the CITY and/or the ENGINEER;
3. Liability or claims arising directly or indirectly from or based on the violation of any Laws or Regulations, whether by the CONTRACTOR, its subcontractors, employees, or agents;
4. Liability or claims arising directly or indirectly from the use or manufacture by the CONTRACTOR, its subcontractors, employees, or agents in the performance of this Agreement of any copyrighted or uncopyrighted composition, secret process, patented or unpatented invention, article, or appliance, unless otherwise specified stipulated in this Agreement;
5. Liability or claims arising directly or indirectly from the breach of any warranties, whether express or implied, made to the CITY or any other parties by the CONTRACTOR, its subcontractors, employees, or agents;
6. Liability or claims arising directly or indirectly from the willful misconduct of the CONTRACTOR, its subcontractors, employees, or agents;
7. Liability or claims arising directly or indirectly from any breach of the obligations assumed in this Agreement by the CONTRACTOR;
8. Liability or claims arising directly or indirectly from, relating to, or resulting from a hazardous condition created by the CONTRACTOR, Subcontractors, Suppliers, or any of their employees or agents, and;
9. Liability or claims arising directly, or indirectly, or consequentially out of any action, legal or equitable, brought against the CITY, the ENGINEER, their consultants, subconsultants, and the officers, directors, employees and agents of each or any of them, to the extent caused by the CONTRACTOR's use of any premises acquired by permits, rights of way, or easements, the Site, or any land or area contiguous thereto or its performance of the WORK thereon.

B. The CONTRACTOR shall reimburse the CITY for all costs and expenses, (including but not limited to fees and charges of engineers, architects, attorneys, and other professionals and court costs of appeal) incurred by said CITY in enforcing the provisions of this Paragraph.

C. The indemnification obligation under this Article 11 shall be in addition to, and shall not be limited in any way by any limitation on the amount or type of insurance carried by CONTRACTOR or by the amount or type of damages, compensation, or benefits payable by or for the CONTRACTOR or any Subcontractor or other person or organization under workers' compensation acts, disability benefit acts, or other employee benefit acts. The CONTRACTOR's responsibility for such defense and indemnity obligations shall survive the termination or completion of this Agreement for the full period of time allowed by law.

D. Pursuant to California Public Contract Code Section 9201, City shall timely notify Contractor of receipt of any third-party claim relating to this Agreement.

ARTICLE 12. DISCLAIMER AND INDEMNITY CONCERNING LABOR CODE SECTION 6400

By executing this agreement the CONTRACTOR understands and agrees that with respect to the WORK, and notwithstanding any provision in this contract to the contrary, the CONTRACTOR, and/or its privities, including, without limitation, subcontractors, suppliers and other engaged by the CONTRACTOR in the performance of the WORK shall be "employers" for purposes of California Labor Code Section 6400 and related provisions of law, and that neither CITY nor its officials, officers, employees, agents, volunteers or consultants shall be "employers" pursuant to California Labor Code Section 6400 with respect to the performance of the WORK by the CONTRACTOR and/or its privities.

The CONTRACTOR shall take all responsibility for the WORK, shall bear all losses and damages directly or indirectly resulting to the CONTRACTOR, any subcontractors, the CITY, its officials, officers, employees, agents, volunteers and consultants, on account of the performance or character of the WORK, unforeseen difficulties, accidents, or occurrences of other causes predicated on active or passive negligence of the CONTRACTOR or of any subcontractor, including, without limitation, all losses, damages or penalties directly or indirectly resulting from exposure to hazards in performance of the WORK in violation of the California Labor Code. The CONTRACTOR shall indemnify, defend and hold harmless the CITY, its officials, officers, employees, agents, volunteers and consultants from and against any or all losses, liability, expense, claim costs (including costs of defense), suits, damages and penalties (including, without limitation, penalties pursuant to the California Labor Code) directly or indirectly resulting from exposure to hazards in performance of the WORK in violation of the California Labor Code, except such liability or costs caused by the active negligence, sole negligence or willful misconduct of the CITY.

