CONTRACT DOCUMENTS

FOR

CITY OF SEDONA
PUBLIC WORKS DEPARTMENT

Wastewater Collection System Improvements – LS Improvements
Chapel & Mystic Hills Lift Stations

2019-WW-01

City of Sedona

WASTEWATER COLLECTION SYSTEM IMPROVEMENTS - LS IMPROVEMENTS

CHAPEL AND MYSTIC HILLS LIFT STATIONS

TITLE **PAGE**

ADVERTISEMENT FOR BIDS
City of Sedona
Wastewater Department
108 Roadrunner Drive
Sedona, AZ 86336

Sealed bids for the construction of the **Wastewater Collection System Improvements - LS Improvements** will be received by the Public Works Department, located at 108 Roadrunner Drive, Sedona, Arizona, until **3:30 P.M. local time, February 20, 2019**. At that time, bids will be publicly opened and read aloud in the Echo Conference Room. Bidders are invited, but not required, to be present at the bid opening.

PROJECT: Wastewater Collection System Improvements – LS Improvements

DESCRIPTION: The project entails the construction of improvements to the City of Sedona's Wastewater Collection System to increase the pumping capacity of its Chapel and Mystic Hills Lift Stations. The project will involve the removal and replacement of wastewater pumping equipment including pumps, wet well, valve vaults, motor control center, back-up generator, electrical systems and related ancillary equipment for both lift station sites. Additional aspects of the work include minor site improvements and conducting bypass pumping operations to maintain and manage wastewater conveyance flows within the collection system during the construction of improvements at each lift station facility.

CONTRACT TIME: 180 calendar days after the Notice to Proceed.

LIQUIDATED DAMAGES: $1,070 per day beyond the 180 calendar day Contract Time.

MANDATORY PRE-BID MEETINGS: Failure to attend and sign attendance sheet at mandatory pre-bid meetings shall render a bid non-responsive.

Copies of the Contract Documents, including plans and specifications for use in preparing bids may be downloaded from the City of Sedona's website at www.SedonaAz.gov under your Business, Doing Business, Bids & RFPs. Downloaded documents may not be returned to the City of Sedona for any deposited refund. If plan documents are downloaded, the City will not be responsible for providing up-to-date information through the website or other communication methods.

PRE-BID CONFERENCE: Pre-bid conference (**mandatory**) will be held on **February 11, 2019, at 1:30 pm. in the Vultee Conference Room at Sedona City Hall,** 106 Roadrunner Drive, Sedona AZ.

Each bidder's proposal shall be made on forms furnished in the Contract Documents, and must be accompanied by a security consisting of a certified check, cashier's check, or bid bond in an amount of not less than ten percent (10%) of the amount of the total bid amount, and made payable to the CITY OF SEDONA, ARIZONA. In the event the successful Bidder, within ten (10) calendar days after award of the Contract, fails to enter into a Contract or fails to post payment and performance bonds satisfactory to the City insuring the faithful fulfillment of the Contract as required by law, the security deposit on this bid shall be forfeited to the City.

Contract Documents, with completed Bid Proposal, must be enclosed in a sealed envelope, addressed to:

HAND DELIVERED: City of Sedona
Public Works Department
108 Roadrunner Drive
Sedona, AZ 86336

U.S. MAIL: City of Sedona
Public Works Department
102 Roadrunner Drive
Sedona, AZ 86336

AND MARKED: Bid Proposal for **Wastewater Collection System Improvements – LS Improvements**

AND RECEIVED: **At the Public Works Department until 3:30 P.M. local time, February 20, 2019** (as determined by reference to www.time.gov ref Arizona area)

The successful Bidder will be required to furnish two (2) bonds. One (1) bond, to become effective upon award of the Contract, shall be a Performance Bond substantially in the form attached, and shall be in a sum of one hundred percent (100%) of the contract price including any additions to the Contract. The Bond shall be effective throughout the construction period, including a two (2) year warranty period. The successful Bidder shall also furnish a Labor and Material Payment Bond, substantially in the form attached, to become effective upon award. Said Labor and Material Bond shall be in the amount of one hundred percent (100%) of the Contract price.

The successful Bidder will be determined on the basis of the lowest responsive and responsible Proposal. The City of Sedona, Arizona reserves the right to reject any or all Proposals, to waive or not to waive any informalities, or irregularities in the Proposals received, and to accept a Proposal which in its judgment best serves the interests of the City.

All questions should be directed in writing to Robert J. Welch, Associate Engineer, Public Works Department, 102 Roadrunner Drive, Sedona, Arizona 86336, or email BWelch@SedonaAZ.gov.

FIRST ADVERTISEMENT: **January 30, 2019**
SECOND ADVERTISEMENT: **February 6, 2019**
RED ROCK NEWS

BY: _____
Roxanne Holland, PE
Wastewater Manager

INFORMATION FOR AND INSTRUCTIONS TO BIDDERS

The City of Sedona herein referred to as the "City" is defined as the City of Sedona, acting through its legally constituted officials, officers, and employees. The City may waive any informality or reject any or all bids. Any bid may be withdrawn prior to the scheduled time and date for the opening of bids or authorized postponement thereof. Any bid received after the time and date specified shall not be opened. No Bidder may withdraw a bid within forty-five (45) days after the actual day of the opening thereof.

Bid prices shall include everything necessary for the completion of the work including but not limited to, materials, equipment, tools, other facilities, management, superintendents, labor, services, insurance, overhead, profit, and Federal, State, and Local taxes.

Each bid must be submitted on the Bid Proposal provided and must be signed by the Bidder or his duly authorized agent. All blank spaces for bid prices must be filled in, in ink or typewritten, IN BOTH WORDS AND NUMBERS where called for in the Bid Proposal. If there is a discrepancy between the price in words and the price in numbers, the price in words will govern.

In case of an error in the extension of the unit price and the total, the unit price shall govern. In the event that the product of a unit price and an estimated quantity does not equal the extended amount quoted, the unit price shall govern, and the correct product of the unit price and the estimated quantity shall be deemed to be the amount bid. If the sum of two (2) or more items in the bid schedule does not equal the total amounts quoted, the individual item amounts shall govern and the correct total shall be deemed to be the amount bid. The bid shall not contain recapitulations of the work to be done.

Each bid must be submitted in a sealed envelope bearing on the outside the name of the Bidder, Bidder's address, and the name of the project for which the bid is submitted.

The City may, by statements in the Special Provisions or other part of the specifications, require submission of sealed Bid Documentation.

The City may make such investigations as City deems necessary to determine the ability of the Bidder to perform the work, and the Bidder shall furnish to the City all such information and data for this purpose as the City may request. The City reserves the right to reject any bid if the evidence submitted by, or investigation of, such Bidder fails to satisfy the City that such Bidder is properly qualified to carry out the obligations of the Contract and to complete the work contemplated therein. Conditional bids will not be accepted.

Bidders must correctly prepare and submit the documents listed below with their bids:

1. Bid proposal
2. Bid Guaranty Bond
3. Certification of the Bidder's experience and qualification and Statement of Bidder's Qualifications
4. List of all proposed Subcontractors
5. Schedule of manufacturers and suppliers, major equipment and material items

6. Non-collusion affidavit
7. Certificate of insurability
8. Signed Addenda

Each bid must be accompanied by either a certified check made payable to the City of Sedona, a cashier's check made payable to the City of Sedona or a bid bond, duly executed by the Bidder as principal and having as surety thereon a surety company licensed to do business in Arizona, in the amount of ten percent (10%) of the bid. The City may retain such checks or bid bonds, of the three (3) apparent lowest Bidders, for a period of forty-five (45) days after the bid opening.

Simultaneously with the delivery of the executed Contract, the Contractor shall furnish a surety bond or bonds as security for faithful performance of this Contract and for the payment of all persons performing labor on the project under this Contract and furnishing materials in connection with this Contract, as specified in the General Conditions included herein. The surety on such bond or bonds or contract bonds must file with each bond a certified and effectively dated copy of their Power of Attorney.

Each Bidder shall have listed, on the form entitled “Proposed Subcontractors”, provided in the Proposal, the name, address, and description of the work of each Subcontractor to whom the Bidder proposes to sublet portions of the work in excess of one and one-half percent (1.5%) of the total amount of his Bid. For the purpose of this paragraph, a Subcontractor is defined as one who contracts with the Contractor to provide materials and labor, labor only, or who specially fabricates and installs a portion of the work or improvement according to drawings contained in the Contract Documents. Failure to list Subcontractors may render a Bid non-responsive and may be grounds for rejection of the Bid. Attention is called to the General Conditions Article 13, limiting the total amount of the work, which may be performed by Subcontractors. Alternate Subcontractors for the same work shall not be listed in the bid. However, substitute Subcontractors may be considered as long as they comply with the requirements of these Contract documents.

Subcontractors listed by the Bidder must be competent and experienced in the type of work which they are to perform. No Contractors shall be required to employ any Subcontractor, other person or organization against which he has reasonable objection.

As evidence of his competency to perform the work, Bidder shall complete and submit with his Bid the Bidder’s Statement of Qualifications which is bound in the Contract Documents. Low Bidders may be asked to furnish additional data to demonstrate competency. Bidders must be, at the time of bidding and throughout the period of the Contract, licensed as required by the State of Arizona, thoroughly competent, and capable of satisfactorily constructing the Project. Bidder shall certify that he is skilled and regularly engaged in the general class and type of work called for in the Contract Documents. Additionally, Bidders shall comply with all provisions of Arizona Revised Statutes, Title 32, Chapter 10. Further, the Bidder certifies that he is knowledgeable of the unusual and peculiar hazards associated with the general class and type of work required to construct the specific project within the terms given in the Contract Documents. Bidder shall be competent and skilled in the protective measures necessary for the safe performance of the construction work with respect to such unusual and peculiar hazards.

The selected Bidder, upon Bidder's failure or refusal to execute and deliver the Contract and bonds required within ten (10) consecutive calendar days from and including the date Bidder received notice of the acceptance of his bid, shall forfeit to the City, for such failure or refusal, the security deposited with his bid.

Bidders are required prior to submitting a bid to inspect the site of the work and satisfy themselves by personal examination or by such other means as they may prefer, as to the location of the proposed work, and of the actual conditions.

Entrance by Bidders to the site of the work for purposes of making exploratory excavations shall be by special arrangement with the City Engineer under conditions established by the City. If, during the course of such an examination, a Bidder finds facts or conditions which appear to be in conflict with the Contract Documents, the Bidder must notify the City Engineer and may apply to the City Engineer, in writing, for additional information and explanation before submitting its bid.

Any information provided by the Design Engineer, the City, or any City personnel is not intended to be a substitute for, or a supplement to the independent verification by the Bidder to the extent such independent investigation of site conditions is deemed necessary or desirable by the Bidder. Bidder acknowledges that he has not relied upon City, City personnel, or Design Engineer furnished information regarding site conditions in preparing and submitting a bid hereunder. The Plans show conditions as they are believed to exist, but it is not intended nor is it to be inferred that the conditions as shown therein constitute a representation by the City or any of its officers that such conditions actually exist, nor shall the City or any of its officers be liable for any loss sustained by the Contractor as a result of any variance between any conditions as shown on the Plans and the actual conditions revealed during the progress of the project, or otherwise.

Any subsurface investigations, which may have been conducted at the site of the work, and the corresponding report, may be examined at the City office. Soil investigations, if performed, were conducted for design purposes, and the data shown in the reports are for subsurface conditions found at the time and location of the investigation. The Contractor shall note that there will be no separate payment for rock excavation and **no blasting** is permitted at the site.

The City disclaims responsibility for the interpretation by Bidders of data, such as projecting or extrapolating from the test holes to other locations on the site of the work, soil bearing values and profiles, soil stability and the presence, level and extent of underground water for subsurface conditions during construction operations.

The lands upon which the work is to be performed, right of way for access thereto, and other lands designated for use by the Contractor in performing the work are identified in the Supplemental Conditions or Drawings.

Submission of a bid by the Bidder shall constitute acknowledgement that, if awarded the Contract, the Bidder has relied and is relying on his own examination of (1) the site of the work, (2) access to the site, and (3) all other data and matters requisite to the fulfillment of the work and on his own knowledge of existing facilities on and in the vicinity of the work to be constructed under the Contract.

The Bidders shall examine carefully the Plans and Specifications and the site of the proposed Project and shall solely judge for themselves the nature and location of the work to be done and all the conditions; and the submission of a Bid shall be deemed as conclusive evidence that a Bidder has made the necessary investigation and is prima facie evidence that he is satisfied with the conditions to be encountered, quantity and quality of the work or materials to be performed or furnished, and the requirements and provisions of the Plans and Specifications and the Contract Documents. The Bidder agrees that if he is awarded the Contract he will make no claim against the City, the City Engineer, or any other City officials or City personnel based on ignorance or misunderstanding of any of the provisions of the Contract Documents, nor because of any unforeseen subsurface conditions except in the manner and under the circumstances as provided in the Contract Documents.

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

All applicable state laws, municipal ordinances, and the rules and regulations of all authorities having jurisdiction over construction for the project shall apply to the Contract throughout, and they will be deemed to be included in the Contract the same as though herein written out in full.

No interpretation of the meaning of the plans, specifications or other pre-bid documents will be made to any Bidder orally. Every proper request for such interpretation shall be made in writing, and to be given consideration must be received at least five (5) days prior to the date fixed for the opening of bids. Any and all such interpretations and any supplemental instruction will be in the form of written addenda to the Contract Documents which, if issued, will be emailed to all prospective Bidders (at the respective addresses furnished for such purposes), not later than three (3) calendar days prior to the date fixed for the opening of bids. At any time prior to an announced bid opening time, the City reserves the right to issue an addendum extending the bid opening time by one (1) or more days. Failure of any Bidder to receive any such addendum or interpretation shall not relieve such Bidder from any obligations under his bid as submitted. All Addenda so issued shall become part of the Contract Documents. It shall be the responsibility of each Prospective Bidder to verify that each addendum has been received applicable to the project. Bidders are responsible to check the City website at www.sedonaaz.gov periodically to verify if new addenda have been posted and shall ensure a reliable and accurate email address is provided to the City to be added to the Plan Holder's List. In order to be added to the Plan Holder's List, a bidder submit a request from the email address intended to be used as the bidder's contact email address, to the project manager listed on page I-3.

Before submitting a Proposal, Bidders shall carefully examine the Plans, read the specifications and all other Contract Documents, visit the site of the project, and fully inform themselves as to all existing and local conditions and limitations. It is expressly stipulated that the drawings, Specifications and other Contract Documents set forth the requirements as to the nature of the work and do not purport to control the method of performing work except in those instances where the nature of the completed work is dependent upon the method of performance.

Submission of a bid shall constitute acknowledgment, upon which the City may rely that the Bidder has thoroughly examined and is familiar with the Contract Documents. Failure or neglect of a Bidder to examine any of the Contract Documents shall in no way relieve him from any obligation with respect to his bid or to the Contract. No claim for additional compensation will be allowed which is based on a lack of knowledge of the work, or of the Contract Documents.

The quantities of the various classes of work to be done and material to be furnished under this Contract, which have been estimated as stated in the Proposal, are only approximate and are to be used solely for the purpose of comparing, on a consistent basis, the Proposals offered for the work under this Contract. The Contractor agrees that the City will not be held responsible if any of the quantities shall be found incorrect; except that in the event that the Contract price may be increased or decreased in accordance with Article 30 of the General Conditions through the issuance of the appropriate change orders to reflect the actual quantities of all items constructed, installed or incorporated in the work, the Contractor will not make any further claim for damages or for loss of profits because of a difference between the quantities of the various classes of work as estimated and the work actually done. If any error, omission, or misstatement is found to occur in the estimated quantities, the same shall not invalidate the Contract or release the Contractor from the execution and completion of the whole or any part of the work in accordance with the Specifications and the Plans herein mentioned, and for the prices herein agreed upon and fixed therefore, or excuse him from any of his obligations or liabilities hereunder, or entitle him to any damages or compensation except as may be provided in this Contract.

The successful Bidder, upon award of a Contract, shall commence work on the date specified in the "Notice to Proceed" and shall complete all work in accordance with the time schedule specified. Should the Contractor fail to complete all work in the allotted time period, liquidated damages shall be assessed as specified.

The City invites bids on the forms included as part of this Document to be submitted at such time and place as is stated in the Advertisement for Bids. All blanks in the Bid Proposal must be appropriately filled in with typewriter or ink. **Bidders are instructed not to turn in Bid Proposals that have been separated from the bound Contract Documents. It is the sole responsibility of the Bidder to see that the bid is received in proper time at the time and place stipulated in the Advertisement For Bids**. Any bids received after the scheduled closing time for receipt of bids will be returned to the Bidder unopened.

The bid must be signed in the name of the Bidder and must bear the signature in long hand of the person or persons duly authorized to sign the bid. Changes in or additions to the bid forms, recapitulations of the work bid upon, alternative proposals or any other modifications of the bid which are not specifically called for in the Contract Documents may be subject to City's rejection of the bid as not being responsive to the advertisements. No oral telephone modifications or telegraphic modifications of any bid submitted will be considered.

The bid submitted must not contain erasures, corrections or changes from the printed forms as completed in typewriter or ink, unless such erasures, corrections or changes are authenticated by affixing in the margin immediately opposite the erasure, correction or change, the full signature of the person who signed the bid or the signature of such other person as may be

authorized by the Bidder to make erasures, corrections or changes in the bid, and said authorization must be evidenced by written confirmation, executed by the person authorized to sign the initial bid, attached to the bid at the time of submittal.

If the bid is made by an individual, his or her name, signature, and post office address must be shown; if made by a firm or partnership, the name and post office of the firm or partnership, a list of the partners, and the signature of at least one of the general partners must be shown; if made by a corporation, the bid shall show the name of the state under the laws of which the corporation is chartered, the name and post office address of the corporation, and the title of the person who signs on behalf of the corporation. All signatures must be made in long hand. If a corporation makes the bid, a certified copy of the By-laws or resolution of the board of directors of the corporation shall be furnished showing the authority of the officer signing the bid to execute contracts on behalf of the corporation. If the bid is made by a joint venture, a representative of each of the joint venture firms shall sign the bid. Additionally, the bid shall include a copy of the resolution or agreement empowering the representative to execute the bid and bind the firm to the joint venture.

The City reserves the right to pre-qualify all bids, post-qualify all bids, or reject all bids, not to make an award or accept the Proposal deemed most advantageous and in the best interest of the City. The City shall enter into a Contract with the lowest responsible responsive bidder whose proposal is satisfactory. A written Notice of Award will be sent to the successful Bidder(s).

OR APPROVED EQUAL CLAUSE -- Manufacturers or suppliers of materials and equipment may request that alternatives to specified products be considered equal and that inclusion of such alternatives be permitted in the bids. Such request must be made in writing and received by the City Engineer at least five (5) calendar days prior to the date bids are to be received. Granting a request that an alternative product be considered equal to those specified may be made only by the issuance of an Addendum by the City. Denial of the request during bidding does not waive the manufacturer's or supplier's right to offer the alternative product to the Contractor after Award of the Contract. After Award of Contract, the offer will be considered as a substitution as provided under Article 6 of the General Conditions and will be considered only if the Engineer believes the offer of substitution is equal to or superior in quality to the specified product.

PREPARATION OF BID

A. City reserves the right to reject any or all Bids, to waive any or all informalities, and the right to disregard all nonconforming, non-responsive or conditional Bids.

B. City reserves the right to reject any Bid not accompanied by specified documentation and Bid security.

C. City reserves the right to reject any Bid if it shows any omissions, alterations of form, additions not called for, conditions or qualifications, or irregularities of any kind.

D. City reserves the right to reject any Bid that, in his sole discretion, is considered to be unreasonable as to the amount Bid for any lump sum or unit price item.

E. A Bidder may withdraw his Bid before the time fixed for the opening of Bids by communicating his purpose in writing to the City. Upon receipt of such written notice, the unopened Bid will be returned to the Bidder.

F. The withdrawal of a Bid does not prejudice the right of a Bidder to file a new Bid, so long as the new Bid is submitted in conformance with the Information for and Instructions to Bidders prior to the closing time indicated for Bids in the Advertisement for Proposals.

G. No Bidder may withdraw his Bid for forty-five (45) days after the time established for receiving Bids or before the Award and execution of the Contract unless the Award is delayed for a period exceeding forty-five (45) calendar days. The Award of the Contract to one party does not constitute a waiver of this condition.

H. In evaluating Bids, City will consider the qualifications of Bidders; whether or not the Bids comply with the prescribed requirements; the alternatives, if any; the time or times for completion as stated in the Bid Form; and the lump sum and unit prices, if requested in the Bid Form.

I. City may consider the qualifications and experience of Subcontractors and other persons and organizations (including those who are to furnish the principal items of material or equipment) proposed for those portions of the work for which the identity of Subcontractors and other persons and organizations must be submitted.

J. City may conduct such investigation deemed necessary to assist in the evaluation of any Bid and to establish the responsibility, qualifications and financial ability of the Bidders, proposed Subcontractors and other persons and organizations to do the work in accordance with the Contract Documents. City reserves the right to reject the Bid of any Bidder who does not pass any such evaluation to City's satisfaction.

K. Modification of a Bid already received will be considered only if the modification is received prior to the time established for receiving Bids. Modifications shall be made in writing, executed, and submitted in the same form and manner as the original Bid. The communication should not reveal the Bid Price, but should provide the addition or subtraction or other modifications so that the final price or terms will not be shown until the sealed Bids are opened.

CONTRACT

THIS CONTRACT, made and entered into this **XXth** day of **Month, 2018** by and between the City of Sedona, Arizona, hereinafter called the "Owner", and **Construction Company, Inc.** Herein after called the "Contractor".

WITNESSETH:

WHEREAS, the City has caused Contract Documents to be prepared for the construction of the **Project Name,** City of Sedona, Arizona, as described therein; and

WHEREAS, the Contractor has offered to perform the proposed work in accordance with the terms of the Contract; and

WHEREAS, the Contractor, as will appear by reference to the minutes of the proceedings of the City Council was duly awarded the work.

NOW, THEREFORE, the parties hereto hereby stipulate, covenant and agree as follows:

1. The Contractor promises and agrees to and with the City that it shall perform everything required to be performed and shall provide and furnish all the labor, materials, necessary tools, expendable equipment, and all utility and transportation services required to perform and complete in a workmanlike manner all of the work required in connection with construction of **Project Name** all in strict accordance with the Specifications and Drawings, including any and all Addenda, and in strict compliance with the Contractor's Proposal and all other Contract Documents, which are a part of the Contract; and the Contractor shall do everything required by this Contract and the other documents constituting a part thereof.

2. The Contractor agrees to perform all of the work described above in accordance with the Contract Documents and comply with the terms therein for the initial estimated Contract price of **$XXX,XXX.00**, subject to increase or decrease in accordance with the Contract Documents, and the Bid Schedule set forth therein; and the City agrees to pay the Contract Prices in accordance with the Bid Schedule for the performance of the work described herein in accordance with the Contract Documents.

3. The Contractor and the City agree that the terms, conditions, and covenants of the Contract are set forth in the Contract Documents including all specifications, and the Drawings Sheets X through XX, all defined as the Contract Documents, and by this reference made a part hereof as if fully set forth herein.

4. The Contractor and the City agree that each will be bound by all terms and conditions of all of the Plans and Technical Specifications, and Contract Documents, as if the same were fully set forth herein, and hereby incorporate all of the foregoing into this Agreement.

5. The Contractor shall abide by all the laws of the United States of America, State of Arizona, Coconino/Yavapai Counties, and the City of Sedona.

6. The Contractor shall carry Workmen's Compensation Insurance and require all Subcontractors to carry Workmen's Compensation Insurance as required by the Law of the State of Arizona, and all other insurance as set forth in the General Conditions.

7. Work under this Contract shall commence on the date specified in the written Notice to Proceed from the City to the Contractor. Upon receipt of said Notice, the Contractor shall diligently and continuously prosecute and complete all work under this Contract within the time specified in the Advertisement for Bids and as said Advertisement may have been amended by issued addendum.

8. The Contract Document consist of the following component parts, all of which are a part of this Contract whether herein set out verbatim, or attached hereto:

Advertisement for Bids
Information for and Instructions to Bidders
Bid Proposal and Bid Guaranty Bond
Contract (this document)
Change Orders
Addenda
Performance Bond, Labor and Material Payment Bond
Special Conditions
General Conditions
Technical Specifications
Notice of Award
Notice to Proceed
Plans and Drawings
Design Reports (including Geotech Report)
Standard Specifications
Army Corps Permit
Insurance Certificates

The above named documents are essential parts of the Contract, and a requirement occurring in one is as binding as though occurring in all. They are intended to be complementary and to describe and provide for a complete work. In case of discrepancy, the order of precedence is as follows:

1. Change Orders
2. Contract (this document), including addenda
3. Payment and Performance Bonds
4. Advertisement for Bids
5. Information for and Instructions to Bidders
6. Notice of Award
7. Notice to Proceed
8. Special Conditions
9. Bid Proposal
10. Technical Specifications

11. Plans and Drawings
12. General Conditions
13. Bid Guaranty Bond
14. Standard Specifications

In the event there is a conflict between any of the above listed documents, the provision of the document with the lower numerical value shall govern those documents with a higher numerical value. Within a category, the last in time is first in precedence.

The Contractor shall not take advantage of any apparent error or omission in the Plans or Specifications. In the event the Contractor discovers such an error or omission, he shall immediately notify the Owner. The City will then make such corrections and interpretations as may be deemed necessary for fulfilling the intent of the Plans and Specifications.

9. As part of the inducement for City to enter into this Agreement, Contractor makes the following representations:

   A. Contractor has familiarized himself with the nature and extent of the Contract Documents, work, locality, and with all local conditions and federal, state and local laws, ordinances, rules and regulations that in any manner may affect cost, progress, or performance of the work.

   B. Contractor has studied carefully all reports of investigations and tests of subsurface and latent physical conditions at the site or those reports that otherwise may affect cost, progress or performance of the work, which were utilized by Design Engineer in the preparation of the Drawings and Specifications and which have been identified in the Contract Documents.

   C. Contractor has made or caused to be made examinations, investigations and tests, and studies of such reports and related data as he deems necessary for the performance of the work at the Contract Price, within the Contract Time and in accordance with the other terms and conditions of the Contract Documents; and no additional examinations, investigations, tests, reports or similar data are or will be required by Contractor for such purposes.

   D. Contractor has correlated the results of all such observations, examinations, investigations, tests, reports and data with the terms and conditions of the Contract Documents.

   E. **Contractor has given the City Engineer written notice of all conflicts, errors or discrepancies that he has discovered in the Contract Documents** and the written resolution thereof by City Engineer is acceptable to Contractor.

   F. Contractor has attended mandatory pre-bid meetings and walk-throughs.

10. A. No assignment by a party hereto of any rights under or interest 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.

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

C. Pursuant to Arizona Revised Statutes Section 38-511, the provisions of which are incorporated by reference as if fully set forth herein, all parties are hereby given notice that this Agreement is subject to cancellation by the City if any person significantly involved in initiating, negotiating, securing, drafting, or creating the Contract or Contract Documents on behalf of the City is, at any time while the Contract or Contract Document or any extension thereof is in effect, an employee or agent of any other party to the Contract or Contract Documents in any capacity or a consultant to any other party to the Contract or Contract Documents with respect to the subject matter of the Contract or Contract Documents.

11. During the performance of this Agreement, Contractor may also be under contract with the City for performance of work on other projects. A breach in the performance of any of Contractor's obligations under this Agreement shall constitute a breach of Contractor's obligations under any other agreement with the City and the breach by Contractor under other agreement with the City shall also constitute a breach of Contractor's obligations under this Agreement. The City may offset any amounts owed by Contractor under any such other agreement from any amounts owed to Contractor under this Agreement.

12. The Contract Documents constitute the entire Agreement between the parties.

IN WITNESS WHEREOF, the parties hereto have executed, or caused to be executed by their duly authorized officials, this Agreement in triplicate (3) each of which shall be deemed an original on the date first above written.

CITY: City of Sedona, Arizona

BY: _____

NAME: _____
(please print)
TITLE: _____

(SEAL)
ATTEST:
BY: _____

NAME: _____
(please print)

CONTRACTOR: Construction Company, Inc.

BY: _____

NAME: _____
(please print)
TITLE: _____

(SEAL)

ATTEST:

BY: _____

NAME: _____
(please print)

APPROVED AS TO LEGAL FORM:

BY: _____
(City Attorney)
DATE: _____

STATUTORY BID BOND

PURSUANT TO TITLE 34, CHAPTER 2, ARTICLE 1
OF THE ARIZONA REVISED STATUTES

(This bond must not be less than ten percent (10%) of the bid amount)

KNOW ALL MEN BY THESE PRESENTS:

That we, the undersigned _____, (hereinafter "Principal"), as Principal, and _____, a corporation organized and existing under the laws of the State of _____, with its principal offices in the City of _____, (hereinafter "Surety"), as Surety, are held and firmly bound unto the City of Sedona, the State of Arizona, (hereinafter "Obligee"), in the amount of _____(Dollars) ($_____), for the payment whereof, the said Principal and Surety bind themselves, and their heirs, administrators, executors, successors and assigns jointly and severally, firmly by these presents.

WHEREAS, the Principal has submitted a bid for

Wastewater Collection System Improvements – LS Improvements

NOW, THEREFORE, if the Obligee accepts the proposal of the Principal and the Principal enters into a contract with the Obligee in accordance with the terms of the proposal and gives the bonds and certificates of insurance as specified in the Contract Documents with good and sufficient surety for the faithful performance of the contract and for the prompt payment of labor and materials furnished in the prosecution of the contract, or in the event of the failure of the Principal to enter into the contract and give the bonds and certificates of insurance, if the Principal pays to the Obligee the difference not to exceed the penalty of the bond between the amount specified in the proposal and such larger amount for which the Obligee may in good faith contract with another party to perform the work covered by the proposal then this obligation is void. Otherwise, it remains in full force and effect provided, however, that this bond is executed pursuant to the provisions of Section 34-201, Arizona Revised Statutes, and all liabilities on this bond shall be determined in accordance with the provisions of the section to the extent as if it were copied at length herein.

Witness our hands this _____ day of _____, 2018.

_____

PRINCIPAL Seal

By: _____

Title: _____

_____

AGENCY OF RECORD

_____

SURETY Seal

_____

AGENCY ADDRESS

(Attach Power of Attorney form)

STATUTORY BID BOND

(Check to accompany bid)

(Note: The following form shall be used when a check accompanies bid)

Accompanying this proposal is a Cashier's Check payable to the order of the City of Sedona hereinafter referred to as "City," for **Wastewater Collection System Improvements – LS Improvements** in the amount of _____Dollars ($_____), this amount being ten percent (10%) of the total amount of the Bid. The proceeds of this check shall become the property of said City provided this proposal shall be accepted by said City through action of its legally constituted contracting authorities and the undersigned shall fail to execute a contract and furnish the required Performance and Payment Bonds and proof of insurance coverage within the stipulated time; otherwise, the check shall be returned to the undersigned. The proceeds of this check shall also become the property of the City if the undersigned shall withdraw his bid within the period of forty-five (45) days after the date set for the opening thereof, unless otherwise required by law, and notwithstanding the award of the Contract to another Bidder.

_____

_____

_____

Bidder

(NOTE: If the Bidder desires to use a bond instead of a check, the Bid Bond Form on the previous two (2) pages shall be executed -- the sum of this bond shall not be less than ten percent (10%) of the total amount of this Bid.)

STATUTORY PERFORMANCE BOND

PURSUANT TO TITLE 34, CHAPTER 2, ARTICLE 2,
OF THE ARIZONA REVISED STATUTES

(This Bond must be 100% of the Contract amount)

KNOW ALL MEN BY THESE PRESENTS:

That,_____ (hereinafter "Principal"), as Principal, and _____, a corporation organized and existing under the laws of the State of _____with its principal office in the City of _____, (hereinafter "Surety"), as Surety, are held and firmly bound unto the City of Sedona, State of Arizona, (hereinafter "Obligee") in the amount of $_____ _____ (Dollars) ($_____) for the payment whereof, the said Principal and Surety bind themselves, and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain written Contract with the _____, dated the _____ day of _____, 2018 to _____ _____ _____ which contract is hereby referred to and made a part hereof as fully and to the same extent as if copied at length herein.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that if the Principal faithfully performs and fulfills all of the undertakings, covenants, terms conditions and agreements of the Contract during the original term of the Contract and any extension of the Contract, with or without notice to the Surety, and during the life of any guaranty required under the Contract, and also performs and fulfills all of the undertakings, covenants, terms conditions and agreements of all duly authorized modifications of the Contract that may hereafter be made, notice of which modifications to the Surety being hereby waived, the above obligation is void. Otherwise it remains in full force and effect.

PROVIDED, HOWEVER, that this bond is executed pursuant to the provisions of Title 34, Chapter 2, Article 2, Arizona Revised Statutes, and all liabilities on this bond shall be determined in accordance with the provisions of Title 34, Chapter 2, Article 2, Arizona Revised Statutes, to the extent as if it were copied at length in this agreement.

The prevailing party in a suit on this bond shall recover as part of the judgment reasonable attorney fees that may be fixed by a judge of the Court.

Witness our hands this _____ day of _____, 2018.

_____

PRINCIPAL Seal

By: _____

Title: _____

AGENCY OF RECORD

_____

_____

_____

AGENCY ADDRESS

_____

_____

_____

_____

SURETY SEAL

By:_____

(Attach Power of Attorney Form)

STATUTORY PAYMENT BOND
PURSUANT TO
TITLE 34, CHAPTER 2, ARTICLE 2,
OF THE ARIZONA REVISED STATUTES

(This Bond must be 100% of the Contract amount)

KNOW ALL MEN BY THESE PRESENTS:

That, _____ (hereinafter "Principal"), as Principal, and _____, a corporation organized and existing under the laws of the State of _____ with its principal office in the City of_____, (hereinafter "Surety"), as Surety, are held and firmly bound unto the City of Sedona, State of Arizona (hereinafter "Obligee") in the amount of _____(Dollars) ($_____) for the payment whereof, the said Principal and Surety bind themselves, and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain written contract with the Obligee dated the _____ day of _____, 2018, _____
_____
_____
_____
_____

which contract is hereby referred to and made a part hereof as fully and to the same extent as if copied at length herein.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH, that if the Principal promptly pays all monies due to all persons supplying labor or materials to the Principal or the Principal's subcontractors in the prosecution of the work provided for in contract, this obligation is void. Otherwise it remains in full force and effect.

PROVIDED HOWEVER, that this bond is executed pursuant to the provisions of Title 34, Chapter 2, Article 2, of the Arizona Revised Statutes, and all liabilities on this bond shall be determined in accordance with the provisions, conditions and limitations of Title 34, Chapter 2, Article 2, Arizona Revised Statutes, to the same extent as if it were copied at length in this agreement.

The prevailing party in a suit on this bond shall recover as part of the judgment reasonable attorney fees that may be fixed by a judge of the Court.

Witness our hands this _____ day of _____, 2018.

PRINCIPAL Seal

By: _____

Title: _____

AGENCY OF RECORD

_____

_____

_____

AGENCY ADDRESS

_____

_____

_____

SURETY SEAL

By:_____

(Attach Power of Attorney Form)

DO NOT DETACH AND SUBMIT SEPARATE FROM OTHER CONTRACT DOCUMENTS

BID PROPOSAL

City of Sedona:

The undersigned Bidder, having examined the specifications, drawings and all other documents contained in the Contract Documents, attended all mandatory pre-bid meetings, and having examined the site where the work is being performed, and having familiarized himself with any local conditions affecting the work and having knowledge of the cost of work at the place where the work is to be done, hereby proposes to execute and perform the formal Contract set forth in these Contract Documents, of which this Proposal forms a part, and will do the work therein described on the terms and conditions therein set forth; and furnish all required labor, materials, tools, equipment, transportation and services for said work, and pay all taxes and other incidental costs, all in strict conformity with the drawings and specifications forming a part of the Contract Documents for the Unit Prices entered based on the Bidding Schedule included herein, said prices to only be amended or altered in accordance with the Contract Documents.

It is understood that any listed quantities of work to be done at unit prices are **approximate** only, and are intended to serve as a guide in evaluating bids.

It is further agreed that any quantities of work to be done at unit prices and material to be furnished may be increased or decreased as may be considered necessary, in the opinion of the City, to complete the work fully as planned and contemplated and that all quantities of work, whether increased or decreased, are to be performed at the unit prices set forth in the Bid Schedule, except as otherwise provided for in the Contract Documents.

It is further agreed that payments may be increased to cover additional work ordered by the City, but not shown on the Plans or required by the Specifications in accordance with General Condition No. 47. Similarly, payments may decrease if work is deleted or changed.

By submitting a bid, the Bidder acknowledges the understanding that the bid process is solely intended to serve the public interest in achieving the highest quality of services and goods at the lowest price, and that no right, interest, or expectation shall vest or inure to the benefit of Bidders as a result of any reliance or participation in the process.

In submitting this Proposal, it is understood that the right is reserved by the City to reject any or all Proposals and waive informalities or irregularities in Proposals. The City also reserves the right to delay the award of a contract for a period not to exceed forty-five (45) days from the date of the opening of bids.

The undersigned Bidder further agrees, if awarded the contract for the work included in this Proposal, to begin and to complete and deliver the work contemplated in accordance with all the conditions set forth in the Contract Documents.

The undersigned Bidder has carefully checked the figures inserted by him and understands that they are the Bidder's sole responsibility, and the City will not be responsible for any errors or omissions on the part of the undersigned Bidder in preparing this Proposal although City may

check and correct mathematical accuracy in evaluation of the bids.

The undersigned Bidder certifies that this Proposal is genuine, not collusive, or made in the interest or behalf of any person not named as provided in the Information for and Instructions to Bidders, and that the undersigned has not, directly, or indirectly, induced or solicited any other Bidder, or induced any other person, firm, or corporation to refrain from submitting a proposal, and the undersigned has not in any manner sought by collusion to secure for himself an advantage over any other Bidder.

Attached is a certified check without endorsement and with conditions payable to the City of Sedona in the sum of ten percent (10%) of the total bid drawn on a bank which is a member of Federal Reserve System or which is a member of the Federal Deposit Insurance Corporation, or a cashier's check for ten percent (10%) of the total bid or a Bid Bond written by an approved surety company for ten percent (10%) of the total bid.

The undersigned submits a bid bond pursuant to Section 34-201, Arizona Revised Statutes, payable to the City, equal to ten percent (10%) of the total amount of this proposal, and agrees that said bid bond shall be given as a guarantee that the Bidder will enter into the Contract within the time herein stated if the award is made to him by the City. In case of the Bidder's refusal or failure to do so within ten (10) days of Notice of the Award of Contract, or within five (5) days after receiving notice from the City of the rejection of any objections to the Notice of Award, the bond will be forfeited.

The Bidder grants the City the right to hold the lowest three (3) Proposals received, together with the accompanying bid securities, for a period of forty-five (45) days after the date of opening of said Proposals.

The undersigned Bidder further grants the City the right to award this Contract on the basis of any possible combinations of Base Bid and add/deduct alternate(s) (if any) that best suits the City's needs.

Bidder agrees that the City has determined that a reasonable time for the **Wastewater Collection System Improvements – LS Improvements** is the contract time stated in the Advertisement for Bids and issued addendum. The Bidder agrees that this proposal is submitted on this basis, subject to provisions contained in the Contract Documents relating to extensions of time, and agrees to plan and prosecute the work with such diligence that the work shall be completed within the time specified.

Bidder agrees that the bid includes the following items which have been completed in full by the Bidder:

(a) Bid or Proposal
(b) Bid Schedule
(c) Bid Guaranty Bond

(d) Certification of the Bidder’s experience and qualifications and statement of Bidder’s Qualifications
(e) List of all proposed Subcontractors

(f) Schedule of manufacturers and suppliers, major equipment and material items
(g) Non-collusion Affidavit
(h) Certificate of Insurability
(i) Signed Addenda

Bidder agrees that the City assumes no responsibility for any understanding or representation made by any of its Council members, officers or agents during or prior to the bidding and execution of the Contract, unless (1) such understanding or representations are expressly stated in the Contract or Addenda thereto, or (2) the Contract expressly provides that responsibility therefore is assumed by the City, or (3) said understanding or representation is contained in the information supplied to Bidders by the City or the City Engineer, or as information distributed pursuant to the Information for and Instructions to Bidders. The Bidder further understands that only the Mayor and Council of the City through action taken at a properly noticed meeting, can waive any term or condition or requirement of this Contract or of the bid.

Bidder agrees that all terms set forth in the Information for and Instructions to Bidders as well as all other Contract Documents shall be binding upon the Bidder if a Notice of Award is issued in favor of said Bidder by the City.

Bidder agrees that all major equipment and suppliers shall be set forth herein on the attached "Schedule of Manufacturers and Suppliers, Major Equipment and Material Items",

Bidder understands that this project is to be constructed in compliance with all City, State and Federal laws, rules and regulations, which are applicable to the project and the Contractor and all work performed hereunder.

In making this proposal, the undersigned incorporates and acknowledges all definitions set forth in the Contract Documents.

The undersigned hereby submits this proposal and the accompanying Bid Schedule as its proposal to construct the improvements described in the Contract Documents.

The name and location of the place of business of each Subcontractor who will perform work or labor or render service to the general Contractor in or about the construction of the work or improvements in an amount in excess of one and one-half percent (1.5%) of the general Contractor's total Bid, and the portion of the work which will be done by each Subcontractor is set forth in the Proposed Subcontractor list attached hereto.

Bidder has received all Addenda before submission of Bid, and has examined the same and has included them in the Contract Documents prior to submitting the Bid and has submitted the Bid based upon them.

The Bonding company which will supply the required Performance and Payment bond is:

_____

_____

Base Bid Schedule

City of Sedona – Wastewater Collection System Improvements – LS Improvements
Project # 2019-WW-01

ITEM NO.	ITEM DESCRIPTION	QTY	UNIT	UNIT PRICE	EXTENDED TOTAL
	Chapel Lift Station				
1	Mobilization	1	LS		
2	Demobilization	1	LS		
3	SWPPP	1	LS		
4	Site Demolition	1	LS		
5	Site Work	1	LS		
6	Construction MOPO	1	LS		
7	Site Compound	1	LS		
8	Water Piping	1	LS		
9	Package Lift Station System [1]	1	LS	$274,500.00	$274,500.00
10	Non-Package Lift Station Equipment	1	LS		
11	Lift Station Installation	1	LS		
12	Force Main	1	LS		
13	Landscaping	1	LS		
14	Reinstallation of Mystic Hills Backup Generator	1	LS		
15	Site Electrical	1	LS		
16	Instrumentation	1	LS		
17	MCC	1	LS		
18	APS Utility Upgrade	1	LS		
	SUBTOTAL - CHAPEL LIFT STATION				
	Mystic Hills Lift Station				
1	Mobilization	1	LS		
2	Demobilization	1	LS		
3	SWPPP	1	LS		
4	Site Demolition	1	LS		
5	Site Work	1	LS		
6	Construction MOPO	1	LS		
7	Site Compound	1	LS		

8	Gravel Access Road	1	LS		
9	Water Piping	1	LS		
10	Gravity Sewer Line	1	LS		
11	Package Lift Station System [1]	1	LS	$370,000.00	$370,000.00
12	Non-Package Lift Station Equipment	1	LS		
13	Lift Station Installation	1	LS		
14	Force Main	1	LS		
15	Landscaping	1	LS		
16	Backup Generator	1	LS		
17	Site Electrical	1	LS		
18	Instrumentation	1	LS		
19	MCC	1	LS		
20	APS Utility Upgrade	1	LS		
	SUBTOTAL - MYSTIC HILLS LIFT STATION				
	TOTAL BID *(Subtotal - Chapel Lift Station + Subtotal - Mystic Hills Lift Station)*				

CIP: COMPLETE IN PLACE

Owner reserves the right to vary the quantities shown at their discretion. The contractor will accept the quantities if no corrections are made at the conclusion of the pre-bid meeting. All facilities incidental to the item are included in the unit price estimate. Bid Prices submitted include all local, state and federal taxes.

UNIT PRICES SHALL BE USED WHEN EXTENSION OF UNIT PRICES AND TOTAL AMOUNT CONFLICT. WRITTEN UNIT PRICES SHALL BE USED WHEN WRITTEN AND NUMERICAL UNIT PRICES CONFLICT. BID PRICES SUBMITTED INCLUDE ALL LOCAL, STATE AND FEDERAL TAXES.

The City of Sedona reserves the right to reject all bids, or to award only the base bid, or to award a bid based upon the total of the Base Bid plus additive alternate(s) as selected for award from the additive alternate bid schedule, if additive alternate bid schedule is applicable.

NOTES:

1 Pre-arranged Lift Station Package equipment/material and pricing. See Special Conditions, Item number 13. Pre-arranged Pricing for Select Lift Station Material/Equipment.

Additive Bid Schedule(s)

City of Sedona – Wastewater Collection System Improvements – LS Improvements, Chapel Lift Station
Project # 2019-WW-01

The Additive Bid Schedule Items are for improvement work that the City of Sedona, at its sole discretion, may authorize for inclusion in the contract work following closure of bidding. Additive Bid Alternative items are not guaranteed to be part of the awarded contract work and the City of Sedona may select any one or combination of Additive Bid Alternative items from the Additive Bid Schedule(s) for inclusion in the contract work.
Bidders must complete and provide pricing for both the Base Bid Schedule and all Additive Bid Alternatives and Schedules. Failure to complete and submit pricing for the Base Bid Schedule and all Additive Bid Alternated Schedules may render a Bid non-responsive and may be grounds for rejection of the Bid

ADDITIVE BID ALTERNATIVE: A1 (CHAPEL)					
ITEM NO.	**ITEM DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED TOTAL**
A1.1	Bid Alternative Flow Meter	1	LS		
A1.2	Bid Alternative Omni Crystal Ball	1	LS		
A1.3	Bid Alternative Backup Generator	1	LS		
				TOTAL ADDITIVE BID ALTERNATIVES	

CIP: COMPLETE IN PLACE
Owner reserves the right to vary the quantities shown at their discretion. The contractor will accept the quantities if no corrections are made at the conclusion of the pre-bid meeting. All facilities ncidental to the item are included in the unit price estimate. Bid Prices submitted include all local, state and federal taxes.

UNIT PRICES SHALL BE USED WHEN EXTENSION OF UNIT PRICES AND TOTAL AMOUNT CONFLICT. WRITTEN UNIT PRICES SHALL BE USED WHEN WRITTEN AND NUMERICAL UNIT PRICES CONFLICT. BID PRICES SUBMITTED INCLUDE ALL LOCAL, STATE AND FEDERAL TAXES.

The City of Sedona reserves the right to reject all bids, or to award only the base bid, or to award a bid based upon the total of the Base Bid plus additive alternate(s) as selected for award from the additive alternate bid schedule, if additive alternate bid schedule is applicable.

Additive Bid Schedule(s)

City of Sedona – Wastewater Collection System Improvements – LS Improvements, Mystic Hills Lift Station
Project # 2019-WW-01

The Additive Bid Schedule Items are for improvement work that the City of Sedona, at its sole discretion, may authorize for inclusion in the contract work following closure of bidding. Additive Bid Alternative items are not guaranteed to be part of the awarded contract work and the City of Sedona may select any one or combination of Additive Bid Alternative items from the Additive Bid Schedule(s) for inclusion in the contract work.
Bidders must complete and provide pricing for both the Base Bid Schedule and all Additive Bid Alternatives and Schedules. Failure to complete and submit pricing for the Base Bid Schedule and all Additive Bid Alternated Schedules may render a Bid non-responsive and may be grounds for rejection of the Bid

ADDITIVE BID ALTERNATIVE: B1 (MYSTIC HILLS)					
ITEM NO.	**ITEM DESCRIPTION**	**QTY**	**UNIT**	**UNIT PRICE**	**EXTENDED TOTAL**
B1.1	Bid Alternative Paved Access Road	1	LS		
B1.2	Bid Alternative Flow Meter	1	LS		
B1.3	Bid Alternative Omni Crystal Ball	1	LS		
				TOTAL ADDITIVE BID ALTERNATIVES	

CIP: COMPLETE IN PLACE
Owner reserves the right to vary the quantities shown at their discretion. The contractor will accept the quantities if no corrections are made at the conclusion of the pre-bid meeting. All facilities incidental to the item are included in the unit price estimate. Bid Prices submitted include all local, state and federal taxes.

UNIT PRICES SHALL BE USED WHEN EXTENSION OF UNIT PRICES AND TOTAL AMOUNT CONFLICT. WRITTEN UNIT PRICES SHALL BE USED WHEN WRITTEN AND NUMERICAL UNIT PRICES CONFLICT. BID PRICES SUBMITTED INCLUDE ALL LOCAL, STATE AND FEDERAL TAXES.

The City of Sedona reserves the right to reject all bids, or to award only the base bid, or to award a bid based upon the total of the Base Bid plus additive alternate(s) as selected for award from the additive alternate bid schedule, if additive alternate bid schedule is applicable.

The undersigned is licensed in accordance with the Laws of the State of Arizona:

License Number _____ Class _____

NOW: In compliance with the Notice Inviting Bids and all the provisions hereinbefore and after stipulated, the undersigned, with full cognizance thereof, hereby proposes to perform the Work for the prices set forth in the preceding Schedule(s) upon which award of contract is made.

Individual Contractor
Name: _____
Address: _____

Partnership
Name: _____
Business Address: _____
_____
By: _____, Partner
Other Partners: _____

Corporation
Name: _____
Business Address: _____
_____
By: _____
_____, President
_____, Secretary

Organized under the Laws of the State of _____

Date: _____ Contractor: _____
_____
_____

(SEAL) By: _____
_____
_____

The undersigned Bidder acknowledges receipt of the following addendum:

Addendum #	Dated	Initial
_____	_____	_____
_____	_____	_____

_____
Signature of Bidder

PROPOSED SUBCONTRACTORS

The following information gives the name, business address, and portion of work (description of work to be done) for each Subcontractor that will be used in the work if the Bidder is awarded the Contract. No Subcontractor doing work in excess of one and one-half percent (1.5%) of the total amount of the bid and who is not listed shall be used without the written approval of the City, which shall not be unreasonably withheld. (Additional supporting data may be attached to this page. Each page shall be sequentially numbered and headed "Proposed Subcontractors" and shall be signed.) Substitutions of Subcontractors may be made by the Bidder as long as all Subcontractors used meet all requirements for all Subcontractors and all subcontract agreements meet all requirements set forth in the Contract Documents. The total value of subcontracted work shall not exceed fifty percent (50%) of the contract work as bid. The Bidder shall perform 50% or more of the contract work using Bidder's organization, unless stated otherwise in the specifications. The subcontractor shall have the license required for the work performed. The subcontractor will be required to have a current City of Sedona Business License for the duration of the contract.