ARTICLE 13. INDEPENDENT CONTRACTOR

It is understood and agreed that in the performance of this Agreement, CONTRACTOR (including its employees and agents) is acting in the capacity of an independent contractor, and not as an agent or employee of the CITY. CONTRACTOR has full control over the means and methods of performing said services and is solely responsible for its acts and omissions, including the acts and omissions of its employees and agents.

ARTICLE 14. SUBCONTRACTORS

CONTRACTOR must obtain the CITY's prior written consent for subcontracting any WORK pursuant to this Agreement. Any such subcontractor shall comply, to the extent applicable, with the terms and conditions of this Agreement. Any agreement between CONTRACTOR and a subcontractor pursuant to this Agreement shall provide that the subcontractor procure and maintain insurance coverage as required herein and which shall name CITY as an additional insured.

ARTICLE 15. COMPLIANCE WITH LAWS/NON-DISCRIMINATION

CONTRACTOR shall comply with all applicable local, state and federal laws, regulations and ordinances in the performance of this Agreement. CONTRACTOR shall not discriminate in the provision of service or in the employment of persons engaged in the performance of this Agreement on account of race, color, national origin, ancestry, religion, gender, marital status, sexual orientation, age, physical or mental disability in violation of any applicable local, state or federal laws or regulations.

ARTICLE 16. NOTICES

All notices required or permitted by this Agreement, including notice of change of address, shall be in writing and given by personal delivery or sent postage prepaid and addressed to the parties intended to be notified, as set forth herein. Notice shall be deemed given as of the date of delivery in person or as of the date deposited in any post office or post office box regularly maintained by the United States Postal Service, unless otherwise stated herein. Notice shall be given as follows:

CITY:

City Clerk
City of Petaluma
Post Office Box 61
Petaluma, California 94953
Telephone: (707) 778-4360

CONTRACTOR:

_____
(Contact Name)

_____
(Business Name)

_____
(Address)

_____
(City, State, Zip)

_____
(Telephone)

_____
(E-mail)

ARTICLE 17. GOVERNING LAW/VENUE

This Agreement shall be construed and its performance enforced under California law. Venue shall be in the Superior Court of the State of California in the County of Sonoma.

ARTICLE 18. NON-WAIVER

The CITY's failure to enforce any provision of this Agreement or the waiver of any provision in a particular instance shall not be construed as a general waiver of any part of such provision. The provision shall remain in full force and effect.

ARTICLE 19. THIRD PARTY BENEFICIARIES

The Parties do not intend, by any provision of this Agreement, to create in any third party any benefit or right owed by one party, under the terms and conditions of this Agreement, to the other party.

ARTICLE 20. ASSIGNMENT

No assignment by a party hereto of any rights under or interests in the Contract Documents will be binding on another party hereto without the written consent of the party sought to be bound; and specifically but without limitation monies that may become due and monies that are due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment, no assignment will release or discharge the assignor from any duty or responsibility under the Contract Documents.

CITY and CONTRACTOR each binds itself, its partners, successors, assigns and legal representatives to the other party hereto, its partners, successors, assigns and legal representatives in respect of all covenants, agreements and obligations contained in the Contract Documents.

ARTICLE 21. SEVERABILITY

If any term or portion of this Agreement is held to be invalid, illegal, or otherwise enforceable by a court of competent jurisdiction, the remaining provisions of this Agreement shall continue in full force and effect.

IN WITNESS WHEREOF, CITY and CONTRACTOR have caused this Agreement to be executed the day and year first above written.

CITY

_____
City Manager

ATTEST:

_____
City Clerk

APPROVED AS TO FORM:

_____
City Attorney

CONTRACTOR _____

By_____
(CORPORATE SEAL)

Attest:_____

Address for giving notices:

_____

_____

Agent for service of process:

_____

_____

_____

_____
License Number

_____
Taxpayer I.D. Number

_____
Petaluma Business Tax Certificate Number

file name:

END OF AGREEMENT

AGREEMENT CERTIFICATE
(if Corporation)

STATE OF CALIFORNIA)
) ss:
COUNTY OF)

I HEREBY CERTIFY that a meeting of the Board of Directors of the _____ _____ a corporation existing under the laws of the State of _____, held on _____, 20____, the following resolution was duly passed and adopted:

"RESOLVED, that _____, as _____ President of the Corporation, be and is hereby authorized to execute the Agreement dated _____, 20____, by and between this Corporation and _____ and that his/her execution thereof, attested by the Secretary of the Corporation, and with the Corporate Seal affixed, shall be the official act and deed of this Corporation."

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the official seal of the corporation this _____, day of _____, 20____.

_____
Secretary

(SEAL)

AGREEMENT CERTIFICATE
(if Partnership)

STATE OF CALIFORNIA)
) ss:
COUNTY OF)

I HEREBY CERTIFY that a meeting of the Partners of the _____
_____
a partnership existing under the laws of the State of _____, held on _____, 20____, the following resolution was duly passed and adopted:

"RESOLVED, that _____, as the General Partner of the Partnership, be and is hereby authorized to execute the Agreement dated _____, 20___, by and between this Partnership and _____ and that his/her execution thereof, attested by the _____ shall be the official act and deed of this Partnership."

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand this _____ day of _____, 20___.

_____
Partner

(SEAL)

AGREEMENT CERTIFICATE
(if Joint Venture)

STATE OF CALIFORNIA)
) ss:
COUNTY OF)

I HEREBY CERTIFY that a meeting of the Principals of the _____ _____ _____ a joint venture existing under the laws of the State of _____, held on _____, 20___, the following resolution was duly passed and adopted:

"RESOLVED, that _____, as_____, of the joint venture, be and is hereby authorized to execute the Agreement dated _____, 20___, by and between this Joint Venture and _____ and that his/her execution thereof, attested by the _____ shall be the official act and deed of this Joint Venture."

I further certify that said resolution is now in full force and effect.

IN WITNESS WHEREOF, I have hereunto set my hand this _____, day of _____, 20___.

_____
Managing Partner

(SEAL)

EXHIBIT B
INSURANCE REQUIREMENTS
FOR ALL AGREEMENTS

Contractor's performance of the Services under this Agreement shall not commence until Contractor shall have obtained all insurance required under this paragraph and such insurance shall have been approved by the City Attorney as to form and the Risk Manager as to carrier and sufficiency. All requirements herein provided shall appear either in the body of the insurance policies or as endorsements and shall specifically bind the insurance carrier.

Contractor shall procure and maintain for the duration of the contract all necessary insurance against claims now and in the future for injuries to persons or damages to property which may arise from or in connection with the performance of the Services by the Contractor, the Contractor's agents, representatives, employees and subcontractors.

A. Required Minimum Scope of Insurance

☒ Coverage shall be at least as broad as:
Insurance Services Office Commercial General Liability coverage:
  a. Personal injury;
  b. Contractual liability.

☒ Insurance Services Office form covering Automobile Liability (any auto), if no company owned autos, non-owned and hired auto applies.

☒ Workers' Compensation insurance as required by the State of California and Employer's Liability Insurance.

☒ Professional Liability/Errors and Omissions

☐ Crime/Employee Blanket Fidelity Bond

☐ Property Insurance against all risks of loss to any tenant improvements or betterments.

☒ Pollution Liability Insurance

☐ Garage Liability

☐ Garagekeepers Insurance

☐ Technology Professional Liability Errors and Omissions Insurance (IT Consultant)/Cyber Liability

☐ Abuse or Molestation Liability Coverage

A.1 Required for All Contracts

☒ Policy Endorsements or Excerpts from the Policy Pursuant to Section D

☒ Copy of the Declarations and Policy Endorsements Page for the CGL Policy

B. Minimum Limits of Insurance

Consultant shall maintain limits no less than:

☒ General Liability: $1,000,000 per occurrence for bodily injury, personal injury and property damage. If Commercial General Liability Insurance or other form with a general aggregate liability is used, either the general aggregate limit shall apply separately to this Agreement or the general aggregate limit shall be twice the required occurrence limit.