Subcontractor Name	Business Address	Description of Work

_____

Signature of Bidder

SCHEDULE OF MANUFACTURERS AND SUPPLIERS - MAJOR EQUIPMENT AND MATERIAL ITEMS

The Bidder proposes that the named items of major equipment and materials required for work will be supplied by the manufacturers or suppliers set forth below as written in by the Bidder. Substitutions will be allowed in accordance with the Contract Documents:

Item	**Manufacturer or Supplier**

WORKMEN'S COMPENSATION INSURANCE
CERTIFICATE

I am aware of the provisions of Arizona Law, which require every employer to be insured against liability for workmen's compensation 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.

Date: _____

By: _____

NON-COLLUSION AFFIDAVIT

TO BE EXECUTED BY EACH AWARDEE OF A PRINCIPAL CONTRACT IN THE

STATE OF _____)
) ss
COUNTY OF _____)

_____, being first duly sworn, deposes and says:

1. That he is _____ (sole owner, a partner, president, secretary, etc.) of_____, the party making the foregoing Bid.

2. That such Bid is not made in the interest of or on behalf of any undisclosed person, partnership, company association, organization, or corporation.

3. That such Bid is genuine and not collusive or sham.

4. That said bidder has not directly 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.

5. That said Bidder has not in any manner, directly or indirectly, sought by agreement, communication, or conference with anyone to fix the Bid Price of said Bidder or of any other Bidder, nor to fix any overhead, profit, or cost element of such Bid Price, nor of that of any other Bidder, nor to secure any advantage against the public body awarding the Contract or anyone interested in the proposed Contract.

6. That all statements contained in such Bid are true.

7. That said Bidder has not, directly or indirectly, submitted his Bid Price or any breakdown thereof, nor the contents thereof, nor divulged information or data relative thereto, nor paid and will not pay any fee in connection therewith to any corporation, partnership, company, association, organization, bid depository, nor to any member or agent thereof, nor to any other individual except to such person or persons as have a partnership or other financial interest with said Bidder in his general business.

NON-COLLUSION AFFIDAVIT
(Continued)

_____
Name of Business

_____
By

_____
Title

Subscribed and sworn to before me this _____ day of _____, 2018.

_____
(Notary Public)

My Commission expires: _____

STATEMENT OF BIDDER'S QUALIFICATIONS

If bidder is a corporation, answer the following:

(a) Date of incorporation: _____

(b) State of incorporation: _____

(c) President's name: _____

(d) Vice President's name(s): _____

(e) Secretary's or Clerk's name: _____

(f) Treasurer's name: _____

If bidder is a partnership, answer the following:

(a) Date of organization: _____

(b) Name and address of all partners. State whether it is a general or limited partnership:

_____

_____

_____

If other than a corporation or partnership, describe the organization and name principals:

_____

_____

_____

_____

Major Types of Work Done by Company: _____

_____

Principal Office: _____

Telephone Number: _____

Contractor's Bank and Local Contact: _____

EXPERIENCE QUESTIONNAIRE

1. How many years has your organization been in business as a contractor under your present business name?

_____

2. How many years' experience in the proposed type and size of construction work has your organization had:

_____

(a) As a general contractor? _____

(b) As a subcontractor? _____

3. Are you licensed as a General Engineering contractor, or any other title?

_____

If "yes", in what city, county and state? _____

What class license and number? _____

4. List the most recent projects your organization has had in construction of work similar in type and size to the work proposed herein:

Contract Amount	Class of Work	When Completed	Name, Address and Telephone No. of City

5. Has any construction contract to which you have been a party been terminated by the owner; have you ever terminated work on a project prior to its completion for any reason; has any surety which issued a performance bond on your behalf ever completed the work

in its own name or financed such completion on your behalf; has any surety extended any monies in connection with the contract for which they furnished a bond on your behalf? If the answer to any portion of this question is "yes", please furnish details of all such occurrences including the name of the owner, architect or engineer, and surety, name and date of project.

o YES o NO

6. Has any officer or partner of your organization ever been an officer or partner of another organization that had any construction contract terminated by the owner; terminated work on a project prior to its completion for any reason; had any surety which issued a performance bond complete the work in its own name or finance such completion; or had any surety expend any monies in connection with the contract for which they furnished a bond? If the answer to any portion of this question is "yes", please furnish details of all such occurrences including name of owner, architect or engineer, and surety, name and date of project.

o YES o NO

7. What is the experience of the principal individuals of your organization?

Individual's Name	Yrs Exp with this Company	Present Position or Office	Years of Construction Experience	Magnitude & Type of Work	In What Capacity

8. How many waste water lift station projects has your company, or the sub-contractor responsible for this work, completed in the past 12-years? (This does not include an individual's experience, separate from the company's experience; an individual's experience should be listed in their resume, if provided. **List a minimum of 3 projects.**)

No.	Project Name	Owner	Contact	Contact Phone	Amount
1					
2					
3					
4					

9. How many municipal projects, has your company completed in the past 10-years? (This does not include an individual's experience, separate from the company's experience; an individual's experience should be listed in their resume, if provided. List a minimum of 6 projects.)

No.	Project Name	Owner	Contact	Contact Phone	Amount
1					
2					
3					
4					
5					
6					

BIDDER'S AFFIDAVIT

The undersigned, as _____
(President, Officer of Corporation, Member of Firm) of the prospective bidder, hereby certifies that the foregoing information is, to the best of his/her knowledge and belief, true and accurate as of the _____ day of _____, 2018. Contractor, by his signature hereon, authorized the obtaining of reference information and hereby releases the party providing such information and the City of Sedona from any and all liability to Contractor as a result of such reference information being provided. Contractor further waives any right to receive copies if information so provided.

Corporate Seal
(If Corporation)

Contractor

BY: _____
Position (must be President, Officer of Corporation or member of Partnership as applicable)

STATE OF _____)
) ss
COUNTY OF _____)

The foregoing instrument was acknowledged before me this _____ day of _____, 2018, by _____as for the _____.

Subscribed and sworn to before me this _____ day of _____, 2018.

_____
(Notary Public)

My Commission expires: _____

CONTRACTOR'S FINANCIAL STATEMENT

1. Submit the most recent financial statements, including the Balance Sheet, Income Statement, sources and uses of funds, notes to the financial statement, and the auditor's opinion, that cover the most recent twelve (12) month period. These statements must have been audited by a Certified Public Accountant. However, if the prospective bidder has previously performed satisfactory work according to the City of Sedona's Engineering Department, unaudited financial statements may be allowed.

   Financial statements must be submitted on an accrual basis, in a form which clearly indicates the bidder's assets, liabilities, and net worth.

2. Also submit the most recent unaudited financial statements subsequent to number 1 above.

(Financial statements shall be required of and submitted by the apparent low bidder within two (2) days after the bid opening)

CERTIFICATE OF INSURABILITY

I hereby certify that as Bidder to the City of Sedona, Arizona, Wastewater Collection System Improvements – LS Improvements project, I am fully aware of the requirements of the City insurance requirements for contractors and that by submitting this bid proposal, assure the City that I am able to produce the required minimum insurance coverage should I be selected to be the successful Bidder.

Should I be selected to be the successful Bidder and then become unable to produce the insurance coverage within ten (10) days of receipt of the Notice of Award, I understand that my bid will be rejected and that I will forfeit my bid bond.

By: _____ Date: _____

Title: _____

SPECIAL CONDITIONS

General

Work shall be in accordance with Uniform Standard Specifications for Public Works Construction, distributed by Maricopa Association of Governments, 2012 edition (MAG), except to the extent that these specifications specify other procedures, processes, forms, materials, details, or other direction regarding the work, and as required to comply with local ordinances and regulations.

Whenever the term County is used it shall be held to mean the City of Sedona. Whenever the term County Engineer is used it shall be held to refer to the City Engineer.

Electrical work shall be subject to inspection by the City of Sedona Building Safety Division and compliance with its requirements.

General Provisions

The General Conditions and Specifications shall be considered as immediately following the Special Conditions in Order of Precedence and are part of the Contract documents.

1. Project Sign

The Contractor shall install one project sign. The sign shall identify the project and the City of Sedona as the Project owner, and provide a contact person for both the City and the Contractor. The sign shall be securely mounted and placed so that the bottom of the sign does not impede vehicular or pedestrian traffic flow or otherwise become a safety concern. The Contractor shall provide the project sign for the duration of the on-site work on the project. Payment of more than 75% of mobilization shall not be payable until the sign is in place. Failure to maintain the sign erect and in legible condition may result in up to a deduction from the contract payment equal to 0.25% for each time a written notice regarding improper sign maintenance is issued by the Engineer.

The required sign shall be mounted at a location within the project limits visible to the public as it enters or moves adjacent to the project area. The Contractor shall locate the sign in a location mutually agreeable to the Project Engineer and the Contractor within the project area. The sign shall be constructed per the Project Construction Sign Detail included at the end of the Special Conditions section. Compensation for this item shall be considered as included in the price for bid item “Mobilization”. The Contractor shall present the sign design as a project submittal. The Percent Complete Bar shall be filled in as the project progresses in accordance with Article 6 of the General Conditions.

2. Public Convenience and Safety

Within the City of Sedona public convenience and safety are matters to which the Contractor is expected to devote attention to at all times during the project. The Contractor shall minimize

disruption of normal vehicular and pedestrian traffic patterns and routes, the disruption of normal property services such as, but not limited to, mail delivery and garbage pick-up. Failure in making these provisions shall subject the Contractor to deductions from payments due under the contract as determined by the City Engineer.

3. Start of Construction

Construction shall not begin until the Contractor has at a minimum provided the following:

- A traffic control plan that has been approved by the City Engineer
- The Storm Water Pollution Control Plan provisions are in place per the SWPPP in the Civil Plans
- The contractor shall have a City of Sedona NOI for storm water pollution prevention
- A minimum of 2 working days written notice delivered to property owners, residents, and HOA President within and 300 feet adjacent to the work area. The notice shall state the Contractor's contact information, brief description of the project, and the project's anticipated start date
- Survey stakes and marks have been placed in the field to accommodate at least two weeks construction work and survey notes have been provided to the City as per the project specifications
- The Project Sign has been posted
- Equipment Rate Submittal as required by Section 47.D.3 of the General Conditions
- A complete project schedule as required by the General Conditions and Section 2 of the Special Conditions

This provision shall not require that the City of Sedona refrain from issuing a notice to proceed or require an extension of time to accommodate Contractor compliance with it.

4. Project Control

- The horizontal and vertical control for this project is shown on the civil drawings
- The benchmarks for this project are indicated on the civil drawings
- The Contractor shall be responsible for all survey on the project **see Section 15 of the General Conditions.**

5. Submittals

In addition to the submittals called for in the Technical Specifications and General Conditions, additional submittals are required for the following items: shoring plan, sewer pipe, manholes, concrete mix design, asphalt mix design, metal fabrications, project sign, and equipment rental rates for all equipment to be utilized for the project (as required by Section 47.D.3 of the General Conditions).

6. Various items of Work

The Contractor shall provide the City reasonable and timely notice in writing prior to exceeding quantities established in the Bid Schedule. Failure to notify the City in a timely manner prior to exceeding the contractual quantities identified in the Bid Schedule shall be sufficient reason for the City to deny such claim.

Roadway specifications shall conform (or comport with City Code Sections…) to City Code Sections 12.05.110 and 12.05.120.

Clearing and grubbing shall be subject to MAG specification Section 201 and full compensation shall be considered as provided in bid item "Mobilization". No separate payment shall be made for trees.

It is the contractor's responsibility to comply with the ADA, specifically the requirements of ADAAG, even if the project plans show an item to not meet the requirements of ADAAG.

The City of Sedona reserves the right to request a schedule of values for any of the lump sum bid items.

All guarantees shall be per Section 51 of the General Conditions.

If it is determined that import or export of earthen material in excess of 40 cubic yards (combined total) is needed, a Haul Plan shall be provided to the City Engineer. At least 5 city working days prior to the placement of fill or excavated material from a grading project within the city on other properties located within the city, Engineering Services shall be notified in writing of the intent to place the material on other property. This requirement shall apply when the total amount of material placed on other properties within the city exceeds 40 cubic yards or if the other property on which the fill is to be placed is located within 0.75 miles of Oak Creek, or lies within a city designated flood plain. The City Engineer may approve or deny permission to place such material.

The contractor shall provide copies of all required testing to Engineering Services.

The City reserves the right to require that payment requests be submitted in a format it approves.

The City may require information as necessary to verify proper work eligibility of persons, subcontractor, or others providing labor, equipment, material or services to this project. This may include but is not limited to social security numbers, driver's license numbers, and evidence of age or citizenship.

7. Permits

The Contractor shall be responsible for obtaining permits bearing on the work and adhere to provisions of said permits. The Contractor shall also adhere to requirements of Homeowner Associations or similar organizations when establishing equipment, storage or other yards within

subdivisions. Evidence of such adherence shall be provided in writing, if requested by the City.

8. Utility Relocation

It shall be the responsibility of the Contractor to arrange and coordinate the relocation of any utilities found to be in conflict with the work. Utility relocation costs not identified as a bid item in the contract will be the City's responsibility.

9. Local Drainage

The Contractor shall reconstruct roadways, driveways, sidewalks, ditches and other surfaces at elevations that will ensure the drainage is improved or unchanged from the existing pre-construction conditions.

The Contractor shall manage any upstream flows during construction to maintain continuous conveyance and historic flow patterns through the project area.

10. Required Inspection

Work requiring inspection includes the following: testing, asphalt preparation and placement, cleanup, rebar inspection, traffic control setup and removal, trench bedding placement and backfill compaction, pipe placement, and concrete formwork prior to pouring concrete.

11. Project Progress Payments

Payment of up to 20% of stored materials or equipment shall be made, upon request of the Contractor, pursuant to the requirements in General Condition 31.C.

12. Subcontractors

General Conditions Section 13.C shall be revised to allow subcontractor to collectively perform no more than sixty-five percent (65%) of the value of the total work required. The Contractor shall self-perform thirty-five percent (35%) of the total contract work.

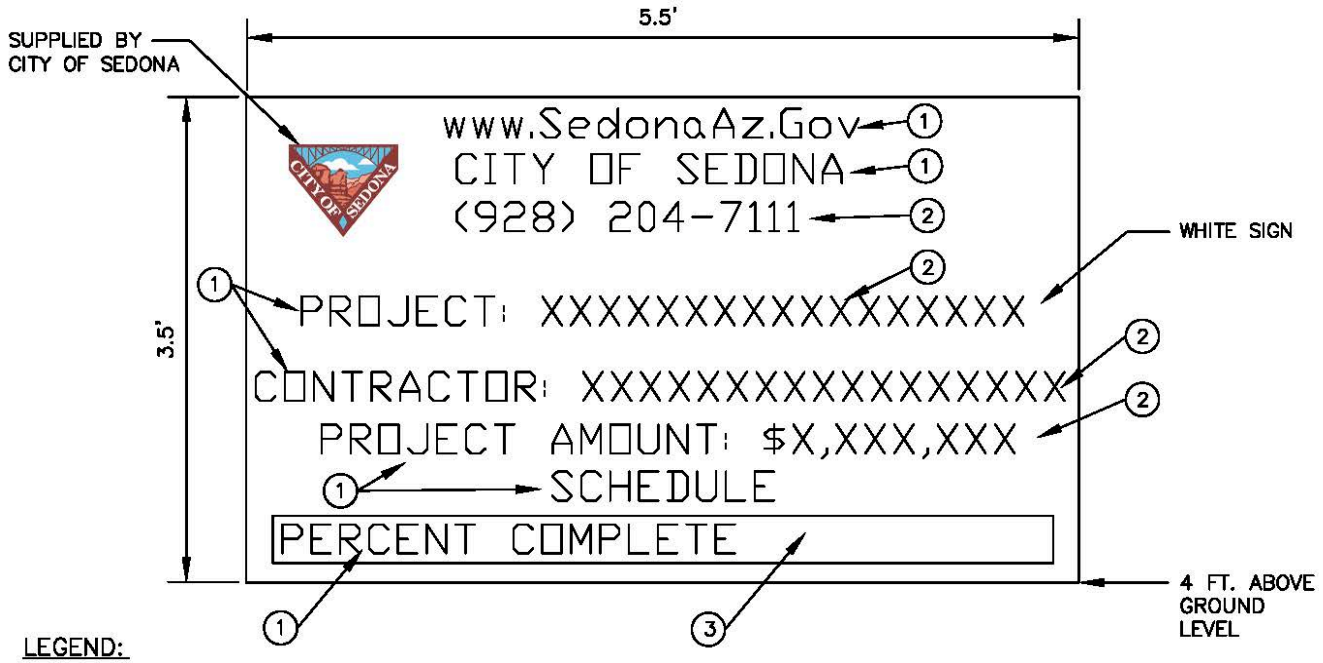
13. Pre-arranged Pricing for Select Lift Station Material/Equipment

The Contractor is advised that certain lift station equipment has been pre-qualified and pre-selected with pricing previously arranged by the City of Sedona for incorporation into the project work. This equipment/material shall be utilized by the Contractor and incorporated into the without substitution.
The pre-selected equipment consists of a Lift Station Package as referenced and shown in the Contract Documents (Plans and Specifications) for both the City of Sedona, Chapel Lift Station Improvements and the City of Sedona, Mystic Hills Lift Station Improvements. The Contractor shall coordinate with the supplier for the Order, Purchase, Delivery and all other arrangements

as needed with the supplier of the Lift Station Package. Contractor shall install the Lift Station Package in accordance the Contract Documents.

The Lift Station Package supplier is JCH/James, Cooke & Hobson Inc, 3501 E Broadway Road, Phoenix, AZ 85040. Contact Eric J Loring, PE at: 602.243-0585 x304 (office); 480.695.9972 (cell).

07.DWG



LEGEND:

(1) – 3" BLACK LETTERING

(2) – 3" BLUE LETTERING

(3) – WHITE WITH RED INDICATOR

SCALE: N.T.S.

DWG FullPath: L:\Sedona Standard Details\07.dwgPlot Date/Time: 01/31/18 09:08am

SPECIAL DETAIL NO. 07	CHECK WITH CITY ENGINEER FOR UPDATES	PROJECT CONSTRUCTION SIGN	SPECIAL DETAIL NO. 07

NOTICE OF AWARD

Date

Contractor Name.
Street or PO Box
City, State Zip

SUBJECT: NOTICE OF AWARD – WASTEWATER COLLECTION SYSTEM IMPROVEMENTS – LS IMPROVEMENTS

The City of Sedona, having duly considered the bid submitted on _____, 2018 for the City of Sedona _____ as outlined in the Contract Documents and detailed on the drawings, and it appearing that your proposal for performing the work is fair, equitable, and in the City's best interest, and the bid includes price for work in the bid schedule in the estimated total amount of **$** _____ said bid is hereby accepted at the prices contained therein, and in accordance with all provisions set forth in the Contract Documents.

In accordance with the terms of the Contract Documents, you are required to execute the formal Contract and furnish the required Performance and Payment Bonds within ten (10) consecutive calendar days from and including the date of receipt of this Notice.

In addition, you are requested to furnish at the same time, the required Owner's protective liability and property damage insurance policy, and certificates of insurance in triplicate evidencing compliance with the other requirements for insurance stated in the Contract Documents. Your certificates of insurance shall be accompanied by a letter from your insurance company stating that the insurance certificate meets the entire requirements of the specifications, or shall state and describe specific exclusions.

The Bid Bond submitted with your proposal will be retained until the Contract has been executed and the required Performance and Payment Bonds have been furnished and approved. In the event that you should fail to execute the Contract or furnish the Performance and Payment Bonds within the time limit specified, the City, at its discretion, may cash the Bid Bond and proceed with steps that are in the City's best interest.

RECEIVED AND ACCEPTED:

Contractor
By:
Name: _____
Date: _____

CITY OF SEDONA, ARIZONA

Sincerely,

_____
Roxanne Holland, P.E.,
Wastewater Manager

Enclosures (3) contracts

JAD/clp
cc: City Manager

NOTICE TO PROCEED

Date

Contractor Name.
Street or PO Box
City, State Zip

Attention:

Subject: **NOTICE TO PROCEED - WASTEWATER COLLECTION SYSTEM IMPROVEMENTS – LS IMPROVEMENTS**

You are hereby authorized to proceed with work effective _____, 2018 and fully complete all work within _____ consecutive days from this date. The completion date for this Project is therefore _____, 2018. Liquidated damages of **$ XXX per day** are applicable for each day past _____ _____, 2018 for which work on this Project is not complete, unless an adjustment is authorized by a change order. Please acknowledge your receipt of this letter and agreement with the terms stated by signing in the space provided and returning to the City for our files.

CITY OF SEDONA, ARIZONA

By: _____
Roxanne Holland, P.E.
Wastewater Manager

Date: _____

Receipt Acknowledged:

By: _____

Date: _____

City of Sedona Public Works Department
102 Roadrunner Drive Sedona, AZ 86336
(928) 204-7111 Fax: (928) 282-5348

Public Works Department
Change Order

This change order is not effective unless signed by the City Manager of the City of Sedona or his properly designated representative. Section 47 of the Contract General Conditions shall apply.

****

THIS CHANGE ORDER CONSTITUTES FULL, FINAL AND COMPLETE COMPENSATION TO THE CONTRACTOR FOR ALL COSTS, EXPENSES, OVERHEAD, PROFIT, AND ANY DAMAGES OF EVERY KIND THAT THE CONTRACTOR MAY INCUR IN CONNECTION WITH THE WORK DESCRIBED IN THIS CHANGE ORDER, INCLUDING ANY IMPACT ON THE DESCRIBED WORK OR ON ANY OTHER WORK UNDER THE CONTRACT, ANY CHANGES IN THE SEQUENCES OF ANY WORK, ANY DELAY TO ANY WORK, ANY DISRUPTION OF ANY WORK, ANY RESCHEDULING OF ANY WORK, AND ANY OTHER EFFECT ON ANY OF THE WORK UNDER THIS CONTRACT. BY THE EXECUTION OF THIS CHANGE ORDER, THE CONTRACTOR ACCEPTS THE CONTRACT PRICE CHANGE AND THE CONTRACT COMPLETION DATE CHANGE, IF ANY, AND EXPRESSLY WAIVES ANY CLAIMS FOR ANY ADDITIONAL COMPENSATION, DAMAGES OR TIME EXTENSIONS, IN CONNECTION WITH THE DESCRIBED WORK.

****

CHANGE ORDER NUMBER: **DATE:**
PROJECT: **SUGARLOAF TRAILHEAD PARKING LOT IMPROVEMENTS**
CONTRACTOR NAME:
REASON FOR CHANGE:

Plan Sheet #'s affected by this change:
Specification Sections upon which Change Order is based: GC 47-49
Change requested by (check one): _____ City _____ Contractor _____ Both
Contract time adjustment: _____ Calendar Days
This contract change order
_____ increases the maximum estimated contract compensation per GC Section 47 contract adjustment as follows:
_____ decreases the maximum estimated contract compensation per GC Section 47 contract adjustment as follows:

$0.00	+ $0.00	+ $0.00	+ $0.00	= $0.00
Method A	+ Method B	+ Method C	+ Method D	= Total Cost Adjustment

Contract Compensation:		Contract Time:	
Original Contract Amount	$1.00	Original Contract Time (days)	60
This Change Order	$0.00	This Change Order (days)	0
All Previous Change Orders	$0.00	All Previous Change Orders (days)	
Total Maximum Compensation	$1.00	Total Maximum Contract Time (days)	60

CONTRACTOR ACCEPTANCE

BY: _____

DATE: _____

CITY OF SEDONA - PUBLIC WORKS DEPT. APPROVED

BY: _____

DATE: _____

CITY OF SEDONA - CITY MANAGER APPROVAL

BY: _____

DATE: _____

Attach a more complete description of the change and supporting documentation to this form.

L:\SHAREPOINT\RESOURCES\CONTRACT DOCUMENTS\2018 CONTRACT DOCUMENTS\Contract Documents\Construction\XYZ Project\Change Order

General Conditions
2018

TABLE OF CONTENTS

GENERAL CONDITIONS

1. CONTENTS

The following Contract Provisions are general in scope and may refer to conditions, which will not be encountered in the performance of the work, included in this Contract and which are not applicable thereto. Any requirements, provisions or other stipulation of these General Conditions, which pertain to a non-applicable condition, shall be excluded from the scope of the Contract. Where conflict appears, “Special Condition” shall take precedence over "General Conditions". Full compensation for compliance with these General Conditions shall be considered as included in the total and various bid items of the contract and the contract time.

2. DEFINITIONS AND TERMS

When the Contract indicates that work shall be "accepted, acceptable, approve, authorized, condemned, considered necessary, contemplated, deemed necessary, designated, determined, directed, disapproved, established, given, indicated, insufficient interpreted, ordered, permitted, rejected, required, reserved, satisfactory, specified sufficient, suitable, suspended, unacceptable, unsatisfactory," it shall be understood that these expressions are followed by the words "by the City of Sedona".

Wherever the following abbreviations, terms, or pronouns are used in the specifications, plans, or other Contract Documents, the intent and meaning shall be interpreted as follows:

ABBREVIATIONS

AAN	American Association of Nurserymen
AAR	Association of American Railroads
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ADOT	Arizona Department of Transportation
AGC	Associated General Contractors of America
AI	Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
ANSI	American National Standards Institute, Inc.
ARA	American Railway Association
AREA	American Railway Engineering Association
ARTBA	American Road and Transportation Builders Association
ASCE	American Society of Civil Engineers
ASLA	American Society of Landscape Architects
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATSSA	American Traffic Safety Services Association

A WG	American Wire Gauge
AWPA	American Wood Preservers' Association
AWS	American Welding Society
AWWA	American Water Works Association
CRSI	Concrete Reinforcing Steel Institute
EIA	Electric Industries Association
FHWA	Federal Highway Administration, Department of Transportation
FSS	Federal Specifications and Standards
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
IMSA	International Municipal Signal Association
IPCEA	Insulated Power Cable Engineers Association
ITE	Institute of Transportation Engineers
MAG	Maricopa Association of Governments
MIL	Military Specifications
MUTCD	Manual on Uniform Traffic Control Devices
NEC	National Electrical Code
NEMA	National Electrical Manufacturers' Association
NIST	National Institute of Standards and Technology
NSF	National Sanitation Foundation (NSF)
SAE	Society of Automotive Engineers
UL	Underwriters Laboratories, Inc.

ADVERTISEMENT - A public announcement inviting proposals for work to be performed or materials to be furnished.

AWARD - The acceptance by the City of a proposal.

BASIS OF PAYMENT - The terms under which "work" is paid, as a designated pay item in accordance with the quantity measured and the pay unit.

BIDDER - Any individual, partnership, joint venture, firm or corporation submitting a proposal for the advertised work, acting directly or through a duly authorized representative.

CALENDAR DAY - Each and every day shown on the calendar, beginning and ending at midnight.

CERTIFIED INVOICE - An invoice from a supplier which has been reliably endorsed by the Contractor guaranteeing that the material was purchased and received for the project and establishing the value of the material.

CLAIM - A written demand or request for additional compensation or additional time submitted to the Engineer that:

A. Contains the words “This is a claim…”, within its Subject line or the first paragraph
B. Cites the contractual basis for the demand or request

C. Relates the Contractual basis cited to factual events occurring or that have occurred within the project.

COMPLETION DATE - The date on which the contract work is specified to be completed

CONTRACT ITEM (PAY ITEM) - A specifically named unit of work for which a price is provided in the Contract. The description, whether general or detailed, the content of the named unit of work shall be as per the project plans and specifications.

CONTRACT CHANGE ORDER - A written order issued to the Contractor by the City covering extra work, additions or alterations to the plans and specifications, and establishing the basis of payment and time adjustment for the work affected by the changes. The Contract Change Order is the only method authorized for changing the Contract.

CONTRACT DOCUMENTS - The following comprise the Contract Documents: Advertisement for Bids, Information for and Instructions to Bidders, Bid Proposal and Bid Guarantee Bond, Construction Contract, Change Orders, Addenda, Performance Bond, Labor and Material Payment Bond, Special Conditions, General Conditions, Technical Specifications, Notice of Award, Notice to Proceed, Drawings, Plans, Standard Specifications and Certificate of insurability. All of these documents together constitute the **CONTRACT.**

CONTRACT TIME - The number of calendar days allowed for the entire completion of the Contract, including authorized time extensions and work required to be complete after substantial completion. Where a calendar date of completion is specified, the Contract shall be completed on or before that date.

CONTRACTOR - Party contracting directly with the City to furnish and perform all work and services in accordance with the Contract Documents.

COUNTY - The County in which the work is to be done.

DAY - Unless otherwise defined shall mean "calendar" day.

ENGINEER - The City Engineer; or his designated representative.

EXTRA WORK - Work not provided for in the Contract as awarded but determined by the City to be essential to the satisfactory completion of the Contract within its intended scope.

FINAL ACCEPTANCE - The acknowledgment by the City that the project or the work has been completed in accordance with the Contract Documents and provides the date at which the warranty or guarantee period begins.

INSPECTOR - A person, persons, or firm authorized by the Engineer to make detailed reviews, observations, reports and determinations of contract performance.

MAY - Used to refer to permissive actions.

METHOD OF MEASUREMENT - The manner in which a pay item is measured to conform with the pay unit.

NOTICE OF CLAIM - A written notification submitted to the Engineer that a demand or request for additional compensation or additional time may be made. The notification shall

1. Contain the words "notification of a potential claim" within its Subject line or the first paragraph
2. Describe the occurrence which is the reason that the Notice of Claim is being presented

NOTICE TO PROCEED - Written notice to the Contractor to proceed with the contract work including, when applicable, the date of beginning of contract time. Start of Construction, as defined below, may start at a later date.

PLANS - The drawings and pictures depicting the location and special orientation of the work to be done.

PROJECT - The work to be completed pursuant to this contract.

PROPOSAL - A standard form plus information supplied by the City, which contains spaces for completion by the Bidder which, when completed in its entirety and executed by the Bidder, along with all required additional documents, shall constitute the Bid. Said Bid shall constitute the Contractor's offer to perform all work required as set forth in the Contract Documents for the amount of money stated in the Bid.

PROPOSAL FORM - The documents furnished by the City on which the offer of a bidder is submitted.

PROPOSAL GUARANTY - The security furnished with a proposal to Guaranty that the bidder will enter into the Contract if the proposal is accepted.

RIGHT OF WAY - A general term denoting land, property, or interest therein, acquired for or devoted to the construction of an improvement.

SALVABLE MATERIAL - Material that can be saved or salvaged. Unless otherwise designated or directed by the City or shown on the plans, all salvable material shall become the property of the Contractor.

SAMPLES - Samples are physical examples furnished or constructed by the Contractor to illustrate materials, equipment, workmanship or finishes, and to establish standards by which the work will be judged.

SHALL - Refers to mandatory actions by either the Contractor or the City.

SHOP DRAWINGS - Drawings, diagrams, illustrations, certificates, test reports, schedules, performance charts, brochures, shop layouts, fabrication layouts, assembly layouts, foundation layouts, wiring and piping layouts, specifications and descriptive literature required by the Contract Documents which the Contractor is required to submit for approval.

START OF CONSTRUCTION – The date in which the Contractor begins physical work at the project site. Restrictions on start of construction are provided in the General Conditions and may be specified in the Special Conditions.

SUBCONTRACTOR - Party supplying labor and/or material for work at the site of the project for, and under separate contract or agreement with, the Contractor. Nothing contained in the Contract Documents shall create any contractual relationship between the City and any subcontractor.

SUBSTANTIAL COMPLETION - The date when the work is sufficiently completed so it may be safely, conveniently, and beneficially utilized by the City for all of the purposes for which it was intended. Reduced liquidated damages are chargeable for a project or portions thereof which have separately specified damages, if there are items of work remaining to be performed relative to such work once full substantial completion status has been attained. In such cases the amount of liquidated damages due shall be twenty-five percent (25%) of the unreduced liquidated damage amount stated in the contract.

SUPERINTENDENT - The Contractor's authorized representative in charge of the work.

WORK - The furnishing of all labor, materials, equipment, and all other incidentals necessary to the successful and acceptable completion of all obligations as described in the Contract Documents, and the carrying out of all of the duties and obligations imposed by the Contract.

3. CONTRACTOR'S UNDERSTANDING

A. It is understood and mutually agreed that by submitting a proposal, the Contractor acknowledges that he has carefully examined all documents pertaining to the work, the locations, accessibility, and general character of the site of the work and all existing buildings and structures within and adjacent to the site, and has satisfied himself as to the nature of the work, the condition of existing buildings and structures, the conformation of the ground, subsurface conditions, the character, quality, and equipment, machinery, plant, and any other facilities needed preliminary to and during prosecution of the work, the general and local conditions, the construction hazards, and all other matters, including but not limited to any labor situation which can in any way affect the work under the Contract. It is further mutually agreed that by submitting a proposal, the Contractor acknowledges that he has satisfied himself as to the feasibility and correctness of the Contract Documents for the construction of the work and that he

accepts all the terms, conditions, and stipulations contained therein; and that he is prepared to work in peace and harmony with other Contractors performing work on the site.

B. No verbal agreement or conversation with any officer, agent, or employee of the City, either before or after the execution of the Contract, shall affect or modify any of the terms, conditions, or other obligations set forth in any of the Contract Documents.

C. The Contractor understands that, unless specifically stated otherwise in the contract documents, the intent of the contract documents is to provide complete and operable facilities. The Contractor's bid amount for this project, therefore, shall be and is considered to be for completion in conformity with this understanding, regardless of whether some aspect of the work to be performed is named as a separate bid item or not.

4. DEFECTIVE WORK

A. A City Representative, designated by the City Engineer, shall give written notice of the noncompliance to the Contractor, when, and as often as the City Representative determines through his inspection that procedures, material, equipment or workmanship incorporated in the Project does not meet the requirements of the Contract. Within five (5) working days from the receipt of such notice, the Contractor shall undertake the work necessary to correct such deficiencies, and to bring the work into compliance with the Contract Documents. Should the Contractor not agree with the City Representative's determination, and as a condition precedent to any request for either additional compensation or time extension, or both, resulting from the City Representative's determination, the Contractor shall within three (3) working days provide a Notice of Claim to the Engineer that he may claim additional compensation, time or both, and detailed explanation of the Contractor's position. The Contractor shall document the costs associated with the corrective work with daily records and cost data and shall furnish such information to the Inspector daily. Receipt of cost data shall not be construed to be an acceptance of the corrective work, or an authorization for a Change Order to cover the corrective work. Failure by the Contractor to provide the specified written notice of an intention to make a claim shall be sufficient basis to reject any related claim subsequently submitted.

B. Prior to initial acceptance of the Project, the City may, at its option, retain work, which is not in compliance with the Contract if the City determines that such defective work is not of sufficient magnitude or importance to make the work dangerous or undesirable. The City also may retain defective work, if in the opinion of the Inspector, and with concurrence of the City Engineer, removal of such work is impractical or will create conditions, which are dangerous or undesirable. Just and reasonable value, for such defective work, shall be judged, by the Engineer and appropriate deductions shall be made in the payments due, or to become due to the Contractor. Initial acceptance shall not act as a waiver of the City's right to recover from the Contractor an amount representing the deduction for retention of defective work.

5. NOTICE AND SERVICE THEREOF

Where the manner of giving notice is not otherwise provided for in the Contract Documents, any notice to the Contractor from the City relative to any part of the Contract shall be in writing and considered delivered and the service thereof completed, when said notice is posted to the Contractor at the address given in the Contractor's proposal, or at the last business address known to the City, or delivered in person to the Contractor or his authorized representative on the site or transmitted electronically by facsimile or electronic mail using phone numbers and addresses last provided by the Contractor. It is mutually agreed that such notice shall be sufficient and adequate. The Contractor shall provide the City, upon written request, facsimile phone numbers and electronic mail addresses, in writing.

6. MATERIAL AND EQUIPMENT SPECIFIED BY NAME

When material or equipment is specified by reference to one or more patents, brand names, or catalog numbers, it shall be understood that this is referenced for the purpose of defining the performance or other salient requirements, and that other materials or equipment, of equal capacities, quality and function may be considered. The Contractor may offer material or equipment of equal or better quality and performance in substitution for those specified which he considers would be in the City's interest to accept. After the Award of the Contract, the City will consider offers for substitution only from the Contractor and will not acknowledge or consider such offers from suppliers, distributors, manufacturers, or Subcontractors.

Substitutions

The Contractor's offer of substitution shall be made in writing to the Engineer and shall include sufficient data to enable the Engineer to assess the acceptability of the material or equipment for the particular application and requirements. If the offered substitution necessitates changes to or coordination with other portions of the work, the data submitted shall include drawings and details showing such changes. Contractor agrees to perform these changes as part of the substitution of material or equipment. Within thirty (30) calendar days after the receipt of the offer of substitution, the Engineer will review the material submitted by the Contractor and notify the Contractor if approved for use or objections, if any, to the proposed substitution or if further information is required. Upon notification by the Engineer, the Contractor shall either provide the approved material or equipment, which complies with project specifications, or furnish requested additional information. While the Engineer might not take any objections to the proposed substitution and may approve the same, such action shall not relieve the Contractor from responsibility for the efficiency, sufficiency, quality and performance of the substitute material or equipment, in the same manner and degree as the material and equipment specified by name. Any cost differential associated with a substitution shall be reflected in the Contractor's offer of substitution and the Contract Documents shall be modified by a Change Order.

When the specifications state the construction shall be performed by the use of certain methods and equipment, such methods and equipment shall be used unless other methods are authorized by the Engineer. If the contractor desires to use a method or type of equipment other than those specified, he may request authority from the Engineer to do so. The request shall be in writing and shall include a full description of the method and equipment proposed to be used and an explanation of the reasons for desiring to make the change. If approval is given it will be on the condition that the Contractor will be fully responsible for producing construction work in conformity with the Contract Documents. If material or equipment is specified by only one patent or proprietary name, or by the name of only one manufacturer, it is for the purpose of standardization, or because the City knows of no equal. If standardization is the reason for using one name to specify any material or equipment, the specifications will so state, and substitutions will not be considered. In other cases, the Contractor may offer substitutions in the same manner as requesting a Change Order for products he considers being equal to those specified.

7. CONTRACT BONDS AND GUARANTEES

A. The Contractor shall provide two surety bonds on the forms provided, each in an amount equal to 100% of the contract price. One shall serve as security for the faithful performance of the work and the other as security for the faithful payment and satisfaction of the persons furnishing materials and performing labor on the work. The bonds shall be issued by a corporation duly and legally licensed to transact surety business in the State of Arizona. Such bonds shall remain in force throughout the period required to complete the work and thereafter for a period of 365 calendar days after final acceptance of the work, plus 365 calendar days following the repair of any work pursuant to the guarantees herein made. The surety's liability on the bonds shall not exceed the underwriting limitations for the respective surety specified in Circular 570, published by the United States Department of the Treasury.

B. Should any surety or sureties be deemed unsatisfactory at any time by the City, notice will be given to the Contractor to that effect and he shall forthwith substitute a new surety or sureties satisfactory to the City. No further payment shall be deemed due or will be made under this Contract until the new surety shall qualify and be accepted by the City.

C. The Contractor guarantees to the City that all materials and equipment furnished under this Contract will be new and of good and sufficient quality, free from faults and defects as is necessary to complete the project as required by the Plans and Specifications.

8. INSURANCE

A. The Contractor, at Contractor's own expense, shall purchase and maintain the herein stipulated minimum insurance with companies duly licensed, possessing a current A.M. Best, Inc. Rating of B+6, as minimum and approved and licensed to do business in the State of Arizona with policies and forms satisfactory to the City.

B. All required insurance herein shall be maintained in full force and effect until all work required to be performed under the terms of the Contract is satisfactorily completed and finally accepted - failure to do so may, at the sole direction of the City, constitute a material breach of this Contract.

C. The Contractor's insurance shall be primary insurance, and any insurance or self-insurance maintained by the City shall not contribute to it.

D. Any failure to comply with the claim reporting provisions of the policies or any breach of an insurance policy warranty shall not affect coverage afforded under the policy to protect the City.

E. The policies, except Workers' Compensation, shall contain a waiver of transfer rights of recovery (subrogation) against the City, its agents, officers, officials and employees for any claims arising out of the Contractor's work or service.

F. The insurance policies may provide coverage, which contains deductibles or self-insured retentions. Such deductible and/or self-insured retentions shall not be applicable with respect to the coverage provided to the City under such policies. The Contractor shall be solely responsible for deductible and/or self-insured retention and the City, at its option, may require the Contractor to secure the payment of such deductible or self-insured retentions by a surety bond or an irrevocable and unconditional letter of credit.

G. The City reserves the right to request and to receive, within ten (10) working days, certified copies of any or all of the herein required insurance policies and/or endorsements. The City shall not be obligated, however, to review same or to advise Contractor of any deficiencies in such policies and endorsements, and such receipt shall not relieve Contractor from, or be deemed a waiver of, the City's right to insist on strict fulfillment of Contractor's obligations under this Contract.

H. The insurance policies, except Workers' Compensation, required by this Contract shall name the City, its agents, officers, officials and employees as additional insured.

I. The making of progress payments to the Contractor shall not be construed as creating an insurable interest by or for the City or be construed as relieving the Contractor or his Subcontractors of responsibility for direct physical loss, damage or destruction occurring prior to final acceptance.

J. Any insured loss under the policies of insurance required by this Agreement shall be adjusted with the City and made payable to City for the insured, as their interests may appear, subject to the requirements of any applicable mortgage clause and of Paragraph K of this Article of these General Conditions. City shall deposit in a separate account any money so received and shall distribute it in accordance with such agreement as the parties in interest may reach. If no other special agreement is reached, the damaged work shall be repaired or replaced, the moneys so received shall be applied on account

thereof, and the work and the cost thereof shall be covered by an appropriate Change Order.

K. City shall have power to adjust and settle any loss with the insurers unless one of the parties in interest shall object in writing within ten (10) working days after the occurrence of loss to City's exercise of this power. If such objection were made, City shall make settlement with the insurers in accordance with such agreement as the parties in interest may reach. If required in writing by any party in interest, City shall upon the occurrence of an insured loss, give bond for the proper performance of these duties

L. If City finds it necessary to occupy or use a portion or portions of the work prior to substantial completion of all of the work, such use or occupancy may be accomplished as provided in these General Conditions, provided that no such use or occupancy shall commence before the insurers providing the property insurance have acknowledged notice thereof and in writing effected the changes in coverage necessitated thereby. The insurers providing the property insurance shall consent by endorsement on the policy or policies, but the property insurance shall not be canceled or lapse on account of any such partial use or occupancy.

M. REQUIRED COVERAGE

The Contractor shall obtain for itself and provide the City with Certificates of Insurance indicating the scope and extent of coverage as set forth below. Required coverage's may be modified by an amendment to the Contract Documents.

1. GENERAL LIABILITY

   Contractor shall maintain Commercial General Liability insurance with a limit of not less than $3,000,000 for each occurrence with a $3,000,000 Products and Completed Operations Aggregate and $3,000,000 General Aggregate Limit. The policy shall include coverage for bodily injury, broad form property damage, personal injury, products/completed operations and blanket contractual coverage including, but not limited to, the liability assumed under the indemnification provisions of this Contract, which coverage will be at least as broad as Insurance Service Office, Inc. Policy Form CG 000211093, or any replacements thereof. The coverage shall not exclude X, C, U.

   Such policy shall contain a severability of interest provision, and shall not contain a sunset provision or commutation clause, or any provision, which would serve to limit third party action over claims.

   The Commercial General Liability additional insured endorsement shall be at least as broad as the Insurance Service Office, Inc.'s, Additional Insured, Form B, CG2010l185, and shall include coverage for Contractor's operations and products and completed operations.

If required by this Contract, the Contractor subletting any part of the work, services or operations awarded to the Contractor shall purchase and maintain, at all times during prosecution of the work, services or operations under this Contract, an Owner and Contractor's Protective Liability insurance policy for bodily injury and property damage, including death, which may arise in the prosecution of the Contractor's work, service or operations under this Contract. Coverage shall be on an occurrence basis with a limit not less than $3,000,000 per occurrence, and the policy shall be issued by the same insurance company that issues the Contractor's Commercial General Liability Insurance.

2. AUTOMOBILE LIABILITY

   Contractor shall maintain Commercial Business Automobile Liability insurance with a combined single limit for bodily injury and property damage of not less than $1,000,000 each occurrence and $2,000,000 for more than one person and property damage in the sum of not less than $1,000,000 resulting from any one accident which may arise from the operation, actions or omissions of the Contractor or any Subcontractor in the performance of the project, and with respect to the Contractor's owned, hired, and non- owned vehicles assigned to or used in performance of the Contractor's work. Coverage will be at least as broad as coverage code 1, "any auto", (Insurance Service Office, Inc. Policy Form CA 00011293, or any replacements thereof). Such insurance shall include coverage for loading and offloading hazards. If hazardous substances, materials or wastes are to be transported, MCS 90 endorsement shall be included and $5,000,000 per accident limits for bodily injury and property damage shall apply.

3. WORKERS' COMPENSATION

   The Contractor shall carry Workers' Compensation insurance to cover obligations imposed by federal and state statutes having jurisdiction of Contractor's employees engaged in the performance of the work; and, Employer's Liability insurance of not less than $1,000,000 for each accident, $1,000,000 disease for each employee, and $1,000,000 disease policy limit.

   In case any work is subcontracted, the Contractor will require the Subcontractor to provide Workers' Compensation and Employer's Liability to at least the same extent as required of the Contractor.

   The Contractor shall furnish the City with a Certificate of Waiver of Subrogation under the terms of the Workmen's Compensation insurance. The Contractor shall defend, protect, and save harmless the City from and against all claims, suits, and actions arising from failure of the Contractor or the Subcontractor to maintain such insurance.

4. BUILDERS' RISK (PROPERTY) INSURANCE

   The Contractor shall purchase and maintain, on a replacement cost basis, Builders' Risk insurance in the amount of the initial Contract Amount as well as subsequent modifications thereto for the entire work at the site. Such Builders' Risk insurance shall be maintained until final payment has been made or until no person or entity

other than the City has an insurable interest in the property required to be covered, whichever is earlier. This insurance shall include interests of the City, the Contractor, and all Subcontractors and Sub-Subcontractors in the work during the life of the Contract and course of construction, and shall continue until the work is completed and accepted by the City. The insurance shall cover work performed under the Contract and materials, equipment or other items to be incorporated therein, while the same are located at the construction site, stored off-site, or at the place of manufacture. The policy shall cover not less than losses due to fire, mischief, weather, vandalism, malicious mischief, wind, collapse, riot, aircraft, smoke or any other casualty, including but not limited to earthquakes, tornadoes or other cataclysmic events, until the date of initial acceptance of the work. For new construction projects, the Contractor agrees to assume full responsibility for loss or damage to the work being performed and to the buildings under construction. For renovation construction projects, the Contractor agrees to assume responsibility for loss or damage to the work being performed at least up to the full Contract Amount unless otherwise required by the Contract Documents or amendments thereto.

Builders' Risk insurance shall be on an all-risk policy form and shall also cover false work and temporary buildings and shall insure against risk of direct physical loss or damage from external causes including debris removal, demolition occasioned by enforcement of any applicable legal requirements, and shall cover reasonable compensation for Architect's service and expenses required as a result of such insured loss and other " soft costs" as required by the Contract.

Builders' Risk insurance must provide coverage from the time any covered property becomes Contractor's control and/or responsibility, and continue without interruption during construction or renovation or installation, including any time during which the covered property is being transported to the construction installation site, and while on the construction or installation site awaiting installation. The policy will provide coverage while the covered premises or any part thereof are occupied. Builders' Risk insurance shall be primary and not contributory.

If the Contract requires testing of equipment or other similar operations, at the option of the City, the Contractor will be responsible for providing property insurance for these exposures under a Boiler Machinery insurance policy.

The maximum deductible allowable under this policy shall be $5,000. The policies providing this insurance shall name the City, its agents and attorneys, the City Engineer, and the Design Engineer as additional insured as their respective interests shall appear.

5. BLASTING INSURANCE:
   If the Contractor determines that the performance of the project will require use of explosives, the public liability and property damage insurance shall specifically cover all liability arising out of the Contractor's acquisition, storage and use of explosives. If work requiring use of explosives is not discovered until after the

commencement of the work, upon discovery, the Contractor shall immediately procure blasting insurance as required by this paragraph. The Contractor shall not undertake any blasting without submission to the City of a Certificate of Insurance covering all liability due to blasting regardless of amount. Any delays incurred by the Contractor in procuring blasting insurance shall not be grounds for an extension of time for completion of the project, nor for any additions to the contract price.

6. OTHER INSURANCE:
   The Contractor shall carry and maintain all other insurance including Flood Insurance as may be required by Federal, State, County and City laws or ordinances. The Contractor may be required to, at the discretion of the City, maintain additional fire and extended coverage with an endorsement for vandalism and malicious mischief in his name and also in the name of the City in an amount of not less than $100,000.00.

   The Contractor may utilize up to $2,000,000 in excess liability coverage to meet the above-required limits for insurance. Any deductibles shall be declared and the City may require deposits be made to it up the amount of such deduction, at its sole discretion.

7. CERTIFICATES OF INSURANCE
   Prior to commencing Services under this Contract, Contractor shall furnish the City with Certificates of Insurance, or formal endorsements as required by the Contract, issued by Contractor's insurer(s), as evidence that policies providing the required coverage's, conditions and limits required by this Contract are in full force and effect.

   All Certificates of Insurance required by this Contract shall be identified with a bid serial number and title. A $25.00 administrative fee shall be assessed for all Certificates received without the appropriate bid serial number and title. Each of the Certificates of Insurance shall contain a clause substantially in the following words:

   It is hereby understood and agreed that if this policy is canceled, a written notice of such cancellation shall be mailed to the City of Sedona within ten (10) working days.

   Such insurance coverage obtained by the Contractor other than Workmen's Compensation Coverage, shall name the City, the City Engineer, the Design Engineer, and their directors, officers, principals, agents, attorneys, and employees as Additionally Insured.

   Insurance evidenced by these certificates shall not expire, be canceled, or materially changed without fifteen (15) days prior written notice to the City.

   All certificates of insurance and endorsements required to be purchased by Contractor pursuant to this Article shall be filed with the City. Certificates shall be

acceptable to City. If a policy does expire during the life of the Agreement, a renewal certificate of the required coverage must be sent to the City not less than five days prior to expiration date.

Each certificate of insurance shall include the job site and project number. Coverage shown on certificate of insurance must coincide with the requirements in the text of the Contract Documents.

9. SCHEDULE OF CONSTRUCTION

A. The Contractor shall submit to the City within five (5) days after award of Contract, or as may be otherwise requested by the City, a schedule showing the order in which the Contractor proposes to carry on the work and at a rate sufficient to successfully construct all of the Work set forth in the Contract Documents within the Contract Period. Such schedule shall show the dates at which the Contractor will start and complete the several parts of the Work. The schedule shall identify the following items if applicable:

1. Potholing.
2. Mobilization.
3. Roadway work to be broken down at a minimum, on a street by street basis.
4. Pipeline work to be broken down on a manhole to manhole basis and individual pump station construction or abandonment.
5. Site prep.
6. Drainage improvements prep and construction.
7. Ramp prep, construction and finish.
8. Sidewalk prep, construction and finish.
9. Bridge prep, abutment construction, bridge construction, bridge placement, and finish.
10. Traffic control.
11. Demobilization
12. SWPPP.
13. Other items as applicable and/or listed in the bid schedule.

The schedule shall also show the order of construction and delivery dates at which the Contractor will start and complete the several other parts of the Work, the order of construction and delivery dates of critical materials and equipment along with monthly payment estimates, dates for submittal of working drawings and shop drawing to the Engineer for review, and the name of the project superintendent. The City shall be notified in writing of changes in the project superintendent. The schedule shall be subject to review and comment by the City as per MAG specifications section 108.4. The schedule shall be binding on the Contractor and shall be complied with by the Contractor unless, for good cause shown, a modification of the schedule shall be requested in writing to and approved by the City. The schedule shall also:

1. Be updated with each progress billing.

2. Include a detailed two week look ahead, indicate work requiring inspection, and be updated at each progress meeting.
3. Show work tasks progress in time periods of seven days or less unless otherwise approved by the Engineer.
4. Identify the critical path(s) for the work and task float.
5. Identify tasks corresponding to bid item descriptions when possible. Less comprehensive task designations may be used to comply with 2 above.
6. Conform to any time and location constraints identified in permits and the contract documents.
7. Span the current contract date to the end of the contract time.
8. Be submitted in an electronic format compatible with Microsoft Project Standard 2007, and hard copy format.
9. Identify long lead items.

The schedule format (size, color, type format) shall be such that the different tasks, durations, critical path and durations can be easily distinguished. The Contractor shall also provide a listing of tasks and durations with the schedule. If the schedule and list is being provided prior to a Notice to Proceed it need not include dates for start and completion of tasks. Any schedule and list provided after the Notice to Proceed has been issued shall include dates. A schedule and list shall be provided on the date of the Notice to Proceed. The Contractor shall begin work on the project site within five (5) working days of the Notice to Proceed, unless stated otherwise in specifications. Failure to do so is sufficient cause for termination in addition to other remedies the City may have.

B. Where the City's operations require specific sequencing of the work, such sequencing requirements as provided for in the Contract Documents shall be followed.

C. When progress has not kept pace within two weeks of the schedule or if otherwise requested by the City the Contractor shall update his schedule within five (5) working days of the City's written request. The revised schedule will include a description of what actions will be done by the Contractor to bring the project back on schedule. **Failure to not provide a revised schedule within one week of its request may result in the withholding of $750 from any progress payment due.** Each written request by the City shall be considered a separate request and subject to the withholdings specified, provided it is within the following billing cycle from a previous request.

D. The Contractor shall provide the City with a list of emergency phone numbers, addresses, pager numbers, facsimile numbers, and electronic mail addresses for contacting key personnel in the case of any after-hours emergency.

E. The Contractor shall furnish the City with a schedule for hours of work. In it, the Contractor shall note the begin work, begin daily clean-up and daily shutdown times to be followed by the Contractor during the project unless otherwise changed. The Contractor's regular work hours on regular workdays shall be between 7:00 AM and 5:30 PM Monday through Thursday, unless otherwise stated in the specifications.

Friday work is permitted between 7:00 AM and 5:30 PM for work that does not require City inspection. This work hours timeframe shall be considered to include start-up of equipment and daily clean-up of the work area. Weekends and Holidays for the City of Sedona shall be considered non-regular work hours. Permission to work non-regular work hours shall be subject to approval by the Engineer and the provisions of General Conditions, Section 39. **The Engineer may deduct $250 per day for work outside of approved work hours after issuance of one written warning during the course of the project.**

The City of Sedona has the following holiday schedule:
New Year's Day, January 1st
Martin Luther King/Civil Rights Day, 3rd Monday of January
President's Day, 3rd Monday in February
Memorial Day, Last Monday in May
Independence Day, July 4th
Labor Day, 1st Monday in September
Veteran's Day, November 11th
Thanksgiving Day, 4th Thursday in November AND the Friday after Thanksgiving Day
Christmas Day, December 25th

10. PROGRESS MEETINGS

Periodic meetings shall be held between the City of Sedona officials, Contractor, and other affected agencies, at a standard time and place, and at a frequency to be established during the pre-construction meeting. These meetings shall be used to discuss scheduling and matters related to the project.

11. TAXES

The Contractor shall be responsible for and shall include in his bid prices all applicable taxes, including but not limited to Federal, State, and Local Taxes.

12. ASSIGNMENTS

The Contractor shall not assign the whole or any part of the Contract or any monies due or to become due hereunder without the written consent of the City and of the Surety on the Contractor's Bond. A copy of such consent of Surety, together with a copy of the assignment, shall be filed with the City. If the Contractor assigns all or any part of any monies due or to become due under the contract, the instrument of assignment shall contain a clause substantially to the effect that it is agreed that the right of the assignee in and to any monies due or to become due to the Contractor shall be subject to prior claims and liens of all persons, firms, and corporations for services rendered; for the payment of all materials and equipment furnished and for payment of all materials and equipment used or rented in the performance of the Work called for in the Contract; and for the payment of any liens, claims, or amounts due the Federal, State, or local government or any of their funds.

13. SUBCONTRACTING

A. Subcontractors will not be recognized as employees or agents of the City, nor as having any privity of contract with the City. All persons engaged in the work of construction will be considered by the City to be employees of the Contractor. The Contractor will be held responsible for their work and for all materials provided by them, which shall be subject to the provisions of the Contract.

B. Each subcontract shall contain a suitable provision for cancellation or termination thereof should the Subcontractor neglect or fail to conform to every provision of the contract.

C. Subcontractors collectively shall not perform more than fifty percent (50%) of the value of the total work required pursuant to the Contract Documents. **The Contractor agrees that should this percentage be exceeded the City may consider the Contractor in breach of this contract and/or make deductions equal to one half of one percent of the total approved contract value for each one percent of subcontracted work beyond that allowed above.** The Contractor shall perform fifty percent (50%) of the contract work using the Contractor's own organization as construed in ADOT Standard Specifications 2000 Section 108.01.

D. The City of Sedona encourages all contractors to utilize minority and women owned businesses whenever possible.

14. COOPERATION AND COLLATERAL WORK

A. In general, the Contractor shall be responsible for the scheduling and coordination of his work with any other work, which may be, carried on in the construction areas for this project by other parties or by the City simultaneously with his construction work. The contractor shall include in his bid any costs, which may be involved on his part as a result of coordinating his construction with such other activity.

B. \When two or more Contractors are employed by the City in related or adjacent work, each shall conduct his operations in such manner as to not cause any delay or hindrance to the other and shall properly connect and coordinate the execution of their respective work with the other. The City will not be responsible for damage caused by such delays, and such delays will not entitle the contractor(s) to an extension of time. The Contractor shall afford other Contractors reasonable opportunity for the introduction and storage of their materials and the execution of their work.

If the proper execution of any part of the Contractor's work depends upon the work of any other Contractor, the Contractor shall inspect and promptly report to the City Engineer any discrepancies between the executed work and the drawings or any defects in such work that render it unsuitable for such proper execution. The failure of the Contractor to inspect and report shall constitute an acceptance of the other contractor's work as fit and proper for the reception of his own work. The exception is for defects, which may develop in the other contractor's work, after the execution of the

Contractor's collateral work that would not have been discovered before the Contractor's collateral work began.

A. The contractor shall coordinate his work, and cooperate with any other persons or entities operating on or adjacent to the site of the project.

Where persons employed by other persons or entities are engaged in or near the construction areas for this project, and where such work on the part of said parties results in a delay in performance by the Contractor, and where such delay, in the opinion of the City Engineer, is of such nature that it could not have reasonably been foreseen or anticipated by the Contractor in time for him to take steps to prevent same, then the Contractor shall be entitled to an extension of time.

The Contractor shall promptly make good any injury or damage caused by him that may be sustained by other Contractors or employees of the City. The Contractor shall join his work to that of others and perform his work in proper sequence in relation to that of others.

15. LINES AND GRADES

The Contractor shall be responsible for providing all construction staking and surveying needed to construct the facilities in accordance with the Plans and Specifications, and shall include such costs in his bid for the applicable items of work. The Contractor shall employ a surveyor licensed in the State of Arizona to perform all surveying necessary to construct this project to the lines and grades provided in the plans. The Contractor shall provide to the Engineer the Surveyor's listing of lines, grades, distances, curve information and point data (including northing, easting and elevation) used to actually establish project staking at least two working days prior to establishing subgrade, setting forms, placing pre-cast facilities, pouring concrete, installing pipe, or placing asphalt. The Contractor shall provide a set of as-built plans showing manhole and inlet inverts, rim and grate elevations, gutter elevations at 50-foot intervals, changes of grade, invert and finished grade elevations of concrete structures at the center and corners, and the inlet and outlet ends of pipes. The surveyor shall seal and designate them as as-built plans. This as-built plan is in addition to the Status As-Builts and Record As-Builts required under other provisions of these specifications. The Final contract payment shall not be due until all as-built plans have been submitted and accepted. Any work performed without complying with the Survey requirements in these specifications shall be considered unauthorized work and subject to the provisions of MAG section 105.11. As-Built plans shall be submitted in the following formats: hard copy in the same size as provided by the City to the Contractor for the contract, AutoCAD 2006, and .pdf.

The Contractor shall pothole utility facilities and report results to the Engineer at least two (2) working days prior to excavating for installation of roadways, asphalt patches, catch basins, underground pipes, manholes, footings, vaults, and basins. The report shall indicate any conflicts or inadequate clearances as related to the work to be performed. Failure to perform potholes and report results, as required, will result in the loss of the right to make a claim for changes in compensation and time due to conflicts, interference, protection or

other costs related to the utility, as such, a claim would have been mitigated by performing the pothole timely.

16. EXCAVATIONS, UNDERGROUND FACILITIES LOCATION, AND STORMWATER POLLUTION PREVENTION.

The Contractor in the execution of the Work shall conform to all applicable Federal and State laws, municipal ordinances, and the rules and regulations of all authorities having jurisdiction over employment discrimination, wages and working conditions, and the construction of the Work, including but not limited to all construction codes, O.S.H.A. Requirements, and safety codes, which may apply to (1) performance of the Work; (2) protection of adjoining and adjacent property; (3) maintenance of passage-ways, guard fences or other protective facilities; and shall obtain all permits and pay for licenses and approvals necessary for the construction of the Work and give all required notices.

ARS-40-360.22 Excavations: Determining locations of underground facilities; providing information. This statute requires that no person shall begin excavation before the location and marking are complete or the excavator is notified that marking is unnecessary and requires that upon notification, the owner of the facility shall respond as promptly as practical, but in no event later than two working days. The "Arizona 811" (1-800-782-5348) (formerly Arizona Blue Stake Center) was formed to provide a more efficient method of compliance with this statute.

ARS-40-360.23 Making excavations in careful, prudent manner: liability for negligence. This statute states that obtaining information as required does no excuse any person making any excavation from doing so in a careful and prudent manner nor shall it excuse such persons from liability for any damage or injury resulting from his negligence.

ARS-40-360.28 Civil penalty: Liability. If the owner or operator fails to locate, or incorrectly locates the underground facility, pursuant to this article, the owner or operator becomes liable for resulting damages, costs and expenses to the injured party.

Licenses and Permits:
The Contractor shall be required to obtain, at his expense, the appropriate licenses and permits from the City of Sedona before the start of construction. It is the duty of the Contractor to determine that all necessary permits have been obtained. Costs associated with obtaining a license are not waived.

Arizona Pollutant Discharge Elimination System (AZPDES) Permit

A. General requirements:
   - The Contractor shall comply with the AZPDES Stormwater requirements for construction sites pursuant to the requirement of the Arizona Department of Environmental Quality (ADEQ). The Contractor shall be designated as permittee and shall be responsible for providing the necessary labor and materials, and for taking the appropriate measures to assure compliance with the ADEQ requirements, as well as other Federal, State and local requirements pertaining to storm water discharges. As

the permittee, the contractor is responsible for completing, in a manner acceptable to the ADEQ, all documents required including the following:

1. Storm water Pollution Prevention Plan (SWPPP) for the project including certification form. The contractor will be required to submit for approval, update and revise the SWPPP as necessary throughout the construction of the project in order to assure compliance with permit requirements. The completed SWPPP shall be kept on the project site at all times during construction of the project.

2. Notice of Intent (NOI) to be covered by Arizona General Permit for Arizona including certification of signature.

3. Notice of Termination (NOT) of coverage under AZPDES (upon project completion).

B. Regardless of whether compliance with AZPDES is required the Contractor shall prepare a Storm Water Pollution Prevention Plan. That Plan shall at a minimum address the following issues:
   - Designation, maintenance and clean-up of vehicle storage, fueling, lubrication and maintenance areas
   - Clean up and off-site disposal of excess construction materials including asphalt, concrete, paints, oils, and wrapping materials
   - Daily work day clean-up of debris in work area
   - Prevention of wind born debris/Dust Control Plan
   - Prevention of erosion resulting from rain or watering activities'
   - Measures to prevent silt and debris generated by this project from migrating beyond the construction site boundaries. Measures such as trapping and removing debris and dirt generated, or other measures acceptable to the Engineer, shall be taken.
   - The Contractor shall comply with the City of Sedona General Storm Water Pollution Prevention Guidelines, this includes filing the City Notice of Intent.

C. Submittals:

1. Preliminary copies of the NOI and SWPPP shall be submitted to the Engineer two days prior to the preconstruction meeting. Any necessary revisions to the SWPPP shall be subject to review by the Engineer, prior to implementation.

2. The Contractor shall submit completed, signed NOI forms at least forty-eight (48) hours prior to the initial start of construction on the project to the Arizona Department of Environmental Quality in Phoenix, Arizona (ADEQ, 1110 West Washington Street, Phoenix, AZ. 85007). Generally projects of less than one (1) acre may not be applicable to this requirement at this time. If the project is subject to these requirements, the Contractor shall be designated the permittee.

3. Failure by the contractor (or any of its appropriate subcontractors) to submit the NOI forms within the required timeframe shall result in delay of the start of

construction, but shall not prohibit issuance of the Notice to Proceed, at the City's sole discretion. A copy of the completed NOI shall be posted on the construction and a copy of the SWPPP shall be kept on the construction site.

Contractor's Responsibilities:

1. It is the Contractor's responsibility to perform inspection of all storm water pollution control devices on the project on a monthly basis and following each rainfall. The contractor shall prepare reports on these inspections and retain these reports for a period of three years following project completion. Inspection reports shall be submitted monthly to the CITY along with payment requests. The contractor shall maintain all storm water pollution control devices on the project in proper working order, including cleaning and/or repair during the duration of the project.

2. No condition of either the AZPDES or the SWPPP shall release the contractor from any responsibilities or requirements under other environmental statutes and regulations.

3. Upon total project completion, acceptance, and de-mobilization, the contractor shall submit its completed, signed NOT form to the ADEQ with copies to the same agencies who received copies of the NOI, thereby terminating all AZPDES permit coverage for the project.

D. Payment: There shall be no separate payment made to the Contractor for all material, labor, and other incidental costs relating to the provision, installation, and maintenance of items relating to this permit during project construction. Such incidental costs shall include contractor costs in order to assure proper operation of the pollution-control devices installed including all maintenance, cleaning, and disposal costs associated with clean-up and repair following storm events or other runoff or releases on the project.

17. EXISTING UTILITIES, RIGHTS-OF-WAY, EASEMENTS

A. EXISTING UTILITIES

Because of the nature of this contract, existing utilities are not shown or indicated in these specifications, except to note that their locations are within rights of way, streets and easements throughout the City of Sedona area. The fact that utilities are not shown shall not relieve the Contractor of the following responsibilities:

1. The Contractor shall be responsible for the preservation of all existing water, sewer, storm sewer, buried transmission lines or any cable or utility. If damaged, all costs for the necessary repairs shall be paid by the Contractor.

2. The Contractor shall locate and verify the location of all existing utilities prior to any excavation. This shall be done at least two (2) days prior to excavation for

installation of project facilities or ordering equipment or materials for those facilities.

3. The Contractor shall be responsible for the location of all service lines.

4. Continuation of Service - All services shall be maintained to all areas at all times during the construction period, except when it is necessary to shut down a line to make a connection with the new line. Residents shall be given twenty-four (24) hour notice when it is known that the service will be interrupted. The Sedona-Oak Creek Fire District shall be kept advised of the status of all fire hydrants affected by any work on this Project.

5. The Contractor is responsible for as-builting all existing utilities within the improvement area (location, depth, and material).

B. RIGHTS-OF-WAY AND EASEMENTS

The City will furnish land, right-of-way, or easements as shown in the Contract Documents for the performance of the Work under the Contract. Contractor shall confine his operations to the land, right-of-way or easements furnished, and will restore the same to their original conditions to the extent reasonably possible prior to final acceptance of the work. Prior to construction or entry thereon, the Contractor shall obtain copies of and become familiar with any agreements and stipulations used by the City in acquiring temporary or permanent easements.

The Contractor shall remain within easement areas and rights-of-way obtained or owned by the City or easement areas the Contractor has obtained. Disturbed areas shall be reasonably restored upon completion of installation of the project improvements and related appurtenances in the easement. The Contractor shall be responsible to adhere to easement provisions whether the easement was obtained by Contractor or City. A temporary 4-foot high orange fence shall be placed to define the work area for all easements encompassing all work that occurs outside the City right-of-way. Clearing by manual means for the purpose of defining the area to be fenced shall be the only activity allowed on the easement before the fence is placed. City shall provide the Contractor with a copy of the easement agreement with the property owner, upon request. Contractor shall be responsible for all restoration of the easement as described in the easement agreement. Trees and larger vegetaion shall be preserved to the maximum extent practicable.

The Contractor shall be responsible for the preservation of all existing property pins. If disturbed or damaged the Contractor shall be responsible for all costs associated with the restoration of any property pin disturbed by the Construction activities. Any property monuments, which require resetting, shall be reset under the direction of a licensed Surveyor by the State of Arizona and proper documentation recorded with the appropriate County.

Access by Residents: The Contractor shall ensure that all residents have access from the Street to their property each night. When access to a resident's property cannot be maintained during normal working hours (week days), the Contractor must personally notify the affected residents two working days in advance of the closure. Such notification shall be documented in writing to the Engineer. Emergency access shall not be blocked, for any reason without the express written permission from the owner.

Access to Public Facilities: The Contractor shall assure that safe access to facilities including, but not limited to, parking lots, picnic shelters, playgrounds, and pedestrian ways is provided. Any disruption to the public's normal use of said facilities shall not occur without the express written permission from the City.

Intersection and Driveway Maintenance: Once work has commenced in a particular street, the Contractor shall provide and maintain access facilities to all connecting streets, intersections and private driveways by ramping or surfacing with suitable materials to ensure access at all times. If in the opinion of the City, such facilities, or materials used, are not capable of supporting traffic, the Contractor shall remove the materials and provide better-suited materials, including asphalt concrete or similar, as directed by the Engineer. This work shall be considered incidental to the Project, and all costs shall be borne by the Contractor. Failure to comply with these requirements may result in stoppage of the work until corrected as determined by the Engineer, with no time extension being granted for such delay to the Project.

18. OPERATIONS, LAYDOWN YARD AND STORAGE AREAS

A. All operations of the Contractor (including laydown yard, storage of materials, supplies, and equipment) shall be confined to areas authorized by the City. **The City of Sedona does not have available construction staging or material lay down facilities, except as specified otherwise in the specifications.** The Contractor is responsible for arranging and providing for such facilities as is deemed necessary for carrying out the work of this contract. The City does not warrant or represent in any way the availability of staging or material lay down areas within the City or vicinity of the project. It is the Bidder's responsibility to make such determinations. The price paid for mobilization shall include all costs for and associated with providing construction staging and material lay down facilities necessary for constructing the project. If a mobilization item is not included in the specification, the cost for compliance with item shall be considered as included in the unit price (s) bid for the various items of work. The Contractor shall be liable for all and any damages caused by him to such premises.

The Contractor shall comply with the following, regarding laydown yards:

- Any use of vacant property adjacent to or near the project used for parking or servicing equipment and/or storing of material will require the Contractor to provide written approval from the property owner, homeowner associations

as applicable, and the filling of a temporary use permit from the City of Sedona.

- A copy of the property owner's approval shall be submitted to the Engineer, stating the use of the laydown yard for use during the construction of this project is acceptable.
- The Contactors yard shall be enclosed with a six (6) foot temporary fence.
- Storage of Gasoline will require Fire Department approval.
- Clearing or grading of the site in excess of fifty (50) CY of soil will require a grading permit. No grading will be allowed which changes the drainage path for the parcel without the approval of the City Engineering Department. All existing pipes and drainage facilities at the laydown yard will be maintained in working order at all times.
- A stabilized construction entrance will be required if the vacant property laydown yard is not already gravel or pavement. The laydown yard shall be adequately maintained to control dust and mud from leaving the property.
- Work in the laydown yard shall be scheduled so as to comply with any City noise or light Ordinances and these specifications.
- Equipment, materials, etc., shall be located so as to minimize impact to adjacent properties.
- Before any grading of any laydown yard, property corners will be located for the parcel. Any property pins disturbed by the Contractors operations will be replaced prior to final acceptance of the project.
- The Contractor shall obtain a written release from the property owner, homeowner's associations or similarly concerned parties after completion of use. A copy of the release shall be presented to the Engineer.
- Equipment and material shall not be stored in the right-of-way and/or street easement during non-work hours without permission of the Engineer. Such permission shall be subject to finding that it is impractical to move the equipment or material because of size or that permission has been granted to close the right-of-way to all traffic, including local traffic. Lack of construction yard or other staging area shall not be considered as reason to grant permission. Such permission, if granted, shall be subject to conditions determined at the sole discretion of the Engineer.

B. The Contractor shall hold and save the City free and harmless from liability of any nature or kind arising from any use, trespass, or damage occasioned by his operations on the premises of third persons.

C. The Contractor shall be wholly responsible for the care, compliance with law, and storage of materials, supplies or equipment delivered on the work site or purchased for use thereon. Stored materials, supplies, or equipment shall be carefully and continuously protected from damage or deterioration and so located so as to facilitate inspection by the City. The responsibility for the care and storage of materials, supplies, or equipment shall be with the Contractor whether such materials, supplies, or equipment are furnished by the Contractor or by the City. Storage of materials, supplies, or equipment shall not unduly interfere with the progress of the Contractor's Work or the work of any other contractor.

D. Traffic Control:
Adequate traffic flow shall be maintained at all times, all barricading and temporary signage for detours and traffic control must meet the standards set by the Manual of Uniform Traffic Control Devices (MUTCD) and the City Engineer. If traffic control is not a separate bid item; then, it is considered incidental to the work and shall be included as appropriate in the Contractors bid. The Contractor must also take responsibility for public safety, meaning:

1. That, except for alleyways, one lane of the roadway for each direction must be kept open at all times; OR

2. Certified flaggers must be provided to properly channel traffic at all times when two separate lanes (one each direction) cannot be maintained open; OR

3. Total closure of a roadway shall only occur with the written permission of the City Engineer. For all rights-of-ways requiring closure for any work therein, appropriate permits shall be obtained. Prior to start of construction, the Contractor shall provide the Engineer with planned traffic control methods and procedures for this project. A notice of closure for residents, along with a map showing the planned area of distribution shall be included as part of the planned methods and procedure. Proper traffic control and advance warning signage shall be in place prior to any road closure.

4. When detours or road closures are implemented an overall map showing anticipated flow of traffic shall be provided.

5. The Contractor shall have a designated person responsible for overall traffic control on-site at all times.

6. A Traffic Control Plan shall be submitted for review. The plan is intended to be a guide; Contractor shall submit any proposed revisions for approval by the Engineer.

7. Pedestrian traffic must be maintained at all times, on at least one side of the road.

8. The Contractor shall supply a Public Announcement showing closures and detours.

E. Water Use

1. All water used by Contractor for testing, compaction, dust control, or other uses related to construction, shall be obtained by the Contractor from an approved water source. The Contractor shall be responsible for all deposits, charges and fees.

   Reclaimed water is available to the Contractor for dust control and other on-site construction uses at no cost to the Contractor (other than testing costs noted

below), according to the following limitations (any required water outside these limitations shall be provided by the Contractor from an approved source):

a. Reclaimed water will be available for use by the Contractor Monday – Friday. It shall be the Contractors's responsibility to apply for and obtain a Type 2 General Water Reuse Permit (Class A+ Reclaimed Water) from ADEQ for dust control and other construction uses. Contractor shall also be responsible for the cost of fecal coliform testing. The cost of testing is $50 for each day that water is taken for construction use.
b. Water shall be provided from the effluent pump station wetwell at the Wastewater Treatment Plant using contractor-provided submersible pump.
c. Contractor is responsible to supply conveyance and storage facilities for water made available by the City. Contractor shall record and report to the City on a weekly basis the date and amount of water used.

F. Dust and Debris Control

1. **The contractor shall cover all trucked loads of soil, rock and material that may drop from, be sifted from or blown from the vehicle. The City may require that trucks arriving with uncovered loads not be allowed to deliver material to the project, regardless of whether or not the truck is the contractor's, a subcontractor's, a service provider's, or a material supplier's vehicle. If trucks leave the site with uncovered loads the City reserves the right to do one or more of the following:**

    a. The truck will not be allowed on the site
    b. The contract compensation will be reduced by $150 per observed uncovered load. The contract time will be reduced by one day
    c. The Police Department may issue a citation.

2. Pine slash and/or cut down pine trees shall be removed from the City within 24 hours, including any non-working days, of being broken or cut. This measure is to minimize pine bark beetle infestation in Sedona.

3. The contractor shall take measures to prevent blowing debris and/or dust from the site.

4. Dust Control shall comply with the following:
    a. Dust control shall be maintained at all times on the project. Spray nozzles shall be used as necessary on equipment to reduce dust. Mist shall be visible when standing adjacent to the equipment.
    b. A Dust Control Plan shall be submitted prior to Start of Construction.
    c. Cleanup and Dust Control shall be in compliance with MAG Section 104.1.3 and 104.1.4.

5. The contractor shall clean any dirt tracked from the project work area from streets and sidewalks using equipment and methods that will not create excessive dust. Sweeping is the preferred cleaning method. Washing of streets and/or sidewalk

and other paved areas will require special permission from the Engineer and shall be subject to conditions imposed by the Engineer. The City reserves the right to require that the Contractor to cease work that is resulting in excessive tracked mud and/or dirt from and within the project area, and to require cleaning prior to allowing the ceased work to continue. The exercise of the City's right and impacts there from shall not provide a basis for claim by the contractor. Failure of the Contractor to cease work shall be sufficient reason for the City to reduce the contract time by one calendar day per incident, at the City's sole discretion.

6. Dirt, debris, wastewater and other debris shall not be disposed of in stormwater facilities and/or natural drainage channels. The City may require inspection of stormwater facilities and/or natural drainage channels prior to and during the work to verify compliance with this requirement. The City may require the contractor to clean stormwater facilities and/or natural drainage channels if the contractor has disposed of material to them. Final Completion will not be issued until all stormwater facilities have been inspected and approved.

G. Open Trenches

MAG Specification Section 601.2.10 is modified to limit the length of open trench to 1100 feet within the project. An open trench includes any longitudinal excavated area 3 inches or more below adjacent land which has settled or been left lower intentionally. All open trenches shall properly marked and protected so as to warn pedestrians and vehicular traffic of a low area.

19. RIGHT-OF-ENTRY

Contractor shall provide to the City, Architect-Engineer, or representative of the Federal, State, County, District and Municipal governmental officials and services, the proper facilities for access to the Work, whenever it is in preparation or progress.

20. ACCESS AND DRAINAGE

The Contractor shall keep a sufficient clear area around fire hydrants to permit their full and effective use in case of fire. The Contractor shall keep natural drainage and watercourses unobstructed by spoil piles, material storage, or any other operations, or provide for other equal courses effectively placed.

21. SANITARY CONVENIENCES

The Contractor shall furnish the necessary sanitary conveniences, properly secluded, for the use of work persons during construction, and these conveniences shall be maintained in a manner that will be inoffensive and in compliance with Federal, State and local health and sanitation requirements.

22. CLEANUP PRACTICES

A. The Contractor shall at all times during the progress of the work maintain a reasonably clean job site, this includes, but is not limited to, keeping signs clean and legible, minimizing mud, rock, and dirt on roadways, and keeping ditches free of trash and construction materials. If in the opinion of the Engineer, excessive dust, mud or debris exists at the job site, the Contractor shall immediately remove said material as directed. All costs associated with this work shall be borne by the Contractor. The location of debris and material stockpiles shall be as directed by the Engineer.

B. The Contractor shall begin his daily clean-up process at a typical time agreed to by the City at the pre-construction meeting. If the Contractors operations and daily shut-down exceed a forty hour work week or eight hour day then the City will be entitled to withhold a portion of the Contractors progress payment for City "overtime" work pursuant to Section 32 and 39, unless authorized by the Engineer.

C. The site shall be kept clean of trash and debris including but not limited to, loose construction materials, such as sand, cement, lime, wood pieces, building paper, and other miscellaneous paper. All trash and debris shall be placed in an appropriate number of approved containers and moved and disposed of off the site daily in a location where it will not be possible to be dispersed. No burning of trash or debris will be permitted on the site, except where designated by the Engineer. The laydown yard shall have a minimum of one container of appropriate size at all times.

When site daily clean-up has not been kept up as requested in writing by the City the Contractor shall bring the site into compliance with the City within 24 hours or the City shall withhold $350 for each day out of compliance.

D. Before final payment, the Contractor shall remove all rubbish, excess materials, temporary structures, and equipment. All parts of the work shall be left in a neat and presentable condition. Excess mounds of earth shall be leveled and ruts and depressions filled, such that the completed work is attractive. If in the opinion of the Engineer, the Contractor does not maintain the Construction Site in a safe and clean condition, or does not adequately clean up the site at the completion of the work, or rectify any valid complaints of damage to property resulting from the Construction, the City may clean up or rectify damage and charge the costs thereof to the Contractor.

E. The Contractor shall be responsible for locating sites and making arrangements for disposal of all material removed from the site. This includes concrete, asphalt, unsuitable or unstable trench material and any other trash, rubbish or debris generated as a result of construction. Asbestos, hazardous substances or materials, hazardous waste or any other regulated substances or materials shall be disposed of in accordance with all applicable federal, state and local regulations.

F. All vegetation and improvements removed from easements by the Contractor shall be removed or repaired by the Contractor in accordance with the easement agreement with the property owner, the same being done at no additional cost to the City.

23. PLANS AND SPECIFICATIONS

A. The City will provide the Contractor with four (4) sets of plans, drawings, and specifications after the execution of the Contract. If additional plans, drawings, and specifications are required, the Contractor shall compensate the City for it.

B. When, in the opinion of the City, revised partial plans, drawings and specifications are required to clarify or reflect authorized changes or additional work the City shall provide four (4) copies of such revisions to Contractor. The Contractor must pay for any additional copies. Contractor shall immediately post such revisions to his record set of Contract Documents.

C. The plans, drawings, and specifications are the property of the City, and are furnished to the Contractor for the construction of Work under the Contract only.

D. The data given in the specifications and shown on the plans and drawings is believed to be accurate but the accuracy is not guaranteed. The Contractor must confirm all levels, locations, measurements, and verify all dimensions on the job site prior to construction and adapt his Work into the exact limits of construction. Scale measurements taken from plans are only for reference.

E. Drawings showing the details of the Work specified are designated "plans" or "drawings" and together with the specifications form an integral part of the Contract Documents.

24. CORRELATION OF DOCUMENTS

A. Plans, drawings, and specifications are cooperative and supplementary. Portions of the Work, which can best be illustrated by the plans or drawings, may not be included in the specifications and portions best described by the specifications may not be depicted on the plans or drawings. All items necessary or incidental to completely construct or erect the Work specified shall be furnished, whether called for in the specifications or shown on the plans or drawings. Unless otherwise stated the plans and specifications shall be considered to require construction or erect of a complete and operable facility.

B. Special Conditions shall take priority over Technical Specifications, which shall take priority over General Conditions; large-scale drawings shall take precedence over small-scale drawings. In case of a disagreement between the plans, drawings, and specifications, or within a document itself, the better quality and the greater quantity of work shall be estimated and included in the bid and contract sums and the matter drawn to the City's attention for further decision, and possible issuance of an addendum.

25. SHOP DRAWINGS, SAMPLES, AND OPERATOR'S INSTRUCTION

A. The Contractor shall furnish all Shop Drawings and Samples required by the Contract Documents. Shop Drawings of equipment and devices offered by the Contractor for approval of the City shall be in sufficient detail to adequately show construction and

operation. The above material shall be submitted to the City for review in electronic format (.pdf and/or .dwg). Shop drawings submitted as herein provided by the Contractor and approved by the City for conformance with the design concept shall be executed in conformity with the Contract Documents unless otherwise required by the City.

B. Work performed in connection with the fabrication, manufacture, shipment, or purchase of material or equipment prior to approval as specified shall be at the Contractor's sole risk and responsibility.

C. Shop Drawings and Samples shall be accompanied by a letter of transmittal indicating that the Contractor has reviewed and approved the submittal. The transmittal shall give a list of the numbers and dates of the submittal, and shall be in the form required by the City. Any re-submittals shall show numbers and dates of previous submittals. Shop Drawings shall be complete in every respect and bound in sets.

D. The Contractor shall submit all Shop Drawings and Samples (submittals) sufficiently in advance of construction requirements to allow ample time for checking, correcting, resubmitting, and rechecking to avoid any delay in progress of the Work. In no case however shall this time be less than five (5) working days without the consent of the Engineer. In the case of submittals for pump installations and similarly complex equipment the minimum timeframe shall be twenty (20) working days. This timeframe shall also apply to resubmittals. If more than five (5) submittals are made in a week the minimum City review time shall be extended by five (5) days for each submittal. The Contractor shall be solely responsible for delays and costs related to resubmittals or untimely submittals.

E. Shop Drawings or Samples submitted shall be marked with the name of the Project, numbered, and bear the stamp of approval of the Contractor as evidence that the Shop Drawings and Samples have been checked by the Contractor. Any shop drawings or samples submitted without this stamp of approval shall not be considered and shall be returned to the Contractor for resubmission. If the Shop Drawings or Samples show variation from the requirements of the Contract, the Contractor shall call such variation to the City's attention in his letter of transmittal in order that, if acceptable and City gives written approval to the variation, suitable action may be taken for proper adjustment.

F. By approving and submitting shop drawings and samples, the Contractor thereby represents that he has determined and verified all field dimensions and measurements, field construction criteria, materials, catalog numbers, and similar data, and that he has checked, and coordinated such submittals with the requirements of the Work and the Contract Documents.

G. If a Shop Drawing or Sample, as submitted, indicates a departure from the Contract requirements which the City finds to be in the interest of the City and to be so minor as not to involve a change in the contract price or time for performance, it may approve

the Drawings or Samples; provided, however, such departure is slight in nature and does not affect the design concept of the Work.

H. All items of standard equipment shall be the latest model at time of delivery.

I. When Shop Drawings are submitted for the purpose of showing the installation in greater detail, their approval shall not excuse the Contractor from requirements shown on the plans and specifications.

J. Shop Drawing and Sample submittals not conforming completely with the above requirements shall be returned to the Contractor, without action, for re-submittal and the resulting delay shall be entirely the responsibility of the Contractor.

K. The City's check and approval of Shop Drawings and Samples, specifications, and descriptive literature submitted by the Contractor shall be only for general conformance with design concept, as otherwise provided, and shall not be construed as:

1. Permitting any departure from the Contract requirements;
2. Relieving the Contractor of the responsibility for any error in details, dimensions, or otherwise that may exist in such submittals;
3. Constituting a blanket approval of dimensions, quantities, or details of the material or equipment shown; or
4. Approving departures from additional details or instruction previously furnished by the City. Such check or approval shall not relieve the Contractor of the full responsibility of meeting all of the requirements of the Contract Documents.

L. One (1) electronic copy and four (4) sets of bound operator's instructions and maintenance manuals shall be furnished by the Contractor for equipment furnished under the Contract that is specially listed or that is considered to be of a special or complex nature. Operator's instruction and maintenance manuals shall include, in part, detailed lubrication drawings showing type and frequency of lubrication. Detailed parts drawings shall show location, name and catalog numbers of parts.

M. One (1) electronic copy and four (4) sets each of bound service parts manuals shall be furnished by the Contractor for all items of standard manufacture.

N. All operator instructions, maintenance, and parts manuals shall be bound in permanent binders satisfactory to the City and shall be furnished to the City before final acceptance of the installation by the City.

O. Four (4) copies of any manufacturer's guaranty/warranty or certificate for any type of material or equipment provided shall be submitted to the City prior to final acceptance of the Work by the City.

26. DRAWINGS SHOWING CHANGES DURING CONSTRUCTION

Throughout the progress of construction, the Contractor shall maintain a careful up-to-date record of all changes on the plans and drawings during actual construction. *With each progress payment invoice the Contractor shall provide a "Status As-Built" showing all work completed to date.* Callouts will identify type, size and quantity of each item installed. The Contractor shall annotate all sewer taps stationing upstream to downstream using swing ties from adjacent manholes or other method the Engineer may approve in writing. Upon completion of Work, and prior to acceptance by the City, the Contractor shall file with the City one set of complete contract drawings with all changes and Contractor's field construction notes neatly and legibly recorded thereon. Such drawings shall include but not be limited to, the exact routing and clearances, if changed from drawing location, of sewer, water, gas, oxygen supply, condenser water lines, fuel oil tanks and lines, fire protection lines, and any other major buried utility lines and routing of buried electrical feeder lines and changes to routing of conduit runs which are buried or concealed in concrete slabs. The Contractor shall furnish such As-Built utility and drainage invert and rim elevations as well as gutter, top of curb shots and horizontal location of valves and hydrants placed as a part of this construction. This information is for use by the City in the preparation of record "As-Built" Drawings. Curb and gutter shots shall be spaced no further than 50 feet apart and shall include any significant bends, drops or other deviations from a straight horizontal or vertical alignment.

27. MATERIALS, EQUIPMENT, SUPPLIES, SERVICES, AND FACILITIES

A. It is understood that, except as otherwise specifically stated in the Contract Documents, the Contractor shall provide and pay for all materials, equipment rental, water, heat, light, fuel, power, transportation, superintendence, temporary construction of every nature, and all other services and facilities of every nature whatsoever necessary to execute, complete, and deliver the Work in a workman like manner within specified time.

B. No materials, equipment, or supplies for the Work shall be purchased by the Contractor or by any Subcontractor subject to any chattel mortgage or under a conditional sale contract or other agreement by which an interest is retained by the seller.

C. Equipment shall be properly equipped with safety devices including but not limited to spark arrestors, back up alarms, reflectors, signage, labeling, and lights.

D. At least one (1) set of all appropriate Material Safety Data Sheets shall be maintained in a common location on the project site at an identified location during all working hours.

28. WORKMANSHIP, MATERIALS, AND EQUIPMENT

A. All material and equipment furnished by the Contractor shall be new and unused and shall strictly conform to the Contract Documents. Competent labor, mechanics and tradesmen shall be used on the Work. Experienced manufacturer's representatives shall be used to supervise the installation of equipment as may be required by the City. Any special tools or equipment, which may be required, shall be provided by the Contractor.

B. The acceptance at any time of materials or equipment by or on behalf of the City shall not be a bar to future rejection if they are subsequently found to be defective, inferior in quality or uniformity to the material or equipment specified, or are not as represented to the City.

29. QUALITY OF MATERIALS IN ABSENCE OF DETAILED SPECIFICATIONS

A. Where the Contract requires that materials or equipment be provided or that construction work be performed, and detailed specifications of such materials, equipment or construction work are not set forth, the Contractor shall perform the work using materials and equipment as described in the specifications. Constructed or installed as described therein, and shall follow standard practices in the performance of construction work. The work performed shall be in conformity and harmony with the intent to secure a good, serviceable standard of construction.

B. All tests and re-tests unless otherwise provided, shall be in accordance with the pertinent sections of the latest edition of the standards applicable to the material or devices to be tested. A partial list of the principal societies referred to and their Abbreviations follows:

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASTM	American Society of Testing Materials
AWWA	American Water Work Association
CPI	Clay Pipe Institute
CS	Commercial Standards
FS	Federal Specifications
NEC	National Electric Code
TMCA	Tile and Marble Contractors of America

30. VARIATIONS FROM ESTIMATED QUANTITIES

When unit prices are utilized in the Contract Documents, it may be reasonably expected that there could be variations in final quantities from the estimated quantities by reason of actual conditions and/or change orders. An adjustment in compensation may be allowed only to the following extent:

A. For a decrease greater than twenty percent (20%) in either the total cost of the contract or the total cost of a major item and when a reasonable cost analysis supports an increase in the pro rata share of fixed cost chargeable to this item in total, an adjustment in the monies due the Contractor may be made. The total amount, including any adjustment, will not exceed eighty percent (80%) of the original lump sum contract

amount or, for a unit price item, the total amount, including adjustment, will not exceed eighty percent (80%) of the original extended unit bid price.

B. For an increase greater than twenty percent (20%) in either the total cost of the contract or the total cost of a major item, any adjustment made will only apply to that cost in excess of one hundred twenty percent (120%) of the original bidding schedule. If either party presents a reasonable cost analysis that shows a change in the pro rata share of fixed costs chargeable to this item in total, an increase or decrease adjustment may be made. This increase or decrease adjustment will be made on such basis as is necessary to cover a reasonable estimate of cost, plus an allowance, not to exceed ten percent (10%), for overhead and profit.

C. A major item is an item whose total cost, determined by multiplying the bidding schedule quantity and the contract unit price, is equal to or greater than the amount indicated below. A major item will remain a major item unless it is completely eliminated. Compensation for a completely eliminated major item shall be limited to the amounts indicated, but not to exceed the amount demonstrated by information provided to show the cost impact of the deletion, not including anticipated profit.

Total Contract amount as awarded equal to or greater than (in dollars)	But is less than (in dollars)	A major bid item Shall be equal to or greater than the following amount (in dollars)	If the item is completely eliminated compensation shall be limited to no more than (in dollars)
$0.00	$1,000,000	$50,000 or 10% of the Contract amount as awarded	$2,000
$1,000,000	$5,000,000	5% of the Contract amount as awarded	$5,000
$5,000,000	$20,000,000	2.5% of the Contract amount as awarded	$7,500

D. For either an increase or decrease in cost, no claim shall be made by the Contractor for any loss of anticipated profits.

31. PROGRESS PAYMENTS

A. When monthly progress payments are authorized, the Contractor shall, on the date determined during the pre-construction meeting, submit to the City an itemized application for payment, supported by “Status As-Builts” and such data substantiating the Contractor's right to payment as the City may require, on forms acceptable to the City. Progress payments shall be made no more than once each calendar month and provided that there are a minimum fifteen (15) calendar days between payments, unless

otherwise authorized on a payment-by-payment basis by the City Engineer or City Manager. Progress payments are subject to retainage of ten percent (10%) with possible reduction to five percent (5%) in accordance with the provisions of Arizona Revised Statues.

B. The Contractor shall provide to the City at the time of payment, a waiver and release to date from the Contractor and each and every Subcontractor and material supplier whose work or materials are included in the application for payment, evidencing that said Contractor, Subcontractor or material supplier has been paid in full to date.

C. Unless otherwise provided in the Special Provisions, payment will not be made on account of materials or equipment not incorporated in the work, at the time of a request for payment, but delivered and stored at the site. Similarly, payment will not be made for materials or equipment stored at some other location unless agreed upon in writing. If payment is allowed per the Special Conditions, payment for materials or equipment stored on or off the site shall be conditioned upon submission by the Contractor of bills of sale or such other procedures satisfactory to the City to establish the City's title to such Materials or equipment or otherwise to protect the City's interest, including applicable insurance and transportation to the site for those materials and equipment stored off-site.

D. The Contractor warrants that title to all materials, supplies, and equipment covered by an application for payment, whether incorporated into the Work or not, shall pass to the City, upon receipt of payment by the Contractor, free and clear of all liens, claims, security interests or encumbrances; and that such materials, supplies or equipment furnished or installed comply with the applicable requirements of the Contract Documents.

E. The passing of title to the City as herein provided shall not be construed as relieving the Contractor of the sole and complete responsibility for:

1. The care and protection of the materials, supplies, equipment, and Work for which payment has been made.
2. The restoration of any damaged or destroyed Work, materials, supplies or equipment. Such responsibility shall continue until all Work under the Contract has been completed and accepted by the City.

F. Under no circumstances shall payment constitute a waiver of the City's right to require the Contractor to fulfill all of the terms and conditions of this Contract.

G. INVOICE PROCESSING: The City will not accept inaccurate, illegible, or incomplete invoices (requests for payments). Invoices shall be hard copy, with original signature. Electronic or facsimile signatures are not acceptable on the invoice.

1. The City distributes payments on every other Friday, beginning on 01/05/18 for calendar year 2018, unless holidays dictate otherwise.

2. The Engineer must receive an acceptable, correct invoice with required supporting documentation not later than close of business on the Wednesday, nine (9) calendar days prior to the expected check distribution day.
3. For projects longer than sixty (60) calendar days duration, each request for payment shall be accompanied by a progress schedule, effective through the invoice period. The City shall not release a payment until the contractor provides an acceptable, accurate, and updated project schedule.

32. PAYMENT WITHHELD

A. The City may decline to certify payment on account of subsequently discovered evidence or observations, may nullify the whole or any part of any payment certificate previously issued to such extent as may be necessary to protect the City from loss on account of any one or more of the following:

1. Defective Work not remedied.
2. A reasonable doubt that the Contract can be completed for the balance then unpaid.
3. Unsatisfactory prosecution of the Work.
4. Not maintaining a current project schedule.
5. Not providing adequate progress payment "Status As-Builts".
6. Deductions for not conforming to daily clean-up requirements.
7. Deductions for reimbursement of City overtime inspection.
8. Liquidated damages payable by the Contractor.
9. Disputed Work or Materials.
10. Failure to comply with other material provisions of the Contract.
11. Third-party claims filed or reasonable evidence that a claim will be filed.
12. Failure of the Contractor or Subcontractor to make timely payments for labor, equipment, and materials.
13. Damage to the Owner.

In addition, the City reserves its rights under ARS Sections 32-1129.01 and 34-221I.

B. When any of the above problems are resolved, payment shall be made for amounts withheld pursuant to Article 31.

33. MEASUREMENTS

A. The itemized Application for Payment will be used by the Engineer as a basis for evaluating requests for payment, except in cases where unit prices have established the basis for payment shall include as a minimum the following items:

1. Separate cost itemizations for mechanical, piping, structural, electrical instrumentation, painting, pre-engineered structures, and architectural finish work.
2. Separate cost line items, showing both purchase and installed cost, for the major equipment items listed in the bidding schedule.

3. A separate line item for mobilization not to exceed ten percent (10%) of the total Contract amount. This limitation shall apply even when a bid item for mobilization is shown in the bid schedule, unless the Engineer has assigned a fixed cost for the item. Amounts excess of this limitation shall be included on the final payment.
4. A separate line item for demobilization, not to exceed one-half of one percent (0.5%) of the total Contract amount. This limitation shall apply even when a bid item for demobilization is shown in the bid schedule, unless the Engineer has assigned a fixed cost for the item. Amount in excess of this limitation shall be included on the final payment.
5. Separate line items for earthwork, demolition and clearing and grubbing, where appropriate. Measurement and payment for the various items shown by the Contract Drawings and described in the construction Specifications, and comprising the completed work, shall be subject to this Article.

B. The contractor may subdivide any of the lump sum bid items in the proposal as necessary to identify items per (A) above, however the neither the total bid or the total of any subdivided bid item line shall exceed the total in the bid proposal as awarded.

C. Payment for each item shall constitute payment in full for the furnishing of all materials, equipment, appurtenances, labor, plant and tools necessary to provide a complete workmanlike, finished, and satisfactory project, as shown by the Contract Drawings and described in the Specifications. Each item shall be completed with all necessary connections, testing, painting and related work accomplished to provide for the satisfactory use and/or operation of the item. No additional payment will be made for work related to each item, unless specifically noted or specified.

D. No additional payments will be made for work related to any item unless specifically noted and called for in the Bid Proposal. Payment will be made at the unit price or lump sum price bid in the Bid Proposal.