☒ Products/Completed Operations: $1,000,000 per occurrence/aggregate.

☒ Automobile Liability: $1,000,000 per accident for bodily injury and property damage.

☒ Employer's Liability: Bodily Injury by Accident - $1,000,000 each accident.

Bodily Injury by Disease - $1,000,000 policy limit.
Bodily Injury by Disease - $1,000,000 each employee.

☒ Professional Liability/Errors and Omissions: $1,000,000 per occurrence or claim. If the policy provides coverage on a claims-made basis, the retroactive date must be shown and must be before the date of the Agreement or the beginning of the contract work.

☐ Crime/Employee Blanket Fidelity Bond - $1,000,000: Contractor, at its own cost and expense, must maintain a Crime/Employee Blanket Fidelity Bond in the amount of $1,000,000 per employee covering dishonesty, forgery, alteration, theft, disappearance, destruction (inside or outside).

☐ All Risk Property Insurance: Full replacement cost.

☒ Pollution legal liability with limits no less than $1,000,000 per occurrence or claim and $2,000,000 policy aggregate. If the policy provides coverage on a claims-made basis, the retroactive date must be shown and must be before the date of the Agreement or the beginning of the contract work.

☐ Garage Liability: $1,000,000 per occurrence.

☐ Garagekeepers Insurance: $1,000,000 per occurrence.

☐ Technology Professional Liability Errors and Omissions Insurance appropriate to the Consultant's profession and work hereunder, with limits not less than $1,000,000 per occurrence. Coverage shall be sufficiently broad to respond to the duties and obligations as is undertaken by the Vendor in this agreement and shall include, but not be limited to, claims involving infringement of intellectual property, copyright, trademark, invasion of privacy violations, information theft, release of private information, extortion and network security. The policy shall provide coverage for breach response costs as well as regulatory fines and penalties as well as credit monitoring expenses with limits sufficient to respond to these obligations.

1. The Policy shall include, or be endorsed to include, **property damage liability coverage** for damage to, alteration of, loss of, or destruction of electronic data and/or information "property" of the City in the care, custody, or control of the Consultant. If not covered under the Consultant's liability policy, such "property" coverage of the City may be endorsed onto the Consultant's Cyber Liability as covered property as follows:

2. **Cyber Liability coverage** in an amount sufficient to cover the full replacement value of damage to, alteration of, loss of, or destruction of electronic data and/or information "property" of the City that will be in the care, custody, or control of the Consultant.

3. The Insurance obligations under this agreement shall be the greater of 1) all the Insurance coverage and limits carried by or available to the Consultant; or 2) the minimum Insurance requirements shown in this Agreement. Any insurance proceeds in excess of the specified limits and coverage required, which are applicable to a given loss, shall be available to the City. No representation is made that the minimum Insurance requirements of this Agreement are sufficient to cover the indemnity or other obligations of the Consultant under this agreement.

☐ Abuse or Molestation Liability Coverage: $1,000,000 per occurrence; $2,000,000 aggregate.

C. Deductibles and Self-Insured Retentions

Any deductibles or self-insured retentions must be declared to and approved by the City. At the option of the City, either: the insurer shall reduce or eliminate such deductibles or self-insured retentions as respects the City, its officers, officials, employees, and volunteers; or the Consultant shall procure a bond guaranteeing payment of losses and related investigations, claim administration and defense expenses. Policies containing any self-insured retention (SIR) provision shall provide or be endorsed to provide that the SIR may be satisfied by either the named insured (Contractor) or the City.

City reserves the right to review any and all of the required insurance policies, declaration pages, and/or endorsements, but has no obligation to do so. City's failure to demand evidence of full compliance with the insurance requirements set forth in this Agreement or City's failure to identify any insurance deficiency shall not relieve Contractor from, nor be construed or deemed a waiver of, its obligation to maintain the required insurance at all times during the performance of this Agreement.

D. Other Insurance Provisions

The required general liability and automobile policies are to contain, or be endorsed to contain the following provisions:

1. Additional Insured: The City, its officers, officials, employees, agents and volunteers are to be covered as Additional Insureds as respects: liability arising out of activities performed by or on behalf of the Consultant; products and completed operations of the Consultant; premises owned, occupied or used by the Consultant; or automobiles owned, leased, hired or borrowed by the Consultant. The coverage shall contain no special limitations on the scope of protection afforded to the City, its officers, officials, employees, agents or volunteers.
2. Primary and Non-Contributory: For any claims related to this project, the Consultant's insurance coverage shall be primary insurance as respects the City, its officers, officials, employees, agents and volunteers. Any insurance or self-insurance maintained by the City, its officers, officials, employees, agents or volunteers shall be excess of the Consultant's insurance and shall not contribute with it.
3. Any failure to comply with reporting or other provisions of the policies including breaches of warranties shall not affect coverage provided to the City, its officers, officials, employees, agents or volunteers.
4. The Consultant's insurance shall apply separately to each insured against whom claim is made or suit is brought except, with respect to the limits of the insurer's liability.
5. Each insurance policy required by this clause shall be endorsed to state that coverage shall not be suspended, voided, canceled by either party, reduced in coverage or in limits except after thirty (30) days' prior written notice by certified mail, return receipt requested, has been given to the City.
6. Waiver of Subrogation: Consultant agrees to waive subrogation rights for commercial general liability, automobile liability and worker's compensation against City regardless of the applicability of any insurance proceeds, and to require all contractors, subcontractors or others involved in any way with the Services to do likewise.
7. It shall be a requirement under this Agreement that any available insurance proceeds broader than or in excess of the specified minimum insurance coverage requirement and/or limits shall be available to the additional insured. Furthermore, the requirement for coverage and limits shall be (1) the minimum coverage and limits specified in this

Agreement, or (2) the broader coverage and maximum limits of coverage of any insurance policy or proceeds available to the named insured; whichever is greater.

8. The limits of insurance required in this Agreement may be satisfied by a combination of primary and umbrella or excess insurance. Any umbrella or excess insurance shall contain or be endorsed to contain a provision that such coverage shall also apply on a primary and non-contributory basis for the benefit of the City of Petaluma before the City of Petaluma's own insurance or self-insurance shall be called upon to protect it as a named insured.

E. Acceptability of Insurers

Insurance is to be placed with insurers with a current A.M. Best's rating of no less than A:VII.

F. Verification of Coverage

NOTE: The City of Petaluma is now using an online insurance program, PINS Advantage. Once you have been awarded a contract with the City of Petaluma, you will receive an e-mail from PINS Advantage/City of Petaluma requesting that you forward the e-mail to your insurance agent(s). Consultant shall furnish the City with Certificate of Insurance along with Declarations and Endorsements effecting coverage required by this clause. The endorsements are to be signed by a person authorized by that insurer to bind coverage on its behalf. All endorsements are to be received and approved by the City before the Services commence.

FAITHFUL PERFORMANCE BOND

WHEREAS, the City Council of the City of Petaluma, State of California, and _____ (hereinafter designated as "Principal") have entered into an agreement whereby Principal agrees to install and complete certain designated public improvements, which said agreement, dated _____, 20_____, and identified as project _____, is hereby referred to and made a part hereof; and,

WHEREAS, said Principal is required under the terms of said agreement to furnish a bond for the faithful performance of said agreement.