E. Measurement will be on the completed work in place, with no allowance for waste, and as may be more particularly described in the description of the various items set forth in the Specifications and as shown by the Contract Drawings.

F. The quantities set forth in the Bid Proposal are used for the purpose of determining the basis of the Award of the Contract, and may be varied by the Engineer to conform to the requirements of the work as set forth in the Contract Drawings, and the Contractor agrees to perform the work on the basis of the prices bid for the items contained in the Bid Proposal regardless of whether or not the items or units are decreased or increased.

G. The Engineer shall have the right to order omitted from the Contract any item or a portion of the estimated quantity for any item found unnecessary to the work without violating the Contract or Performance Bond.

H. Except in cases where unit prices form the basis for payment under the Contract, the Contractor shall, within twenty (20) days of receipt of the notice to proceed, submit a

breakdown of the Contract price showing the value assigned to each part of the work including an allowance for profit and overhead. In submitting the breakdown, the Contractor certifies that it is not unbalanced and that the value assigned to each part of the work represents his estimate of the actual cost, including profit and overhead, of performing that part of the work. The breakdown shall be sufficiently detailed to permit its use by the Engineer as one of the bases for evaluating requests for payment.

H. Mobilization and Demobilization: Payment for Mobilization shall include the cost for setting up Project offices and moving Equipment to the site, storage facilities, obtaining permits, and all other items required to prepare the Project site for commencement of construction activities. Demobilization shall include removal of Contractor's facilities and Equipment, and final cleanup, and all other items required to complete Demobilization.

Payment for mobilization shall be in accordance with Section 901 of ADOT Standard Specifications for Road and Bridge Construction (most current edition), except as modified by this section and General Conditions Section 18, 33, and 66. Retention shall apply to mobilization payments. The first payment for mobilization shall be contingent on providing:

1. A traffic control plan that has been approved by the Engineer
2. The Storm Water Pollution Control Plan provisions are in place per the SWPPP in the Civil Plans
3. The Contractor shall have a City of Sedona or ADEQ NOI for stormwater pollution prevention
4. The Project Sign has been posted
5. A complete project schedule as required by the General Conditions, Section 9.

I. Excavation-Generally: The excavation rates shall include the amount for working in such a manner as not to interfere with the stability of adjacent structures and properties, for the costs of all timbering or other support required, for all necessary measures to keep the excavation free from water and sewage whether affected by floods, storms or otherwise, for working space, refilling, consolidating and disposal of surplus material from temporary spoil heaps or disposal as directed by the Engineer. The rate shall apply to the excavation in any material, including rock.

No extra payment will be made if the position of the work as set out will not allow the use of a mechanical plant or necessitates the cartage to temporary spoil heaps of excavated material and the reloading and cartage back for refilling of excavations or disposal.

34. PAYMENT, USE OR OCCUPANCY OF WORK

A. No progress or final payment, nor any partial or entire use or occupancy of the Work or improvement, nor acceptance thereof, by the City shall be evidence of the performance of the Contract or construed to be acceptance of defective work or

improper materials, either wholly or in part. The Contractor's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute.

B. The City shall have the right to take possession of, use, or occupy any completed or partially completed portions of the Work, notwithstanding the time for completing the entire Work or any portions, may, or may not, have expired. Such taking possession, use or occupancy shall not be deemed an acceptance of any Work until all Work has been completed in accordance with the Contract Documents. If such prior use or occupancy increase the cost, or delays the Work, the Contractor shall be granted such extra compensation or extension of time, or both, as City may determine.

C. Consent of Surety and endorsement from the insurance carrier or carriers permitting prior occupancy or use of any completed or partially completed portions of the Work by the City shall be secured by the Contractor. Contractor and his Surety and enforcement from the insurance carrier or carriers permitting prior occupancy or use of any completed or partial completed portions of the Work by the City shall be secured by the Contractor. Contractor and his Surety and insurance carrier hereby agree that such consent shall not be unduly withheld.

35. CLOSEOUT PROCEDURE

When the Contractor considers that the Work, or a portion thereof which the City has allowed to be accepted separately, is substantially complete, the Contractor shall prepare a letter stating the work, or a portion of the work, is substantially complete and submit to the City a comprehensive list of items to be completed or corrected. Substantial completion shall not operate to change the contract time to which liquidated damages are applicable. Reduced liquidated damages are chargeable for a project or portions thereof which have separately specified damages, if there are items of work remaining to be performed relative to such work once full substantial completion status has been attained. In such cases the amount of liquidated damages due shall be twenty-five percent (25%) of the unreduced liquidated damage amount stated in the contract, and shall not begin until after the contract completion date.

The Contractor shall proceed promptly to complete and correct items on the list. Failure to include an item on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents. Upon receipt of the Contractor's list, the City will make an inspection to determine whether the Work or designated portion thereof is substantially complete. The City Engineer shall have the sole right to determine if a Work or portion thereof is substantially complete. If the City's inspection discloses any item, whether or not included on the Contractor's list, which is not in accordance with the requirements of the Contract Documents, the Contractor shall, before issuance of the Certificate of Substantial Completion, complete or correct such item upon notification by the City. The Contractor shall then submit a request for another inspection by the City to determine Substantial Completion. When the Work or designated portion thereof is substantially complete, the City will prepare a certificate of Substantial Completion which shall establish the date of Substantial Completion, shall establish responsibilities of the Contractor and City for security, maintenance, heat, utilities, damage to the Work and

insurance, and shall fix a reasonable time within which the Contractor shall finish all items on the list accompanying the Certificate. If the Contractor does not complete the items within the time fixed by the City, the City, upon ten (10) working days notice, shall have the option to complete the uncompleted Work for the Contractor and deduct the cost from any amount due to the Contractor, whether or not the contract completion date has passed.

The Contractor may request a written statement from the City Engineer of what constitutes substantial completion by writing a letter of "Notice Of Intent to Declare Substantial Completion." The letter shall be sent no later than fifteen (15) working days prior to the anticipated date of Substantial Completion. The letter shall state what items the Contractor intends to complete prior to declaring substantial completion and what date substantial completion is anticipated by. The City Engineer shall respond to the letter within ten (10) working days accepting or adding to the list of items to complete prior to substantial completion. The City Engineer's response to the list shall not prevent the City Engineer from amending the list within a reasonable time prior to the anticipated date of substantial completion, or from considering factors not known at the time the response was prepared.

36. FINAL PAYMENT

A. Prior to receiving final payment, the work shall be completed according to the Contract Documents, as determined by the City. Retention shall be as provided in A.R.S. §34-221. This includes, but is not limited to, submittal of complete as constructed documents.

B. The acceptance of final payment by the Contractor shall operate as a release to the City of all claims by the Contractor for all things done or furnished in connection with the Contract and for every act and neglect of the City, and others relating to or arising out of the Work under the Contract, except for claims made in writing and still unsettled, and specifically itemized at the time the final payment request is made.

C. No payment, final or otherwise, shall operate to release the Contractor or his Surety from any obligations under the Contract or under the Performance Bond or Labor and Materials Payment Bond, including, but not necessarily limited to anyone or more of the following:

1. Obligations arising from or relating to latent defects.
2. Faulty or defective work or material, which does not comply with the requirements of the Contract.
3. Failure of the construction, equipment, or fixtures to perform properly in accordance with the requirements of the Contract Documents.
4. Unsettled claims.
5. Claims for non-payment of laborers, mechanics, material men, or suppliers, or for equipment used or rented.
6. Claims under the maintenance requirements of the Contract Documents or any special warranties provided for in the Contract Documents.

37. SUPERVISION BY CONTRACTOR

A. The Contractor or his designated representative will be required to give personal attention to the fulfillment of this Contract and to keep the work under control and in accordance with the Schedule for Completion. The contractor shall provide a competent Representative with full authority to receive and execute such instructions, orders or directions as the Engineer, or his agents or representatives may issue in connection with the Contract.

   The Contractor will supervise and direct the work at all times. He has the obligation to determine the means, methods, techniques, sequences and procedures of construction, except in those instances where the City, to define the quality of an item of work, specifies in the Contract a means, method, technique, sequence or procedure for construction of that item of work. The Contractor shall be responsible to perform the Work so that the quality of the Work conforms to the plans and the specifications while in progress and as finally completed.

B. Instructions and information given by the City, Engineer, or his agents or representatives to the Contractor's representative on the work shall be considered as having been given to the Contractor. Before any work is done at the job site, the Contractor shall give written notice to the Engineer stating the name, home address and telephone number of the Contractor's representative. The Contractor shall also inform the Engineer in writing prior to any change of representative. A statement naming more than one person to be in charge depending upon which one is present at the time will not be acceptable.

C. The Contractor shall file with the Engineer the names, addresses, and telephone numbers of representatives who can be contacted at any time in case of emergency. These representatives must be fully authorized and equipped to correct unsafe or excessively inconvenient conditions immediately on order of the Engineer.

D. The Contractor shall pay and cause his Subcontractors to pay any and all accounts for labor, services, equipment, and materials used by the Contractor and his Subcontractors during the performance of work under this Contract, including all applicable taxes and insurance. Such accounts shall be paid as they become due and payable within the time limits set forth by law. The Contractor shall furnish proof of payment of such accounts to the City.

E. The plan or method of work suggested by the City or the Engineer to the Contractor but not specified or required, if adopted or followed by the Contractor in whole or in part, shall be used at the risk and responsibility of the Contractor. The City and the Engineer assume no responsibility therefore and in no way will be held liable for any defects in the work which may result from or be caused by the use of such plan or method of work.

38. WEATHER

A. During periods when weather or other conditions are unfavorable for construction, the Contractor shall pursue only such portions of the work as shall not be damaged thereby. No portions of the work where acceptable quality or efficiency will be affected by unfavorable conditions shall be constructed while those conditions exist. It is expressly understood and agreed by and between the Contractor and the City that the Contract time for completion of the work described herein is a reasonable time taking into consideration the average climatic and economic conditions and other factors prevailing in the locality of the work.

B. The Contractor shall not be assessed liquidated damages, nor the cost of engineering and inspection during any delay in the completion of work caused by Acts of God, acts of the public enemy, acts of a public agency or owner, or a utility to provide for removal or relocation of existing utilities, unless such delay is caused in whole or in part by Contractor or any of its Subcontractors.

C. A rain, windstorm, high water or other natural phenomena for the specific locality of the work, which might reasonably have been anticipated from historical records of the general locality of the work, shall not be construed as abnormal. It is hereby agreed that rainfall greater than the following cannot be reasonably anticipated:

    1. Daily rainfall equal to, or greater than, one inch during a month when the monthly rainfall exceeds the normal monthly average by fifteen percent or more.
    2. Daily rainfall equal to, or greater than one and one-half (1-1/2) inch at any time.

Rainfall data shall be collected at the job site by the Contractor.

39. OVERTIME

Any Work necessary to be performed after regular working hours, on Sundays, or legal holidays, shall be performed without additional expense to the City unless otherwise provided in the Contract Documents.

The Contractor is responsible for completing his work activities within regular working hours. Should the Contractor elect to run his crews more than a typical 10-hour day, he may elect to with prior coordination with the City. Any inspection, which is required beyond the City of Sedona's Standard 10-hour work day due to extended work hours or late daily cleanup, is subject to a withholding by the City from the Contractors progress payment for the cost of the overtime inspection during that period. The amount withheld shall be itemized by person and reflect any overtime premiums paid.

40. INDEMNIFICATION

A. To the fullest extent permitted by law, the Contractor shall defend, indemnify and hold harmless the City, its agents, officers, officials and employees from and against all tortuous claims, damages, losses and expenses (including but not limited to attorney fees, court costs, and the cost of appellate proceedings), relating to, arising out of, or alleged to have resulted from the acts, errors, mistakes, omissions, work, and/or

services of the Contractor, its agents, employees or any tier of Contractor's subcontractors in the performance of this Contract. Contractor's duty to defend, hold harmless and indemnify the City, its agents, officers, officials and employees shall arise in connection with any tortuous claim, damage, loss or expense that is attributable to bodily injury, sickness, disease, death, or injury to, impairment, or destruction of property including loss of use resulting there from, caused by Contractor's acts, errors, mistakes, omissions, work or services in the performance of this Contract including any employee of the Contractor, any tier of Contractor's subcontractor or any other person for whose acts, errors, mistakes, omissions, work or services the Contractor may be legally liable. The Contractor shall, with respect to all work which is covered by or incidental to this Contract, indemnify and hold the City, Engineering Dept., all officers, employees, attorneys, agents of the City and the City Engineer, harmless from and against all of the following made by any person or entity not a party to this Agreement:

1. Any claim, liability, loss, damage, costs, expenses, including reasonable attorneys' fees, expert witness fees, court costs and other expenses of litigation, awards, fines, or judgments, arising by reason of the death or bodily injury to persons, injury to property, design defects (if design originated by Contractor only) or other loss, damage or expense, including any of the same resulting from any alleged or actual negligent or intentional acts or omissions of the Contractor, the Subcontractors, or anyone directly or indirectly employed by any of them or anyone for whose acts any of them may be liable, regardless of whether it is caused in part by a party indemnified by this Contract and regardless of whether said acts or omissions of such party are active or passive.

2. Any claim, liability, loss, damage, costs, expenses, including reasonable attorneys' fees, expert witness fees, court costs and other expenses of litigation, awards, fines, or judgments, arising out of any dispute regarding the Contract or any work performed under the Contract.

3. Any claim, liability, loss, damage, costs, expenses, including reasonable attorneys' fees, expert witness fees, court costs and other expenses of litigation, awards, fines, or judgments, arising out of any dispute regarding the Contract or any work performed under the Contract by any Subcontractor.

4. Any loss or damage that may happen to the work or any part thereof, and any loss or damage to any of the materials or other property used or employed in performing the work, including any loss or damage during transit or storage of any property or materials, including any property or materials furnished by the City, including reasonable attorneys' fees, awards, fines, or judgments.

B. However, the Contractor shall not be obligated under this Contract to indemnify the City with respect to the sole negligence or willful misconduct of the City or its agents or employees or Design Engineer.

C. The indemnity obligations of this Contract shall not be construed to negate, abridge, or otherwise reduce any other right or obligation of indemnity which

otherwise exists by statute or under the common law of the State of Arizona, except those in conflict with the express terms of these General Conditions. The law of comparative negligence, as adopted by the State of Arizona, shall be binding upon the relationship between the parties, except as set forth herein.

D. The amount and type of insurance coverage requirements set forth herein will in no way be construed as limiting the scope of the indemnity in this paragraph.

41. ACCIDENT PREVENTION - EMERGENCY - AUTHORITY TO ACT

After the Contract Notice to Proceed has been issued through final acceptance of the Contractor's work, it shall be the Contractors responsibility for protection and safety of the public and workers twenty-four (24) hours a day, seven (7) days a week. This responsibility will also be placed on the Contractor after final acceptance when the Contractor is on site performing any Guaranty/Warranty work.

Whenever, in the opinion of the Engineer, the Contractor has not taken sufficient precaution for the safety of the public or the protection of the work to be constructed under this Contract, or of adjacent structures or properly, and whenever, in the opinion of the Engineer, an emergency has arisen and immediate action is considered necessary, then the City, with or without notice may provide suitable protection by causing work to be done and materials to be furnished and placed. The cost of such work and materials shall be borne by the Contractor, and if the same is not paid on presentation of the bills, such costs will be deducted from any amounts due or to become due to the Contractor. The performance of such emergency work shall not relieve the Contractor of responsibility for any damage that may occur.

42. PROTECTION OF WORK

The Contractor, at no additional expense to City, shall at all times safely guard and protect his own Work; provide, erect, and maintain suitable barriers around all improvements, work areas, excavations, or obstructions to prevent accidents; and provide, place, and maintain during the night sufficient lights, signals, and signs for this purpose on or near the Work. The Contractor shall at all times, until its completion and final acceptance, protect his Work apparatus, equipment, and material from accidental or any other damage; and make good any damages thus occurring at no additional cost to the City.

43. PROTECTION OF PROPERTY

A. The Contractor, at no additional expense to the City, shall at all times (1) safely guard the City's property and abutting or adjacent property from injury, loss, or damage in connection with the Contract; (2) protect by false work, braces, shoring, or other effective means all buildings, foundations, walls, fences, property pins and other property along his line of Work, or affected directly by his Work, including, but not limited to the City’s property, against damage; (3) cover or otherwise protect stockpiles of materials to avoid damage to any property from such materials; and/or (4) repair,

replace, or make good any such damage, loss or injury, unless such is caused directly by the City or his duly authorized representatives.

B. The Contractor shall exercise care to protect from injury all water lines, sanitary sewer lines, gas mains, telephone cables, electric cables, services pipes, and other utilities or fixtures which may be encountered during the progress of the Work. All utilities and other service facilities or fixtures if damaged, shall be repaired by the Contractor without additional compensation.

C. The Contractor shall personally check and verify utility information on the plans. Where existing utilities or structures are shown on the plans or drawings, they are believed to be accurate but are not guaranteed to be such or that these are the only utilities or structures in the construction area. Protection is completely the responsibility of the Contractor and he must satisfy himself as to the existence and location of all utilities and structures.

D. The Contractor shall give written notice of at least forty-eight (48) hours before breaking ground, to all persons, superintendents, inspectors, or those otherwise in charge of property, streets, water, gas, or sewer pipes, telephone or electrical cables, railroads, or otherwise who may be affected by the Contractor's operation in order that they may remove any obstruction for which they are responsible and have a representative on the site to see that their property is properly protected.

44. PROTECTION OF PERSONS

A. The Contractor shall:

1. At all times protect the lives and health of his employees under the Contract.
2. Take all necessary precautions for the safety of all persons on or in the vicinity of the Work site.
3. Comply with all applicable provisions of Federal, State, and Municipal safety laws and building codes.
4. Comply with all pertinent provisions of the "Manual of Accident Prevention on Construction" issued by the Associated General Contractors of America, Inc., latest edition, to prevent accidents or injury to persons, on, or adjacent to the premises where the Work is being performed. The Contractor shall erect and properly maintain at all times, as required by the conditions and progress of the Work, all necessary safeguards for the protection of persons and shall post danger signs warning against the hazards created by such features of construction as protruding nails, rod hoists, well holes, elevator hatchways, scaffolding, window openings, stairways, and falling materials; and he shall designate a responsible member of his organization on the Work site whose duty shall be the prevention of accidents.

B. The Contractor shall comply with all provisions of the "Occupational Safety and Health Act" (OSHA), including any amendments thereto and rules and regulations issued pursuant thereto, applicable to the Work and performance of the Contract. Whereas state in which Work is performed has passed legislation bearing on Occupational Safety

and Health, such legislation and amendments thereto, together with rules and regulations issued pursuant thereto shall be complied with by the Contractor.

45. POTENTIALLY DANGEROUS WORK

A. When the use of explosives, driving, or removal of piles, wrecking, excavation Work or other similarly potentially dangerous Work is necessary for the prosecution of the Work, the Contractor shall exercise the utmost care so as not to endanger life or property. The Contractor shall be fully responsible for any and all damages, claims, and for the defense of any actions against the City resulting from the prosecution of such Work in connection with or arising out of the Contract.

B. The Contractor shall notify each private and public utility company or other owner of property having structures or improvements in proximity to the site of the Work, of his intent to perform potentially dangerous Work. Such notice shall be given sufficiently in advance to enable the companies or the owners of property to take such steps as they may deem necessary to relieve the Contractor of responsibility for all damages, claims, or the defense of any actions against the City resulting from the performance of such Work in connection with or arising out of the Contract.

C. All explosives shall be stored in a secure manner and all storage places shall be marked clearly "EXPLOSIVES-KEEP OUT", and shall be in the care of competent watchmen at all times. Blasting Permits must be obtained from the Sedona-Oak Creek Fire District, 2860 Southwest Drive, Sedona, AZ 86336 (602) 282-6800.

D. If blasting is required, building inspection reports must be conducted for properties within 150-feet of the proposed blasting area. For affected structures that are to remain after the construction, the report shall consider and document the existing structural and architectural condition of those structures. The intent of this report is to document the condition of such structures before construction, obtain agreement with the property owner, and use for comparison purposes after construction is completed, to ensure the structure was not damaged from construction activities. Blasting will only be considered if rock excavating equipment equal to or better than that provided by “drum-cutters” (see www.drumcutters.com), would not be effective for excavation.

46. PATENTS, COPYRIGHTS, AND ROYALTIES

A. The Contractor shall assume all costs arising from the use of any patented article, material, device, equipment or process used or furnished by him in connection with, or incorporated in the Project. The Contractor shall save, and hold harmless the City and all officers and agents thereof from all damages, costs and expenses in law or equity (including attorneys' fees, expert witness fees, court costs, and other expenses of litigation) that may come at any time, arise or be set up by reason of any infringement or alleged infringement of any patent rights as a consequence of the installation or use of any such article, material, device, equipment or process in or about the Project. The Performance Bond required by Arizona Revised Statutes Section 34-221 shall be deemed to apply expressly to this provision of the Contract.

B. Should the Contractor, his agent, employer or any of them be enjoined from furnishing or using any invention, article, material or plans supplied or required to be supplied or used under this Contract, the Contractor shall promptly pay such royalties and secure the requisite licenses; or, subject to acceptance by the City, substitute other articles, materials or appliances in lieu thereof which are of equal efficiency, quality, finish, suitability and market value to those planned or required under the Contract. Descriptive information of these substitutions shall be submitted to the Engineer for determination of general conformance to the Design concept and the Construction Contract. Should the City elect to refuse a substitution, the Contractor agrees to pay such royalties and secure such valid licenses as may be requisite for the City, his representatives, agents and employees or any of them, to use such invention, article, material or appliance without being disturbed or in any way interfered with by any proceeding in law or in equity on account thereof.

47. CHANGE ORDERS FOR CHANGED OR EXTRA WORK

A. The City reserves the right at any time during the progress of the Work to make necessary alterations of, deviations from, additions to, or deletions from the Contract, or may require the performance of extra Work neither covered by the specifications nor included in the Proposal, but forming a part of the Work contracted for; provided however, the Contractor shall not proceed with any such change or extra Work without a written Change Order approved by the City. Until a resolution is reached by the City and the Contractor, the Contractor is to continue work on the project. Additional time may or may not be added to the projected (and approved) contract end date. Such changes or extra Work shall in no way injuriously affect or invalidate the Contract or the Contractor's bond, but the difference in cost shall be added to or deducted from the amount of the Contract, as the case may be. Adjustments, if any, in the amounts to be paid to the Contractor by reason of any such change or extra work shall be determined by one of the following methods in the order as listed:

1. Method A Unit prices contained in the Contract Documents for the same type or class of work.
2. Method B By an acceptable unit price proposal from the Contractor.
3. Method C By an acceptable lump sum price proposal from the Contractor.
4. Method D If neither Method “B" or “C" can be agreed upon before the change or extra work is started, then the Contractor shall be paid the "actual field cost" of the work plus eighteen percent (18%) or twelve percent (12%) as stated herein below.

B. Whenever any change or extra work is to be done, for which unit prices for the same type or class of work are contained in the Contract Documents, such work shall be done and shall be measured and paid for pursuant to Method A herein above set forth and the other applicable portions of the Contract Documents, subject to Article 30 of the General Conditions. Full compensation for taxes, overhead and other costs shall be considered as included in the unit prices bid.

C. Methods B and C shall include an itemized cost breakdown including overhead and profit. In determining the amount payable to the Contractor, an additional five percent (5%) may be added to the amount payable to a Subcontractor, but no "pyramiding" or additional percentage shall be authorized for any work done by a Subcontractor. This percentage may be increased to seven percent (7%) if the Contractor provides proof that it is paying transaction taxes for the subcontractor. The subcontractor percentage shall be considered as compensation for taxes paid on the subcontracted work, and any other costs or profit associated the subcontracted work. The taxes shall not be separately shown as a cost in the amount to which the seven percent (7%) is applied. Full compensation for taxes, overhead and other costs shall be considered as included in the unit price or lump sum price accepted whether such items are explicitly itemized or not.

D. When any change or extra work is performed under "Method D", the term "actual field cost" of such change or extra work is hereby defined to be and shall include:

1. The actual wages paid to all the Contractor's workmen such as foremen, equipment operators, mechanics, and laborers, for the time actually performing the change or extra work. Superintendents are considered as compensated for in the overhead.
2. All of the Contractor's materials and supplies incorporated in the change or extra work, unless the total cost for a particular material or supply is less than twenty dollars ($20). Materials and supplies with a total cost of less than twenty dollars ($20) will be considered as compensated for in the overhead and profit allowance.
3. All machinery and equipment for the time actually employed or used in the performance of the changed or extra work shall be based on the submitted and approved schedule of equipment rates, unless the hourly cost for the machinery or equipment is less than twenty-five dollars ($25.00) per hour or one hundred fifty dollars ($150) per day. Items with rates less than twenty-five dollars ($25.00) per hour or one hundred fifty ($150) per day will be considered as compensated for in the overhead and profit allowance. The contractor shall submit machinery and equipment rates for approval prior to Start of Construction.
4. Any transportation charges necessarily incurred in connection with any equipment authorized by the City for use on said change or extra work, but which is not already on site provided the transportation cost exceeds twenty-five dollars ($25.00).
5. All power, fuel, lubricants, water, and similar operating expenses as well as other expendable materials.
6. Incidental expenses incurred as a direct result of such change or extra work, including payroll taxes and a pro rata portion of premium in the Performance Bond and Labor and Materials Payment Bond, and where the premiums therefore are based on payroll costs, on Public Liability and Property Damage insurance, Workmen's Compensation insurance, and Occupational Disease Disability insurance, Builder's Risk, and other insurance required by the Contract. **In order to be allowed these amounts shall be provided in writing when submitting the first request for a progress payment. These amounts payable by the City shall not change for the duration of the contract. The twelve percent (12%) mark-up shall not apply to these items.**

7. No repairs, replacements, or other forms of overhead expense shall be included in "actual field costs".
8. The Engineer may adjust the amount due under this method based upon a reasonable estimate of the actual cost of performing deleted work in the case of a change in work method or work material. In this case the amount due shall be the difference between the estimated cost to perform work per the original method based on conditions known at the time of the change to the extent such conditions are not the basis for a change, and the method proposed to be used plus the unit bid price for the original method.

E. The Engineer may direct the form in which the accounts of the actual field costs shall be kept and may also specify in writing, before the work commences, the method of doing the work and the type and kind of machinery and equipment, if required, which shall be used in the performance of any change or extra work under method "D". In the event that machinery and heavy construction equipment are required for such change or extra work, the authorization and basis of payment for the use thereof shall be stipulated in the written Change Order.

F. The twelve percent (12%) or eighteen percent (18%) of the "actual field cost" to be paid to the Contractor shall cover and be full compensation for the Contractor's profits, overhead, superintendence, and field and home office expense, and all other elements of cost not embraced within the "actual field cost" as defined herein. Eighteen percent (18%) shall be payable for Contractor costs for that portion of total change orders less than or equal to thirty thousand dollars ($30,000). For that portion exceeding thirty thousand dollars ($30,000) the twelve percent (12%) factor shall be applied to Contractor costs. In determining the amount payable to the Contractor, an additional percentage per C above may be added to the amount payable to a Subcontractor, but no "Pyramiding" or additional percentage shall be authorized for any work done by Subcontractors.

G. No claim for any change or extra work of any kind shall be allowed unless the work is ordered and approved in writing by the City in the form of a Change Order.

H. No anticipated profits shall be allowed for work deleted.

I. If the City has work accomplished by other sources due the Contractor’s failure to perform required work it may deduct an additional five hundred dollars ($500) or five percent (5%) of the cost of accomplishing the work, whichever is greater, in addition to the cost of accomplishing the work using other sources. The City shall consider this additional amount as compensation for overhead and administration.

J. The Contractor shall furnish satisfactory bills, payrolls, and vouchers covering all items of cost and when requested by the City, give the City access to accounts relating thereto.

K. Any Change or extra work shall be considered a part of the Contract, subject to all of its terms, conditions, stipulations, review, guaranties, and tests may be performed

without notice to the surety on the Contractor's bond. The Contractor and surety hereby agree to these provisions.

L. The following language shall apply to all change orders:
"THIS CHANGE ORDER CONSTITUTES FULL, FINAL, AND COMPLETE COMPENSATION TO THE CONTRACTOR FOR ALL COSTS, EXPENSES, OVERHEAD, PROFIT, AND ANY DAMAGES OF EVERY KIND THAT THE CONTRACTOR MAY INCUR IN CONNECTION WITH THE WORK DESCRIBED IN THIS CHANGE ORDER, INCLUDING ANY IMPACT ON THE DESCRIBED WORK OR ON ANY OTHER WORK UNDER THE CONTRACT, ANY CHANGES IN THE SEQUENCES OF ANY WORK, ANY DELAY TO ANY WORK, ANY DISRUPTION OF ANY WORK, ANY RESCHEDULING OF ANY WORK, AND ANY OTHER EFFECT ON ANY OF THE WORK UNDER THIS CONTRACT. BY THE EXECUTION OF THIS CHANGE ORDER, THE CONTRACTOR ACCEPTS THE CONTRACT PRICE CHANGE AND THE CONTRACT COMPLETION DATE CHANGE, IF ANY, AND EXPRESSLY WAIVES ANY CLAIMS FOR ANY ADDITIONAL COMPENSATION, DAMAGES OR TIME EXTENSIONS, IN CONNECTION WITH THE DESCRIBED WORK."

M. The Contractor shall not be entitled to adjustments in contract price or contract time related to submittal of any cost estimates.

48. PROCEDURE FOR REQUESTING CHANGE ORDERS –EXTRA

A. In case any instructions, either oral or written, appear to the Contractor to involve a change or extra work for which, in his opinion, he should receive extra compensation, he shall make a written request to the Engineer for a written Change Order authorizing such change or extra work. Should a difference of opinion arise as to what does or does not constitute a change or extra work, or concerning the payment thereof, and the City insists on conformance, the Contractor shall proceed with the work after presenting written notice of claim for extra cost to the City and shall keep an accurate account of the "actual field cost" thereof as provided for in Method "D" under "Changed or Extra Work". The Contractor shall thereby not waive any right he might have to compensation for the claimed "extra cost" in connection with a change or extra work. The matter shall be submitted to the City for final determination as to whether or not a change or extra work was involved, and if so, the amount due to the Contractor.

B. Any claims for extra cost pursuant to this section, together with supporting documents and receipts, must be filed within ten (10) consecutive calendar days after performing the work for which extra cost is claimed. The City shall have the right to reject any claim for extra cost if the foregoing procedure is not followed.

C. In giving instructions, the Engineer shall have the authority to make minor changes that do not involve extra cost or time of performance and are not inconsistent with the design concept and purposes of the contracted work; but otherwise, except in an emergency endangering life or property, no change or extra work shall be performed unless authorized by a written "Change Order" approved by the City Council or its

designee in accordance with the City Code, and no claim for extra cost shall be valid unless so approved, except as otherwise provided herein.

49. PROCEDURE FOR REQUESTING CHANGE ORDERS--EXTRA TIME

A. The Contract time may be changed only by a change order either alone or in conjunction with other changes. Any claim for an extension of Contract time shall be based on written notice delivered to the Engineer within seven days of the occurrence of the event giving rise to the claim. Notice of the extent of the claim with supporting data shall be delivered within forty-five days of such occurrence unless Engineer allows an additional period of time to ascertain more accurate data. Notice of the extent of the claim must state the cause of the delay, the date of occurrence causing the delay, and the amount of additional time requested. Requests for extensions of time shall be supported by all evidence reasonably available or known to the Contractor, which would support the extension of time requested. If the Contractor is requesting an extension of time because of weather, he shall supply daily written reports to the Engineer describing such weather and the work which could not be performed that day because of such weather or conditions resulting there from and which he otherwise would have performed. The Engineer's acceptance of the daily reports shall not be deemed an admission of the Contractor's right to receive an extension of time or waiver of the City's right to strictly enforce the time provisions contained in the Contract Documents. Requests for extensions of time failing to include the information specified in this Article and requests for extension of time which are not received within the time specified above shall result in the forfeiture of the Contractor's right to receive any extension of time requested. Any change in the Contract time resulting from any such claim shall be incorporated in a change order. The percentages specified in Section 38 and 47 G above shall be considered to include full compensation for each day or portion thereof of extra time.

B. The Contract time will be extended in an amount equal to time loss due to delays beyond the control of Contractor if a claim is made there for as provided in paragraph A. Such delays shall include, but not be limited to, acts or neglect by City or others performing additional work, or to fires, floods, labor disputes, epidemics, abnormal weather conditions, or act of God. No extension of the Contract time will be granted where the delay is attributable to a Subcontractor, manufacturer, fabricator, supplier or distributor or any other party performing services or furnishing material or equipment on behalf of the Contractor unless such party's delay is attributable to one of the above enumerated causes. Time limits concerning substantial completion and final completion as stated in the Contract Documents are of the essence.

C. An extension of time may be granted by the City after the expiration of the time originally fixed in the Agreement or as previously extended, and the extension so granted shall be deemed to commence and be effective from the date of such expiration. However, such extension shall not be deemed to be a release of any of the City's rights under the Contract Document unless expressly stated as such.

50. DIFFERING SITE CONDITIONS

If conditions or objects are encountered at the site which are (1) sub-surface or otherwise concealed and which differ materially and substantially from those indicated or anticipated in the Contract Documents or (2) are of an unusual nature, which differ materially and substantially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents, then notice, in writing, by the Contractor shall be given to the City promptly before conditions are disturbed and in no event later than 24 hours after first observance of the conditions. The City shall promptly investigate such conditions and, if they differ materially and substantially and cause an increase or decrease in the Contractor's cost of, or time required for, performance of any part of the work, shall provide an equitable adjustment in the Contract Amount or Contract Period, or both as per Sections 47 through 49 of these General Conditions. If the City determines that the conditions at the site are not materially and substantially different from those indicated in the Contract Documents and that no change in the terms of the Contract is justified, the City shall so notify the Contractor in writing, stating the reasons. No claim by the Contractor for an equitable adjustment shall be allowed if asserted after final payment has been made under this agreement. Weather, and the effects of weather on surroundings, surface, or subsurface are to be anticipated and do not constitute a differing condition. No contract change, which results in a benefit to the Contractor, shall be allowed unless the contractor has provided the required written notice. No contract adjustment will be allowed under this section for any effects caused on unchanged work.

51. WARRANTY PERIOD

A. Besides guarantees required elsewhere, the Contractor shall and hereby does guarantee all work for a period of two (2) years after the date of final acceptance of the work by the City and shall repair and replace any and all work together with any other work, which may be displaced in so doing, that may prove defective in workmanship or materials within the two-year period from the date of final acceptance, without expense whatsoever to the City, ordinary wear and tear and unusual abuse or neglect excepted. If the Contractor is required to repair or replace any portion of the Project pursuant to the two-year guarantee provided by this section, the repair or replacement shall similarly be guaranteed for an additional one-year period from the date of completion of the repair. In the event of failure to comply with the above mentioned conditions, within a week (seven consecutive days) after being notified in writing by the City, the City is hereby authorized to proceed to have the defects repaired and made good at the expense of the Contractor, who hereby agrees to pay the cost and charges therefore immediately upon demand by the City. In case of emergency, where, in the opinion of the City, delay could cause serious loss or damage, repairs may be made without notice being sent to the Contractor and the expenses in connection therewith shall be charged to the Contractor.

B. The Contractor guarantees to the City that all materials and equipment furnished under this Contract will be new and of good and sufficient quality, free from faults and defects as is necessary to complete the project as required by the plans and specifications.

C. The City and the Contractor agree that the guarantee on the equipment possessed and used by the City, in accordance with Article 34 of these General Conditions, shall commence on the date that the City takes possession of the equipment and so notifies the Contractor in writing. City and Contractor further agree that such taking possession and use shall not be deemed as acceptance of any part of the work. Take-over of equipment may occur when such equipment can be put into routine service on a permanent basis at City's discretion.

52. AUTHORITY OF ENGINEER

A. The Engineer shall furnish engineering services during construction of the work to the extent provided in the Contract Documents. He shall observe and review the work in the process of construction or erection. Compliance with the Contract Documents shall be the Contractor's responsibility notwithstanding such observation or review. The Engineer has authority to recommend suspension of the work when it appears such suspension may be necessary to accomplish the proper implementation of the intent of the Contract Documents. The authority to observe, review, or recommend suspension of all or any portion of the work, or exercise such other authority as may be granted by the Contract Documents, shall not be construed or interpreted to mean supervision of construction, which is the Contractor's responsibility, nor make the Engineer responsible for providing a safe place for the performance of work by the Contractor or by the Contractor's employees or those of suppliers or subcontractors or for access, visits, use, work, travel, or occupancy by any other person. The provisions of MAG Sections 104.1.4 and 104.2.5 as contained in the 2012 edition apply to this contract.

B. The Engineer shall have authority to reject any or all work, materials, or equipment, which do not conform to the Contract Documents, and to decide technical questions, which arise in the execution of the work. The Engineer shall determine the amount, quality, acceptability, and fitness of the several kinds of work, materials, equipment, and supplies which are to be paid for under the Contract and shall decide all questions which may arise in relation to said work and the construction thereof. The Engineer's estimates and decisions shall be final and conclusive, except as otherwise expressly provided. In case any question shall arise between the parties to the Contract relative to the Contract Documents, the determination or decision of the Engineer shall be a condition precedent to the right of the Contractor to receive any money or payment for work under the Contract affected in any manner or to any extent by such question.

53. DECISIONS OF THE CITY

If the Contractor is not in agreement with any final decision of the Engineer, then he may appeal, in writing, such decisions to the City Manager, who shall within a reasonable time after presentation, make decisions in writing on claims properly made by the Contractor. The appeal shall contain the final decision of the Engineer as an attachment, or in the absence of such final decision a copy of a certified letter sent to the Engineer, at least fifteen (15) working days prior to the appeal, requesting such a final decision in writing. The decision of the City Manager shall be regarded as final.

54. TEMPORARY SUSPENSION OF THE WORK

A. The City Manager may, upon the recommendation of the Engineer, or by the Manager's own determination, suspend the work.

B. Should the discovery of a potential archaeological or historic resource occur during construction, the Contractor shall cease work at that site, immediately notify the Engineer, and shall not proceed until instructed to do so by the City. In the event such a suspension of the work occurs, the provisions of Article 49 shall apply to extend the time for final completion of the work.

55. AUTHORITY AND DUTIES OF CITY'S FIELD REPRESENTATIVE

A. Inspectors may be placed on the work to keep the City informed as to the progress of the work and the manner in which it is being done; to keep records; act as liaison between the Contractor and the City; and to call the attention of the Contractor to any deviations from the Contract Documents. However, failure of the inspector to call the attention of the Contractor to faulty work or deviations from the Contract Documents shall not constitute acceptance of said work.

B. The inspector cannot control how the material is used; therefore, the responsibility for its safety and proper use shall be the Contractor's. Until the job is finally completed, the Contractor may do work that changes or modifies work previously done, and even though at any given time, a piece of work might be well done and acceptable in quality, the responsibility for keeping it in that condition until the work is complete is the sole responsibility of the Contractor. For this reason, it is impossible to accept, finally, any portion of a project until the project as a whole is accepted and control of said project is transferred from the Contractor by final official written acceptance by the City.

C. Any personal assistance which an inspector may give the Contractor will not be construed as the basis of any assumption of responsibility in any manner, financial or otherwise, by the inspector or the City.

D. The inspector is not and does not purport to be a Safety Engineer and is not engaged in that capacity by the City and shall have neither authority nor the responsibility to enforce construction safety laws, rules, regulations, procedures, or the safety of persons on and about the construction site.

E. The presence or absence of an inspector on any job will be at the sole discretion of the City, and such presence, or absence of an inspector will not relieve the Contractor of his responsibility to obtain the construction results specified in the Contract Documents.

F. The inspector is not authorized to approve or accept any portion of the work or to issue instructions contrary to the Contract Documents. Approvals, acceptance or instructions, when given, must be in writing and signed by the City. The inspector shall have

authority to reject defective materials; however the failure of the inspector to reject defective material or any other work involving deviations from the Contract Documents shall not constitute acceptance of such work.

G. Nothing in this subsection shall in any way be so construed as to require or to place responsibility for the method, manner or supervision of the performance of the work under this Contract upon the inspector, or the City. Such responsibility rests solely with the Contractor.

56. CHARACTER OF WORKERS, METHODS, AND EQUIPMENT

A. The Contractor shall at all times employ sufficient skilled labor in accordance with Federal, State and local labor laws; and the proper equipment for completing the project in the manner and time required by the Contract. All equipment, which is proposed to be used on the project, shall be of sufficient size and in such mechanical condition as to meet requirements of the work and to produce a satisfactory quality of work. Equipment used on any portion of the project shall be used such that it will not damage property adjacent to the work area.

B. Any person employed by the Contractor or any Subcontractor who, in the opinion of the Engineer, does not perform his work in a proper and skillful manner or is intemperate or disorderly shall, at the written request of the Engineer, be removed from the work by the Contractor or Subcontractor employing such person, and shall not be employed again in any portion of the work without the approval of the Engineer. Should the Contractor or Subcontractor fail to remove such person as required above, or fail to furnish suitable and sufficient personnel for the proper prosecution of the work, the Engineer may suspend the work by written notice until such orders by the Engineer are followed by the Contractor. The Contractor or Subcontractor shall hold the City harmless from damages or claims for compensation that may occur in the enforcement of this section.

C. The City may require submittal of Certified Payrolls at any time from the Contractor showing the employee names, addresses, Social Security Numbers, rates of pay, payments received, payroll deductions, occupational classification(s), and hours per day worked in such classification(s) for work performed on this project by employees. The contractor shall retain such records for the minimum time required by law or three (3) years after project completion, whichever is longer. The Contractor shall also be responsible to produce upon request from the City such payroll records from its subcontractors.

57. WARRANTY OF COMPLIANCE WITH STATE AND FEDERAL LAW

CONTRACTOR understands and acknowledges the applicability to it of the Americans with Disabilities Act, the Immigration Reform and Control Act of 1986 and the Drug Free Workplace Act of 1989. CONTRACTOR must also comply with A.R.S. § 34-301, "Employment of Aliens on Public Works Prohibited," and A.R.S. § 34-302, as amended, "Residence Requirements for Employees."

A. Under the provisions of A.R.S. § 41-4401, CONTRACTOR hereby warrants to CITY that CONTRACTOR and each of its subcontractors will comply with, and are contractually obligated to comply with, all Federal Immigration laws and regulations that relate to their employees and A.R.S. § 23-214(A) (hereinafter "Contractor Immigration Warranty").

B. A breach of the Contractor Immigration Warranty shall constitute a material breach of this contract and shall subject CONTRACTOR to penalties up to and including termination of this contract at the sole discretion of CITY.

C. CITY retains the legal right to inspect the papers of any contractor or subcontractor employee who works on this contract to ensure that the contractor or subcontractor is complying with the Contractor Immigration Warranty. CONTRACTOR agrees to assist CITY in regard to any such inspections.

D. CITY may, at its sole discretion, conduct random verification of the employment records of CONTRACTOR and any subcontractors to ensure compliance with Contractor's Immigration Warranty. CONTRACTOR agrees to assist CITY in regard to any random verification performed.

E. Neither CONTRACTOR nor any subcontractor shall be deemed to have materially breached the Contractor Immigration Warranty if CONTRACTOR or any subcontractor establishes that it has complied with the employment verification provisions prescribed by sections 274A and 274B of the Federal Immigration and Nationality Act and the E-Verify requirements prescribed by A.R.S. § 23-214, Subsection A.

F. The provisions of this article must be included in any contract that CONTRACTOR enters into with any and all of its subcontractors who provide services under this contract or any subcontract. "Services" are defined as furnishing labor, time or effort in the State of Arizona by a contractor or subcontractor. Services include construction or maintenance of any structure, building or transportation facility or improvement to real property.

58. QUALITY CONTROL AND TESTING

A. The Contractor will support the Testing Company when contracted by the City for Quality Control and testing for specification compliance and assurance.

B. During the progress, the work shall be subject to the review and observation of the City. The Contractor shall afford every reasonable facility and assistance to the City to make such review. If any work is covered up without approval or consent of the City, it will be uncovered for examination at the Contractor's expense.

C. The fact that the City is on the job site shall not be taken as an acceptance of the Contractor's work or any part of it. The Contractor shall notify the City upon completion of his Contract, and the work shall be given final construction review by

the City, and any tests and re-tests shall be witnessed by the City or his representative. If all parts of the work are acceptable and substantially comply with the intent of the Contract Documents, initial acceptance shall be made by the City. If parts of the work are not acceptable and require additional work or rework by the Contractor to complete the Project, such costs shall be borne by the Contractor.

D. Contractor shall submit to the City, ten (10) days in advance of construction and without charge, samples or specifications of materials he proposes to use and shall not use these materials until he has received approval from the City.

E. Contractor shall furnish tests and reports on tests of all materials, equipment and installations called for in the Contract Documents. The testing laboratory must be approved by the City and the Contractor shall pay the cost of the tests, and necessary re-tests, including all transportation charges unless otherwise provided by the Contract Documents.

F. Required certificates of inspection, testing, or compliance shall be secured by the Contractor and promptly delivered by him to the Engineer. Certificates shall be provided within five (5) working days after the test is conducted. Each report shall indicate compliance with the specifications.

G. The City reserves the right to perform additional inspections and testing deemed appropriate with their own forces or with outside consultants or testing agencies. Should such inspection or testing reveal work that is not in compliance with Contract Documents, such costs of inspection or testing, and any required rework shall be borne by the Contractor.

H. Following is a summary of minimum frequency of testing the city shall require. If there are conflicts in the frequency of testing between this Section and the Technical Specifications, the stricter of the two will govern. This list is a partial list of major items of work, if an item is a part of the project and not listed the Contractor shall provide testing for that item. The Contractor shall provide the appropriate tests for the activities a part of the project. The City reserves the right to request a greater frequency for the testing.

The following frequencies are based on a maximum of 8" lifts. When the lifts are greater than 8", the frequency of testing shall increase proportionately with the increased depth of lift.

Activity	Frequency
Roadway Fills	1 each 300 ft per lift
AB Subgrade	1 each 300 ft per lift
AC Pavement	1 each 300 ft per lift
Trench Backfill	1 each 300 ft per lift
Concrete Curb & Gutter	4 cylinders per 50 cy concrete
Concrete Sidewalk	4 cylinders per 50 cy concrete

59. TERMINATION OF CONTRACT

A. The City may, at any time, terminate the Contract at the City's convenience and without cause. Such termination shall be effective upon receipt by Contractor of written notice from the City of such termination for the City's convenience. Contractor shall cease operations as directed by the City in the notice of termination and take actions necessary, or that the City may direct, for the protection and preservation of the work. In the event of a termination for convenience, the Contractor shall be paid only the direct value of its completed work and materials supplied as of the date of termination, and Contractor shall not be entitled to anticipated profit or anticipated overhead or any other claim of damages from the City. Further, in the event a termination of the Contractor for cause is determined to have been without legal right, then the termination shall be deemed to have been a termination for convenience.

B. If the Contractor refuses or fails to prosecute the work or any separable part thereof with such diligence as will ensure its completion within the time specified herein, or any extension thereof granted in the manner specified herein, or fails to complete the work within such time, or if the Contractor fails to comply with any written order of the Engineer or the City or fails to timely pay Subcontractors, material, men, or laborers, or if the Contractor should be adjudged bankrupt, or if he should make a general assignment for the benefit of his creditors, or if a receiver should be appointed on account of his insolvency, or if he or any of his Subcontractors should violate any of the provisions of the Contract, then the City may serve written notice upon the Contractor and his surety of its intention to terminate the Contract and, unless within ten (10) days after the service of such notice such violations of the Contract cease and satisfactory arrangements for the corrections thereof are made, the Contract shall without further notice, upon the expiration of said ten (10) days or such extensions thereof as may be expressly granted by the City in writing, cease and terminate.

C. In the event of any such termination, the Contract shall be deemed terminated and not rescinded. Following such termination of the Contract, the City will take possession of the Project and of all materials, equipment, tools, construction equipment and machinery thereon owned by the Contractor, and finish the Project by whatever method the City may deem expedient. In such case the Contractor shall not be entitled to receive any further payment until the work is finished, or completion is permanently suspended by the City. If the unpaid balance of the Contract price exceeds the direct and indirect costs of completion of the project, including compensation for additional professional service, including but not limited to fees charged by the City's attorney, such excess shall be paid to the Contractor. If such costs or liquidated or actual damages as provided by this Contract exceed such unpaid balance, the Contractor shall pay the difference to the City. Such additional costs and any liquidated or actual damages due to the City under this Contract will be determined by the City Manager and be submitted to the City Council in the form of a Change Order to the Contract.

D. Any extensions of time granted by Change Order or other extensions granted by the Council do not constitute a waiver of the City's right to terminate the Contract pursuant to this section for the Contractor's failure to complete the Project within the time

specified in the Contract and any authorized extensions thereto, nor do such extensions constitute a waiver of the City's right to collect liquidated damages.

E. If the work is stopped by order of a court, public authority, or the City for a period of ninety (90) calendar days or more, through no act or fault of the Contractor, anyone employed by such Contractor or his Subcontractors, then the Contractor may terminate the Contract in accordance with these Contract Documents.

60. TIME IS OF THE ESSENCE

It is mutually understood and agreed by and between the parties to the Contract that in the execution of the same, time is an essential element of the Contract, and it is important that the work progress vigorously to completion.

61. LIQUIDATED DAMAGES

For each and every calendar day that work shall remain uncompleted after the time specified for the completion of the work in the Contract, or as adjusted by a change order, the sum per calendar day, as stipulated in the Advertisement for Bids, shall be deducted from any money due or to become due to the Contractor, not as forfeit or penalty, but as liquidated damages. This sum is fixed and agreed upon between the parties because the actual loss to the City and to the public caused by delay in completion will be impractical and extremely difficult to ascertain and determine. It is agreed that the City has made a good faith attempt to estimate the loss caused by any delays and that the estimate is incorporated in the sum, which is agreed to be reasonable. If the City allows the Contractor to complete or attempt to complete the work subsequent to the date of completion specified herein, such action shall not constitute a waiver by the City of the imposition of the liquidated damages provision as specified herein.