NOW, THEREFORE, WE, the Principal and _____, duly authorized to transact business under the laws of the State of California, as Surety, are held and firmly bound unto the City of Petaluma, hereinafter called "City," in the penal sum of _____ Dollars ($_____) lawful money of the United States, for payment of which sum well and truly to be made, we bind ourselves, our heirs, successors, executors, and administrators, jointly and severally, firmly by these present. The conditions of this obligation are such that if the above-bound Principal, the Principal's heirs, executors, administrators, successors or assigns, shall in all things stand to and abide by, and well and truly keep and perform the covenants, conditions and provisions in the said agreement and any alteration thereof made as therein provided, on his or their part, to be kept and performed at the time and in the manner therein specified, and in all respects according to their true intent and meaning, and shall indemnify and save harmless the City of Petaluma, its officers, agents, employees, and volunteers, as therein stipulated, then this obligation shall become null and void; otherwise it shall be and remain in full force and effect.

As a part of this obligation secured hereby and in addition to the face amount specified therefore, there shall be included costs and reasonable expenses and fees, including reasonable attorney's fees, incurred by the City in successfully enforcing such obligation, all to be taxed as costs and included in any judgment rendered.

The Surety hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of this agreement or to the work to be performed thereunder or the specifications accompanying the same shall in anywise affect its obligations on this bond, and it does hereby waive notice of any such change, extension of time, alteration or addition to the terms of the agreement or to the work or to the specifications.

And the said Surety, for value received, hereby stipulates and agrees that upon termination of the Contract for cause, the Obligee reserves the right to refuse tender of the Principal by the Surety to complete the Contract work.

IN WITNESS WHEREOF, this instrument has been duly executed by the Principal and Surety above named, on _____, 20_____.

PRINCIPAL	SURETY
By_____	By_____
_____	_____
Name and Title	Name and Title
	_____
	Address
	_____
	City State Zip
	_____
	Phone Number

# # #

NOTE: No substitution or revision to this bond form will be accepted. Be sure that all bonds submitted have a certified copy of the bonding agent's power of attorney attached. Also verify that Surety is an "Admitted Surety" (i.e., qualified to do business in California), and attach proof of verification (website printout from the California Department of Insurance website (http://www.insurance.ca.gov/docs/index.html) or certificate from County Clerk).

APPROVED AS TO AMOUNT:	APPROVED AS TO FORM:
_____	_____
City Manager	City Attorney

END OF FAITHFUL PERFORMANCE BOND

LABOR AND MATERIALS BOND

WHEREAS, the City of Petaluma, State of California, and _____ (hereinafter designated as "Principal") have entered into an agreement whereby the Principal agrees to install and complete certain designated public improvements, which said agreements, dated _____, 20_____, and identified as project _____, is hereby referred to and made a part hereof; and,

WHEREAS, under the terms of said agreement Principal is required before entering upon the performance of the work, to file a good and sufficient payment bond with the City of Petaluma, to secure the claims to which reference is made in Title 15 (commencing with Section 3082) of Part 4 of Division 3 of the Civil Code of the State of California.

NOW, THEREFORE, said Principal and the undersigned, duly authorized to transact business under the laws of the State of California, as corporate surety, are held firmly bound unto the City of Petaluma, and all contractors, subcontractors, laborers, materialmen and other persons employed in the performance of the aforesaid agreement and referred to in the aforesaid Civil Code of the State of California, in the sum of _____ Dollars ($_____) for materials furnished or labor thereon of any kind, or for amounts due under the Unemployment Insurance Act with respect to such work or labor, that said surety will pay the same in an amount not exceeding the amount hereinabove set forth, and also in case suit is brought upon this bond, will pay, in addition to the face amount thereof, costs and reasonable expenses and fees, including reasonable attorney's fees, incurred by City in successfully enforcing such obligation, to be awarded and fixed by the Court, and to be taxed as costs and to be included in the judgment therein rendered.

It is hereby expressly stipulated and agreed that this bond shall inure to the benefit of any and all persons, companies and corporations entitled to file claims under Title 15 (commencing with section 3082) of Part 4 of Division 3 of the Civil Code, so as to give a right of action to them or their assigns in any suit brought upon this bond.

Should the condition of this bond be fully performed, then this obligation shall become null and void, otherwise it shall be and remain in full force and effect.