62. CITY'S REMEDIES CUMULATIVE AND NONWAIVER

No right or remedy conferred upon or reserved to the City by the Contract shall be considered exclusive of any other remedy or contractual right, but the same shall be distinct, separate, and cumulative, and shall be in addition to every other remedy existing at law or in equity or by statute; and every remedy given by the Contract to the City may be exercised from time to time as often as the occasion may arise, or as may be deemed expedient. No delay or omission on the part of the City to exercise any right or remedy arising from any default on the part of the Contractor shall impair such right or remedy or shall be construed to be a waiver of any such default or an acquiescence thereto, or otherwise affect the right of the City to enforce the same in the event of any subsequent breach or default by the Contractor.

63. SEVERABILITY CLAUSE, DISPUTE RESOLUTION, APPLICABLE LAW

A. This Contract shall be governed by the laws of the State of Arizona, and venue for any litigation arising out of this Contract shall be in the Superior Court of the State of Arizona in and for the County of Coconino or the County of Yavapai, depending upon

the location of the work, if the amount in dispute is in excess of $5,000.00. If the amount in dispute is less than $5,000.00, jurisdiction and venue shall lie in the nearest Justice of the Peace Court of the appropriate county. Arbitration shall not be an alternative method of settling disputes unless separately agreed upon in writing by the parties. This Contract shall not be construed to create any contractual relationship of any kind between the Engineering Dept., and the Contractor or any Subcontractor, or between the City and any Subcontractor. During any dispute arising hereunder, the Contractor shall continue to perform all work in accordance with the Contract Documents. In the event of any dispute arising hereunder, the prevailing party in the resolution of such dispute shall be entitled to recover its attorney's fees and costs incurred.

B. The provisions of this Contract shall be deemed to be severable, and if any term, phrase or portion of the Contract shall be determined to be unlawful or otherwise unenforceable, the remainder of the Contract shall remain in full force and effect.

C. Any and all disputes relating to this Contract shall be subject to the provisions of Chapter 3.10 of the Sedona City Code. The City Code can be viewed on the City of Sedona website, as well as, the City Clerk's Office, City Hall, Sedona, Arizona.

D. Notwithstanding the mediation provisions set forth in Paragraph 62.C above, either party may submit, by demand letter, correspondence or notice, to the other party, any claim, counterclaim, dispute or other matter in question between the Contractor and the City arising out of or relating to this Contract, the Contract Documents, the Plans, the Project or the work, or breach thereof, and such claim, counter claim, dispute or other matter in question shall be subject to and decided by arbitration in accordance with the Rules for Non-Administered Arbitration of Business Disputes (the "Rules") of the Center for Public Resources ("CPR") currently in effect, except as provided herein and except where modified by the provisions hereof.

E. Any arbitration arising out of this Contract, the Contract Documents, the Plans, the Project or the work, or any breach thereof may include, by consolidation or joinder, or in any other manner, at the discretion of either the Contractor or the City, any other entities or persons whom the Contractor or the City, as the case may be, believes to be substantially involved in a common question of law or fact.

F. All demands for arbitration and all responses thereto that include any monetary claim, must contain a statement that the total sum or value in controversy as alleged by the party making such demand or response is not more than $150,000.00 (exclusive of interest and arbitration fees and costs). The arbitrators will not have jurisdiction, power or authority to consider or make findings except the denial of their own jurisdiction concerning any controversy where the amount at issue is more than $150,000.00 (exclusive of interest and arbitration fees and costs) or to render a monetary award in response thereto against any party which totals more than $150,000.00 (exclusive of interest and arbitration fees and costs). Notwithstanding the foregoing provisions, the parties may mutually agree to waive the jurisdictional limitations set forth in this sub-

paragraph. In the event of such mutual waiver, all other provisions in this sub-paragraph shall apply.

G. Demand for arbitration shall be filed with the other party in accordance with Rules. A demand for arbitration shall be made within a reasonable time after the claim, dispute, or other matter in question has arisen. In no event shall the demand for arbitration be made after the date when institution of legal or equitable proceedings based on such claim, dispute or other matter in question could be barred by the applicable statute of limitations.

H. In the event the amount in controversy is less than $50,000.00 a sole arbitrator shall be appointed in accordance with Rules. In the event the amount in controversy is $50,000.00, the demanding party shall appoint one party-appointed arbitrator in its notice demand for arbitration. The responding party may within ten (10) days, appoint a second party-appointed arbitrator. The party-arbitrators shall appoint a third arbitrator in accordance with the Rules. If the party-arbitrators fail to appoint a third arbitrator, the third arbitrator shall be appointed in accordance with the Rules. If the responding party fails to appoint a second party-appointed arbitrator within the time so provided, selection of the second arbitrator shall be in accordance with the Rules.

I. The decision of the arbitrators shall be in accordance with laws of the State of Arizona and the United States. The arbitrators shall prepare written findings of fact and conclusions of law upon which the decision and award shall be based. The arbitrators may award compensatory damages and attorneys' fees and costs to the prevailing party. The arbitrators shall have no authority to award consequential damages or punitive damages, and the parties hereby waive any claim to those damages to the fullest extent allowable by law.

J. The demanding party shall select the locale of arbitration, but shall not choose a location greater than twenty-five (25) miles from the Project site.

K. This agreement to arbitrate shall be specifically enforceable by either party under the prevailing laws of the State of Arizona and the United States. Any award rendered by the arbitrators shall be final and enforceable by any party to the arbitration, and judgment shall be made upon it in accordance with the applicable laws of any court having jurisdiction thereof. The arbitrators' decision shall be final and conclusive as to the facts. Either party may appeal manifest errors of law to a court of competent jurisdiction within fifteen (15) days of the award.

L. Unless otherwise agreed in writing, and notwithstanding any other rights or obligations of either of the parties under the Contract, the Contractor and the City shall carry on with the performance of their respective duties, obligations and services hereunder during the pendency of any claim, dispute or other matter in question giving rise to arbitration or mediation, as the case may be. The City shall be under no obligation to make payments to the Contractor on or against such claims, disputes or other matters in question giving rise to arbitration or mediation, during the pendency of such

arbitration or mediation or other proceedings to resolve such claims, disputes or other matters in question.

64. POTHOLING REQUIREMENTS

The Contractor shall pothole all existing utilities 1,000 feet ahead of trenching activities to allow adequate time and distance to allow for the adjustment of grade or location of the construction activities. The contractor shall pothole at least two (2) working days ahead of installing facilities such as manholes, sidewalks, storm drainage inlets, footing, headwalls, and similar non-longitudinal installations. The Contractor shall backfill the pothole after verifying the depth, size and location of the utility. If a potential conflict is encountered, temporarily plating the potholed utility will be allowed for review and coordination of a resolution of the conflict with the City and affected utilities representatives.

The City requests a minimum of five (5) working days notification of a potential conflict for marked utilities. This requirement does not relieve the Contractor of the responsibility to make the City aware of conflicts timely of the Contractor's awareness. If potholing 1,000 feet in advance of trenching activities has not been kept up and a conflict creates down time or delays in work no extension of time or compensation for down time will be considered for that conflict.

65. UNMARKED UTILITY REPAIR

If in the course of work, a conflicting utility line that was not shown on the plans is discovered, the Contracting Agency will either negotiate with the owner of the Utility for relocation, change the alignment and grade of the trench or roadbed, provide encasement or sleeving, relocate the utility, or as a last resort, declare the conflict as "extra work" to be accomplished by the Contractor in accordance with Section 47 of these General Specifications. In the case of unmarked or incorrectly marked utilities the Contractor shall consider that responsibilities are per Arizona State Statutes Section 40 –360.

The Contractor shall contact the City and utility affected immediately upon damaging or breaking an unmarked utility. If an unmarked utility is found the Contractor shall take every precaution to not damage the utility and work around the conflict with the City and Utility representatives. No interpretation of this provision that changes the responsibility for non-located and improperly located utilities per Arizona State Statutes Section 40 –360 shall be valid.

66. UTILITY SEPARATION

The Contractor shall maintain as a minimum one (1) foot of vertical clearance and three (3) feet of horizontal clearance for all utility crossings. Water/sewer minimum separations will be two (2) feet vertical clear and six (6) feet horizontal clear. If less than one (1) foot but more than six (6) inches clearance is all that can be accommodated concrete encasement shall be provided.

67. NOTIFICATION TO RESIDENTS & COMMUNITY RELATIONS

The Contractor shall inform the residents along the construction area of the proposed work. This notification and community relations shall include, but not necessarily be limited to:

A. Mailings

The Contractor shall prepare a letter for mailing to the residents located adjacent to the project. This mailing will include a description of work to be done, work hours, date's for begin and end construction, Contractor representative contact name and phone number. The cost for the mailings shall be incidental to the project.

B. Informational Signage

The Contractor shall provide and install advance information signs and project information signs before beginning construction to inform the public of the forthcoming project, construction dates, and suggested alternate routes. Sign layout shall be as approved by the Engineer. Signs shall not be constructed or installed prior to approval by the Engineer for the designs, sizes and locations. The Contractor shall maintain the signs as necessary and update the information as requested by the Engineer. The information signs shall be shown on the traffic control plan. The cost for this work shall be included in the unit bid price for Mobilization.

C. Meetings

The Contractor may be requested to attend and participate in a pre-construction public meeting if deemed necessary by the Engineer. Meeting time, location and agenda will be determined by the Engineer. The cost for this meeting if held shall be incidental to the project.

D. Driveway impact notification

The Contractor shall notify any resident or business of any access restrictions at least 48 hours prior to access restriction. Notification to residents is considered incidental to the projects activities and included in the unit price of the various activities.

TECHNICAL SPECIFICATIONS
(Chapel Lift Station)

SUNRISE
ENGINEERING

City of Sedona
Chapel Lift Station Improvements

Technical Specifications
SEI Project No. 06306 January 30, 2019

TECHNICAL SPECIFICATIONS

For the

City of Sedona

Chapel Lift Station Improvements

Prepared For:
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FOR
TECHNICAL SPECIFICATIONS

00700.1 GENERAL SPECIFICATIONS/PROJECT REQUIREMENTS

All items of work and associated construction requirements are adequately described and defined in the Uniform Standard Specifications for Public Works Construction sponsored and distributed by the Maricopa Association of Governments (MAG) along with the MAG Uniform Standard Details, latest revisions, and City of Sedona (Sedona) Specifications or Standards and within these special provisions. Copies of the Standard Specifications may be obtained from the Maricopa Association of Governments, 1820 W. Washington Street, Phoenix, AZ 85007 (602) 254-6308.

The information written into these special provisions will:

1. Describe any special or unusual conditions.
2. Explain details of the work not covered in the MAG Specifications and Standard Details.
3. Relate certain work to specific bid items or payment quantities.

00700.2 MAG SPECIFICATIONS (2015) PART 100 – GENERAL CONDITIONS

The order of precedence from Section 104.1 shall be deleted in its entirety and shall be per the contract.

00700.2.1 DEFINITIONS

In addition to the definitions already listed in MAG, the following terms shall have meanings indicated which shall be applicable to both the singular and plural thereof:

ADDENDA - Written or graphic instruments issued prior to the execution of the Agreement which modify or interpret the Contract Documents, Drawings, and specifications, by additions, deletions, clarifications, or corrections.

BID - The offer or proposal of the Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

BONDS - Bid, Performance, and Payment Bonds and other instruments of security, furnished by the Contractor and its surety in accordance with the Contract Documents.

CONTRACT PRICE - The total monies payable to the Contractor under the terms and conditions of the Contract Documents.

CONTRACT TIME - The number of calendar days stated in the Contract Documents for the completion of the Work.

DRAWINGS - The part of the Contract Documents which show the characteristics and scope of the Work to be performed and which have been prepared or approved by the Engineer.

PROJECT – Synonymous with The Work, i.e., the total construction to be provided under the Contract Documents which may be the whole or a part as indicated elsewhere in the Contract Documents.

RESIDENT PROJECT REPRESENTATIVE - The authorized representative of the Owner who is assigned to the Project 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.

SUPPLIER - Any person or organization who supplies materials or equipment for the Work, including that fabricated to a special design, but who does not perform labor at the site.

00700.3 CONSTRUCTION REQUIREMENTS

00700.3.1 MATERIAL PROCUREMENT

Due to the proximity to neighbors, it is the intention of the City to limit the onsite construction time line of the project. In order to accomplish this, the contractor is required to have 95% of all equipment procured before construction begins. This means that submittals have to be approved and equipment stored and in the physical possession of the contractor. Materials must be dedicated to the job and not shared with other projects. Contractor to provide proof that 95% of equipment and materials is in their possession before construction begins.

00700.3.2 DELIVERY SCHEDULING

The contractor is responsible for efficiently planning deliveries/pickups of equipment and materials to prevent multiple trucks from being onsite at a time and to limit idle time. The contractor shall schedule accordingly to ensure proper spacing between trucks.

00700.3.3 CONSTRUCTION HOURS

Construction shall be per the General Conditions.

007003.4 EXISTING LIFT STATION OPERATION

The contractor shall stage the construction in a way to minimize the use of bypass pumping. All existing lift station equipment shall be protected and kept in operation for as long as possible. The contractor shall notify and get approval of the City before they shut down any component of the lift station.

END OF SECTION

01019.1 DESCRIPTION

Measurement and payment for all pay items in the proposal shall conform to section 109 of the MAG Uniform Standard Specifications for Public Works Construction (MAG Specifications) latest edition, City of Sedona (Sedona) General Conditions and standards as specified in these Technical Specifications. In the event of a conflict between these Technical Special Provisions and the requirements of the plans, detail drawings, or the MAG Specifications, these Technical Special Provisions shall prevail. In the event of a conflict between the Technical Special Provisions and Sedona's General Conditions, the General Conditions shall prevail.

Payment of the contract items shall be compensation in full for furnishing all overhead, labor, material, tools, equipment, and appurtenances necessary to complete the work in a good, neat, and satisfactory manner as indicated on the plans, or as specified, with all necessary connections and appurtenances for the satisfactory use of and/or operation of said item. No additional payment will be made for work related to each item unless specifically noted or specified. Measurement will be in place for the completed work with no allowance for waste.

01019.2 BID FORM DESCRIPTION

Bid form description shall be per the General Conditions.

01019.3 BID ITEMS

The measurement and payments for Section 01019.3 shall govern in the case of a conflict with measurement and payment of any subsequent sections.

Anything shown on the plans, but not specifically detailed in a bid item, is considered to be included in the cost of the project and these costs shall be spread out across other items.

01019.3.1 Item No. 1 - Mobilization

Mobilization shall be per Specification Section 02000 and General Conditions and include all aspects of the section including visual records.

Measurement and payment shall be per the General Conditions Section 33 and Section 901 of ADOT Standard Specifications for Road and Bridge Construction (most current edition) Payment will be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.2 Item No. 2 - Demobilization

Demobilization shall be per the General Conditions and Specification Section 02000 and include all aspects of demobilizing, disposal of debris, and cleanup of the site to bring the site back to the preconstruction condition or better.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.3 Item No. 3 - SWPPP

The Contractor is responsible for providing, submitting, and implementing the Stormwater Pollution Prevention Plan (SWPPP). The Notice of Intent (NOI) form provided by the City will be filled out and submitted to the City. However, the contractor must ensure compliance with AZPDES requirements, and all other applicable federal, state and local laws, ordinances, statutes, rules and regulations pertaining to the stormwater discharge and air, ground water and surface water quality. It must be prepared with the same level of detail and documentation as required by ADEQ and EPA and include all documents required by regulations. This bid item shall include all items required to submit, obtain, and implement the SWPPP.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.4 Item No. 4 - Site Demolition

All site demolition shall be per Specification Section 02500, 02520 and 02900 and shall include, but is not limited to, all materials, equipment and labor for the removal of existing lift station, valve vault, piping, valving, electrical equipment, instrumentation, CMU walls, and concrete slab as depicted on sheet 6 (DEMO Drawing) of the plans. Items listed to be salvaged shall be carefully removed to prevent damages. Some items will be reinstalled, and others transported to the WWRP as dictated in the drawings.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.5 Item No. 5 - Site Work

Site work shall be per MAG Section 201, 505, 725 and Specification Section 02020, 02125, 02510, and 02520. Work shall include all subsurface investigation, clearing and grubbing, material and sampling testing, concrete cutting, reinstallation of aesthetic fence, ½" crushed rock inside the compound, and concrete work. Concrete pads include those inside the CMU walls and APS transformer pad.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.6 Item No. 6 – Construction MOPO

The construction MOPO shall be per Specification Section 02553, 02930, the Bypass Pumping Report and all applicable regulations. This work includes keeping the existing lift station online for as long as feasibly possible, switching between the existing lift station and the temporary bypass pumping system, the temporary bypass pumping system and all requirements associated with it, and then switching between the temporary bypass pumping system and the new lift station. The bid item shall include all plans, equipment, piping, fencing and sound dampening devices required. It shall also include the reconnection of the 50 Talia Ct resident and the Back O' Beyond force main connection to the existing sewer line. This bid item shall also include the required man power to oversee the MOPO as called for in the Contract Documents and Specifications.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.7 Item No. 7 – Site Compound (Wall and Gates)

The site compound shall be per MAG Section 206, 301, 505, 510, 725 and Specification Section 02910, 09910, and 10420. The work includes the CMU wall, reinstalling the wood slates, reinstallation of the access gate, and manway gate along with required painting. This work includes all excavation and grading required.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.8 Item No. 8 – Water Piping

The site water piping shall be per MAG Section 601, 610, and 753. Work shall include installing the frost-free hydrant, reinstalling the backflow preventer and hot box, reinstalling the shutoff valve and water meter box, extending the existing water line to the shutoff valve and hydrant, and capping the abandoned water line. The existing water line size is unknown, but the water line extension shall match existing size. Bid item includes all trenching, backfilling, and compaction required. Pipe fittings and miscellaneous appurtenances shall be considered incidental to the water piping. Bid item shall also include all required testing and disinfection.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.9 Item No. 9 – Package Lift Station System

The package lift station shall be per Specification Section 13105. The bid item shall include all material and equipment listed under the "Lift Station Package" items on Sheet 10 (DT1 Drawing) of the plans and Section 13105. This includes, but is not limited to, the wet well/valve vault, pumps, pump base, guide rails, internal piping and fittings, couplings, odor control unit, DIP vent, wet well hatch and safety grate, valve vault hatch and safety grate, coring and link seals, and stilling well as required to provide a fully functional system that meets the intent of the Contract Documents and Specification. Installation of the package lift station is covered under Item No. 13.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.10 Item No. 10 – Non-Package Lift Station Equipment

The non-package lift station equipment shall be per Specification Section 15100, Division 26, and Division 40. The bid item shall include all material and equipment associated with the lift station that is not included as part of the package system. This includes but is not limited to, as called out on Sheet 10 (DT1 Drawing) of the plans and Section 13105. This includes but is not limited to, RFCA located inside the valve vault, stainless steel piping, fitting, and ball valves, coring where called for by the contractor, link seals where called for by the contractor, and reinstallation of the safety harness plate as required to provide a fully functional system that meets the intent of the Contract Documents and Specification. Installation of the non-package lift station equipment is covered under Item No. 13

The unit price of the package lift station has been already been negotiated by the City. The cost shall be as listed in the Bid Schedule. Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item as indicated in the Contract Documents and Specifications.

01019.3.11 Item No. 11 – Lift Station Installation

The lift station installation is per MAG Section 206, 301, 728 and Specification Section 13105, Division 26, and Division 40. This bid item shall include the installation of all items covered under Item No. 11 and 12 above. Items required for installation will include, but not be limited to, excavation, shoring, slurry, backfill, compaction, coring, and connection the existing sewer line to the wet well. A 1 sack slurry will be used around the lift station up to 3 feet below finish grade. The last 3 feet will be backfilled and compacted, excepted in between the flow meter vault lift station, per MAG and the Specification. The area between the flow meter vault and lift station will be slurried. Rock exaction is anticipated and shall be included. Bid item shall include all required startup and testing per MAG, the Specifications, and the General Conditions.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.12 Item No. 12 – Force Main

The force main shall be per MAG Section 601, 610, 611, 615, 750 and Specification Section 15240. This bid item includes the piping, fittings, RFCA, plug valve and valve box, coupling adaptors, trenching, backfilling, compaction, connection to existing force main, and abandonment of force main connection to existing lift station as indicated in the plans. The location of the existing force main is an estimate. All fittings, couplings, and miscellaneous appurtenances required shall be considered incidental to the force main. Any procedures required to tie into the existing force main, and all testing required, shall be included in this bid item.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.13 Item No. 13 - Landscaping

The landscaping shall be per Specification Section 02900. The bid item shall include the replacement of any damaged plants in kind, replacing landscape rock in kind, both to their original condition or better, and reinstall/install the drainage riprap and geotextile fabric. All planting, installation, and grading shall be included.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.14 Item No. 14 – Reinstallation of Mystic Hills Backup Generator

The backup generator shall be per Specification Section 09910, 26_32_14 (relevant sections) and Sheet 18 (E-6 DWG) of the plans. The bid item shall include the reinstallation of the generator removed from the Mystic Hills Lift Station, the reinstallation of the generator fuel tank with required piping, all appurtenances, painting, and the required installation to provide a fully functional system that meets the intention of the plans and specifications. Bid item shall include all required startup and testing per MAG, the Specifications, and the General Conditions.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.15 Item No. 15 – Site Electrical

The site electrical shall be per Specifications Section 26_27_26, 26_50_10, Division 26 and Sheet 19 (E-7 Drawings) of the plans. This bid item includes the all conduit

and wiring not covered elsewhere, light switches, GFCI receptible, Light Fixtures, and all electrical components and work required to provide a fully functional system that meets the intent of the Contract Documents and Specifications.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.16 Item No. 16 – Instrumentation

The instrumentation shall be per Specifications Section 40_72_76, 40_73_65, 40_73_13, Division 40 and Sheet 30 (N-9 Drawing) of the plans. This bid item includes the pressure transmitter, level floats, level transducer indicator in the MCC, pressure gauge with snubber and diaphragm, and all electrical components and work required to provide a fully functional system that meets the intent of the Contract Documents and Specifications.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.17 Item No. 17 – MCC

The MCC shall be per Specifications Section 26_24_20 and Sheet 15 and 16 (E-3 and E-4 Drawings) of the plans. bid item include the MCC with all of its internal components (not called out elsewhere), the 200 Amp enclosed service entrance breaker, painting of the MCC and all electrical components and work required to provide a fully functional system that meets the intent of the Contract Documents and Specifications.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.18 Item No. 18 – APS Utility Upgrade

The APS utility upgrade shall be per Specifications Section 26_05_03 and the electrical plans. This bid item includes the utility meter cabinet, transformer, cable, conduit, and all electrical components and work required to provide a fully functional system that meets the intent of the Contract Documents and Specifications. This item shall also include any coordination required between the utility and the contractor.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.19 Item No. 19 – Bid Alternative Flow Meter

The flow meter is a bid alternative and shall be per MAG Section 615 and Specification Section 03150, 08122, 15100, 15240, 40_71_15, Division 40. This bid section includes all the items listed under "BID ALTERNATIVE ITEMS" on Sheet 10 (DT1 Drawing) of the plans. This includes, but is not limited to the flow meter vault, hatch with safety grate, flow meter, RFCA, piping, fittings, pipe supports, conduit, wiring, electrical components, and electrical work as required to provide a fully functional system that meets the intention of the plans and specifications. All fittings, couplings, and miscellaneous appurtenances required shall be considered incidental to the flow meter. All excavation, including rock excavation, backfilling, compaction, and grading is included. Bid item shall include all required startup and testing per MAG, the Specifications, and the General Conditions.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.20 Item No. 20 – Bid Alternative Omni Crystal Ball

The Omni Crystal Ball is a bid alternate and shall be per Specification Section 40_61_00 and Sheets 30 and 31 (N-9 and N-10 Drawings) of the plans. This bid item shall include the Omni Crystal Ball and all conduit, wiring, electrical components and electrical work required to install it in the MCC to provide a fully functional system that meets the intent of the plans and specifications. Bid item shall include all required startup and testing per MAG, the Specifications, and the General Conditions.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.21 Item No. 21 – Bid Alternative Backup Generator

The new backup generator is a bid alternative and shall be per Specification Section 09910, 26_32_14 and Sheet 20. The generator will be purchased and installed by the City. Responsibilities of the Contractor shall be as follows:

- Provide crane/equipment to place the generator and ATS
- Coordinate with Empire on deliver, installation, testing, startup, and training
- Housekeeping pads
- All conduit required to connect the generator and ATS
- Pull all wires in conduits
- Install generator and bolt it to the ground
- Install ATS and secure it (bolting, supports, etc)
- Connection of all wiring including the main cabling at the generator and ATS and the DC control wire.
- Painting of the generator.

The bid item shall include the reinstallation of the generator fuel tank with required piping and painting, and all equipment, materials, and appurtenances, to install the generator, in order to provide a fully functional system that meets the intention of the plans and specifications.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

END OF SECTION

01030.1 DESCRIPTION

This section covers project meetings including the pre-construction meeting and other progress and/or work coordination meetings conducted to provide communication and awareness to all parties associated with the Contract.

01030.2 PRE-CONSTRUCTION CONFERENCE

Prior to the commencement of work at the site, a pre-construction conference will be held at a mutually agreed time and place to be arranged by the Owner. The Owner shall also provide notification to all parties expected to attend the meeting. Attendees will include the following:

- Engineer
- Project Inspector
- Owner/Owner's Representative
- Contractor/Contractor's Representative/ Subcontractors as appropriate
- Governmental Representatives as appropriate (State, County, Municipal, etc.)
- Manufacturer/Supplier Representatives/Adjoining Contractors, as appropriate.
- Utility Service Representatives as appropriate.

Additional requirements are located in the General Conditions. If there is a conflict the General Conditions shall supersede this section.

01030.2.1 Unless previously submitted to the Engineer, the Contractor shall bring to the conference one copy each of the following:

- Contract construction schedule in accordance with the General Conditions.
- Procurement schedule of major equipment and materials and items requiring long lead-time.
- Shop Drawings, samples or substitution proposals for items proposed as substitutions or "or equal" items.
- Schedule of work that includes the anticipated monthly payment amounts during the contract.
- A Schedule of Values of work to be paid for as lump sum items where partial payment is anticipated.

Additional requirements are located in the General Conditions. If there is a conflict the General Conditions shall supersede this section.

01030.2.2 The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The agenda may include but not be limited to the following items:

- Contractor's Work Schedule.
- Transmittal, review, distribution and approval of Contractor's submittals.
- Processing of applications for payment.
- Maintaining records and documents.
- Critical work sequencing.
- Field decisions and Change Orders.
- Use of project site, office and storage areas, security, housekeeping, and Owner's needs.
- Major equipment deliveries and priorities.
- Interpretation of Drawings and Specifications.
- Contractor's responsibilities for safety, first-aid and sanitation.

Additional requirements are located in the General Conditions. If there is a conflict the General Conditions shall supersede this section.

01030.2.3 The Engineer will preside at the pre-construction conference and will arrange for keeping minutes and distributing them to all attendees to the meeting.

01030.3 PROGRESS/COORDINATION MEETINGS

01030.3.1 The Contractor shall conduct regular on-site progress and coordination meetings at least weekly and at other times as requested by Engineer or as required by progress of the work. The Contractor, Engineer, and all Subcontractors active on the site shall be represented at each meeting. The Contractor may, at its discretion, request attendance by representatives of its suppliers, manufacturers, and other Subcontractors. The Contractor shall be responsible for providing written notification to those deemed necessary for attendance at least 36 hours prior to the time set for the meeting.

01030.3.2 The Contractor shall preside at the meetings and maintain a file of minutes of the proceedings. The purpose of the meetings will be to review the progress of the work, maintain coordination of effort, discuss changes in scheduling, and resolve other problems which may develop.

01030.3.3 Additional requirements are located in the General Conditions. If there is a conflict the General Conditions shall supersede this section.

01090.1 DESCRIPTION

Wherever in these Specifications references are made to the standards, specifications, or other published data of the various national, regional, or local organizations, such organizations may be referred to by their acronyms or abbreviations only. As a guide to the user of these Specifications, the following acronyms or abbreviations, which may appear herein, shall have the meanings indicated below. Additional abbreviation and reference standards are listed in the General Conditions. If there is a conflict the General Conditions shall supersede this section.

01090.1.1 DEFINITIONS OF ABBREVIATIONS AND ACRONYMS

AAR	Association of American Railroads
AASHTO	American Association of the State Highway and Transportation Officials
ACI	American Concrete Institute
ADC	Air Diffusion Council
AGA	American Gas Association
AGC	Associated General Contractors
AGMA	American Gear Manufacturers Association
AI	The Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute, Inc.
APWA	American Public Works Association
ARI	Air Conditioning and Refrigeration Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASQC	American Society of Quality Control
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BLM	Bureau of Land Management (U.S. Department of Interior)
CDA	Copper Development Association
CEMA	Conveyor Equipment Manufacturer's Association
CGA	Compressed Gas Association
CFR	Code of Federal Regulations
CISPI	Cast Iron Soil Pipe Institute
CLFMI	Chain Link Fence Manufacturer's Institute
CMA	Concrete Masonry Association
CS	Commercial Standard of NBS (U.S. Dept. of Commerce)
CTI	Cooling Tower Institute
DIP	Ductile Iron Pipe
EIA	Electronic Industries Association
EPA	U. S. Environmental Protection Agency
ETL	Electrical Test Laboratories
FEMA	Federal Emergency Management Administration
FERC	Federal Energy Regulatory Commission
FS	Forest Service (U.S. Department of Agriculture)
FWS	Fish and Wildlife Service
GI	Galvanized Iron
IAPMO	International Association of Plumbing and Mechanical Officials

ICBO	International Conference of Building Officials
ID	Inside Diameter
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
IMC	International Mechanical Code
IME	Institute of Makers of Explosives
IPC	International Plumbing Code
ISA	Instrument Society of America
ISO	International Organization for Standardization
MBMA	Metal Building Manufacturer's Association
MOPO	Maintenance of Plant Operation
NACE	National Association of Corrosion Engineers
NBS	National Bureau of Standards
NEBB	National Environmental Balancing Bureau
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NFGC	National Fuel Gas Code
NFPA	National Fire Protection Association
NFPA	National Forest Products Association
NRCS	Natural Resources Conservation Service (U.S. Department of Agriculture) (formerly SCS)
NSF	National Sanitation Foundation
OD	Outside Diameter
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PDI	Plumbing and Drainage Institute
PE	Polyethylene
PVC	Polyvinyl Chloride
RWMA	Resistance Welder Manufacturer's Association
SAE	Society of Automotive Engineers
SMACNA	Sheet Metal and Air Conditioning Contractor’s National Association
SSPWC	Standard Specification for Public Works Construction
UBC	Uniform Building Code
UL	Underwriters Laboratories, Inc.
UMC	Uniform Mechanical Code
UPC	Uniform Plumbing Code
UPRR	Union Pacific Railroad
USDARD	Rural Development (U.S. Department of Agriculture) (formerly Farmers Home Administration)
WCRSI	Western Concrete Reinforcing Steel Institute
WRI	Wire Reinforcement Institute, Inc.
WWPA	Western Wood Products Association
WWRP	Wastewater Reclamation Plant

01090.2 REFERENCED WORKS, CODES AND STANDARDS

Whenever references to specifications, codes, standards and other publications are made to these Specifications, the following rules shall apply:

01090.2.1 TITLES OF SECTIONS AND PARAGRAPHS

Titles of sections and/or paragraphs shown in these Specifications are for convenience of reference only, and do not form a part of the Specification.

01090.2.2 APPLICABLE PUBLICATIONS

Whenever references in these specifications are made to published specifications, codes, standards, or other requirements, it shall be understood that unless a date is specified, only the latest edition of these specifications, codes, and/or standards which have been published as of the date that the work is advertised for bids, shall apply; except to the extent that said standards or requirements may be in conflict with applicable laws, ordinances, or governing codes. No requirements set forth herein or shown on the Drawings shall be waived because of any provision of, or omission from, said standards or requirements.

01090.2.3 SPECIALISTS AND SPECIAL ASSIGNMENTS

In certain instances, specification text requires (or implies) that specific work is to be assigned to specialists or expert entities, who must be engaged for the performance of that work. Such direction shall be recognized as special requirements and is not intended to interfere with local union jurisdiction settlements and similar conventions. Such assignments are intended to establish which party or entity involved in a specific unit of work is recognized as "expert" and qualified for the assignment of the work. Nevertheless, the final responsibility for fulfilling this assignment remains with the Contractor.

01090.2.4 BUILDING CODES

Reference herein to "Building Code" shall mean the Uniform Building Code issued by the International Conference of Building Officials (ICBO). The latest edition of the code as approved and used by the local agency as of the date of award, as adopted by the agency having jurisdiction, shall apply to the work herein, including all addenda, modifications, amendments, or other lawful changes thereto.

01090.2.5 OSHA

01090.2.5.1 OSHA REGULATIONS - References herein to "OSHA Regulations for Construction" shall mean Title 29, Part 1926, Construction Safety and Health Regulations, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

01090.2.5.2 OSHA STANDARDS - References herein to "OSHA Standards" shall mean Title 29, Part 1910, Occupational Safety and Health Standards of the U.S. Code of Federal Regulations, including all changes and amendments thereto.

01090.2.6 DOT STANDARDS/SPECIFICATIONS

References to "State DOT Specifications" or "State DOT Requirements" shall mean the Specifications for Excavation on State Highway Right-of-Way and/or Standard Specifications for Road and Bridge Construction, including all amendments thereto, issued by the State agency responsible for highways wherein the Contract is located and any other written requirements or provisions issued by that agency which are contained in these Contract Documents.

01090.2.7 FEDERAL PIPELINE SAFETY STANDARDS

Reference to "Federal Pipeline Safety Standards" shall mean Title 29, Parts 191 and 192, Federal Pipeline Safety Minimum Standards, U.S. Code of Federal Regulations including all changes and amendments thereto.

01090.2.8 STATE GAS PIPELINE SAFETY STANDARDS

References to "State Gas Pipeline Safety Standards" shall mean the appropriate section/s of the legal code or regulations adopted in the State wherein the work is located, including all changes and amendments thereto.

01090.3 STANDARDS IMPOSED BY OTHER AGENCIES OR ORGANIZATIONS

01090.3.1 PROPERTY BELONGING TO OTHER AGENCIES OR ORGANIZATIONS

Construction may occur on property owned or administered by agencies or organizations other than the Owner, such as federal and/or state departments of transportation, the U. S. Forest Service, the U. S. Bureau of Land Management, the U.S. Fish and Wildlife, counties, canal companies, irrigation companies, utility companies, other federal and state agencies, municipal governments, etc. Work which is to take place on such property may be required to be in accordance with special construction requirements of that agency or organization as well as these specifications.

01090.3.2 ADDITIONAL INFORMATION AND SPECIFICATIONS

Information will be provided on the plans to indicate areas of the Work which fall on property owned or administered by agencies and organizations other than the Owner. Specifications from agencies which are affected by the work will be provided in the Appendix to the Contract Documents. Those specifications provided in the Appendix shall be considered part of the Contract Documents and the Contractor shall include sufficient compensation in its bid to cover the work required for compliance thereto.

01090.4 CONFLICTS

In case of conflict between codes, reference standards, Drawings and the other Contract Document, the most stringent requirements shall govern. All conflicts shall be brought to the attention of the Engineer for clarification and directions prior to bidding (pre bid), or ordering and providing any materials or labor required therefrom (post bid). The Contractor shall assume the most stringent requirements apply when preparing bids for this Contract.

01300.1 DESCRIPTION

The Contractor shall submit to the Engineer, for review, a proposed schedule of shop drawings, materials information, samples, operations and maintenance manuals, equipment information, procedures, and construction photography records. The submittals of shop drawings and product data shall conform to the General Conditions, this specification, and section 105.2 of the MAG Specifications with the following exceptions.

Paper copies of submittals for approval are not required. Contractor to submit information in PDF form. Response to submittal will also be provided by PDF. This does not apply to final O&M manuals. Final O&M manuals shall be submitted according to Section 01300.3 of these Specifications.

Submittals will be stamped with either "Approved", "Approved as Noted" or "Not Approved".

01300.2. SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

In addition to MAG 105.2 the following conditions apply to shop drawings and material submittals. Any conflict between MAG and these specifications shall be brought to the attention of the Engineer for final decision.

01300.2.1 ADDITIONAL REQUIREMENTS

1. Shop Drawings, Product Data, Samples and similar submittals are not part of the Contract. The purpose of their submittal is to demonstrate, for those portions of the Work for which submittals are required by the Contract Documents, the way by which the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents.

2. The Contractor shall review for compliance with the Contract Documents, approve and submit to the Engineer/Consultant Shop Drawings, Product Data, Samples and similar submittals required by the Contract Documents in such sequence as to cause no delay in the Work or in the activities of the Owner or of separate contractors. Submittals which are not marked as reviewed for compliance with the Contract Documents and approved by the Contractor will be returned by the Engineer/Consultant without action. Contractor shall submit to Engineer/Consultant for review and approval or for other appropriate action, electronic copies and/or five (5) hard copies, if requested by the Engineer, of all Shop Drawings, Product Data, Samples or similar submittals bearing a stamp or specific written indication that Contractor has satisfied the Contractor's responsibilities under the Contract Documents with respect to his review of his submission.

    a. By approving and submitting Shop Drawings, Product Data, Samples and similar Submittals, the Contractor represents that the Contractor has

determined and verified materials, quantities, specified performance criteria, installation requirements, catalog numbers, field measurements and filed construction criteria related thereto, or will do so, and has checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents.

b. Contractor shall give Engineer specific written notice of each variation that the Shop Drawings, Product Data, Samples and similar submittals may have from the requirements of the Contract Documents, and, in addition, shall cause a specific Contractor notation to be made on each Shop Drawing, Product Data, Sample and similar submittals submitted to Consultant for review, approval, or other appropriate action highlighting each such variation.

c. The Contractor shall perform no portion of the Work for which the Contract Documents require submittal and review of Shop Drawings, Product Data, Samples or similar submittals until the respective submittal has been approved by the Engineer. The Engineer will review and return such submittals within ten (10) working days or within a reasonable period so as to not delay the project.

d. Engineer's review, approval, or other appropriate action regarding Contractor's submissions will be only to check conformity with the design concept of the Project and for compliance with the information contained in the Contract Documents and shall not extend to means, methods, techniques, sequences or procedures of construction (except where a specific means, method, technique, sequence or procedure of construction is indicated in or required by the Contract Documents) or to safety precautions or programs incident thereto. The review and approval of a separate component item will not indicate approval of the assembly into which the item is functionally integrated. Contractor shall make corrections required by Engineer, and shall return the required number of corrected copies of Shop Drawings, Product Data, Samples or similar submittals to the Contractor. Contractor may be required to resubmit as required revised Shop Drawings, Product Data, Samples or similar submittals for further review and approval. Contractor shall direct specific attention in writing to any new revisions not specified by Contractor on previous Contractor submissions.

3. The Work shall be in accordance with approved submittals, except that the Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the Engineer's approval of Shop Drawings, Product Data, Samples or similar submittals unless the Contractor has specifically informed the Engineer in writing of such deviation at the time of submittal and (1) the Engineer has given written approval regarding the specific deviation as a minor change in the Work, or (2) a Change Order or Field Work Directive has been issued authorizing the deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples or similar submittals by the Engineer's approval thereof.

4. Where Engineer requires by written request an approved Contractor Shop Drawing, Product Data, Sample, or similar submittals any related Work performed

by Contractor prior to Consultant's review and approval of the affected submission will be at the sole risk of Contractor.

5. The Contractor shall not be required to provide professional services which constitute the practice of architecture or Engineering unless such services are specifically required by the Contract Documents for a portion of the Work or unless the Contractor needs to provide such services in order to carry out the Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. The Contractor shall not be required to provide professional services in violation of applicable law. The Contractor shall cause such services or certifications to be provided by a properly licensed design professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional. Professional's must be licensed in the state of Arizona. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to the Engineer. Any changes to the professional's work must be approved, in writing, by the professional. The Owner and the Engineer shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications or approvals performed by such design professionals. The Engineer will review, approve or take other appropriate action on submittals only for the limited purpose of checking of conformance with information given and the design concept expressed in the Contract Documents.

01300.2.2 ENGINEER APPROVAL - When the submittals are reviewed by the Engineer, A pdf copy will be returned to the Contractor marked "Approved", "Not Approved", "Approved as Noted", or similar notification. If changes or corrections are necessary, a pdf will be returned to the Contractor with such changes or corrections indicated by a brief statement, and the Contractor shall correct and resubmit the drawings, as a pdf, to the Engineer.

Fabrication work shall not commence until the Engineer has reviewed the pertinent shop drawing/s and returned copies to the Contractor marked either "Approved" or "Approved as Noted". Corrections indicated on such submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as the basis of claims for extra work.

Approval of shop drawings will not be required for reinforcing steel that is detailed by the Contractor in accordance with the Plans and Specifications. Any change from the Plans and Specifications made by the Contractor in any aspect of the Work shall be approved by the Owner and the Engineer in a written Change Order prior to any work being altered from that already approved for construction.

01300.2.3 SPECIFICATION VERIFICATION

Each submittal shall include a specification section which provides the relevant specification section, including relevant addendum updates.

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.

001300.2.4 MATERIALS INFORMATION SUBMITTALS

In keeping with 01300.2.1 above, the Contractor shall assemble and submit each manufacturer's catalog cuts and materials information sheets pertaining to materials and equipment to be furnished and installed in the Work. Preliminary submittals shall be submitted as pdf for review. The Contractor shall submit two (2) original hard copies. Hard copies shall be enclosed in 3-ring binders. Failure to submit all materials information may result in the Contractor's partial payments to be withheld until submittals are complete. Photocopies of the catalog cuts and information sheets will not be acceptable as submittals without prior authorization from Engineer.

01300.2.5 CONTRACTOR LIABILITY

The Contractor shall assume all responsibility and risk for any re-work or other costs resulting from errors in Contractor submittals. The Contractor shall be responsible for showing accurate dimensions and details of connections required to ensure the function of the equipment and/or component of the Work being illustrated.

01300.3 OPERATIONS AND MAINTENANCE MANUALS

01300.4.1 STRUCTURE OF OPERATIONS AND MAINTENANCE MANUALS

The Contractor shall provide preliminary Operations and Maintenance (O&M) manuals in pdf format for review. The Contractor shall furnish two (2) identical sets of the Final O&M manuals. Each set shall consist of one or more volumes, each of which shall be bound in a standard size, 3-ring, loose-leaf, vinyl plastic, hard cover binder suitable for bookshelf storage. Binder ring size shall not exceed 2.5 inches. A table of contents shall be provided which indicates all equipment in the O&M manuals. Additionally, a bookmarked PDF copy of all O&M manuals must be provided to the owner. Final completion will not be issued until the bookmarked PDF copy of all the O&M manuals have been received and approved by the Engineer and the Owner.

01300.4.2 CONTENTS

The Contractor shall include in the Operations and Maintenance Manuals the following information for each item of mechanical, electrical, and instrumentation equipment:

- Care and maintenance of all finished exposed surfaces.

- Complete operating instructions, including location of controls, special tools or other equipment required, related instrumentation, and other equipment needed for operation.

- Preventive maintenance procedures and schedules.

- Complete parts lists, by generic title, identification number, and catalog number, complete, with exploded views of each assembly.

- Disassembly and reassembly instructions.

- Name and location of nearest supplier and spare parts warehouse.

- Name and location of manufacturer.

- Recommended start-up, testing and troubleshooting procedures.

- Prints of the record drawings, including diagrams and schematics, as required under the electrical and instrumentation portions of these specifications.

01300.4.3 SCHEDULE OF DELIVERY

Operations and Maintenance manuals shall be submitted in final form to the owner before seventy-five (75) percent of the Work is completed. Any discrepancies found by the owner and Engineer in the Operations and Maintenance manuals shall be corrected by the Contractor prior to final acceptance of the project.

01300.5 SCHEDULE OF VALUES

At the time of the pre-construction conference, the Contractor shall submit a Schedule of Values of the Work measured as lump sum bid items. On the Schedule, those items shall be subdivided into component parts in sufficient detail as to form a basis for determining progress payments during construction. Quantities, and/or prices, shown on the Schedule shall equal the total contract price for each lump sum item. Information provided on the Schedule will be reviewed and approved by the Engineer when found acceptable. That information will then be incorporated into the data used for preparing the Application for Payment by the Engineer.

01300.6 CONTRACT CONSTRUCTION SCHEDULE

A construction schedule, prepared in accordance with requirements of the General Conditions, shall be submitted to the Engineer at the pre-construction conference. Unless required otherwise in Special Provisions, such schedule shall show the anticipated time of completion, approximate start dates of identifiable segments of the

Work, and anticipated value of the work expected to be completed in monthly time periods within the contract period.

01300.7 PROCUREMENT SCHEDULE

At the time of the pre-construction meeting (see Section 01030), the Contractor shall submit a procurement schedule to the Engineer. This plan shall include all equipment and materials required for the Work included in the Contract that are not readily available and will require off-site manufacture and lead time which can affect the progress of the Work. The plan shall show at least the following information:

- Equipment/Material Name
- Anticipated amount of time for ordering, manufacturing, and shipping to Work site.
- Anticipated dates for ordering, receiving and installing.

01300.8 CONSTRUCTION PHOTOGRAPHY RECORDS

When required in the Contract Documents and prior to commencement of any of the Work, the Contractor shall prepare colored CD photography records of all areas of the Contract work site and provide copies of such records to the Engineer. Such records shall become the property of the owner and may be used for determining the condition of work site/s and degree of restoration required for completion of the Work (see also Section 2000).

END OF SECTION

01510.1 DESCRIPTION

This section covers measures and instructions for prevention of damage to existing structures and utilities, whether above ground or underground, during execution of the Work of the Contract. The protection of existing improvements shall conform to section 107 of the MAG Specifications, the General Conditions and the following Sections.

01510.2 PROTECTION OF EXISTING UTILITIES

01510.2.1 INTEGRITY OF UTILITIES

The Contractor shall be responsible for safeguarding and maintaining the integrity of all conflicting utilities. This responsibility includes securing the assistance of available utility location services in the area in which the Work is being performed. The Engineer has attempted to show the location of all utilities anticipated to conflict with the Work. However, when a conflicting utility line is discovered that was not shown on the plans, the Contractor shall contact the utility's owner and notify the Engineer immediately for resolution of the conflict. When realignment or relocation of the Work, or relocation of the conflicting utility is deemed necessary, the Engineer shall give direction in writing for the Contractor to proceed. Work resulting from such direction may be treated as a changed condition, and appropriate authorization and payment will be made in accordance with the General Conditions.

01510.2.2 LOCATING UTILITIES

It shall be the responsibility of the Contractor to locate and expose or identify all existing utilities, both underground and overhead, for the purpose of preventing damage to them. The Contractor shall notify all concerned utility offices at least 48 hours in advance of construction operations in which a utility agency's facilities may be involved. This shall include, but not be limited to, irrigation water, culinary water, telephone, gas, and electric.

01510.2.3 CHANGES TO UTILITIES

The Contractor shall be responsible for any and all changes to, or re-connections to, public utility facilities encountered or interrupted during execution of the Work, and all costs related thereto shall be borne by the Contractor. The Contractor shall negotiate with, and pay, the respective utility agency for work it must do in connection with moving, repairing, or restoring its utility(s). The Contractor shall further make all necessary notifications, scheduling, coordination, and management of details related to any such interference. The potential or projected cost of any public utility interference shall be included in the Contractor's price covering the major Contract Item to which the interference or changes are attributable.

01510.2.4 MAINTENANCE OF SERVICE

01510.2.4.1 CONTINUOUS SERVICE - Unless otherwise required in the Contract Documents, all utilities, both underground and overhead, shall be maintained in continuous service throughout the entire contract period. The Contractor shall be responsible and liable for any damages to or interruption of service caused by the construction.

01510.2.4.2 ACCIDENTAL INTERRUPTION OF SERVICE - In the event of interruption of other utility services as a result of accidental breakage, the Contractor shall promptly notify the appropriate responsible authority. The Contractor shall then cooperate with that authority in restoration of service as soon as possible, and shall bear all cost of repair. In no case shall interruption of any water or other utility service be allowed outside working hours unless the Engineer has issued prior authorization. When changeover of service connections to new utility lines becomes necessary, interruptions of individual services for periods of up to 8 hours will be allowed providing 24 hour advance notice has been given to affected users.

01510.2.4.3 TEMPORARY INTERRUPTION AND RELOCATION - If the Contractor desires to temporarily or permanently relocate or shut down any utility or appurtenance, the Contractor shall make the necessary arrangements and agreements with the owner or operator of the respective utility and shall be completely responsible for all costs concerned with the relocation or shutdown and reconstruction. Shutdown and relocation and/or reconstruction shall be subject to inspection and approval by the Engineer and the owner of the utility.

01510.3 PROTECTION OF PROPERTY AND EXISTING STRUCTURES

01510.3.1 REMOVAL OR RELOCATION OF PROPERTY - All property removed or relocated by the Work shall be reconstructed in its original or new location as soon as possible. Restoration of existing property or facilities shall be to a condition as good or better than its original condition.

01510.3.2 DAMAGE TO PROPERTY - All property damaged by the Contractor, whether inside or outside the limits of easements provided by the Owner, shall be the responsibility of the Contractor. All such damages shall be repaired with like material and restored to its original condition, or better. Such repair or restoration shall be accomplished at the Contractor's expense without additional compensation from the Owner.

01510.4 PROTECTION OF PAVED SURFACES

To avoid unnecessary damage to paved surfaces, tracked equipment shall use rubber cleats or paving pads when operating on or crossing all existing paved surfaces unless authorized otherwise in writing by the Engineer.

01510.5 RIGHTS-OF-WAY AND EASEMENTS

01510.5.1 MINIMAL DISTURBANCE OF RIGHTS-OF-WAY - When construction easements have been obtained by the Owner, the Contractor shall take appropriate

measures to minimize disturbances to surface improvements within the easements. The Contractor shall obtain a signed release from each property owner, approving restoration work in the construction easements across its respective property/s.

01510.5.2 CONSTRUCTION AREAS - The Contractor shall confine construction operations to the area within the dedicated rights-of-way for public thoroughfares, or within areas for which construction easements have been obtained, unless the Contractor has made separate special agreements with the affected property owners in advance.

01510.5.3 PROPERTY OWNER NOTIFICATION - The Contractor shall give at least 48 hours advance notification of commencement of construction to property owners having land on which construction will take place. During all construction operations, the Contractor shall construct and maintain such facilities as may be required to provide access by all property owners to their property. No one shall be cut off from access to their property for a period exceeding eight (8) hours unless the Contractor has made special arrangements with the affected persons. The Contractor shall grade all disturbed surfaces required for motor vehicle traffic at least daily unless directed otherwise in the Contract Documents or in writing by the Engineer.

END OF SECTION

01520.1 DESCRIPTION

This Section includes requirements that shall be followed by the Contractor, to protect the environment, while performing work under this contract. The Contractor shall also comply with any applicable additional requirements made by federal, state, or local government agencies.

01520.1.1 RELATED WORK AND REFERENCED SECTIONS

Most current version of MAG Standard Specifications.

01520.1.2 SUBMITTALS

Section 01300 – Submittals.

01520.1.3 DEFINITIONS

Not used.

01520.2 MATERIALS

Not used.

01520.3 CONSTRUCTION REQUIREMENTS

01520.3.1 EXPLOSIVES AND BLASTING

The use of explosives on the work will not be permitted unless approved otherwise in the Contract Documents or in writing by the Engineer.

01520.3.2 DUST ABATEMENT

01520.3.2.1 CONTROL MEASURES - The Contractor shall furnish all labor, equipment, water and means required to provide effective dust control and abatement measures. Control measures shall be applied as often as necessary and wherever directed in writing by the Engineer, to prevent construction operations from producing dust in amounts that may be damaging to property, vegetation, or animals, or detrimental to persons within reasonable proximity of the work site. Dust Control shall conform to section 104.1.4 of the MAG specifications.

01520.3.2.2 HAUL ROUTES AND WORK SITES - The Contractor shall identify haul routes or material handling areas, outside of the Work site, whereon dust may be generated, and shall exercise appropriate measures to abate any dust problem caused by its operation. Such dust abatement measures shall be taken immediately when observed or when required in writing by the Engineer.

01520.3.3 STORM AND GROUND WATER

01520.3.3.1 PERMITS REQUIRED – A storm water NPDES permit may be required. The Contractor is responsible to obtain such permit and comply with the conditions thereof. This includes preparation of a SWPPP (Storm Water Pollution Prevention Plan) and filing a NOI (Notice of Intent) with ADEQ (Arizona Department of Environmental Quality).

01520.3.3.2 CONTROL MEASURES - The Contractor shall provide and maintain, at all times during construction, ample means and devices to promptly remove all water entering the Work, whether the water is surface or ground water. Water removed by the Contractor shall be directed into ponds or areas separated from live streams or drainage ways, to keep sediment from entering live water.

01520.3.3.3 DRAINAGE PATTERNS - In excavation, fill, and grading operations, the Contractor shall take care, to disturb the existing drainage pattern as little as possible. Particular care shall be taken not to direct drainage water onto private property or into streets or drainage ways inadequate for the increased flow.

01520.3.3.4 FORDING OF WATERWAYS - Fording of live streams or any body of live water to accomplish the Work shall not be permitted. Mechanized equipment also shall not be operated in live water to accomplish the Work unless authorized in writing by the Engineer, or in the Contract Documents.

01520.3.3.5 FILLING OF WATERWAYS - The Engineer will not approve the filling of any ditches, washes, drainage ways, streams, wetlands, or other surface waters by the Contractor to accomplish the Work unless specific instructions are included in the Contract Documents which will provide for how the affected drainages or surface waters are to be treated.

01520.3.4 NOISE ABATEMENT

In or near inhabited areas, particularly residential areas, the Contractor's operations shall be performed in a manner to prevent noise from becoming a nuisance or problem. Particular consideration shall be given to noise generated by repair and service activities during the night hours. Noise abatement shall conform to section 107.6.2 of the MAG specifications.

01520.3.5 CHEMICALS

All chemicals and/or petroleum based products used during project construction or furnished for project shall be handled, applied and disposed of in strict accordance with the printed instructions of the manufacturer and shall conform to section 106 of the MAG specifications.

01520.3.6 WASTE AND SURPLUS MATERIALS DISPOSAL

01520.3.6.1 CLEAN WORK SITE - The Contractor shall keep the work site, haul roads and other areas of use in a neat, clean condition, free from any accumulation of surplus materials. It shall be the responsibility of the Contractor, at its own expense, to remove and legally dispose of all surplus materials resulting from all Work activities performed in accordance with the Contract Documents.

01520.3.6.2 SURPLUS MATERIAL - Surplus material includes, but is not limited to, salvaged materials and equipment that otherwise would have been abandoned in place, rocks too large to be used as backfill, wood and other organic or unsuitable materials, trash, rubbish, and waste products of any nature, and any other debris generated by the Work.

01520.3.6.3 REGULATORY COMPLIANCE - Disposal of surplus materials shall be accomplished in accordance with all local codes, laws, ordinances, and all applicable safety laws (particularly to the requirements of Part 1926 of the OSHA Safety and Health Standards for Construction) in affect at the approved disposal site. In no case shall it be acceptable for any surplus material to be disposed of in streams, marshes or wetlands.

01520.3.6.4 APPROVAL OF DISPOSAL - The Engineer will not approve any disposal operation, which creates an unsightly and/or unsanitary nuisance. The Contractor shall maintain disposal sites in a reasonable condition of appearance during construction. When designated and/or public disposal sites are unavailable, written approval must be obtained from the Engineer to dispose of any surplus materials on any other site. All disposal sites are subject to approval by the Engineer. The Contractor shall secure permission and all permits required for use of any dumpsite not previously arranged and designated by the Owner. The Contractor shall retain copies, and provide copies upon request, of all disposal permits and/or agreements obtained for the Contract Work.

01520.3.6.5 SCHEDULED REMOVAL - The Contractor shall establish regular intervals of collection and disposal of surplus materials during construction. Stockpiling of surplus materials for later disposal will not be approved or allowed.

01520.3.7 OPEN BURNING

Open burning of materials may be allowed only, when approved by the Engineer, in strict accordance with all regulations in effect for the area at which the burning would be performed, and the Contractor shall obtain any necessary permits from the appropriate governing entity prior to the start of burning. The Contractor shall not allow fire to spread beyond the material intended for burning. No accumulation of residue from burning shall remain on or adjacent to the construction site, without written approval of the Engineer.

01520.3.8 SANITATION

01520.3.8.1 TOILETS - The Contractor shall provide fixed or portable chemical toilets for employee use in conformance with the requirements of Part 1926 of the OSHA Standards for Construction and when public toilets are not available or within fifteen (15) minutes walking distance of the Work site.

01520.3.8.2 COLLECTION OF WASTES - The Contractor shall be responsible for daily collection of all sanitary and organic wastes. All wastes and refuse from sanitary facilities provided by the Contractor shall be disposed of away from the site in accordance with all laws and regulations pertaining thereto.

01520.3.9 HAZARDOUS MATERIAL

01520.3.9.1 REGULATORY COMPLIANCE - Disposition of any hazardous material or toxic or hazardous waste shall be made in accordance with the requirements and regulations administered by the State agency wherein the Work site is located.

01520.3.9.2 ABNORMAL CONDITONS - Abnormal conditions include, but are not limited to, the following: buried barrels with liquid or solid contents; buried or above ground tanks with liquid contents; obnoxious odors; excessively hot earth; stained and discolored soils; smoke; unidentifiable powders, sludge, pellets; or any other similar condition.

01520.3.9.3 DISCOVERY AND NOTIFICATION - If any abnormal conditions are encountered during construction, which indicate the presence of a hazardous material, toxic, or hazardous waste, the Contractor shall immediately suspend work in the area of the discovery and notify the Engineer and treat the situation with extreme caution. The Contractor's operation in the area of discovery shall not resume until so directed by the Engineer; however, the Contractor shall continue working in other areas of the project, unless otherwise directed by the Engineer.

01520.3.9.4 DISPOSAL - When it becomes necessary for the Contractor to dispose of discovered materials, the work may be considered a change and administered in accordance with the General Conditions. Should the disposition of discovered waste material require special procedures or handling by certified personnel, the Contractor will make all such arrangements. When it becomes necessary to obtain permits for transporting or handling discovered material, the Owner will obtain the permits.

01520.3.9.5 SPILLS AND NOTIFICATION - In the event of spills of petroleum-based products or hazardous wastes by the Contractor, the Contractor shall immediately notify the Engineer. The Contractor shall also notify the appropriate State environmental enforcement agency, unless the spill consists of less than one (1) gallon of petroleum based products. In no case will notification be made later than 24 hours after the discovery of the spill. In addition, written notification shall also be made within 5 calendar days of the discovery.

01520.3.9.6 COST OF CLEANUP - All costs for cleanup and disposal of hazardous materials due to spills, inappropriate handling, or negligence of the Contractor shall be borne by the Contractor.

01520.3.10 ENVIRONMENTAL COMPLIANCE

01520.3.10.1 REGULATORY COMPLIANCE - The Contractor shall comply with the applicable requirements of the National Historic Preservation Act as it relates to the preservation of ALL environmental resources. Clearance for protection of environmental resources located within the designated Work site is the responsibility of the Owner and such clearance has been obtained for the Contract, unless provided for otherwise in the Contract Documents.

01520.3.10.2 DISCOVERY OF HISTORIC/ARCHEOLOGICAL OBJECTS – The Contractor shall observe the following:

- DISCOVERY AND NOTIFICATION - If a suspected or unsuspected historic, archeological, or paleontological item, feature, or site is encountered, construction operations shall be immediately stopped in the vicinity of the discovery and the Engineer shall be notified of the nature and exact location of the findings. The Contractor shall not damage the discovered objects and shall provide written confirmation of the discovery to the Engineer within two (2) calendar days.

- RESTRICTION OF CONSTRUCTION - Should operations in the vicinity of a discovery be restricted, the Engineer will keep the Contractor informed concerning the status of the restriction. The Contractor should be aware that the time necessary for the Owner to negotiate the handling of the discovered is variable and is dependent on the nature and condition of the circumstances. It is possible that a delay of as much as three weeks in the vicinity of the discovery can be expected. The Engineer will inform the Contractor when the restriction is terminated. Changes required to accommodate delay or Work resulting from the discovery will be authorized in accordance with the General Conditions.

01520.3.11 OPERATIONS OUTSIDE OF THE PROJECT SITE

In the event the Contractor chooses to use any site or means of obtaining resources beyond those provided as part of the Contract, the Contractor shall retain the services of a qualified, certified environmental consultant to produce a research design or plan for obtaining any and all necessary environmental clearances for such use. The Contractor shall provide the plan to the Engineer for review and approval, as required, following which the plan shall be implemented. The Contractor shall submit evidence of environmental clearances and compliance before commencing any activities within the extended use area. At a minimum, clearances will include those listed below. Additional clearances may be required as necessary.

01520.3.11.1 CULTURAL RESOURCES (Archeological and Historic) - Clearance may require consultation with the State Historic Preservation Office.

01520.3.11.2 THREATENED AND ENDANGERED SPECIES - Compliance may require written clearance from the U.S. Fish and Wildlife Service.

01529.3.11.3 FLOOD PLAINS – May require consultation with the Federal Emergency Management Agency (FEMA) or corresponding state agency.

01520.3.11.4 WETLANDS AND OTHER BODIES OF WATER – May require consultation with the Army Corps of Engineers and/or appropriate state agency.

The Contractor is cautioned that obtaining environmental clearances can be costly and time consuming.

01520.4 METHOD OF MEASUREMENT

No separate measurement shall be made for environmental controls. Measurement for this item is included as part of another bid item.

01520.5 BASIS OF PAYMENT

No payment shall be made for environmental control. The environmental control shall be considered incidental to the project.

01560.1 DESCRIPTION

All construction staking shall be supervised by a land surveyor registered in the state in which the Work is located. Surveys will be performed consistent with professional practices and precision generally conducted by surveyors licensed in that state. The construction staking shall conform to section 105.8 of the MAG Specifications with the following exceptions. Construction staking shall be the responsibility of the Contractor and not of the Engineer.

The first two paragraphs of Section 105.8 shall be deleted in their entirety and replaced with the following:

"The Contractor will provide a Registered Land Surveyor (RLS) who will set construction stakes establishing lines and grades for road work, structures and centerlines for utilities and necessary appurtenances as he may deem necessary. The Engineer will furnish the Contractor with all necessary information relating to the lines and grades.

The Contractor provided RLS will be responsible for resetting any survey monuments as required by the plans and/or contract documents.

There will be no separate payment for the construction staking. Construction staking will be considered incidental to the project and other related bid items."

Additional requirements are located in the General Conditions. If there is a conflict the General Conditions shall supersede this section.

END OF SECTION

01580.1 DESCRIPTION

In general, the Contractor is responsible for providing and maintaining access to the Work, handling and storing of materials and equipment, safety and security within the Work site, and coordination and cooperation with the Owner, its representatives, governing authorities and other contractors working for the Owner in accordance with the provisions of the General Conditions. This section contains specific requirements which apply to these responsibilities. Additional requirements are located in the General Conditions. If there is a conflict between the General Conditions and this specification, the General Conditions dictate.

01580.1.1 RELATED WORK AND REFERENCED SECTIONS

Section 02005 – Traffic Control

01580.1.2 SUBMITTALS

Not used.

01580.1.3 DEFINITIONS

Not used.

01580.2 WORK SITE ACCESS

01580.2.1 INVESTIGATION OF WORK SITE AREA

The Contractor shall make its own investigation of the condition of available public and private roads and of clearances, restrictions, bridge load limits, and other limitations affecting ingress and egress to the site of the work.

01580.2.2 HAUL ROADS

It shall be the Contractor's responsibility to construct and maintain any new haul roads required for its construction operations.

01580.2.3 USE OF PUBLIC STREETS AND ALLEYWAYS

Nothing herein shall be construed to entitle the Contractor to the exclusive use of any public street, alleyway, or parking area during the performance of the Work, unless shown otherwise in the Contract Documents.

01580.2.4 CLOSURE OF PUBLIC ROADWAYS

No street, road, or highway shall be closed to the public without first obtaining permission from the proper governmental authorities and the Engineer. Where excavation is being performed in streets or highways, one lane in each direction shall be kept open to traffic at all times, unless otherwise authorized by the Contract Documents or the Engineer. Toe boards, or other measures, may be required by the Engineer to retain excavated material when deemed necessary.

01580.2.5 INTERFERENCE WITH UTILITIES

The Contractor shall so conduct operations as not to interfere unnecessarily with the infrastructure of utility companies or other agencies in such streets, alleyways, or parking areas.

01580.3 PUBLIC SAFETY AND ACCESS

Fire hydrants, approaches to fire stations, police stations and hospitals on or adjacent to the Work shall be kept accessible at all times. Appropriate measures shall be taken by the Contractor, to assure the use of sidewalks, and the proper functioning of all gutters, sewer inlets, water mains, drainage facilities and other infrastructure.

The Contractor's responsibility for Work safety or liability for Work site accidents is not lessened by the presence of the Engineer or his or another inspector performing monitoring of Work site safety conditions.

See also Section 02005 – Traffic Control.

01580.4 CONTRACTOR'S USE OF THE WORK SITE

The Contractor's use of the Work site shall be limited to its construction operations. Written approval by the Engineer will be required for any other use of the site, such as material and equipment storage, personnel vehicle parking, on-site fabrication facilities and field office.

01580.5 OFF-SITE STORAGE

The Contractor shall make arrangements for, bear any use costs associated with, and obtain written permission from the Engineer prior to using any off-site storage or shop areas or facilities determined necessary for execution of the Work. Storage facilities shall be equipped with fences and/or lockable entries that will prevent entry by unauthorized parties. Before off-site storage facilities are placed in use, the Contractor shall provided the Owner keys or combinations to locking devices used to secure the facility.

01580.6 COOPERATION WITH OTHER CONTRACTORS

Prior to authorizing other contractors to work on or adjacent to the Work site, the Owner shall notify the Contractor in writing and provide the name and address of the contractor, the name of its supervisor, a description of the work to be performed, and a schedule which shows the dates and planned segments of the work to be completed by the other contractor. In the event that conflicts or interferences occur between the Contractor and the other contractor's operation, the Engineer shall be notified immediately. The Engineer shall then take appropriate action needed to resolve the problem.

02000.1 DESCRIPTION

This section describes various tasks associated with project execution and close out. Mobilization shall include: preparatory work and materials necessary for obtaining clearances for the Work; moving personnel, equipment, supplies, storage facilities, traffic control plan, and incidentals to and from the Project Site; quality control; clean-up; temporary utilities and quarters; permits, bonds and insurance; dust abatement, storm water control, and noise abatement; waste and rubbish disposal and control; sanitation; and project close-out operations.

02000.1.1 RELATED WORK AND REFERENCED SECTIONS

Contract Closeout Section 107.2 of MAG Standard Specifications
Section 01510 - Protection of Existing Property
Section 01520 - Environmental Controls

Additional requirements are located in the General Conditions. If there is a conflict the General Conditions shall supersede this section.

02000.1.2 SUBMITTALS

02000.1.2.1 VISUAL RECORDS - The Contractor shall furnish at least one copy of all visual records, as described below in 02000.3.2, to the Owner.

02000.1.2.2 SERVICE CONNECTION LOCATION AND DOCUMENTATION – When service connections are included in the scope of work the Contractor shall deliver all signed tie-sheets (see 02000.3.3 below) to the Engineer not less than forty-eight hours prior to when the service connection is to be installed.

02000.1.3 DEFINITIONS

DVD Record - Photography on DVDs of areas potentially liable for disturbance as a result of the Work required by this Contract.

Service Connection Interview & Documentation - Interviews with potential system users and the documentation of location data for service connections to the respective property from utility lines being installed under this Contract.

Tie Sheets - Forms provided by the Engineer for use in documenting the location of service connection/s of system users.

Service Connection - Piping extending from the main utility line to the property line, or designated connecting point, of any user of the system.

02000.2 MATERIALS

02000.2.1 VISUAL RECORD

Records shall be made on professional quality, standard DVD format recording. DVD's shall be provided with protective covers and shall be labeled to indicate the area covered by the photography. Visual record shall have date stamp in video.

02000.3 CONSTRUCTION REQUIREMENTS

02000.3.1 VISUAL RECORDS

Prior to any disturbance of the area, the Contractor shall produce a DVD photography of all areas, including but not limited to right-of-ways, streets and roadways, haul-roads and access routes, storage areas, construction sites, and buildings or structures, which will be, or may be, affected by the Work. Such photography will be of a quality to allow accurate determination of location, size, and condition of existing features and improvements taken prior to any occupancy or execution of Work by the Contractor. Additionally, video for each street shall be separated into different chapters, which should each be accessible from the startup menu. Video footage shall have a date stamp to demonstrate time of recording. Coverage should be taken while the camera is stationary, not from a moving vehicle or other means. DVD's are subject to approval by the engineer and owner. Construction may not begin until the engineer has approved the visual record.

02000.3.2 SERVICE CONNECTION LOCATION AND DOCUMENTATION

Unless called for differently, the Contractor shall contact and interview the owners of all properties indicated on the Drawings and obtain from them sufficient information for location of workable service connections for each property. The Contractor shall document those locations on the tie sheets and obtain a confirmation signature from the connection owner.

02000.4 METHOD OF MEASUREMENT

02000.4.1 MOBILIZATION

Mobilization shall be measured by the lump sum.

02000.4.3 VISUAL RECORDS

Pre-Construction Photography shall be measured by the lump sum.

02000.4.4 SERVICE CONNECTION DOCUMENTATION

Service Connection Documentation shall be measured by the lump sum.

02000.5 BASIS OF PAYMENT

02000.5.1 Payment for Mobilization shall conform to Section 109 of MAG Standard Specifications.

02020.1 DESCRIPTION

Furnish and provide labor and equipment for investigation of existing miscellaneous pipelines, wires or cables, and other miscellaneous sub-surface features as required by the Engineer. Surface Investigation shall conform to MAG Standard Specifications.

02020.1.1 RELATED WORK

Section 01510 - Protection of Existing Improvements

02020.1.2 SUBMITTALS

Not used.

02020.1.3 DEFINITIIONS

Not used.

02020.2 MATERIALS

The Contractor shall provide a backhoe and qualified operator; laborer with hand shovel: appropriate fuel and lubricants, necessary equipment servicing materials; and appropriate equipment for transporting the backhoe to perform the investigation. The backhoe shall be a rubber tired CASE 580 backhoe, or an approved unit of equivalent or greater size and capacity, having accumulated not more than 5,000 hours operating time.

02020.3 CONSTRUCTION REQUIREMENTS

02020.3.1 EXPOSURE BY EXCAVATION

When directed by the Engineer, the Contractor shall excavate and expose miscellaneous pipelines, structural features, soil materials and other underground features which may be present at the work site. The location and extent of exposure shall be determined on site by the Engineer. Designation of such areas shall be made in writing, usually in the form of a Work Order, by the Engineer.

02020.3.2 REPLACEMENT OF EXCAVATED MATERIALS

Work required hereunder shall include replacement of excavated materials sufficiently to restore the site to a safe condition as determined by the Engineer. Full restoration of materials such as pavement, concrete slabwork, sod, etc., in the investigated area will be accomplished in accordance with the Contract Documents and as directed by the Engineer.

02020.4 METHOD OF MEASUREMENT

02020.4.1 MEASUREMENT BY HOURS OF WORK

Measurement of subsurface investigation shall be made by counting the actual number of hours of work completed by the machine and operator to investigate miscellaneous underground features as required by the Engineer. No allowance of time will be made for transporting the backhoe to and from the job site when the backhoe is located on the site of the Contract.

02020.4.2 MEASUREMENT FOR OTHER ITEMS OF WORK

When restoration of the excavated area requires provision of pavement, concrete slabwork, sod, etc., separate measurement will be made for those materials in accordance with the respective requirement(s) for measurement of that item in the Contract Documents.

02020.5 BASIS OF PAYMENT

The accepted quantity of work will be paid for at the contract unit price of:

PAYMENT ITEM	**UNIT**
Subsurface Investigation	Hour

When provision of designated materials is required for restoration of the excavation, payment for such materials shall be made in accordance with the respective provisions of the Contract documents.

END OF SECTION

02105.1 DESCRIPTION

This section covers obtaining permission, permits, clearances, etc.; as necessary to develop source(s), purchasing or manufacturing, loading, hauling, placing and compacting earthwork materials described herein, as shown on the Drawings and/or required by these Specifications. Earthwork Materials shall conform to MAG Standard Specifications.

02105.1.1 RELATED WORK

MAG Section 206 – Structure Excavation and Backfill
MAG Section 220 – Riprap Construction
MAG Section 301 – Subgrade Preparation
MAG Section 601 – Trench Excavation, Backfilling, and Compaction
MAG Section 702 – Base Materials
MAG Section 710 – Asphalt Concrete
Section 1300 – Submittals

02105.1.2 SUBMITTALS

When the Bid Schedule indicates quantities of materials described in this section in excess of 50 cubic yards or 50 tons, or when requested otherwise by the Engineer, the Contractor shall provide test results from a certified independent laboratory which has sampled and performed the prescribed test(s) for those materials.

02105.1.3 DEFINITIONS

Granular Material - Material for which the sum of plasticity index (AASHTO T-90) and the percent of material passing a No. 200 sieve (AASHTO T-27) shall not exceed 23.

Silt - Material which passes the No. 200 (AASHTO T-11) sieve and has a plasticity index not greater than 10.

Clay - Material which passes the No. 200 sieve and has a plasticity index greater than 10.

Bedding - Materials placed immediately around and adjacent to pipe installed in trenches.

Borrow - Material obtained from a source away from the site on which installed and/or excavated and used to supplement insufficient quantities of material required.

02105.2 MATERIALS

02105.2.1 STRUCTURAL BACKFILL

Structural Backfill shall be per MAG 206 and the Drawings.

02105.2.2 "PIPE ZONE" MATERIAL

"Pipe Zone" materials includes all material defined in MAG 601.4: foundation, bedding, haunching, and backfill. "Pipe Zone" materials shall be per MAG 601.

02105.2.3 SAND

Sand shall be graded granular material which passes a 3/8-inch sieve, with not more than 10 percent passing the No. 200 sieve (AASHTO T-27) and free from cinders, ashes, wood, vegetation, frozen or other deleterious material.

02105.2.4 AGGREGATE BASE COURSE

Aggregate base course shall be per MAG 702 and the Drawings.

02105.2.5 BITUMINOUS SURFACING

Plant mix bituminous material shall be per MAG 710.

02105.2.6 DRAIN GRAVEL

Drain gravel consists of washed natural gravel or crushed rock, with a maximum particle size of 1-inch, with not more than 40 percent passing the No. 4 sieve, with 100 percent being retained on the No. 10 sieve, and without any deleterious material.

02105.2.7 RIPRAP

Riprap materials shall be per MAG 220 and the Drawings.

02105.2.8 SUBGRADE GRANULAR FILL

Subgrade granular fill consists of well graded granular soils with a maximum of 50 percent passing the No. 4 sieve and a maximum of 20 percent passing the No. 200 sieve and no materials greater than 4-inches in diameter.

02105.2.9 ½" CRUSHED ROCK

½" Crushed rock shall meet the requirements of the Standard Specifications for Public Works Construction, Section 200-1.2, except that the grading shall be as follows:

Sieve Size	% Passing
1/4"	100
No. 4	50 - 90

Color shall be selected by the Owner.

02105.2.10 GRAVEL SURFACE COARSE MATERIAL

The gravel road extends from West Mallard Dr to the lift station and is the bid base for the project.

a) The surface course shall meet the requirement of ASTM D 1241 for Type I with Gradation C or any other gradation, which will grade within the following limits:

Sieve Size	Percent Passing by Weight
3/4"	100
No. 4	38 - 65
No. 8	25 - 60
No. 30	10 - 40
No. 200	3 - 12

b) The gravel road surfacing shall meet the following requirements:

i. Percentage of Wear: When tested in accordance with ASTM C 131, the percentage of wear shall not exceed 40 percent after 500 revolutions.
ii. Plasticity Index: When tested in accordance with ASTM D 4318, the plasticity index shall not be more than five (5).
iii. Liquid Limit: When tested in accordance with ASTM D 4318, the liquid limit shall not be more than 25 percent. The moisture content of the fill matrix at the time of compaction shall be neither less than one (1) percent below optimum moisture content nor one (1) percent above optimum moisture content.

02105.3 CONSTRUCTION REQUIREMENTS

02105.3.1 LOCAL GOVERNMENT SPECIFICATIONS

Differences may exist between the requirements of these Specifications for sitework materials such as backfill, bedding, untreated base course and bituminous surface course, and those of local government entities. Such differences may affect Contract prices; therefore, when Contract Work falls within the boundaries of any local government, the Contractor shall make himself aware of that entity's specifications for those materials. If differences exist between those specifications and these, unless otherwise approved by the Engineer, the more stringent ones shall apply.

02105.3.2 BORROW AND DISPOSAL SITES

The Contractor shall, at its own expense, secure all necessary access and borrow sites for acquisition or removal and to dispose of excess backfill or waste materials, unless otherwise shown on the Drawings.

02105.3.3 SCALES

When ton weight is to be used to determine quantities of earthwork materials used, the Contractor shall provide his own scales or access to other scales at his own cost. Scales shall be certified accurate. Include certification in submittals.

02105.3.4 MATERIAL PLACEMENT

Unless stated otherwise, material placement shall be per MAG standards. Gravel road shall be installed per Section 02120 and MAG standards.

02105.4 METHOD OF MEASUREMENT

The method of measurement shall be incidental to other bid items.

02105.5 BASIS OF PAYMENT

The basis of payment shall be incidental to other bid items.

END OF SECTION

02125 CRUSHED ROCK

02125.1 DESCRIPTION

This section is for the ½" crushed rock materials and installation. The crush rock is the surface cover inside the lift station compound.

02125.1.1 REFERENCES

MAG Section 201 – Clearing and Grubbing
Section 01300 – Submittals
Section 02105 – Earthwork Materials

02125.1.2 SUBMITTALS

Submittals shall be in accordance with Section 01300 and these Specifications. Contractor shall finish conformance tests and approval of material prior to deliver. Rock samples shall be provided for approval.

02125.2 MATERIALS

02125.2.1 Crushed rock shall be per Section 02105

02125.3 CONSTRUCTION REQUIREMENTS

02125.3.1 PLACEMENT

Clear and grub area and subcut to 2 inches below finish grade. Maintain uniform subgrade slope to drain. Treat grade area with a non-translocating, pre-emergent herbicide. Crushed rock shall be evenly distributed on the designated areas to a depth as indicated on the plans and details. Grade to uniform slope. Thoroughly moisten without flooding and compact to minimum 95%.

02125.3.3 CLEANING

After placing and grading the crushed rock, the Contractor shall water rock with a light spray to settle the to granite and remove fine materials from the surface

02125.7 METHOD OF MEASUREMENT

02125.7.1 The method of measurement shall be per Section 01019.3.

02125.8 BASIS OF PAYMENT

The basis of payment shall be per Section 01019.3.

02500.1 DESCRIPTION

This work includes removal and restoration of existing features, public or private, including but not limited to asphalt or concrete pavement, concrete structures, curb and gutter, sidewalk, gravel surfacing, driveways, crosswalks, landscaping, field crops, irrigation ditches, fences, culverts, buried or exposed utilities, abandoned utilities, small utility buildings and the disposal of resulting waste materials and debris.

02500.1.1 RELATED WORK

Section 01510 - Protection of Existing Properties
MAG Section 201 – Clearing and Grubbing
MAG Section 601 – Trench Excavation, Backfilling and Compaction
Section 02511 - Hot Plant Mix Bituminous Surfacing
Section 02520 - Pavement Cutting
Section 02900 - Landscaping

02500.1.2 SUBMITTALS

When any improvement not owned by the Owner is designated for restoration work, then, upon completion of such restoration, the Contractor shall obtain a written statement of acceptance or release from the responsible owner of the feature. This statement, in turn, will be submitted to the Engineer for his review and approval prior to acceptance of the work for payment.

02500.1.3 DEFINITIONS

Not used.

02500.2 MATERIALS

02500.2.1 GENERAL

When restoration of a feature is indicated in the Contract Documents, such work shall be accomplished so as to restore the feature to its original, or better, condition and/or function as it existed prior to removal.

It is recognized that exact duplication of materials cannot always be achieved, but reasonable effort is expected from the Contractor to restore the feature with materials which will provide the same or better service and appearance as observed prior to removal.

All materials shall be new.

02500.2.2 BITUMINOUS SURFACE

02500.2.2.1 PRIMER OR TACKER COAT – Shall be an approved bituminous material such as type MC-70-250, SS1, or CS-1.

02500.2.2.2 PATCHING AND REPAIR - Plant mix material that meets or exceeds the requirements of Section 02511 herein, or of the local State Department of Transportation for asphalt surface road repair, shall be used for patching and repair.

02500.2.2.3 SURFACING – Shall be hot mix bituminous surfacing, meeting or exceeding the requirements of Sections 02511 herein, or of the local State Department of Transportation for asphalt surface road repair.

02500.3 CONSTRUCTION REQUIREMENTS

02500.3.1 UNCLASSIFIED REMOVAL AND RESTORATION

02500.3.1.1 EXISTING IMPROVEMENTS - All existing facilities disturbed by the Contractor in prosecution of the Work, including but not limited to asphalt or concrete pavement, concrete structures, curb and gutter, sidewalk, gravel surfacing, driveways, crosswalks, landscaping, field crops, irrigation ditches, fences, culverts, buried or exposed utilities, abandoned utilities, small utility buildings or any other structures or obstructions designated to be removed on the Drawings, by the Engineer, or these Specifications, shall be removed, cleaned up, and then restored or replaced in kind by the Contractor in new condition.

02500.3.1.2 ADJACENT IMPROVEMENTS - Care shall be exercised in such removal to assure that adjacent facilities or structures, which are to remain, are not disturbed. Any damage to such existing facilities or structures resulting from carelessness or negligence on the Contractor's part shall be satisfactorily restored to new condition at the Contractor's expense.

02500.3.1.3 VEGETATION - Trees, shrubs, and other landscape plants designated to be saved for replanting shall be carefully removed, bundled, set aside and protected for replanting by the Contractor. Turf Sod to be saved for replanting shall be removed by machine cutting. In lieu of removal and replacement of turf sod or field crops, the Contractor may, upon approval of the property owner, remove and replant the same. Such agreements shall be documented on the final property release to be signed by the property owner.

Replanting of landscape items shall be performed in accordance with Section 2900.

02500.3.2 TOPSOIL

02500.3.2.1 REMOVAL AND PROTECTION - In all construction areas where re-growth of vegetation is desired, and when called for by the Contract Documents, the Contractor shall remove, segregate, stockpile, store, and protect topsoil during excavation in accordance with Section 02900. Topsoil shall be kept free from

contamination from foreign materials and other soils. The Contractor shall arrange construction activities to avoid damage or disturbance to the stockpiled soil.

02500.3.2.2 REPLACEMENT - When backfill operations have been completed, the topsoil shall be replaced and restored to the original contours or as called for on the Drawings, in accordance with Section 2900 of these Specifications.

02500.3.3 GRAVEL SURFACE

02500.3.3.1 REMOVAL - When restoration of graveled driveways, roadways, or parking areas is required, the existing gravel surfacing shall be graded off and stockpiled safely away from ongoing work activities, to prevent contamination with subsurface materials. It may then be reapplied and compacted during restoration activities.

02500.3.3.2 RESTORATION - Areas to be restored shall be backfilled and graded to uniform lines and compacted to the density prescribed for trenching in MAG Section 601. Existing gravel surfacing materials shall then be replaced in uniform 3 inch layers compacted to 95% of maximum density. After compaction, the affected area shall be graded smooth. Sufficient new material of equal or better quality shall be applied and mixed in, to replace materials lost during prosecution of the Work, to ensure a 3-inch minimum gravel cover after compaction and grading.

02500.3.4 BITUMINOUS SURFACE

02500.3.4.1 REMOVAL - Bituminous pavement surface shall be removed and restored in accordance with this paragraph unless provisions for restoration are made in other Sections of these Specifications. The pavement surface, public or private, designated for removal shall be removed to neat lines, which shall be cut in accordance with Section 02520. No ripping or rooting will be permitted outside of the limits of the cut lines.

Existing driveways, sidewalks, etc., which do not match the new finish grade as shown on the Drawings, also shall be removed preparatory to restoration work.

02500.3.4.2 DISPOSAL - Surfacing materials removed shall be disposed of in accordance with Section 1520 of these Specifications, and will not be permitted in the backfill, except as specifically authorized by the Engineer and in accordance with local requirements.

02500.3.4.3 RESTORATION – Restoration of bituminous surface shall proceed according to the following steps:

- First, the sub-grade shall be graded to a uniform surface, and 6 inches of Untreated Base Coarse (UBC) gravel shall be placed over the area in lifts not thicker than 3 inches, compacted to 95% of its maximum density.

- Then, the exposed edges of existing pavement shall be primed with a material approved for this purpose.

- Unless shown otherwise on the drawings or required otherwise by the Engineer, hot or cold mix bituminous surfacing shall be spread and compacted in individual, 3-inch maximum lifts over the base course. Minimum thickness of the new bituminous surfacing layer shall be equal to the adjacent surface thickness, but shall be not less than 3 inches thick when compacted to 95% of its maximum density.

- Rolling operations shall be conducted in such a manner that shoving or distortion will not develop beneath the roller. The surface shall be finished to a smooth, uniform line and grade with surface deviations not exceeding plus or minus 1/4 inch in 10 feet, unless the surface is subject to more stringent State, County, or Municipal requirements. The determination of smoothness compliance may be made with a straight edge or string line at the option of the Engineer. Any irregularities shall be satisfactorily corrected at the sole expense of the Contractor.

- Existing driveways, sidewalks, etc., which were removed because they did not match the new finish grade, shall be replaced and restored to their original or better condition to match the new finish grade shown on the Drawings, or as directed by the Engineer.

02500.3.5 REMOVAL AND RESTORATION OF CONCRETE IMPROVEMENTS.

02500.3.5.1 REMOVAL - Existing concrete pavement in streets, alleys, driveways, sidewalks, etc., public or private, shall be cut in accordance with Section 02520, and removed to the lines indicated on the Drawings, or as directed by the Engineer. No ripping or rooting will be permitted outside of the limits of saw cut lines.

Existing driveways, sidewalks, etc., which do not match the new finish grade as shown on the Drawings, also shall be removed preparatory to restoration work.

02500.3.5.2 DISPOSAL - All materials removed shall be disposed of in accordance with Section 1520 of these Specifications, and will not be permitted in the backfill, except as specifically authorized by the Engineer and in accordance with local codes.

02500.3.5.3 RESTORATION - Sub surface preparations shall be the same as those in paragraph 02500.3.4.3 above.

- Concrete pavement including sidewalks, driveways, roadways, and parking area surfacing shall be replaced by the Contractor in accordance with Division 3 of these Specifications, unless otherwise directed by the Engineer

- Those existing driveways, sidewalks, etc., which were removed because they did not match the new finish grade, shall be replaced and restored to their original or better condition to match the new finish grade shown on the Drawings, or as directed by the Engineer.

- All other concrete improvements shall be restored in accordance with details shown on the Drawings, or as directed by the Engineer, and as required by the provisions of Division 3 of these Specifications.

02500.3.6 REMOVAL AND RESTORATION OF FENCES

When necessary to remove any fence to facilitate its operation, the Contractor shall obtain prior agreement with the owner of the fence for its removal. Temporary containment measures shall be provided, if needed, at no additional expense to the Owner. As soon as practical, the permanent fence shall be restored to its original condition or better.

02500.3.7 RESTORATION OF IRRIGATION DITCHES

Restoration of irrigation ditches shall be made in such a manner that the ditch configuration and size will be equivalent to its original condition and the ditch will be located on its original alignment. Any embankment required to restore the original slope of the ditch will be layer compacted with mechanical compaction equipment to 90% of maximum dry density determined by AASHTO T-99.

02500.3.8 CLEANUP

Areas of construction activity shall be left in a condition of uniform grade, blending into pre-existing contours and concealing, as much as possible, evidence of construction activity by back dragging or raking to conceal tire marks. Cleanup and disposal of surplus materials shall be performed in accordance with Section 1520.

02500.4 METHOD OF MEASUREMENT

02500.4.1 NO BID SCHEDULE LINE ITEM

When the Bid Schedule in the Contract does not contain a line item for "Removal and/or Restoration of Surface Improvements", then this work will be considered incidental to other items included in the Bid Schedule, and no separate measurement shall be made for this work.

02500.4.2 "DESIGNATED AREA" LINE ITEM

Measurement for removal and/or of surface improvements in a designated area shall be the "lump sum" of the work required to remove and properly dispose of materials resulting from removal.

02500.4.3 "DESIGNATED FEATURE" LINE ITEM

Measurement for removal and/or restoration of designated features shall be per unit as described in the Bid Schedule.

02500.4.4 BITUMINOUS SURFACE PAY LIMIT

Measurement for bituminous surface removal and replacement shall be made by multiplying the pay limit by the actual length of removal and replacement in lineal feet as determined using a tape measure or other accurate measuring device.

In general, for pipe trench excavation, the pay limit shall be determined by the formula W = OD + 18 inches (pay limit width equals pipe outside diameter plus 18 inches), rounded up to the nearest standard bucket width. Actual measurement may be modified according to information indicated on the Drawings or as directed by the Engineer.

The pay limit for removal of bituminous surface for other purposes shall be as shown on the Drawings or directed by the Engineer.

02500.4.5 DAMAGED ITEMS

Measurement of items damaged or removed as a result of the Contractor's negligence shall not be allowed and no payment will be made under this contract.

02500.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit prices as follows:

PAY ITEM	UNIT
Removal of Site Surface Improvements	Lump Sum
Removal of (*Name of Structures*)	Each
Removal of Sidewalk	Square Yard
Removal of Fences	Lineal Foot
Removal of Driveway Slabs	Square Yard
Removal of Curb and Gutter	Lineal Foot
Removal of Bituminous Surface	Square Yard
Replace (*Name of Structure*)	Each
Replace (*Thickness*) Sidewalks	Square Yard
Replace (*Thickness*) Driveway Slabs	Square Yard
Replace *(Thickness)* Bituminous Surface	Square Yard
Replace (*Description*) Fence	Lineal Foot
Replace (*Description*	Lineal Foot or Lump sum
Restore (*Description*)	Lineal Foot or Lump Sum

02510.1 DESCRIPTION

This section covers all sampling and testing of all materials used on this project. The materials sampling and testing shall be done by an independent certified testing company and all testing reports shall be submitted to the Engineer within a reasonable time period. All material and sampling shall be in accordance with the General Conditions, these specifications, and MAG Section 106.

If there is a conflict between requirements the order of precedence is as follows: General Conditions, these specifications, then MAG Section 106.

02510.1.1 RELATED WORK AND REFERENCED SECTIONS

MAG Section 106 – Control of Materials
MAG Section 601 – Trench Excavation, Backfilling, and Compaction
MAG Section 725 – Portland Cement Concrete
Section 01300 – Submittals
Section 01400 – Quality Control

02510.1.2 SUBMITTALS

All sampling and test reports shall be submitted in accordance with Section 01300.

02510.1.3 DEFINITIONS

Not Applicable

02510.1.4 MODIFICATION TO MAG

Section 106.2, second paragraph shall be deleted completely and replaced with the following:

The Contractor will pay for the initial or normal test required by the Engineer to guard against unsuitable materials or defective workmanship. Additional tests, required due to failure of the initial or normal test(s), shall be paid for by the Contractor. The Engineer will designate the laboratory which will accomplish the additional test(s).

02510.2 MATERIALS

Not Applicable

02510.3 CONSTRUCTION REQUIREMENTS

02510.3.1 TESTING

The minimum testing requirements are as follows: All Materials sampling and testing shall be done by an independent certified testing company and all testing

reports shall be submitted to the Engineer within a (2) two week time period or sooner.

02510.3.1.1 EMBANKMENT

• Maximum Laboratory Density	1 test in each soil type
• Field Density and Moisture	1 test per 2000 square yards

02510.3.1.2 BACKFILL

• Field Density and Moisture	2 tests per culvert or structure (Refer to Section 02200 for Trench Excavation and Backfill Testing)

02510.3.1.3 UNTREATED BASE COURSE

• Sieve Analysis	1 test per production day
• Maximum Laboratory Density	1 test per 10,000 tons
• Field Density and Moisture	1 test per 2000 square yards

02510.3.1.4 ASPHALT CONCRETE PAVEMENT

• Mix design (ASTM 1559 and AASHTO T-283)	1 mix design for the project
• Asphalt temperature	As necessary to assure compliance
• Gradation and Asphalt Content	2 tests per production day
• Field Density	1 test per 1600 square yards
• Mix and Laydown Temperature	As necessary to assure compliance
• Thickness	1 test per 1600 square yards

02510.3.1.5 PORTLAND CEMENT CONCRETE

• Slump Test	1 test per load of concrete
• Air Test	1 test per load of concrete
• Strength Test	1 compressive strength per 50 cubic yards

02510.4 METHOD OF MEASUREMENT

Measurement for this pay item will be by the lump sum.

02510.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price:

PAY ITEM	UNIT
Materials Sampling and Testing	Lump Sum

END OF SECTION

02553.1 GENERAL

Notice. The site will be without power when APS is upgrading the transformer. The Contractor is responsible for coordinating with APS so the transformer upgrade occurs during the bypass pumping stage of the project.

02553.1.01 SUMMARY

A. Section includes: Requirements for temporary bypass pumping of wastewater flows at the Chapel and Mystic Hills lift stations to complete the Work.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.

02553.1.02 REFERENCES

A. National Fire Protection Association (NFPA):
   1. 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

02553.1.03 GENERAL REQUIREMENTS

A. Provide all necessary labor, tools, materials, and supervision to provide temporary bypass pumping and flow control in accordance with the requirements of this Section.

B. Operate and maintain bypass pumping facilities including, but not limited to, pumps, piping, valves, controls, and monitoring until the involved portion(s) of the Work have been completed to the satisfaction of the Owner/Engineer.

C. Bypassing wastewater in a way that assures that no wastewater is allowed to leak outside of the bypass system or lift station facilities. If leakage does occur, pay all fines and reimburse the Owner for all costs associated with the cleanup of the leakage, as wells as costs associated with legal actions.

D. Accept responsibility for any release of wastewater and for penalties associated with bypass pumping activities, including commissioning, operating, and decommissioning of bypass pumping facilities.

E. Coordinate the placement of the bypass piping and pumping equipment with the Owner.

F. The means and methods of accomplishing and maintaining the temporary bypass pumping and associated facilities shall be the sole responsibility of the Contractor.

Except as otherwise specified or authorized in writing, no interruption of wastewater flow shall be permitted throughout the duration of the project. Contractor is responsible for all wastewater overflows during construction of this work and bypass operations.

H. Take precautions to prevent any potential spillage of wastewater from entering the stormwater system.

I. Temporary bypass pumping operation:
   1. Limited to the months, times, or seasons indicated, unless approved in writing by the Engineer.
   2. Continuous operation for 24 hours per day and 7 days per week is anticipated during the period of Work.

J. Continuously monitor temporary bypass pumping.

K. Provide qualified operators continuously during operation of the bypass systems.

L. Equipment and personnel cannot be located on residential property unless written approval has been provided by the resident and the City.

02553.1.04 SUBMITTALS

A. Prepare and submit a project-specific wastewater bypass pumping plan with completed wastewater bypass pumping checklist for approval.
   1. Be advised that the bypass plan must provide accessibility for Owner operations and vehicular traffic in accordance with Owner requirements.

B. Wastewater bypass pumping plan: Include the following at a minimum:
   1. Capacities and sizes of pumps, standby equipment, and power requirements, if applicable.
   2. Design calculations of the system and selected equipment, including flow, TDH with static head including all friction and minor losses, pump curves showing operating range of flow and TDH at minimum, average, and peak flow.
   3. Standby power generator size and location for electrically-driven bypass pumps (if used).
   4. Downstream discharge plan.
   5. Pipe thrust and restraint types, sizes, and locations.
   6. Temporary pipe supports and anchoring required.
   7. Plans for access to bypass pumping locations.
   8. Schedule that shows duration of temporary bypass pumping including milestones for installation, maintenance, and removal of equipment and accessories.

9. Means and methods of installing, operating, monitoring, and maintaining the temporary bypass pumping.
10. Plan indicating bypass pumping line locations.
    a. Include details showing methods used to protect and identify the bypass pumping lines through the length of the bypass route.
11. Detailed plans of a backup system.
12. Address access for operators and vehicular traffic.
13. Mechanical plan showing equipment, valves, pipe sizes and locations, pipe materials, dimensions, vehicle access (where applicable), pedestrian access (where applicable).
14. Schematic drawings and written description of the control system and its' operating sequence.
15. Proposed type and location of collection system plugs.
16. Catalog cut sheets for pumping equipment, pipe and fittings, valves.
17. Emergency response plan.
18. Staffing plan.
19. Spill prevention and cleanup plan.
20. Noise control system.
21. Health and safety plan.
22. Surge or water hammer calculations and attenuation means.
23. Maintenance history of pumps.
24. Operating permits from jurisdictional air quality agency for each engine.
25. Temporary Bypass Pumping plan must meet the requirements laid out in the Bypass Pumping Report by Carollo.

02553.1.05 QUALITY ASSURANCE

A. Contractor's qualifications:
   1. Minimum 5 years' experience in performing substantially similar temporary bypass operations.
   2. Submit evidence of satisfactory operation of temporary bypass facilities similar to those specified in at least 5 separate projects in accordance with the specifications, including references.

B. Fulfillment of the specified experience requirements shall be a condition of acceptance.

PART 2 PRODUCTS

02553.2.01 CAPACITY

A. Pumps, piping and accessories: Of adequate capacity and size to handle the range of wastewater flows from minimum flow to peak flow.

B. Piping, fittings, and all accessories shall withstand 2.0 times the maximum pressure including surge.

C. Maintain on site sufficient equipment and materials to ensure continuous and successful operation of the bypass system.
   1. Have standby pump(s) on site to provide 100 percent redundancy of the bypass system design Peak Flow.
      a. The redundant pump(s) shall be plumbed, fueled, and ready for operation at all times.
   2. Provide sufficient bypass lines to provide 100 percent redundancy of the bypass system design Peak Flow.
      a. The bypass lines and separate redundant lines shall be connected via a combined header that enables the shutdown and isolation of each individual line should a leak or rupture occurs.
   3. Maintain on site a sufficient number of valves, tees, elbows, connections, tools, pipe plugs, piping, and other parts or system hardware to ensure immediate repair or modification of any part of the bypass system as necessary.

02553.2.02 BYPASS PUMPS

A. Provide a minimum of 2 pumps: 1 duty and 1 standby.

B. Pump capacity: Sufficient to pump the anticipated peak hour flow with the largest pump out of service.

C. Pumps: Packaged units with a skid base or trailer.

D. Pumps: Fully automatic, self-priming, close-coupled centrifugal units that do not require use of foot valves or vacuum pumps for priming.

E. Pumps shall use oil-lubricated mechanical seal. F.

Pump materials: As follows:
1. Volute: Cast iron.
2. Impeller: Cast iron.
3. Pump shaft: Type 431 stainless steel.
4. Mechanical seal faces: Silicon carbide.

G. Pumps shall be capable of passing 3-inch diameter solids, rags, rocks, hair, and other debris encountered in municipal wastewater.

H. Pump driver: Diesel engine or 480-V electric engine and include the following:
   1. Minimum 48-hour capacity diesel fuel tank as defined by fuel consumption during peak pumping rate.
   2. Fuel gauge with red warning light when tank approaches empty.