THE SURETY hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of said agreement or the specifications accompanying the same shall in any

manner affect its obligations on this bond, and it does hereby waive notice of any such change, extension, alteration or addition.

IN WITNESS WHEREOF, this instrument has been duly executed by the Principal and surety above named, on _____, 20_____.

PRINCIPAL	SURETY
By_____	By_____
_____	_____
Name and Title	Name and Title
	_____
	Address
	_____
	City State Zip
	_____
	Phone

# # #

NOTE: No substitution or revision to this bond form will be accepted. Be sure that all bonds submitted have a certified copy of the bonding agent's power of attorney attached. Also verify that Surety is an "Admitted Surety" (i.e., qualified to do business in California), and attach proof of verification (website printout from the California Department of Insurance website (http://www.insurance.ca.gov/docs/index.html) or certificate from County Clerk)..

APPROVED AS TO AMOUNT:	APPROVED AS TO FORM:
_____	_____
City Manager	City Attorney

END OF LABOR AND MATERIALS BOND

MAINTENANCE BOND

WHEREAS, the City Council of the City of Petaluma ("City") and _____, (hereinafter designated as "Principal") have entered into an agreement whereby Principal agrees to install and complete certain designated public improvements, which said agreement, dated _____, 20_____, and identified as project _____, is hereby referred to and made a part hereof; and,

WHEREAS, said Principal is required under the terms of said contract to furnish a maintenance bond for the correction of any defects due to defective materials or workmanship in the work performed under said agreement.

NOW, THEREFORE, we the Principal and _____ as Surety, are held and firmly bound unto the City of Petaluma in the penal sum of _____ Dollars ($_____), lawful money of the United States for the payment of which sum well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors, and assigns jointly and severally, firmly by these presents.

THE CONDITIONS OF THIS OBLIGATION ARE SUCH that if, during a maintenance period of one (1) year from the date of acceptance of the contracted work, the Principal upon receiving written notice of a need for repairs which are directly attributable to defective materials or workmanship, shall diligently take the necessary steps to correct said defects within seven (7) days from the date of said notice, then this obligation shall be null and void; otherwise it shall remain in full force and effect.

As part of this obligation secured hereby and in addition to the face amount specified therefor, there shall be included costs and reasonable expenses and fees, including reasonable attorney's fees, incurred by the City in successfully enforcing such obligation, all to be taxed as costs and included in any judgment rendered.

The Surety hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of this agreement or to the work to be performed thereunder or the specifications accompanying the same shall in anywise affect its obligations on this bond, and it does hereby waive notice of any such change, extension of time, alteration or addition to the terms of the agreement or to the work or to the specifications.

IN WITNESS WHEREOF, this instrument has been duly executed by the Principal and Surety above named, on _____, 20_____.

PRINCIPAL	SURETY
By_____	By_____
_____	_____
Name and Title	Name and Title
	_____
	Address
	_____
	City State Zip
	_____
	Phone Number

# # #

NOTE: No substitution or revision to this bond form will be accepted. Be sure that all bonds submitted have a certified copy of the bonding agent's power of attorney attached. Also verify that Surety is an "Admitted Surety" (i.e., qualified to do business in California), and attach proof of verification (website printout from the California Department of Insurance website (http://www.insurance.ca.gov/docs/index.html) or certificate from County Clerk).

APPROVED AS TO AMOUNT:	APPROVED AS TO FORM:
_____	_____
City Manager	City Attorney

END OF MAINTENANCE BOND

NOTARIAL ACKNOWLEDGEMENT OF ATTORNEY-IN-FACT OF SURETY

STATE OF CALIFORNIA)
) SS.
COUNTY OF SONOMA)

On _____ before me, a Notary Public, personally appeared _____, personally known to me (or proved to me on the basis of satisfactory evidence) to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument.

WITNESS my hand and official seal.

_____
Notary Public

(Seal)

SECTION VI

PROJECT PLANS

See Volume 2 of 2