I. Pumps shall be capable of dry operation for up to 12 hours to accommodate large fluctuations in flow.

J. Maximum pump speed: Not exceeding 2,200 revolutions per minute. K.

The system shall include the following features:
1. START/STOP OPERATION.
2. Variable flow based on water level in suction structure.
3. Instrumentation and controls for operation and monitoring for each pump.

L. Electrical equipment, instrumentation, and accessories: Suitable for Class 1 Division 2 service as defined by NFPA 820.

M. Comply with applicable air quality regulations.

N. Utilize low noise level pumps as size permits manufactured by BakerCorp or Goodwin Quiet Pumps. Due to bypass into existing force mains, sound attenuated pumps may not be available for high head conditions. In this case, sound curtains are to be utilized for noise control.

02553.2.03 BYPASS PIPING

A. Use HDPE piping for the temporary bypass pumping system. B.

Piping integrity: 0 leakage.

1. Include spill containment vessels or 'spillguards' as needed.

C. Provide sewage type air release valve at high point in piping and containment spills from valves.

D. Provide temporary ramps constructed over pipelines 6 inches in diameter or less to allow access to driveways.
1. Bury pipelines larger than 6 inches in diameter crossing driveways, a minimum of 6 inches below the existing ground or pavement surface and backfilled with
temporary asphalt concrete.
2. No driveway access shall be blocked without the written authorization of the Owner.

02553.2.04 PIPE PLUGS IN EXISTING PIPE

A. Pipe diameters 24 inches and smaller: Mechanical plugs with EPDM gaskets.

B. Pipe diameters larger than 24 inches: Inflatable bag stoppers with 2 or more pieces. Provide 2 plugs in series.

02553.2.05 NOISE CONTROL

A. Pumping equipment: Equipped with devices or enclosures for noise attenuation including but not limited to mufflers and/or acceptable noise panels or

enclosures. Due to the high head requirements for bypass of flow into existing force mains, pumps may not be available with noise attenuation. In that case, sound curtains shall be provided around the pumps to meet the noise level requirements of this Specification.

B. The noise level: The City of Sedona sound ordinance requires that the maximum permissible sound level limits be at or below 60 dBa from 7:00 AM to 10:00 PM and at or below 50 dBA from 10:00 PM to 7:00 AM as measured at any location at or within the property line of the receptor property.

02553.2.06 ODOR CONTROL

A. The Contractor shall employ methods and procedures that mitigate the generation and discharge of objectionable odors to the surface environment at all times.

B. Seal all open manholes with plastic or similar material around suction piping that is adequately taped or tied to maintain an odor barrier.

C. All odor control methods shall be routinely inspected for maintaining of installation integrity.

PART 3 EXECUTION

02553.3.01 GENERAL

A. Notify the Owner a minimum of seven (7) days prior to the Work and notify the Engineer at least 48 hours prior to bypassing or diverting flow in any of the pipelines or laterals.

B. Place pumps, generators, and other equipment on a plastic tarp to protect against spills of petroleum products used by the equipment.

C. Before taking process or pipeline out of service, verify that bypass system is fully operational and acceptable to Engineer. Testing of bypass system over a weekend period prior to taking pipeline out of service shall be performed.

02553.3.02 PROTECTION

A. Be responsible for all bypass flows.
   1. Inspect the entire bypass pumping and piping system for leaks or spills at a frequency of not less than 4 times per day.
   2. Do not shutdown the temporary bypass system between shifts, on holidays or weekends, or during work stoppages without written permission from the Engineer.

B. Provide trained and qualified attendants 24 hours per day 7 days per week until the bypassing is no longer required. The attendants shall:

1. Be capable of performing pump and piping maintenance required.
2. Be capable of monitoring flows/levels in suction manhole and any upstream manholes to verify system operations.
3. Have cellular phones for communication with the Contractor and the Owner in the event of emergencies.
4. The person responsible for the bypass pumping may perform other construction duties in the immediate vicinity of the bypass pumping system but must not leave the site for any reason without first handing off responsibilities to another competent person. All responsibilities of this specification apply to the new person until relieved.

5. A list of those responsible for the bypass pumping supervision, and the times they will be onsite, shall be provided to the City and the Engineer.

C. No bypassing to the ground surface, receiving waters, storm drains, or bypassing which results in soil or groundwater contamination or any potential health hazards shall be permitted.
   1. In the event of any wastewater spill, be responsible for the prompt cleanup and disinfecting of the spill as called for in the wastewater bypass pumping plan.
   2. Compensate the Owner for the cost of any fines levied as the result of a spill or unauthorized discharge.

D. Implement measures to prevent interference between Owner operations and the bypass pumping equipment, pipelines and wastewater.

E. Take precautions to protect all bypass lines from damage.
   1. Clearly identify above ground portions of the bypass lines by flashers, fencing, or other means to warn of their presence.

02553.3.03 FIELD QUALITY CONTROL

A. Hydrostatic pressure test:
   1. Prior to operation, test each section of discharge piping with maximum pressure equal to 2.0 times the maximum operating Pressure.
   2. Conduct test for a duration of 2 hours.
   3. Test using non-potable water.
   4. The line in service after test if the pressure has been maintained and there are no observable leaks.
   5. Notify Engineer at least 48 hours prior to testing.

B. Inspection:
   1. Inspect temporary bypass piping system at a minimum of four times per day.

   2. An attendant/operator shall be present to monitor the operation of the bypass pumps at all times 24 hours per day.
   3. Inspection log: Keep at each pumping location.

02553.3.04 CLEAN-UP

A. The temporary bypass pumping system: Flush, clean and drain prior to dismantling. B. Dispose of flushing water in approved manner.

C. Disturbed areas: Upon completion of bypass pumping operation, clean disturbed areas, restoring to original condition, including pavement and landscape restoration, at least equal to that which existed prior to start of Work.

02553.3.05 SYSTEM CONDITIONS

A. Refer to Table below.

Bypass	Route		Flows (gpm)				
Description	From	To	Max	Avg	Min	Time	Conditions
Chapel LS	MH#1 Upstream of LS	Existing 6" Force Main (75' of existing head	153	85	57	Continuous	Max wet condition flow = 392 gpm. Design for no more than 4' of vertical storage in MH#1
Mystic Hills LS	MH#1 upstream of LS	Existing 6" Force Main (202' of existing head)	207	115	20	Continuous	Max wet condition flow = 553 gpm. Design for no more than 4' of vertical storage in MH#1

02900.1 DESCRIPTION

This section covers providing materials, equipment and labor necessary for installing topsoil, turf, trees, shrubs, grasses, forbs, field seeding, re-seeding, fertilizer, mulch, and soil amendments.

02900.1.1 RELATED WORK

Not used.

02900.1.2 SUBMITTALS

The Contractor shall submit for approval product data and seed mixtures in accordance with the requirements of Section 01300.

02900.1.3 DEFINITIONS

Not used.

02900.2 MATERIALS

02900.2.1 TOPSOIL

Topsoil shall be obtained from local sources, and shall have similar soil characteristics to those of the soil at the location where it is to be used. Topsoil shall be obtained from well-drained sites where it occurs to a depth of not less than 4 inches, and it shall not be obtained from bogs or marshes. Topsoil shall be fertile, friable, natural loam, reasonably free of subsoil, clay lumps, brush, weeds, litter, roots, stumps, stones larger than 2 inches in any dimension, or any other material which would inhibit the germination of seeds or the growth of the cover crop.

02900.2.2 TURF SEED

If not otherwise required in the Contract Documents, seed for turf sod shall be composed principally of Kentucky bluegrass (Poa pratensis), testing 99.9% pure live seed (PLS), or as approved. Other acceptable varieties include Merion, Baron, Fylking, Tall Fescue, and Brome.

02900.2.3 TURF SOD

Turf sod shall be vigorous, viable, strongly rooted sod, not dormant or less than 2 years old, free of weeds, undesirable native grasses, insect infestations, and fungus. It shall be machine cut to a pad thickness of 1 inch ($\pm$ 0.33 inch).

02900.2.4 TREES AND SHRUBS

02900.2.4.1 NURSERY GROWN - Trees and shrubs shall be nursery-grown, with botanical and common names of plants true to the approved names given in the latest edition of "Hortus", and shall meet the requirements of the American Standard for Nursery Stock adopted by the American Association of Nurserymen. Plants shall be sound, healthy, vigorous, symmetrically proportioned, well branched, densely foliated when in leaf, free of disease, insect pests, eggs, and larvae and shall have well developed root systems.

02900.2.4.2 ROOT BALLS AND PRUNING - Root balls shall be protected at all times from sun, drying winds and frost. Plants shall not be pruned prior to delivery. If balled and burlapped plants are not installed immediately upon delivery, they shall be set on the ground and protected with moist soil or wet mulch.

02900.2.4.3 WARRANTY - Trees and shrubs shall be warranted for a period of 1 year after Substantial Completion, against death and unsatisfactory growth, except in cases resulting from Owner's neglect, abuse by others or natural phenomena. Unacceptable plant material shall be replaced at end of warranty period. Only one replacement is required.

02900.2.4.4 FIELD SEED MIX

The seed mix listed below is suggested as a standard for field seeding when no other information is available. However, seed mix requirements can vary widely from area to area, and the Contractor shall contact the local office of the Natural Resources Conservation Service (NRCS) to obtain an appropriate seed species mix and application rate for the location in question. The Contractor shall follow the directions of the NRCS, the Engineer, and the property owner in doing field seeding.

SUGGESTED FIELD SEED MIX

Species	**Amount** (%)
Nardan Crested Wheatgrass	30
Russian Wild Rye	20
Y.B. Sweet Clover	15
Slender Wheatgrass	10
Oahe Intermediate Wheatgrass	10
Fairway Crested Wheatgrass	5
Western Wheatgrass	4
Other	6

02900.2.5 RESEEDING AND REVEGETATING

As with the field seed mix, non-field seed mix and/or vegetation requirements are usually area sensitive. Different government agencies, such as the Forest Service or the Bureau of Land Management, may have separate seed mix and vegetation requirements within the same area. The Contractor shall contact the respective property owner at their local office, address, or telephone number to obtain the appropriate reseeding and revegetating requirements and follow the same, in concurrence with the Engineer, in acquiring the appropriate seed and vegetation.

02900.2.6 MULCH

02900.2.6.1 TREE AND SHRUB MULCH - Tree and shrub mulch shall consist of well-aged fibrous or shredded bark, old sawdust, pine needles or leaf mold.

02900.2.6.2 FIELD SEED MULCH - Field seeding mulch shall be certified weed free small grain straw or native hay.

02900.2.6.3 HYDRAULIC MULCH - Hydraulic seeding mulch shall consist of pigments and wood cellulose fiber or paper pulp and shall form a blotter-like ground cover with moisture absorption and percolation properties. It shall have the ability to cover and hold the seed in contact with the topsoil, yet not inhibit the penetration of seedlings through it.

02900.3 CONSTRUCTION REQUIREMENTS

02900.3.1 SCOPE OF REQUIREMENTS

The Contractor shall furnish all equipment, labor, topsoil, seed, seed mixes, turf, shrubs trees or other materials required to landscape, re-seed, or re-vegetate all areas disturbed by the Work, as

required by the Drawings and these Specifications. The disturbed area shall be kept as small as possible.

02900.3.2 EROSION CONTROL

The condition of landscaped, re-seeded and re-vegetated areas shall be checked to determine the effectiveness of erosion control methods and materials. Checks will be made upon project completion, at three months following project completion, and at nine months following project completion. Any modifications or repairs required by the Engineer shall be promptly performed by the Contractor, at no additional cost to the Owner.

02900.3.3 TOPSOIL

02900.3.3.1 REMOVAL OF TOPSOIL - Topsoil to be saved shall be carefully removed to a depth of 24 inches, or to the actual depth of the existing layer, which ever is less, and set aside in a separate location. It shall not be mixed with the remainder of excavated material.

02900.3.3.2 REPLACEMENT OF TOPSOIL - When site work conditions permit, topsoil shall be spread as shown on the Drawings. The minimum depth of topsoil shall be 6 inches over all designated areas. Topsoil shall be fine graded to a firm even surface, matching existing slopes, with no lumps or stones present. The topsoil shall be prepared to a good condition, not muddy or hard, and shall be scarified to a friable condition if it is hard before turf is placed.

02900.3.3.3 PROTECTION AGAINST EROSION - Areas where topsoil has been spread shall be protected against erosion.

02900.3.4 TURF SEED

02900.3.4.1 SEEDBED PREPARATION - Where required, turf seed shall be installed as specified herein. Seedbed preparation shall be accomplished by spreading peat moss or manure uniformly at a rate of 3 cubic yards per 1000 square feet and worked into the soil by light tilling.

02900.3.4.2 APPLICATION - Seed shall be applied at a rate of 2 pounds per 1000 square feet using a drop (band) type spreader unless otherwise approved by the Engineer. The seed shall be divided into two halves and then distributed, half in north/south directions and half in east/west directions. Seed shall be raked into the soil, a layer of mulch shall be applied, and then lightly watered, at least four times daily for two weeks, or until the seed germinates.

02900.3.5 TURF SOD

02900.3.5.1 INSTALLATION - Where required, turf sod shall be laid across slopes such that butt joints alternate. Sod pieces shall be fitted tightly together so no joint is visible and then firmly and evenly hand tamped. The sod shall then be rolled with a 150-pound roller to level and seal all seams.

02900.3.5.2 WATERING - After rolling, sod shall be watered until water soaks into underlying topsoil to a depth of not more than 3 inches. For grades of 50% slope or steeper, the sod shall be secured with wooden pegs driven flush with the soil portion of the sod and 2 feet maximum on center.

02900.3.5.3 MOWING - Prior to Substantial Completion, sod shall be mowed as required to maintain a maximum height of 2 1/2 inches.

02900.3.6 TREES AND SHRUBS

02900.3.6.1 LOCATION - When required trees and shrubs shall be installed, as specified herein, at locations designated on the Drawings. Trees and shrubs to be saved and replanted shall be carefully removed, set aside, protected and preserved until they can be safely replanted.

02900.3.6.2 PREPARATION OF PLANTING PIT - Tree and shrub pits shall be five times the diameter of the root ball. The bed shall be prepared by loosening the soil with a tiller or shovel to a depth of 12 inches. Topsoil and organic matter shall then be added and distributed uniformly within the planting bed as necessary. The Contractor shall not proceed with planting until the pit locations and bedding are approved by the Engineer.

02900.3.6.3 PLANTING - The plant shall be set in the center of a hole of the proper size, plumb and straight. Burlap, ropes and all wire and other materials shall be removed, and then the excavated soil shall be returned to the hole and gently packed around the root ball. The planting shall be flooded with water to promote additional soil consolidation. The Contractor shall give care that, after settling, the top of the root collar shall be even with the adjacent finished grade A 2-inch layer of mulch shall be applied around the base of the tree, to extend 2 feet in radius beyond the root ball.

02900.3.6.4 SUPPORT - Trees shall be guyed with two wires anchored securely to steel posts not less than 5 feet from the trunk, and directly opposite each other. The trees shall be protected from direct contact with the wires.

02900.3.6.5 PRUNING - Each plant shall be pruned with clean, sharp tools, to remove suckers and broken, badly bruised or dead branches. Tree trunks shall be wrapped with Tubex or equivalent translucent material unless directed otherwise by the Engineer.

02900.3.6.6 WATERING - Trees and shrubs shall be watered and maintained until Substantial Completion and defective work shall be corrected as soon as it becomes apparent and as weather and season permit.

02900.3.7 FIELD SEEDING

Field seeding shall be accomplished using one of the following methods.

02900.3.7.1 BROADCAST - Broadcast seeding shall only be applied after October 15 and prior to April 15, unless authorized otherwise and directed in writing by the Engineer. No seed bed preparation will be required for this seeding method.

02900.3.7.2 DRILLING - Drilling shall be set forth in uniform rows with spacing not to exceed 8 inches and the depth set correctly for the type of seed being drilled. The minimum distribution rate shall be 20 pounds per acre, and may be more if so recommended by the local Soil Conservation Service.

02900.3.7.3 HYDRAULIC - For hydraulic seeding the Contractor shall use equipment designed for such work. Seed and water shall be uniformly applied to the areas scheduled to be seeded. Fertilizer, water and approximately 1 ton per acre of hydraulic mulch shall be homogeneously mixed and uniformly applied to seeded areas.

02900.3.8 RESEEDING AND RE-VEGETATING

02900.3.8.1 RE-SEEDING - Reseeding of areas disturbed by the Work shall be accomplished with grasses compatible with the pre-construction vegetation. The Contractor shall consult the local office of the U.S. Forest Service, Bureau or Land Management, Soil Conservation Service, or other applicable affected agency, for appropriate seed species and application rates. Unless otherwise

directed by the Engineer or these Specifications, reseeding shall be accomplished by broadcast seeding in accordance with this section.

02900.3.8.2 RE-VEGETATING - Re-vegetation of areas disturbed by the Work shall be accomplished with started trees and shrubs, compatible with the pre-construction vegetation, and is performed in addition to reseeding as discussed in paragraph 02900.3.8.1 above. When re-vegetation is required, the Contractor shall consult the local office of the applicable affected agency, for appropriate species and instructions.

02900.3.9 MULCH

Mulch shall be incorporated as prescribed on the Drawings and in these Specifications. Where the slope exceeds 10%, the Contractor shall use a tie down mulching material.

02900.4 METHOD OF MEASUREMENT

02900.4.1 LUMP SUM - Lump sum measurement for landscaping shall include all grading, soil preparation, planting, furnishing materials and plants in accordance with the Drawings and these Specifications when shown as a single item in the Bid Schedule.

02900.4.2 SEPARATE MEASUREMENT - When and if applicable, separate measurements for topsoil, turf seeding, turf sod laying, reseeding, re-vegetating, mulching and planting of trees and shrubs shall be made in the units shown and as identified in the Bid Schedule.

02900.5 BASIS OF PAYMENT

The accepted quantity(s) shall be paid for at the contract unit price for:

PAY ITEM	UNIT
Landscaping	Lump Sum
Topsoil	Square Yard
Turf, Seed	Square Foot
Turf Sod	Square Foot
Trees & Shrubs	Each
Field Seeding	Acre
Re-seeding	Acre
Mulch	Acre

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes vehicle and manway gates.

1.2 SUBMITTALS

A. Product literature and data for manufactured items.

B. Shop drawings showing location and fabrication details of posts, wood privacy slats, hardware, accessories, and specific description of material components.

1.3 QUALITY ASSURANCE

A. Fabricator Qualifications: Firm experienced in successfully producing access gates and manways similar in type and style shown in the Drawings. Shall have a minimum three years' experience.

B. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code-Steel". Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.4 FIELD MEASURMENTS

A. It is the contractors responsibility to take field measurements to ensure the shop drawings dimensions will fit in the allotted space.

PART 2 PRODUCTS

2.1 METALS

A. General: Provide metals free from surface blemishes exhibiting pitting, seam marks, roller marks, stains, discolorations, or other imperfections, where exposed to view in the finished unit.

B. Steel and Iron: Provide steel and iron in the form indicated suitable for specified finish, complying with the following requirements:

1. Square Tubing: Cold-formed steel structural tubing conforming to ASTM A 500, Grade B with minimum yield strength of 42,000 psi and not less than 1.8 oz. of zinc per sq. ft. Type A costing inside and outside according to ASTM F 1234, as determined by ASTM A 90.
2. Steel Plate, Shapes, and Bars: ASTM A 36/A 36M.

C. Stainless Steel: Hardware per Drawings.

2.2 WOOD PRIVACY SLATES

A. The wood privacy slats shall be Construction Common Redwood dog-ear pickets. Sized and spaced per the Drawings.

2.3 MISCELLANEOUS MATERIALS

A. Welding Electrodes and Filler Metal: Type and alloy of filler metal and electrodes as recommended by producer of metal to be welded, complying with applicable AWS specifications, and as required for color match, strength, and compatibility in the fabricated items.

B. Fasteners: Use fasteners of same basic metal as the fastened metal, unless otherwise indicated. Do not use metals that are corrosive or incompatible with materials joined. Provide non-corrosive spacers as required.

C. Cast-in-Place and Post-Installed Anchors: Expansion anchors, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

D. Non-shrink, Non-metallic Grout: Premixed, factory-packaged, non-staining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.4 FITTINGS AND ACCESSORIES

A. Material: Per Drawings Comply with ASTM F 626.

1. Post and Line Caps: Provide weather tight closure cap for each post.

2.5 CONCRETE

A. Concrete: Class "AA" Per MAG Section 725 (4,000 psi)

2.6 FABRICATION

A. Form gate frame metals to required shapes and sizes, with true curves, lines, and angles. Provide components to sizes and profiles indicated, but not less than required to comply with requirements for structural performance per shop drawings.

B. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Drill and tap for required fasteners, unless otherwise indicated. Use concealed fasteners wherever possible.

C. Comply with AWS for recommended practices in shop welding and brazing. Provide welds and brazes behind finished surfaces without distortion or discoloration of

exposed side. Clean exposed welded and brazed joints of flux, and dress exposed and contact surfaces.

D. Mill joints to a tight, hairline fit. Cope or miter corner joints. Form continuous weld joints to exclude water penetration.

E. Provide castings that are sound and free of warp, cracks, blow holes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gatemarks, casting flash, and other casting marks.

F. Finish exposed surfaces to smooth, sharp, well-defined lines and arises.

G. Assemble items in the shop to the greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

H. Welded Connections: Use welding method that is appropriate for metal and finish indicated and that develops strength required to comply with structural performance criteria. Finish exposed welds and surfaces smooth, flush and blended to match adjoining surfaces.

I. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect access and manway gate to other work as called for in the Drawings.

2.7 WOOD PRIVACY SLATES FINISHES, GENERAL

A. Wood slates shall be painted according to Specification 09910.

2.8 IRON AND STEEL FINISHES

A. Metal components (excluding hardware unless specified in the Drawings) shall have a powder coated finish. Color per plans. Coating fabrication shall be per the following

1. Sandblast to a "White Finish" removing all trace oil, paint, rust, corrosion, etc.
2. Apply Epoxy Primer
3. Apply Powder coating with an electrostatic spray to a 2-3 mils thickness.

PART 3 EXECUTION

3.1 PREPARATION

A. Coordinate and furnish anchorages and setting drawings, diagrams, templates, instructions, and directions for installing items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

3.2 INSTALLATION

A. Provide anchorage devices and fasteners where necessary for securing metalwork to in-place construction.

B. Perform cutting, drilling, and fitting required to install wood privacy slates. Set products accurately in location, alignment, elevation, plumb, level and true, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

C. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, with uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of fence sections, restore finishes to eliminate any evidence of such corrective work.

D. Do not cut or abrade finishes that cannot be completely restored in field. Return items with such finishes to shop for required alterations, followed by complete refinishing, or provide new units as required.

E. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at the same location.

F. Field Welding: Comply with the applicable AWS specification for procedures of manual shielded metal-arc welding, for appearance and quality of welds made, and for methods used in correcting welding work. Weld connections that are not to be left as exposed joints but cannot be shop-welded because of shipping size limitations. Grind exposed welded joints smooth and restore finish to match finish of adjacent surfaces.

3.3 PROTECTION

A. Protect finishes from damage during construction period with temporary protective coverings approved by gate fabricator. Remove protective covering at time of Substantial Completion.

B. Restore finishes damaged during installation and construction so that no evidence remains of correction work. Return items that cannot be refinished in field to shop; make required alterations and refinished entire unit or provide new units as required at no cost to the client.

3.4 METHOD OF MEASUREMENT

The method of measurement shall be per Section 01019.3.

3.5 BASIS OF PAYMENT

The basis of payment shall be per Section 01019.3

02900 DEMOLITION AND REMOVAL

02900.1 DESCRIPTION

This section is a specification regarding the demolition, removal or abandonment of existing equipment, structures, piping, fencing and appurtenances.

02900.1.1 REFERENCES

Section 01520 – Environmental Control
MAG Section 601 – Trench Excavation, Backfill and Compaction

02900.1.2 Definitions

Not used.

02900.2 REMOVAL OF EQUIPMENT

02900.2.1 Non-Salvaged Equipment – Non-salvaged equipment shall be removed in a manner that produces the least amount of debris as practical. All debris created in the demolition process shall be removed. All removed equipment and debris shall be disposed of according to Section 01520. Non-Salvage equipment includes but is not limited to the following: APS utility meter, MCC, and lighting.

02900.2.2 Salvaged Equipment – Salvaged equipment, unless incorporated in the new work, shall be remain the property of the client and be transported to the WWRP. Such items and materials shall be carefully removed and in such a manner as to permit reuse. Salvaged equipment includes but is not limited to the following: generator, generator diesel tank, lift station pumps, lift station float system, valves, water spigot, davit crane base, ATS, and manual transfer switch.

02900.2.3 Reinstalled Equipment – Some existing equipment will be incorporated in the new work. This equipment shall be removed in such a manner as to permit reuse. It shall be stored in a secure place and protected from the elements. The contractor shall reinstall the equipment in kind. Reinstalled equipment includes but is not limited to the following: portable generator receptacle, shut off valve and water meter box, generator diesel tank, wood slats, rip rap, backflow preventer and hot box, decorative fence, safety harness plate and access gate.

02900.3 REMOVAL/ABANDONMENT OF PIPING

Pipe removal/abandonment shall be in accordance with these Specifications and the Drawings. All above ground pipe to be abandoned shall be removed. All below ground piping shall be grouted and abandoned in place, unless the piping must be removed for construction of new piping or structures, or if piping is fully exposed during the course of construction and is easily removable. Removal and abandonment of piping includes all fittings, restraints, and appurtenances. All

removed piping, unless stated otherwise in the Drawings or by the Engineer shall be disposed of according to Section 01520.

02900.4 REMOVAL OF STRUCTURES AND PADS

All concrete structures and pads shall be removed according to the Drawings and these Specifications. Demoed structures include but are not limited to the following: Concrete pads, housekeeping pads, wet well, and valve vault. Concrete shall be broken up and removed with appropriate equipment to complete the task in a timely manner. Dust shall be controlled during and after removal and debris barriers shall be set up if deemed necessary by the Contractor or Engineer to protect existing structures and workers. Concrete debris shall be neatly stockpiled and disposed of according to Section 01520.

02900.5 REMOVAL OF EXISTING WALLS

02900.5.1 CMU walls and footing – The CMU wall and footing shall be removed according to the Drawings and these Specifications. The CMU wall and footing shall be broken up and removed with appropriate equipment to complete the task in a timely manner. Dust shall be controlled during and after removal and debris barriers shall be set up if deemed necessary by the Contractor or Engineer to protect existing structures and workers. Care shall be taken to not damage the CMU wall/footing that is not removed as the new CMU wall/footing will tie in with existing wall where applicable. Concrete debris shall be neatly stockpiled and disposed of according to Section 0152.

02900.5 EARTHWORK

Upon completion of removal or abandonment activities soils shall match grading called out in the Drawings. Backfill and compaction shall be completed in accordance with the Drawings and these Specifications.

02900.6 REMOVAL/ABANDONMENT ACTIVITIES CLEANUP

Upon completion of removal or abandonment activities the areas shall be free of debris. Area shall match surrounding areas.

02900.7 METHOD OF MEASUREMENT

02900.7.1 The method of measurement shall be per Section 01019.3.

02900.7.2 DAMAGED ITEMS

Measurement of items damaged or removed as a result of the Contractor's negligence shall not be allowed and no payment will be made under this contract.

02900.8 BASIS OF PAYMENT

The basis of payment shall be per Section 01019.3.

02930.1 DESCRIPTION

This section describes the minimum requirements for maintenance of plant operation (MOPO) during construction until the new lift station is brought online. The purpose of this MOPO is to ensure continues service by:

1. Keeping the existing lift station stays online as long as feasibly possible during construction;
2. Switches to temporary bypass pumping once existing system must be taken offline;
3. Bring the new lift station online.

A full MOPO plan addressing the above items is the responsibility of the Contractor. The Contractor is responsible for providing all equipment and personnel unless stated otherwise in these specifications.

02930.1.1 RELATED WORK AND REFERENCED SECTIONS

Section 01019 – Measurement and Payment
Section 01300 – Submittals
Section 01510 – Protection of Existing Property
Section 01520 – Environmental Control

02930.1.2 SUBMITTALS

02930.1.2.1 A PDF copy of the MOPO must be provided to the Owner and Engineer three (3) weeks before the scheduled work for approval. The MOPO must be approved before work begins. The MOPO must describe in detail how the Contractor will approach construction to ensure the existing system is kept online as long as possible, how the system will transition to bypass pumping, and how the new system will be brought online once complete. A schedule shall be provided that shows when the events will occur. If the MOPO is not approved, it will be the Contractors responsibility to provide an alternative MOPO at no additional cost to the Owner.

02930.2 MOPO REQUIREMENTS

02930.2.1 Keeping Existing Lift Station Online During Construction:

It is the contractor's responsibility to stage construction in order to keep the existing system online for as long as feasible. Work that can be done without impacting the existing lift station shall be done first when reasonable. Existing lift station, valve vault, equipment, piping and electrical crucial to the lift station operation shall be protected in place until the system is switched over to temporary bypass pumping.

02930.2.2 Temporary Bypass Pumping:

Once it is no longer feasible to keep the existing lift station online, the Contractor shall switch over to a temporary bypass pumping system. The Contractor to provide a detail

plan on how the system will be switched over from the existing lift station to the temporary bypass pumping system. The temporary bypass pumping system shall be per Specification Section 02553. Switching of the systems shall be during a low flow period at a time approved by the City.

02930.2.3 Bring New Lift Station Online:

Once the new lift station has been constructed, tested, and approved by the City, it will be brought online and the temporary bypass pumping system will be discontinued. The Contractor is responsible for providing a detail plan on how the switch between the temporary bypass system and the new lift station will occur. Plan shall include the reconnection of all required lines. Switching of the systems shall be during a low flow period at a time approved by the City.

02930.2.5 MOPO Supervision – The Contractor shall be responsible for providing supervision over the MOPO where required. The person in charge of the supervision must be competent and responsible. During working and nonworking hours, one person must be in charge of monitoring the MOPO at all times, where required. This person may perform other construction duties in the immediate vicinity of but must not leave the site for any reason during the MOPO activities. If the person must leave the vicinity they must first handoff the MOPO supervision to another individual with all aspects of this specification applying to the new person. A list of those responsible for the MOPO supervision, and the times they will be onsite, shall be provided to the Owner and Engineer.

02930.2.6 MOPO Duration – The MOPO shall be in place during the duration of construction until the new lift station is successfully brought online. It is the Contractors responsibility to meet these specifications throughout the duration of the MOPO.

02930.2.7 MOPO Implementation – It is solely the responsibility of the Contractor to implement the MOPO successfully throughout the course of construction. If at any point there is an issue with the MOPO, or alternation to the plan is required, all cost associated with meeting the intent of the MOPO is the responsibility of the Contractor.

02930.4 METHOD OF MEASUREMENT

The method of measurement shall be per Section 01019.3.

02930.5 BASIS OF PAYMENT

The basis of payment shall be per Section 01019.3.

03150 PRE-CAST FLOWMETER VAULT

03150.1 DESCRIPTION

This section is for the manufacturing and construction of the pre-cast flowmeter vault.

03150.1.1 REFERENCES

MAG Section 206 – Structure Excavation and Backfill
MAG Section 301 – Subgrade Preparation
MAG Section 506 – Precast Prestressed Concrete Members
Section 01300 – Submittals
Section 08122 – Embedded Access Hatch

03150.1.2 SUBMITTALS

Submittals shall be according to MAG 506 and Section 01300. Drawings and calculations shall be provided for the pre-cast concrete structure. They shall be stamped and signed by a registered professional engineering, licensed in Arizona.

03150.2 MATERIALS AND FABIRCATION

03150.2.1 The pre-cast vault shall meet the requirements of MAG 506 and ASTM C890. The pre-cast vault shall be designed for H-20 loads.

03150.3 CONSTRUCTION REQUIREMENTS

The pre-cast vault shall be constructed according to the Drawings, these Specifications and manufacturers recommendation. Earthwork shall be completed according to the Drawings and MAG 206 and MAG 301.

03150.7 METHOD OF MEASUREMENT

03150.7.1 The method of measurement shall be per Section 01019.3.

03150.8 BASIS OF PAYMENT

The basis of payment shall be per Section 01019.3.

05010.1 GENERAL

This section of the Specifications covers metals and metal work required to furnish, fabricate, and to install the following nonexclusive list of items:

- Aluminum and miscellaneous nonferrous metals
- Anchors and anchor bolts
- Bolts
- Cast-iron frames and covers
- Grating and frames
- Ladders
- Louvers
- Manhole frames and covers
- Metal roof decking
- Miscellaneous metal items shown on the Plans or specified
- Miscellaneous structural steel
- Pipe handrails, pipe sleeves, inserts, and chains
- Platforms
- Sheet metalwork
- Special supports, hangers, and anchors
- Stairs and treads
- Steel lintels
- Supports for mechanical equipment
- Tread plates and frames

05010.1.2 RELATED WORK

Not used.

05010.1.3 SUBMITTALS

Certified copies, in duplicate, of mill tests or reports from a recognized commercial laboratory shall be furnished when requested as to the chemical, tensile, and bending properties of each shipment of structural metal or part thereof having common properties. All tests and analyses shall be made in accordance with the applicable ASTM Specification.

05010.1.4 DEFINITIONS

Not used.

05010.2 MATERIALS

05010.2.1 ALUMINUM

05010.2.1.1 SHEET ALUMINUM - Except as otherwise specified or indicated on the Plans, sheet aluminum shall be alloy 50050H14 conforming to the requirements of ASTM B 209 and shall be not less than 0.025 inch in thickness.

05010.2.1.2 STRUCTURAL ALUMINUM - Structural aluminum shall be 6061-T6, and extruded aluminum shall be 6063-T42.

Aluminum shapes and appurtenant materials shall conform to the requirements of ASTM B 221 and ASTM B 308 and shall be of aluminum alloy known commercially as 6061-T6. Materials not otherwise specified shall conform to the latest applicable Specifications of ASTM.

05010.2.1.3 BOLTS - All bolts for bolting aluminum shall be Type 304 or 316 stainless steel of sizes indicated on the Plans.

05010.2.2 STEEL

05010.2.2.1 SHEET STEEL - Galvanized sheet iron or steel shall conform to ASTM A 525, 1.25-ounce coating; black steel to ASTM A 569.

05010.2.2.2 STRUCTURAL STEEL – Structural steel shall be as follows:

- Unless otherwise specified, structural steel shall conform to ASTM A 36.
- Cast iron shall conform to ASTM A 48, Class 40B.
- Galvanized structural steel or iron shall be "hot dipped" galvanized after fabrication. Electro-galvanizing shall not be used unless specified otherwise.
- All structural steel shall be delivered free from mill scale, rust, or pitting.
- Items not galvanized or protected by a shop coat of paint shall be protected from the weather until erection and painting.

05010.2.2.3 STAINLESS STEEL - Stainless steel, unless specifically specified or indicated on the Plans otherwise, shall be Type 316 or Type 304, nonmagnetic.

05010.2.2.4 STEEL PIPE - Steel pipe shall conform to ANSI B 36.10, Table I.

05010.2.2.5 BOLTS - High tensile bolts shall conform to ASTM A 325.

05010.2.2.6 OTHER ITEMS

Other structural and miscellaneous metal items shall be as indicated on the Plans or as specified elsewhere.

05010.3 CONSTRUCTION (FABRICATION) REQUIREMENTS

05010.3.1 GENERAL

All structural or foundry items shall be carefully fabricated to true dimensions without warp or twist. Welded closures shall be neatly made; and where weld material interferes with fit or is unsightly in appearance, it shall be ground off smooth.

05010.3.1.1 INSTALLATION - Each structural item shall be installed true to level, plumb, alignment, and grade with all parts bearing or fitting the structure or equipment for which it is intended accurately and securely. It shall not be permitted to cock out of alignment, re-drill, reshape, or force to fit any fabricated item. It is the Contractor's responsibility to place anchor bolts or other anchoring devices accurately and to make any surfaces, which bear against structural items smooth and true to level to preclude the necessity of any springing, re-drilling, or reshaping.

05010.3.1.2 SPECIAL ALIGNMENT - Pipe railings, posts, and structural items needing a special alignment to preserve straight, level, even, smooth lines shall be rigidly supported and braced and kept braced until concrete, grout, or dry pack cement mortar has hardened for a period of not less than 48 hours.

05010.3.1.3 FIT - The Contractor shall be responsible for the correct fitting of all metalwork in the field. The Contractor shall take all measurements necessary to properly fit its work in the field, and it shall be governed by and be responsible for these measurements and the proper working out of all details.

05010.3.1.4 WELDING – General welding procedures are as follows (see also Subsections below):

- The Contractor shall notify the Engineer at least 24 hours before starting shop or field welding.
- A welding inspector may check the materials, the equipment, and the qualifications of the welders.
- The inspector may use gamma ray, magnetic particle, dye penetrant, trepanning, or any other aid to visual inspection which it may deem necessary to be assured of the adequacy of the welding.
- The costs of any tests and all re-tests on defective welds shall be borne by the Contractor. Cost in connection with qualifying welders shall also be borne by the Contractor.
- The cost of tests on sound welds will be borne by the Owner.

- Welders doing unsatisfactory work shall be removed or may be required to pass qualification tests again.

05010.3.1.5 MISCELLANEOUS METALWORK - Where anchors, connections, or other details of miscellaneous metalwork are not definitely shown or specified, its material, size, form, attachment, and location shall conform to best practice.

05010.3.1.6 HAZARDOUS PROJECTIONS - Sharp or hazardous projections shall be rounded off and ground smooth.

05010.3.1.7 CHIPS AND DEBRIS - All chips and other debris lodged between contacting surfaces shall be removed before assembly.

05010.3.2 ALUMINUM

05010.3.2.1 STRUCTURAL ALUMINUM

The Contractor shall furnish and install all structural aluminum items in accordance with the Plans and as specified. It shall provide all supplementary parts necessary to complete each item even though such work is not definitely covered by the Plans and Specifications. Its size, form, attachment, and location shall be such as to conform to the best of current practice.

05010.3.2.2 LAYOUT ON ALUMINUM - Hole centers may be center punched and cutoff lines may be punched or scribed. Center punching and scribing shall not be used where such marks would remain visible on the surface of the fabricated material.

When critical dimensions exist, a temperature correction shall be applied in the layout as necessary. The coefficient of expansion shall be taken as 0.000013 per degree F.

05010.3.2.3 CUTTING AND DRILLING ALUMINUM – Aluminum may be cut and drilled as follows:

- Material 1/2 inch thick or less may be sheared, sawed, or cut with a router. Material more than 1/2 inch thick shall be sawed or routed.

- Cut edges shall be true, smooth, and free from excessive burrs or ragged breaks.

- Edges of plates carrying calculated stresses shall be planed to a depth of 1/4 inch. Sawn or routed edges will be acceptable when the finish is of equal quality to a planed edge.

- Re-entrant cuts shall be avoided wherever possible. If used, they shall be filleted by drilling prior to cutting.

- Rivet or bolt holes may be punched or drilled to finished size before assembly.

- The finished diameter of holes for unfinished bolts shall be not more than 1/16 inch larger than the nominal bolt diameter.

- All holes shall be cylindrical and perpendicular to the principal surface. Holes shall not be drifted in such a manner as to distort the metal.

- Flame cutting of aluminum alloys is not permitted.

05010.3.2.4 ALUMINUM FORMING AND ASSEMBLY - Structural aluminum material may not be heated except in forming operations where material may be heated to a temperature not exceeding 400 degrees F for a period not exceeding 30 minutes to facilitate bending. Such heating shall be done only when proper temperature controls and supervision are provided to insure that the limitations on temperature and time are carefully observed.

05010.3.2.5 WELDING ALUMINUM - This Specification shall apply to both field and shop welding operations. The general recommendations and regulations shown in the American Welding Society Specifications D1.1, "Structural Welding Code," apply to 6061-T6 structures. Detail requirements for welding aluminum alloy 6061-T6 are given as follows:

- Filler metal for welding shall be aluminum alloy welding rods conforming to the requirements of AWS A 5.10 and shall be AWS classification ER 4043, ER 5154, ER 5254, ER 5183, ER 5356, or ER 5556.

- The welding process and welding operators shall both meet a qualification tests. The method of qualification shall conform to the method described in the ASME Boiler and Pressure Vessel Code, Section IX, "Welding Qualifications," Part B. Aluminum alloy 6061-T6 shall be used for the qualification test plates. Operators shall be qualified on the basis on bend tests and a fillet weld soundness test.

- Dirt, grease, forming or machining lubricants, or any organic materials shall be removed from the areas to be welded by cleaning with a suitable solvent or by vapor degreasing. Additional operations to remove the oxide coating just prior to welding are required when the inert gas tungsten arc welding method is used. This may be done by etching or by scratch brushing. The oxide coating may not need to be removed if the welding is done with the automatic or semi-automatic inert gas shielded metal arc.
- Suitable edge preparation to assure 100 percent penetration in butt welds shall be used. Oxygen cutting shall not be used. Sawing, chipping, machining or shearing may be used.

- Any welding of aluminum shall be done using a nonconsumable tungsten electrode with filler metal in an inert gas atmosphere (TIG) or using a consumable filler metal electrode in an inert gas atmosphere (MIG). No welding process that requires the use of a welding flux shall be used unless prior approval has been obtained from the Engineer. Preheating for welding is permissible provided the temperature does not exceed 400° F for a total time of 30 minutes.

- Welding of any structure which is to be anodized shall be done using filler alloy rods that will not discolor when anodized. ER 5154, ER 5254, ER 5183, ER 5356, or ER 5556 filler alloy rods shall be used.

05010.3.2.6 PROTECTION OF ALUMINUM SURFACES - Aluminum surfaces to be placed in contact with wood, concrete, masonry, or dissimilar metals other than stainless steel shall be protected as specified in the appropriate sections of Division 9 – Finishes.

05010.3.2.7 BOLTING - Where aluminum comes in contact with steel it shall be bolted with stainless steel bolts and separated or isolated from the steel with neoprene gaskets or washers or as specified in Division 9.

05010.3.3 STEEL

05010.3.3.1 STRUCTURAL STEEL – The following shall apply:

- The Contractor shall furnish and install all structural steel items in accordance with the plans and as specified herein.

- The Contractor also shall provide all supplementary parts necessary to complete each item even though such work may not be specifically covered by the Plans and Specifications.

- Wherever applicable, all fabrication and erection of steel items shall conform to AISC "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings" except as the same may be modified by applicable building codes, the General Conditions, and these Specifications.

05010.3.3.2 WELDING OF STEEL – Both the general recommendations and regulations shown in the American Welding Society Specifications D1.1, "Structural Welding Code," as well as the detail requirements in those specifications apply to welding of steel structures. Welding of steel shall adhere to the following:

- All welding of steel under this section shall be done by welders who have a current AWS certificate for the type of welding to be done by the welder.

- All welding of structural steel type ASTM A 36 shall be done using mild steel covered Arc Welding Electrodes conforming to ASTM A 233, Series E70, or

shall be done using Electrodes and Fluxes for Submerged Arc Welding conforming to ASTM A 558, Classification F70-XXXXX, where XXXXX refers to any electrode referred to in ASTM A 558.

- Welding of stainless steels shall be done with electrodes and techniques as recommended in Welded Austenitic Chromium - Nickel Stainless Steels - Techniques and Properties as published by the International Nickel Company, Inc., New York, New York. All welds shall be full penetration welds, unless specified otherwise.

05010.3.3.3 PROTECTION OF STEELWORK - The Contractor shall paint steel and miscellaneous ferrous metal items as specified in the appropriate sections of Division 9-Finishes.

05010.3.4 DUCTWORK

05010.3.4.1 DESIGN AND FABRICATION - Ducts shall be fabricated of aluminum or galvanized steel sheets with gauges of sheet metal, joint types, reinforcing, bracing, supporting, fabricating, installing, and other requirements in accordance with Duct Manual and Sheet Metal Construction for Ventilating and Air Conditioning Systems of the Sheet Metal and Air Conditioning Contractors National Association, Inc. Ducts shall be designed for the appropriate pressure type as shown in the above mentioned Duct Manual. Details on the Plans in some cases call for sheet metal thicknesses greater than called for in the Duct manual. Sheet metal shall conform to whichever requirement calls for the greater thickness. Aluminum ducting shall be not less than 0.063 inches thick.

05010.3.4.2 HANGERS - Ducts shall be supported on both sides at all changes in direction and at not greater than eight foot intervals by suitable hangers as specified herein or as detailed on the Plans. For galvanized ducting, hangers for ducts 12-inch by 24-inch or smaller shall be galvanized sheet metal straps not lighter than 18-gauge by one inch secured to the structure by one 5/16-inch bolt and to the duct by not less than two No. 10 sheet metal screws or 3/16-inch stove bolts. Hangers for ducts larger than 12-inch by 24-inch shall be galvanized steel straps or rods not less than 0.13 square inches in net cross section, secured to the structure by a Grinnell Figure 152, Size 2, concrete insert, or approved equal, and to a duct pocket or reinforcing angle by two 1/4-inch stove bolts. For aluminum ducting, supports shall be equivalent to supports for galvanized ducting except that all fasteners, fittings, and shafting shall be stainless steel.

05010.3.4.3 FLEXIBLE CONNECTIONS - Where blowers or equipment containing blowers or other machine elements, which may cause vibration, are connected to ducts or housing, such connections shall be by means of flexible connections. These flexible connections shall be airtight at the pressures encountered and be flame proof and water proof. The flexible material shall be equivalent to 14 ounce canvas.

05010.4 METHOD OF MEASUREMENT

Not used.

05010.5 BASIS OF PAYMENT

Not used.

05050.1 DESCRIPTION

This section covers a generic list of miscellaneous metals specifications.

05050.1.1 RELATED WORK

Not used.

05050.1.2 SUBMITTALS

Not used.

05050.1.3 DEFINITIONS

Not used.

05050.2 MATERIALS

05050.2.1 LADDERS AND METAL STAIRS

All ladders shall be safety ladders conforming to OSHA standards. All ladders and stairways supplied to the project shall be of one manufacturer. All stair and ladder wells shall be adequately guarded, and all stairs shall have handrails as specified or shown on the Plans.

Ladders shall be secured to the supporting surface by bent plate chips providing not less than 7 inches between the supporting surface and center of rungs. If exit from the ladder is forward, over the top rung, side rails shall be extended not less than 3-feet-3 inches above, and returned to the landing. If exit from the ladder is to the side, the ladder shall extend not less than 5-feet 6-inches above the landing and be rigidly secured at the top.

05050.2.2 ALUMINUM LADDERS

Aluminum ladders shall be made of 6063-T5-aluminum alloy, of welding construction. Rungs shall be not less than 1-inch square bar with 1/8-inch grooves in the top and redivided edges. Side rails shall be no lighter than 3 inches by 3/8 inches. Ladders shall be of the size, shape, location, and details indicated on the Plans. Ladders greater than 20 feet in height shall have standard ladder cages designed in accordance with State and OSHA requirements. All aluminum surfaces, which will be in contact with concrete, shall be coated as specified in Division 9.

05050.2.3 ALUMINUM STAIRWAYS

Aluminum stairways shall be fabricated and installed as shown on the Plans. Stairway stringers shall be fabricated of aluminum alloy 6061-T6. Treads shall be

aluminum as specified below. Handrail shall be fabricated of aluminum pipe as specified under aluminum handrail.

Stair treads shall be aluminum of the sizes called for on the Plans, and shall be of the same type and make as called for under GATING. All fasteners shall be of Type 304 or 316 stainless steel.

Stair treads shall be furnished with cast abrasive type safety nosing.

05050.2.4 ARCHITECTURAL AND MISCELLANEOUS SHEET METAL

Sheet metal flashing and counterflashing shall be installed as indicated on the Plans. Galvanized steel or anodized aluminum flashing shall be used when indicated and specified on the Plans. Unless otherwise indicated flashing shall be 0.025-inches thick. The aluminum flashing shall receive a 215-R1 anodic finish after fabrication as indicated on the Plans. Exposed edges shall be folded back 1/2-inch to provide stiffness. Except as otherwise indicated and specified on the Plans, counterflash shall be provided over all base flashings.

Unless specifically noted, galvanized steel flashing shall be used in contact with structural steel and anodized aluminum flashing shall be used in contact with structural aluminum. This shall be done to protect against dissimilar metal action.

Surfaces to which sheet metal is to be applied shall be even, smooth, round, thoroughly clean and dry, and free from all defects that might affect the application. All cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades shall be performed under this section. All accessories or other items essential to the completeness of this sheet metal installation, though not specifically shown or specified, shall also be provided under this section. Nails, screws, and bolts shall be of the types best suited for the intended purpose and shall be of a composition that will not support galvanic action in the installation. Where sheet metal abuts into adjacent materials, the juncture shall be executed in a manner satisfactory to the Engineer.

Sheet metal items not covered elsewhere shall be as indicated on the Drawings and as required to provide a watertight installation. Formed sheet metal for metal covered work shall accurately reproduce the detail and design shown and profiles, bends, and intersections shall be sharp, even, and true.

05050.2.5 ALUMINUM SHEET METAL WORK

Except as otherwise specified or indicated on the Plans, sheet aluminum shall be alloy 5005-H14 conforming to the requirements of ASTM B 209 and shall be not less than 0.025 inch in thickness and extruded aluminum shall be 6063-T42.

05050.2.6 MISCELLANEOUS STRUCTURAL STEEL

Miscellaneous steel items not specified herein shall be as shown on the Plans or specified elsewhere and shall be fabricated and installed in accordance with the best practices of the trade.

05050.2.7 LINTELS

Lintels for masonry construction shall be structural steel beams or angles, fabricated as indicated on the Plans.

05050.2.8 SUBMERGED ASSEMBLY BOLTS

Assembly bolts for wood baffles, collectors, and other assemblies in areas where stainless steel anchor bolts would be required shall be stainless steel bolts Type 304 or 316.

05050.2.9 ANCHOR BOLTS AND INSERTS

Wherever feasible, anchor bolts shall be cast in place when concrete is placed.

All anchor bolts and concrete anchors embedded in concrete shall be accurately spaced with bolts truly normal to the surfaces from which they project. Type 304 or Type 316 stainless steel anchor bolts and nuts shall be used under these circumstances:

- Any time they are submerged in water.
- In the case of structures customarily containing water, placed in walls, ceilings, or overheads, even if above water level.
- In the dry side of water bearing walls.
- Where securing aluminum to steel or concrete.

Anchor bolts not required by above conditions to be of stainless steel, may be of carbon steel conforming to ASTM A 307 or ASTM A 36. Carbon steel anchor bolts in the following locations shall be hot-dip galvanized.

- Anchor bolts exposed to the weather.
- In electrical manholes or pull boxes.
- In tunnels, passageways, galleries, vaults, or rooms below grade or enclosed in part by water bearing walls.

In anchoring machinery bases subject to heavy vibration, two nuts shall be used, one serving as a locknut. In all cases where steel anchor bolts are used, a liberal coating of nonoxidizing wax shall be applied to the threads before screwing on nuts.

All bolts, when indicated for future use, shall be first coated thoroughly with nonoxidizing wax, followed by turning nuts down to the full depth of thread. Exposed thread shall then be neatly wrapped with a waterproof polyvinyl tape.

05050.2.10 INSTALLATION

Anchor bolts shall be embedded not less than 12 diameters. Where shown on the Plans, anchor bolts shall be set in metal sleeves having an inside diameter approximately 3 times the bolt diameter and not less than 12-bolt diameters in length. Sleeves shall be filled with grout when the machine or other equipment is grouted.

05050.2.11 CONCRETE ANCHORS

Concrete anchors, where indicated on the Plans or specified, shall mean drilled in place anchors with integral anchor bolts. Concrete anchors shall be Phillips "Wedge Anchors" with integral anchor bolts, or Expansion Products Company "Wej-It" concrete anchors with integral anchor bolts, or approved equal.

The material of each concrete anchor, including its integral anchor bolt, shall be the same material as would be required, under these Specifications, for anchor bolts in the same location that the concrete anchor is to be used.

Concrete anchors shall have the following minimum embedment lengths:

EMBEDMENT OF CONCRETE ANCHORS

Size	Embedment Length
3/8"	1-1/2"
½"	2-1/4"
5/8"	2-3/4"
¾"	3-1/4"

If Wej-It expansion anchors are used they shall have the following minimum embedment length:

WEJ-IT ANCHORS

Size	Embedment Length
¼"	1-1/2"
½"	5"
5/8"	5"
¾"	5"

Anchor bolts, of the same material and size as required for the specified concrete anchors, may be cast in the concrete in lieu of using concrete anchors. Embedment of bolts in concrete shall be not less than 12-bolt diameter plus a standard hook.

No cast iron, lead cinch, or slug-in anchors will be permitted for use.

05050.2.12 MISCELLANEOUS CAST IRON

All castings shall be tough, gray iron, free from cracks, holes, swells, and cold shuts, and be of workmanlike finish, and shall conform to the Standard Details and with the ASTM Specification Designation A 48, Class 40 B. The quality shall be such that a blow from a hammer will produce an indentation on a rectangular edge of the casting without flaking the metal. Before leaving the foundry, all castings shall be thoroughly cleaned and subjected to a hammer inspection, after which they shall receive a coating of coal-tar pitch varnish in such a manner as to form a firm, tenacious coating.

05050.2.13 MANHOLE FRAMES AND COVERS

Manhole frames and covers shall be made from a superior quality gray iron, conforming to the requirements of ASTM A 159, Class G3000, or ASTM A 48, Class 30-B. Frames and covers shall have horizontal and vertical bearing surfaces machined to fit neatly, and the cover shall bear firmly in the frame without rocking and shall be easily removable. Frames and covers shall be heavy-duty traffic type designed for H-20 loading and shall have a combined set weight of at least 265 pounds.

Frames shall have a clear inside opening of 24 inches diameter and shall be of the bottom flange type. Frame height shall be approximately 4½" and bottom flange outside diameter shall be approximately 32 inches.

Covers shall have a skid resistant grid pattern design as recommended ASTM publication STP326.

The elevations at which manhole frames and covers are to be set shall conform to the requirements set forth on the Plans, but in all cases shall be governed by the Engineer in the field. Where the cover is in existing pavement or in the traveled way of the existing road shoulder, it is to be placed flush with the existing surface. Where the structure is outside the limits of the traveled shoulder but not in the roadside ditch, it should be placed 1/10 foot or more above the existing ground surface. Where the manhole cover falls in the existing roadside ditch or right of way, it is to be placed approximately 1-1/2 feet above the existing ground surface or as directed by the Engineer. Manhole frames shall be set at the required grade and shall be securely attached to the top precast manhole shaft unit. After the frames are securely set in the place provided herein, covers shall be installed and all necessary cleaning and scraping of foreign materials from the frames and covers shall be accomplished to ensure a fine satisfactory fit. All costs of setting and securing manhole frame and cover sets in place as herein provided, including all necessary concrete work shall be considered as included in applicable contract unit prices and no additional allowance will be made therefor.

Cast lettering on manhole covers shall be as shown on the Plans. Shop drawings of all manhole rings and covers shall be submitted to the Engineer.

05050.2.14 CAST IRON PRESSURE MANHOLE FRAME AND COVER

The Contractor shall furnish and install, ready for use as indicated on the Plans and as specified herein, rectangular pressure manholes and covers. Each pressure manhole shall have a clear opening of 18" X 30". The pressure plate shall be flat on top and shall not be less than 1/2 inch thick steel and fastened with 316 stainless steel studs and stainless steel nuts. A 1/8-inch thick neoprene gasket shall be supplied between the frame and pressure plate. Lifting shall be provided with a watertight pickhole. The frame shall be a seal-type with flanges at the base and at the top.

05050.2.15 MISCELLANEOUS ALUMINUM

Structural and other metal items fabricated from aluminum, not covered separately herein shall be fabricated in accordance with the best practices of the trade and shall be field assembled by riveting or bolting with no welding or flame cutting permitted except as approved by the Engineer.

05050.2.16 ALUMINUM STAIR NOSING

Stair nosings shall be installed on all treads of all concrete stairs including the top tread of the upper slab. Stair nosings shall be aluminum abrasive cast nosings with aluminum oxide granules integrally cast into the metal forming a permanent nonslip long wearing surface. The nosings shall be Type 101 Stair Tread by Wooster Products, Inc., Spruce Street, Wooster, Ohio 44691, Type A stair treads by American Abrasive Metals Company, or approved equal. The treads shall have integrally cast anchors. Stair nosings shall be cast in fresh concrete and shall be flush with the tread and riser faces. Stair nosing shall be coated with zinc chromate primer in accordance with the provisions of Division 9. Screws shall be 304 or 316 stainless steel.

05050.2.17 MANHOLE STEPS

Manhole steps shall consist of 3/4-inch diameter stainless steel or polyethylene rungs. Rungs shall extend 7-inches from the face of the wall to which they are anchored and shall have a minimum clear width of 16-inches. Rungs shall be designed such that the foot cannot slide off the end. Distance between rungs shall be 12-inches. Rungs shall be hook anchored into walls a minimum of 6-inches.

05050.3 CONSTRUCTION REQUIREMENTS

Not used.

05050.4 METHOD OF MEASUREMENT

Not used.

05050.5 BASIS OF PAYMENT

Not used

08122.1 DESCRIPTION

The Contractor shall furnish and install embedded access hatches and associated fittings in designated structures in accordance with the Drawings and these Specifications.

08122.1.1 RELATED WORK

MAG Section 505 – Concrete Structure

08122.1.2 SUBMITTALS

08122.1.2.1 DESCRIPTIVE LITERATURE - Descriptive literature which identifies the manufacturer, model number, size and materials of fabrication for all equipment and materials furnished under this section shall be provided by the Drawings in accordance with Section 01300 of these Specifications.

08122.1.2.2 CERTIFICATION OF COMPLIANCE - Certification of compliance with the standards and Specifications contained herein shall be obtained from the manufacturer and provided by the Contractor at the time of delivery of these materials to the project site.

08122.1.3 DEFINITIONS

Not used

08122.2 MATERIALS

08122.2.1 QUALITY CONTROL

This specification is not intended to be exclusive or limit competition, but rather to set forth the minimum standards for quality and performance. The Owner reserves the right to reject substitutions if in his opinion, the proposed substitutions will not achieve comparable equipment installation and performance standards.

08122.2.2 HATCH

The embedded access hatch shall be as manufactured by the Bilco Company, or approved equal. The model number or type shall be shown on the Drawings, but as a minimum shall be equal to a Type J-AL or Type JD-AL, as applicable. Frame shall be ¼" extruded aluminum with built-in neoprene cushion and with strap anchors bolted to exterior. Door leaf shall be ¼" aluminum diamond plate reinforced with aluminum stiffeners as required. Stainless steel 316 hinges shall be bolted to underside along with compression spring operators enclosed telescopic tubes lift assistance. The door shall open to 90 degrees with automatic hold-open arm with release handle that automatically locks cover in the open position. A vinyl grip handle shall be provided to release the cover for closing. Doors shall be built to withstand a live load of 300 pounds per square foot and equipped with a snap lock and removable handle or be H-20 traffic rated where called for in the plans. Aluminum shall be mill finish, with bituminous coating to be applied to exterior of frame by manufacturer.

08122.2.3 HARDWARE

Hardware shall be type 316 stainless steel throughout. Installation shall be in accordance with manufacturer's instructions. Manufacturer shall guarantee against defects in material or workmanship for a period of five years.

08122.3 CONSTRUCTION REQUIREMENTS

The Contractor shall install all equipment and components under this section in accordance with the manufacturer's installation instructions, the Drawings and these Specifications. Where instructions are unavailable or unnecessary, the Contractor shall at all times use good workmanship practices, applicable building codes, and regulations. The Contractor shall supply and install all miscellaneous fittings required to provide a complete operating system or component, as applicable.

08122.4 METHOD OF MEASUREMENT

08122.4.1 NO MEASUREMENT

Unless a separate bid item for furnishing and installing the work outlined in this Section is provided in the Bid Schedule, this work shall not be measured for separate payment, but shall be considered incidental to other items in the Bid Schedule.

08122.4.2 SEPARATE MEASUREMENT

Where items installed under this section are listed separately in the Bid Schedule, the items shall be measured by counting the number of units installed and accepted.

08122.5 BASIS OF PAYMENT

Complete compensation for the accepted work outlined in this Section shall be included in other bid items when no separate bid item is provided in the Bid Schedule for this work.

When a separate bid item is provided in the Bid Schedule, complete compensation for this accepted work shall be included in the contract unit price on the Bid Schedule.

PAY ITEM	UNIT
Embedded Access Hatch (*Type*)	Each

09910.1 DESCRIPTION

The Contractor shall furnish all labor, materials and equipment necessary to paint all designated components of buildings, piping and equipment in accordance with these Specifications.

09910.1.1 RELATED WORK

Not used.

09910.1.2 SUBMITTALS

09910.1.2.1 DESCRIPTIVE LITERATURE - Descriptive literature identifying manufacturer, type, content, application recommendations, and color samples, shall be provided in accordance with Section 01300 of these Specifications.

09910.1.2.2 DATA FOR PAINT APPROVAL - Complete data on each type and kind of paint and primer shall be submitted to the Engineer for approval. Approval shall be received from the Engineer before the paint is delivered to the jobsite. This procedure must be followed whether or not the paint that the Contractor proposes to use is named in the Specifications. Approval data shall show where and for what uses each paint product is proposed. Information submitted on each proposed type and kind of paint shall include data to show that the paint meets the detailed requirements of these Specifications.

09910.1.2.3 SAMPLES - The Contractor shall prepare and submit sample colors for all items which require color selection by the Engineer. No color selection will be made until all samples of all paints have been submitted. After all samples of all paints have been submitted, the Engineer will prepare a color scheme using the submitted colors. Colors will not necessarily be standard colors with all suppliers. The manufacturer shall mix colors, to secure the desired color when it is not one of his standard colors.

09910.1.2.4 SAND BLAST PANELS - The Contractor, at the beginning of the Project, shall furnish one square foot steel panels sandblasted in accordance with the sandblasting specifications and coated with non-yellowing shellac or clear non-yellowing plastic coating. Panels shall be used as the standards for preparation of steel surfaces for the duration of the project.

09910.1.2.5 PAINT REMNANT - At the end of the project, the Contractor shall turn over to the Owner a gallon can of each type and color of paint, primer, thinner, or other coating used in the field painting. If the manufacturer packages the material concerned in gallon cans, then it shall be delivered in unopened labeled cans as it comes from the factory. If the manufacturer does not package the material in gallon cans, and in the case of special colors, the materials shall be delivered in new gallon containers, properly closed with typed labels indicating brand, type, color, etc. The manufacturers' literature describing the materials and giving directions for their use

shall be furnished in three bound copies. A typewritten inventory list shall be furnished at the time of delivery.

09910.1.3 DEFINITIONS

Submerged Surfaces - In general, items shall be treated as submerged if they are to be at any time under water or are in structures that normally contain water. Unless specified otherwise, anything below the tops of the walls of such structures shall be considered as submerged.

09910.2 MATERIALS

09910.2.1 QUALITY CONTROL

This Specification is not intended to be exclusive or limit competition, but rather to set forth the minimum standards for quality and performance. The Owner reserves the right to reject substitutions if in his opinion, the proposed substitutions will not achieve comparable equipment installation and performance standards.

09910.2.2 COLOR

The Engineer will make color selection from color samples provided by the Contractor.

09910.2.3 PAINT SELECTION

All paint and coating systems shall include high quality materials, resistant to temperatures up to 130°F, and sunlight exposure. Paints selected shall meet the manufacturer's recommendations and suitability standards for the specific application where it will be used.

09910.2.3.1 MINIMUM REQUIREMENTS - Minimum requirements for paint materials and their application shall be as shown in the tables below:

EXTERIOR PAINT APPLICATION TABLE

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
Wood Siding, Trim, Doors, and Fencing	1 2 1 2	A-100 Exterior Alkyd Wood Primer A-100 Exterior Latex Flat House & Trim by Sherwin Williams - OR - SUPRIME 8 Exterior Pro-Hide Plus Latex Satin House	2.3 1.3 1.3 1.3

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
	1 2	by Pratt & Lambert- OR - System 2H-4 Alkyd by Tnemec Tnemec Series 10-99W Undercoater 2H-Color Hi-Build Tnemec Gloss	2.5 2.5
Porous Masonry (Block)	2	Tnemec Series 180 WB TnemeCrete	4-8
Concrete Walls, Above Grade	1 2 2 2	Loxon Ext. Masonry Acrylic Primer A-100 Exterior Latex Satin House & Trim by Sherwin Williams -OR - Pro-Hide Plus Latex Satin House by Pratt & Lambert – OR – Series 1029 Acrylic Latex Low Sheen by Tnemec	3.1 1.3 1.3 2.5
Metal (Aluminum)	2 1 2 1 1 1	A-100 Exterior Latex Satin House & Trim by Sherwin Williams - OR - SUPRIME 3 Latex Metal Primer Pro-Hide Plus Latex Satin House by Pratt & Lambert – OR – DEFLEX 4020 Primer DEFLEX 4206 S/G Waterborne Acrylic Enamel by DeVoe Tnemec Series 115 Unibond	1.3 1.3 1.3 3 1.5 2-3
Metal, New Steel, (Mild Service)	1 2 1 2 1 1 2 1 1	Kem Kromik Universal Metal Primer Direct to Metal Enamel by Sherwin Williams - OR - SUPRIME 3 Latex Metal Primer Pro-Hide Plus Latex Satin House by Pratt & Lambert – OR – Devguard 4160 Primer followed by Devguard 4308 Alkyd Enamel or DEFLEX 4218 DTM Enamel by DeVoe Tnemec Series 115 Unibond Tnemec Series 1029 Enduratone	2.5 3.0 1.3 1.3 2 2 2 2-4 2-3
Metal, New Steel, (Severe Service)	1 1	Series 27 WB Typoxy by Tnemec 73-Color Endura-Shield	4 2
Metal, Galvanized Steel, (Mild	1 2	Galvite HS A-100 Exterior Latex Satin House	2.0 1.3

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
Service)		& Trim by Sherwin Williams -OR -	
	1	SUPRIME 2 Latex Metal Primer	1.3
	2	Pro-Hide Plus Latex Satin House by Pratt & Lambert – OR –	1.3
	1	Devguard 4020 Primer	3
	2	DEFLEX 4206 S/G Waterborne Acrylic Enamel by DeVoe	1.5
	1	Tnemec Series 115 Unibond	2-4
	1	Tnemec Series 1029 Enduratone	2-3
Metal, Galvanized Steel, (Severe Service)	1	Series 27 WB Typoxy by Tnemec	4
	1	Series 10 Primer by Tnemec	2
PVC Pipe		System 66-23 Epoxy Polyamide by Tnemec	
	1	66-Color Hi-Build Epoxoline	4

INTERIOR PAINT APPLICATION TABLE

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
Woodwork	1	ProMar 200 Alkyd Enamel	1.9
	2	Undercoater ProMar 200 Int Alkyd Semi-Gloss by Sherwin	1.7
	1	Williams-OR	1.5
	2	SUPRIME 11 Int Alkyd Wood Primer	1.5
Woodwork Continued	1	Pro-Hyde Plus Alkyd Satin by Pratt & Lambert – OR –	2.5
	2	Tnemec Series 10-99W Tnemec Primers Tnemec 2H-Color Hi-Build Tnemec Gloss	2-3
Drywall	1	ProMar 200 Latex Wall Primer	2.5
	2	ProMar 200 Int Alkyd Semi-Gloss by Sherwin Williams - OR -	1.8
	1	SUPRIME 1 100% Acrylic MP	1.1
	2	Primer	1.5
	2	Pro-Hyde Plus Latex Satin by Pratt & Lambert – OR – Tnemec Series 1029 Enduratone	2-3

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
Metal (Aluminum)	1	SUPRIME 9 Int/Ext Alkyd Metal Primer	1.1
	2	Pro-Hyde Plus Alkyd Satin by Pratt & Lambert – OR –	1.5
	1	DEFLEX 4020 Primer	3
	1	DEFLEX 4206 Semi-Gloss Waterborne Acrylic Enamel	1.5
	1	Tnemec Series 115 Unibond	2-4
	1	Tnemec Series 1029 Enduratone	2-3
Metal, New Steel, (Mild Service)	1	Kem Kromik Universal Metal Primer	2.5
	2	ProMar 200 Int Alkyd Semi-Gloss by Sherwin Williams - OR -	1.7
	1	SUPRIME 9 Int/Ext Alkyd Metal Primer Pro-Hyde Plus Alkyd Satin by Pratt & Lambert – OR –	1.1
	2	Devguard 4160 Primer followed by Devguard 4308 Alkyd Enamel or	1.5
	1	DEFLEX 4218 DTM Enamel by DeVoe	2
	1	Tnemec Series 115 Unibond	2.5
	2	Tnemec Series 1029 Enduratone	2
	1		2-4
	1		2-3
Metal, New Steel, (Severe Service)	1	Tnemec Series 66-1211 Epoxoline Primer	3-5
	1	Tnemec Series 66 Color Hi-Build Epoxoline	4-6
Metal, Galvanized Steel, (Mild Service)	1	Galvite Paint	2.0
	2	ProMar 200 Int Alkyd Semi-Gloss by Sherwin Williams - OR -	1.8
	1	SUPRIME 9 Int/Ext Alkyd Metal Primer Pro-Hyde Plus Alkyd Satin by Pratt & Lambert – OR –	1.1
	2	Devguard 4020 Primer	1.5
	1	DEFLEX 4206 S/G Waterborne Acrylic Enamel by DeVoe	3
	2	Tnemec Series 115 Unibond	1.5
	1	Tnemec Series 1029 Enduratone	2-4
	1		2-3
Metal, Galvanized Steel, (Severe Service)	1	Tnemec Series 66-1211 Epoxoline Primer	3-5
	1	Tnemec Series 66-Color Hi-Build Epoxoline	4-6

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
Ductile Iron (DI) Pipe and fittings	1 2 1 1 2 1 1	SUPRIME 9 Int/Ext Alkyd Metal Primer Pro-Hyde Plus Alkyd Satin by Pratt & Lambert – OR – Devguard 4160 Primer followed by Devguard 4308 Alkyd Enamel or DEFLEX 4218 DTM Enamel by DeVoe Tnemec Series 115 Unibond Tnemec Series 1029 Enduratone	1.1 1.5 2 2.5 2 2-4 2-3
PVC Pipe (Mild Service, Interior Only)	2	Tnemec Series 1029 Enduratone	2-3
PVC Pipe (Severe Service)	1	System 66-23 Epoxy Polyamide by Tnemec 66-Color Hi-Build Epoxoline	4
Concrete Walls and Ceilings (Mild Service)	1 2 1 2 1	ProMar 200 Latex Wall Primer ProMar 200 Int Alkyd Semi-Gloss by Sherwin Williams - OR - SUPRIME 4 Latex Wall Primer Pro-Hyde Plus Latex Satin by Pratt & Lambert Tnemec Series 1029 Enduratone	1.1 1.3 1.2 1.5 2-3
Concrete Walls and Ceilings (Severe Service)	2	Tnemec Series N69 Hi-Build Epoxoline II	4-6
Porous Masonry Walls (Mild Service)	 1 2 1 2	Pre-Prime 167 by Devoe ProMar 200 Latex Wall Primer ProMar 200 Int Alkyd Semi-Gloss by Sherwin Williams - OR - SUPRIME 4 Latex Wall Primer Pro-Hyde Plus Latex Satin by Pratt & Lambert	1.5 1.1 1.3 1.2 1.5
Porous Masonry Walls (Severe Service)	1 2	Tnemec Series 1254 Epoxoblock Tnemec Series N69 Hi-Build Epoxoline II	 75-100 sf/gallon 4-6
Concrete Floors (Mild Service)	1 1 2	Pre-Prime 167 by Devoe Concrete and Terrazzo Sealer (ANCO Cure and Hard by Intermountain Concrete Specialties. Industrial Enamel by Sherwin	1.5 None 2

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
	2 2 2	Williams - OR - With STAND Alkyd Floor Enamel by Pratt & Lambert – OR – Devguard 4328 Alkyd Enamel by DeVoe Tnemec Series 205 TerraTread	1 2 3-5
Concrete Floors (Severe or Mild Service)	2	Tnemec Series 280 TnemeGloss	6-8

*Brand names of materials have been used to indicate the types and quantities of materials required. Approved equals will be accepted.

09910.2.3.2 PAINT FOR WASTEWATER SYSTEMS - All paint for concrete and metal surfaces in wastewater systems shall be especially adapted for such use.

- Fume Resistance. All paint for final coats shall be fume resistant, compounded with pigments suitable for exposure to sewage gases, especially to hydrogen sulfide and to carbon dioxide. Pigments shall be materials, which do not tend to darken, discolor, or fade due to the action of sewage gases. If a paint manufacturer proposes use of paint which is not designated "fume resistant" in its literature, it shall furnish full information concerning the pigments used in this paint.
- Interior coating for metal pipes shall be Novocoat SP-2000W by ErgonArmor or Series 431 Perma-Shield PL by Tnemec. Installation shall be per the manufacturer recommendation and shall include any required primers or under coatings.
- Buried exterior piping shall coated with a bituminous coat, 4 mils minimum dry film thickness

- Lead Paint. No lead paints shall be used.

09910.2.3.3 PAINT FOR POTABLE WATER SYSTEMS - All paint systems to be used in potable water service shall meet NSF requirements. See also Subsection 09910.2.3.4 below.

09910.2.3.4 PAINT FOR SUBMERGED SURFACES

- Coal Tar Epoxy. Coal tar epoxy shall meet and conform with Government Specification Mil P-23236 with further qualification that the coal tar epoxy

manufacturer and product must be listed on the current U.S. Navy Qualified Products List. Coal tar epoxy shall be subject to the Engineer's approval.

- Alternate Systems. Alternate coating systems for submerged service, such as Tnemec Series 141Epoxy Polyamide Epoxoline by Tnemec, Epoxy Bar Rust 233H, by DeVoe, or equal, may be required for some applications, or may be approved in lieu of coal tar by the Engineer, upon request. Some colors of Epoxy Polyamide Epoxoline, or equal may be acceptable for use in potable water systems, however the manufacturer must be consulted for verification of acceptability prior to use in potable water applications.

- Submerged DIP that come into contact with the potable water process must be painted with Tnemec Pota-Pox Plus Series N140 or approved equal. This includes all submerged DIP in the surface water tank, floc tank, treated water tank, FEQ tank, recovery clarifier, recovery clarifier lift station and any other process that has the ability to come into contact with the potable water process. The surfaces shall be prepped and painted according to manufacturer's recommendation. The DIP shall be coated according to manufacturer's recommendation with a minimum of 2 coats.

09910.2.3.5 HIGH TEMPERATURE SURFACE TO 400°F - Paint for high temperature surfaces shall be DeVoe Hi-Heat Aluminum HT-4, Glidden 592 Metallite Aluminum, or Sherwin-Williams Silver-Brite Heat resisting aluminum paint B59 S1, or approved equal.

09910.2.4 CLEANING MATERIALS

Cleaning materials shall be best quality solvents, chemicals or detergents, which are commercially prepared for preparing painted surfaces and delivered to the site in sealed containers bearing an identifying label and the manufacturer's name.

09910.2.5 STEEL HAND RAILING

Steel hand railing shall be painted according to the manufacturers recommendation according to the following application.

Surface Preparation:
SSPC SP3 Power Tool Cleaning

Prime Coat:
Tnemec Series 135 Chembuild (or approved equal); 1 coat; 3-4 mils DFT

Finish Coat:
Tnemec Series 1026 Enduratone (or approved equal); 1 coat; 2-3 mils DFT

09910.3 APPLICATION REQUIREMENTS

ALL paint and coating systems shall be applied in strict accordance with the manufacturer's published instructions for use.

09910.3.1 SURFACE PREPARATION

09910.3.1.1 CLEANING - All surfaces to be painted shall be clean and dry except that in some cases the paint manufacturer's directions may require wetting the surface before painting. Grease and oil shall be removed by wiping with mineral spirits or naphtha per Specification SP-1. Rust, scale, welding slag, and spatter shall be removed and the surface prepared by hand tool cleaning, power tool cleaning, or blast cleaning in accordance with the appropriate Specification SP-2 through SP-10.

09910.3.1.2 METAL SURFACES - Except as otherwise provided, all preparation of metal surfaces shall be in accordance with Specifications SP-1 through SP-10 of the Steel Structures Painting Council (SSPC). Sandblasting procedures shall be as follows:

- No surface, which is to be sandblasted, shall be given a coat of primer or paint in the shop or in the field before sandblasting.

- Unless otherwise specified, all iron or steel surfaces which are to be painted as submerged metal shall be dry sandblasted on the site in accordance with Specification SP-10, near white blast cleaning.

- Except as otherwise specified, all metal surfaces, which are to be painted as non-submerged metal, shall be commercial blast cleaned per Specification SP-6. This sandblasting shall be done not more than 12 hours ahead of the painting, subject to humidity and weather conditions between the time of sandblasting and painting operations. If any rusting of sandblasted surfaces occurs before painting, such rusting shall be removed by additional sandblasting.

- Threaded portions of valve and gate stems, machined surfaces intended for sliding contact, surfaces to be assembled against gaskets, surfaces of shafts for sprockets or to fit into bearings, machined surfaces of bronze trim on slide gates, and similar surfaces shall be masked off to protect them from the sandblasting of adjacent surfaces.

- Cadmium-plated or galvanized items shall not be sandblasted except that cadmium plated, zinc-plated, or sheradized fasteners used in assembly of equipment to be sandblasted shall be sandblasted in the same manner as the other metal.

- Surfaces which cannot be sandblasted, or cannot be sandblasted and then painted after the assembly of which they are a part has been completed and placed in final position, shall be sandblasted, or sandblasted and painted, before the items are put into final position. In some cases, while the painting could be done after the items concerned were in place, the limitation on time between

sandblasting and painting may make it necessary to paint the surfaces before installation of those items.

- Sand or other media residue from sandblasting operations shall be thoroughly removed, using any method necessary and consistent with the requirements of the painting system, including vacuum cleaners or other means.

09910.3.1.3 GALVANIZED SURFACES - Galvanized surfaces which are to be painted shall first be treated with Koppers No. 40 Metal Conditioner; Amercoat No. 59 as manufactured by Amercoat Corporation, Brea, California; Galvaprep No. 5 as manufactured by Amchem Products, Fremont, California; or approved equal.

09910.3.1.4 CONCRETE SURFACES - Concrete and masonry surfaces shall be free of dust, mortar droppings and spatter, fins, loose concrete particles, form release materials, oil, grease, and other deleterious materials. If required by the coating manufacturer, such surfaces shall be etched as specified below or brush off blast cleaned per ICRI CSP 3=6.

Concrete surfaces specified to be acid etched shall be etched with a 15 to 20 percent solution of muriatic or sulfamic acid until the surface has the texture of find sandpaper. The surface shall then be thoroughly scrubbed with clean water, rinsed, and allowed to dry.

09910.3.1.5 WOOD SURFACES - Wood shall be cleaned and dusted immediately prior to painting. Final dusting shall be accomplished using tack cloth. Shelves, drawers, benches, and associated woodwork shall be sanded before painting and lightly sanded between coats. Prior to application of each coat, the surfaces shall be again dusted with tack cloth to remove all dust.

09910.3.1.6 BITUMINOUS PAINTED SURFACES - Surfaces, which are to be painted with other than bituminous paint, and which have a bituminous coating (such as coal tar varnished pipe), shall be sealed with not less than 2 coats of Inertol Tar Stop; Sherwin-Williams Metalatex B42W100; Glidden Insulcap as manufactured by the Glidden Company; or approved equal. This seal coating shall be applied in sufficient quantity to permanently prevent bleeding of the bituminous coating.

09910.3.1.7 HIGH TEMPERATURE SURFACES - In general, high temperature paint shall be applied to exposed (un-insulated) steam line valves and traps, heat exchangers, and miscellaneous metal piping and equipment in piping and mechanical systems exposed to high temperatures. The Contractor shall paint these surfaces with two coats of high temperature paint as specified herein or as otherwise shown or directed. No painting shall be done on surfaces with a temperature in excess of 125 degrees F at the time of application. Immediately before application of the first coat of paint, the surface shall be sandblasted according to SSPC-SP-5 (Blast Cleaning to "white" metal). See also Subsection 09910.3.1.2 above.

09910.3.1.8 THINNING - No thinning of paint other than as directed by the manufacturer's published directions shall be done without the approval of the Engineer. No painting shall be done under conditions, which, in the opinion of the Engineer, will jeopardize the appearance of quality of the painting in any way.

09910.3.1.9 TINTING OF FIRST COAT - When two coats of the same material are specified, the first coat applied shall be tinted with aluminum powder, lampblack, or other suitable pigment to distinguish it from the top coat.

09910.3.1.10 BETWEEN-COATS TREATMENT - All painted surfaces shall be dusted between coats, and high gloss finish shall be lightly sanded and dusted between coats unless otherwise directed by the manufacturer.

09910.3.2 PAINT APPLICATION

09910.3.2.1 PAINTER QUALIFICATIONS - Contractor or subcontractor personnel applying the coating system shall have had past experience in application of the type or types of coatings and under similar conditions that it will be required to meet in this contract. The qualifications of personnel applying the coating system, whether Contractor or subcontractor shall be verified by the Contractor prior to allowing application to proceed. The Contractor shall not subcontract paint application to a subcontractor that is not qualified to apply the coating system.

09910.3.2.2 WEATHER CONDITONS - No painting shall be done under dusty conditions, during or immediately after a rain, during rainy weather, or when the temperature is less than 50°F.

09910.3.2.3 GENERAL REQUIREMENTS FOR APPLICATION OF PAINT – These requirements shall be as follows:

- All work shall be done in a workmanlike manner, leaving the finished surfaces free from drops, ridges, waves, holidays, laps, or brush marks.
- Where possible, prime coats shall be applied by brush and well worked into the surface, unless directed otherwise by the paint manufacturer.
- Other paints may be applied by brush, roller, trowel, or spray, unless manufacturer's recommendations or these Specifications require a particular method of application.
- Primer and intermediate coats of paint shall be un-scarred and completely integral at the time of application of each succeeding coat.
- Each coat shall be subject to the inspection and approval of the Engineer before the next succeeding coat is applied, and defective work of any kind shall be deemed sufficient cause for re-coating the entire surface involved.

- Where spray application is used, each coat of paint shall be applied to a thickness equivalent to a brush coat application at a coverage rate not greater than that specified by the manufacturer for a brush coat application. All spray painting shall be done with airless type spray units.

- The time interval between paint coats shall meet the recommendations of the paint manufacturer, and these Specifications. The Contractor shall not allow excessive time or exposure between coats, where such excessive time or exposure will impair the bond between the coats.

- The number of coats specified in these Specifications is the minimum to be applied. Suction spots between coats shall be touched up, and additional coats shall be provided if required to produce a finished surface with a solid, even color free from defects.

- The total thickness of the coating shall be as specified. Additional coats of paint shall be added if necessary to bring the total thickness up to not less than that specified. For control, the Contractor shall determine the dry film thickness of the coatings on metal surfaces with a correctly calibrated thickness meter. The Contractor also shall check for holidays with a low voltage holiday detector. The Engineer may use the Contractor's meter and detector for additional inspection and checking deemed necessary.

- Particular care shall be used to assure that the specified coverage is secured on the edges and corners of all surfaces. Additional brush coats shall be applied if necessary to ensure coverage of the edges and corners.

- Damaged paint or scratched painted surfaces shall be sanded smooth before repainting. Sanding and repainting shall be done to such a degree and in such a manner that all evidence of the scratches or damages is obscured.

09910.3.2.4 COAL TAR EPOXY – Application of coal tar epoxy shall be as follows:

- Where called for in the Painting Schedule, shown on the Drawings, or required in these Specifications, concrete and some other submerged surfaces shall be coated with not less than two coats of coal tar epoxy.

- Structures to be coated are as follows:

  a) Surface Water Flow Meter Vault
  b) Static Mixer Vault
  c) Reuse Flow Meter Vault
  d) Sewer Flow Meter Vault
  e) Main Lift Station Dry Pit
  f) 4" ARV Assembly Vault

- Only components from new, previously unopened containers shall be used to mix coal tar epoxy coatings. Coal tar epoxy shall be mixed and applied in accordance with the manufacturer's recommendations. All coating components shall be mixed with power mixers. The time during pouring or stirring will not be allowed as mixing time. The minimum mixing time as recommended by the manufacturer shall be met. Only unit quantities shall be mixed.

- Coal tar epoxy shall be applied to a total dry film thickness of not less than 16 mils.

- Some metal surfaces may require sandblasting prior to application of the coating system. See Subsection 09910.3.1.2 above.

- In some cases it may also be necessary to apply coatings to parts or subassembly surfaces before they are actually installed at their final Project or system location. All support brackets, stem guides, pipe clips, fasteners, etc. that are bolted to concrete shall be painted on all sides.

- Application of coal tar epoxy shall be performed only at the job site unless specific approval is granted for offsite application. Offsite application will not be allowed unless by an applicator with acceptable proven and documented experience in the application of coal tar epoxy systems.

- Each succeeding coat shall be applied over the previous coat as soon as possible in accordance with the manufacturer's instructions, without causing sagging. Succeeding coats shall not be delayed longer than allowed by the manufacturer's instructions. In no case shall the application of subsequent coats be made after the previous coat has set or oxidized. All coats, and the full thickness on all parts, shall be applied before the previous coat has cured. The Contractor shall check the film thickness after application, and before the coating has cured, to ensure that sufficient coating thickness has been applied. If additional coating is necessary, it shall be applied the same day. Checking and control of thickness at this stage shall be the Contractor's obligation and responsibility and not the Engineer's.

- If the surface coating has been applied for a longer period of time than the limits in the Table below, and if it is found that bituminous paint has not been applied to the specified thickness, the areas that are too thin shall be sandblasted to remove the surface film from the coating. These sandblasted areas shall then be washed and cleaned with the solvent recommended by the manufacturer and shall be re-coated within the time limits specified for coating over fresh bituminous paint. Washing or cleaning the surface of the paint with solvents or other solutions will not be a satisfactory substitute for the specified sandblasting if the painted surface is older than the time limits indicated in the table. This applies even if the paint manufacturer approves the solvent method as adequate for preparing the old surface.

TEMPERATURES AND COATING TIMES

Average Temperature	Maximum Time Between Coats
50 - 60° F	36 hours
60 - 70° F	24 hours
70 - 80° F	12 hours
80 - 120° F	4 hours

Coal tar epoxy shall not be applied when the ambient temperature is less than 50 degrees.

09910.3.2.5 EDGES AND CORNERS - The Contractor is hereby CAUTIONED that the edges and corners of members are difficult places upon which to build the required thickness of paint. The required thickness must be applied to all surfaces, including the corners and edges, by applying as many spray coats as necessary or by additional brush coats on the corners and edges, if necessary, in order to build up the required thickness.

09910.3.3 FINISH SCHEDULE

The Contractor shall finish all work as follows unless indicated otherwise on the Drawings or within these Specifications:

TABLE OF FINISH SCHEDULES

NO FINISH	FACTORY FINISH	SITE FINISH
Stainless Steel Surfaces	Heating Units	Interior Concrete Building Floors and Walls
Polished Aluminum Surfaces	Electric Control Panel Cabinets	Interior Building Walls & Ceiling
Name Plates	Cranes & Hoists	All Interior and Exterior Exposed Piping, Valves & Pipe Supports
Exterior Concrete	Gauges and Meters	Exposed Electrical Conduit & Junction Boxes
Exterior Masonry Surfaces	Instruments	Entry Doors and Frames
Exposed Plastic Pipe & Fittings	Light Fixtures and Cover Plates	Wood Moldings and Trim
Warning Labels	Electrical Wiring & Transformers	Other Exterior Surfaces Indicated on drawings
Operating Instructions	Ventilating Fans	Sludge Clarifier Equipment
Gratings	Dampers	GAC Units
Ladders	Air Conditioning Units	Bollards
Stairs	Metal Soffit & Fascia Covering	
Buried or Encased Pipe	Roofing and Siding	
	Roll-Up Overhead Doors	
	Motors, Pumps, Equipment	
	Chain Link Fencing	

09910.3.4 CLEANUP

Upon completion of painting, the Contractor shall remove all masking and protective covers and properly dispose of all rubbish, debris and unused paint materials. The Contractor shall remove and cleanup all paint overspray, drips, spatters and etc. from any and all surfaces where it does not belong.

09910.4 METHOD OF MEASUREMENT

09910.4.1 NO MEASUREMENT

Separate measurement for Painting will not be made when painting is included as part of an item, building or structure listed in the Bid Schedule.

09910.4.2 SEPARATE MEASUREMENT

Separate measurement for Painting will be made as a Lump Sum when painting is listed as a separate item in the Bid Schedule.

09910.5 BASIS OF PAYMENT

When Painting is included as part of the measurement of another item, structure or building listed in the Bid Schedule, separate payment will not be made.

When Painting is required for a specific item, the accepted quantity will be paid for at the contract unit price for:

PAY ITEM	**UNIT**
Paint *(Item Description)*	Lump Sum

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Sewage/Non-Potable Water
   1. Pump Stations
      i. Extent of packaged pump station work required by this Section is indicated on Drawings and Schedules and by requirements of this Section.
         a) Under this Section the Contractor shall furnish and install one (1) pre-packaged, pre–assembled pump station complete with submersible pumps, precast concrete pump chamber with integral valve vault structure, slide rail pump removal system, discharge piping with required supports and fittings, discharge check and plug valves, access hatches, internal wiring and other required appurtenances.
         b) The pre-packaged pump station shall be manufactured and pre-assembled off site to ensure product quality and consistency. The pre-package pump station manufacturer or their distributors shall provide sole-source responsibility to the owner through the warranty period.

1.2 RELATED SECTIONS

A. MAG Section 206 – Structure Excavation and Backfill
B. MAG Section 301 – Subgrade Preparation MAG Section
C. MAG Section 725 – Portland Cement Concrete
D. Section 01300 - Submittals
E. Division 26 – Electrical
F. Division 40 – Process Integration

1.3 REFERENCES

Where applicable, the latest editions of the following standards shall form a part of this specification to the extent referenced. The publications are referenced to in the text of this guide specification by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

Standard Specifications for Highway Bridges

AASHTO LRFD Bridge Design Specification

ACI INTERNATIONAL (ACI)

ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete

ACI 211.2	Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 304R	Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R	Hot Weather Concreting
ACI 306R	Cold Weather Concreting
ACI 309R	Consolidation of Concrete
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures and Commentary
ACI 517.2R	Accelerated Curing of Concrete at Atmospheric Pressure

AMERICAN NATIONAL STANDARDS INSTITUTE (ASTM)

ASTM A 36	Specification for Carbon Structural Steel
ASTM A 82	Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM A 615	Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM C 31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 33	Specification for Concrete Aggregates
ASTM C 39	Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 40	Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C 70	Standard Test Method for Surface Moisture in Fine Aggregate
ASTM C 117	Standard Test Method for Materials Finer than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 123	Standard Test Method for Lightweight Particles in Aggregate
ASTM C 136	Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 138	Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C 150	Specifications for Portland Cement
ASTM C 172	Standard Practice for Sampling Freshly Mixed Concrete

ASTM C 192	Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	Specification for Air-Entraining Admixtures for Concrete
ASTM C 494	Standard Specification for Chemical Admixtures for Concrete
ASTM C 566	Test Method for Total Evaporable Moisture content of Aggregate by Drying
ASTM C 595	Specification for Blended Hydraulic Cements
ASTM C 617	Standard Practice for Capping Cylindrical Concrete Specimens
ASTM C 618	Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
ASTM C 805	Test Method for Rebound Number of Hardened Concrete
ASTM C 857	Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
ASTM C 858	Specification for Underground Precast Concrete Utility Structures
ASTM C 890	Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
ASTM C 891	Practice for Installation of Underground Precast Concrete Utility Structures
ASTM C 913	Specification for Precast Concrete Water and Wastewater Structures

ASTM C 920	Specification for Elastomeric Joint Sealants
ASTM C 990	Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM C 1037	Practice for Inspection of Underground Precast Concrete Utility Structures
ASTM C 1064	Standard Test Method for Temperature of Freshly Mixed Concrete
ASTM C 1107	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C 1231	Standard Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Concrete Cylinders
ASTM C 1240	Standard Specification for Use of Silica Fume for Use as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar, and Grout
ASTM C 1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C 1293	Standard Test Method for Determination of Length Change of Concrete due to Alkali-Silica Reaction
ASTM C 1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM C 1611	Standard Test Method for Slump Flow of Self-Consolidating Concrete

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

Manual of Standard Practice

Placing Reinforcing Bars

NATIONAL PRECAST CONCRETE ASSOCIATION (NPCA)

NPCA QC Manual	Quality Control Manual for Precast Concrete Plants

1.4 GENERAL REQUIREMENTS

Precast concrete units shall be designed and fabricated by an experienced and acceptable precast concrete manufacturer. The manufacturer shall have been regularly and continuously engaged in the manufacture of precast concrete units similar to that indicated in the project specifications or drawings for at least 10 years with annual sales of more than $40 million. In addition, the manufacturer shall employ a professional engineer registered in the state where the product is to be installed.

1.5 SUBMITTALS

Submittals shall be per Section 01300 and contain the following items unless specified otherwise herein.

A. Preconstruction Submittals
    1. Upon request by the customer, submit quality control procedures established by the precast manufacturer's Quality Control Manual

B. General
    1. Submit Four (4) copies of complete project submittals for the Engineer's review and Approval. The submittal shall be provided in and electronic pdf format with relevant bookmarks for easy navigation, complete with index and cover, clearly identifying the Project Title, Customer, Project Engineer and submittal date. The submittal shall be compiled in a logical and organized manner.
    2. Partial or incomplete submittals will not be reviewed, but instead will be returned as "Incomplete- Revise and Resubmit".
    3. Product Data: Submit manufacturer's specific technical product data, including installation and start-up instructions, furnished specialties and accessories, and pump characteristic performance curves with selection points clearly indicated. Provide structural calculations stamped by a Professional Engineer registered in the State the project is being installed.

C. Drawings
    1. Submit manufacturer's assembly-type shop drawings indicating dimensions, mechanical & electrical components, complete bill of materials, structural layout & reinforcing per calculations and structural weights. Structural reinforcing drawings shall be stamped by a Professional Engineer registered in the State the project is being installed.
    2. The drawings for precast concrete units shall be furnished by the precast concrete producer for approval. These drawings shall show the design loads and standards

have been met. Installation and construction information shall be included on shop drawings upon request. It is the responsibility of the project's engineer-of-record to verify that the design assumptions are suitable for the proposed application.

3. For custom made precast concrete units, in addition to the requirements in B.1, the drawing for submittal shall show locations and dimensions to all penetrations and special embed items. Product dimensions and thicknesses shall be shown, and the drawing shall be to a common architectural scale with the precast producer's information in the title block.

D. Precast Concrete Unit Data

1. Anchorage, Lifting Inserts and Devices
    i. For anchors, lifting inserts and other devices, the precast concrete producer shall provide product data sheets and proper installation instructions upon request.
2. Accessory Items
    i. For items including, but not limited to sealants, gaskets, pipe entry connectors, steps, racks, and other items installed before or after delivery, the precast concrete producer shall include proper installation instructions and relevant product data upon request.

E. Design Data

1. The precast concrete producer shall supply submittals showing design loading and material specifications for supplied products. At a minimum, the following shall be shown on the submittals:
    i. Live load used in design
    ii. Vertical and lateral earth loads used in design
    iii. Depth of soil fill on the structure
    iv. Water table depth used in calculations
2. Upon request, the precast concrete producer shall supply precast concrete unit design calculations and concrete mix design proportions and appropriate mix design test data. Structural design calculations shall be sealed by a licensed professional engineer in the state of this project.

F. Test Reports

1. Upon request, the precast concrete producer shall supply copies of material certifications and/or laboratory test reports, including mill tests and all other test data, for Portland cement, blended cement, pozzolans, ground granulated blast-furnace slag, silica fume, aggregate, admixtures, and curing compound proposed for use on this project
2. Upon request, the precast concrete producer shall submit copies of test reports showing that the mix has been successfully tested to produce concrete with the properties specified and will be suitable for the project conditions. Such tests may include compressive strength, plastic air content, temperature of freshly mixed concrete, and slump of freshly mixed concrete. Special tests for precast concrete items shall be clearly detailed in the specifications
3. Upon request, the precast concrete producer shall supply copies of in-plant QA/QC inspection reports.

1.6 DESIGN

All components of the pre-package submersible pump station with integral valve vault shall be

designed for all stresses that may occur during continuous operation, and for any additional stresses that may occur during fabrication or erection. Workmanship shall be high quality in all respects. All equipment shall be constructed of materials that will maintain their functional integrity during continuous handling, and in contact with the liquids and atmosphere, likely to be encountered in this application. The following items shall be accounted for in the precast unit design.

A. Precast Concrete Unit Design
   1. Design standard precast concrete units to withstand design load conditions in accordance with ACI 350. Precast structures will be in close proximity to CMU walls and must account for the transfer of forces. Design must also consider stresses induced during handling, shipping, and installation in order to avoid product cracking or other handling damage. Design loads for precast concrete units shall be indicated on the shop drawings, and designed by a licensed professional engineer.
   2. The structural design shall take into account discontinuities in the structure produced by openings.
   3. The Precast Pump Station with Integral Valve vault shall be designed to support its own weight as well as the minimum superimposed loads tabulated below. All additional equipment shall be accounted for in the design of the elements.
      i. Pump Station with Integral Valve Vault
         a) Top Slab
         b) Live Load & Impact Load – AASHTO LRFD HL-93
         c) Floor Slab (valve vault & base)
         d) Live Load – 200 psf
         e) Dead Loads – CMU walls are located in close proximity to the wet wells and must be taken into consideration. CMU design calculations will be provided for wet well design purposes.
         f) Exterior Walls
         g) All exterior walls below finished grade shall be designed for an equivalent fluid pressure of 90 psf caused by saturated earth pressure. The top of the pressure diagram is assumed to originate at finished grade. In addition to the soil pressure, a Live Load Traffic Surcharge shall be applied according to the AASHTO Specification.
   4. The structures shall be designed to prevent floatation without the benefit of skin friction and the weight of mechanical equipment when the ground water level is at finished ground surface. The factor of safety against uplift calculated as a ratio of the total resisting force (excluding skin friction and the weight of the equipment) to the total hydrostatic uplift force shall be at least 1.15. The net uplift force shall be transferred to the anti-buoyancy collar.

B. Joints and Sealants
   1. Joints and sealants between adjacent units shall be of the type and configuration indicated on the shop drawings meeting specified design and performance requirements.

C. Concrete Mix Design
   1. Concrete type
      i. For non machine cast products, the concrete shall be self-consolidating concrete which produces minimal bugholes and does not segregate.
   2. Concrete Proportions
      i. Selection of proportions for concrete shall be based on current self-

consolidating concrete mix design techniques. At a minimum, ACI 211.1 shall be used.

ii. Upon request the precast concrete producer shall submit a mix design for each strength and type of concrete that will be used. Submitted mix designs shall include the quantity, type, brand and applicable data sheets for all design constituents as well as documentation indicating conformance with applicable reference specifications.

iii. Concrete mix design shall meet the requirements of MAG Specification 725 - Portland Cement Concrete.

3. Durability and Performance Requirements

i. Concrete Compressive Strength

1. Precast concrete units shall have a 28-day compressive strength of 5000 psi for SCC.

ii. Water-Cementitious Ratio

1. Concrete that will be exposed to freezing and thawing shall contain air and shall have a water-cementitious ratio of 0.45 or less. Concrete which will not be exposed to freezing, but which is required to be leak resistant, shall have a water-cementitious ratio of 0.48 or less. For corrosion protection, reinforced concrete exposed to deicer salts, brackish water or seawater shall have a water-cementitious ratio of 0.40 or less.

iii. Air Content

1. The air content of concrete that will be exposed to freezing conditions shall be within the limits given below

Nominal Maximum Aggregate size (in)	Air Content %	
	Severe Exposure	Moderate Exposure
3/8	6.0 to 9.0	4.5 to 7.5
1/2	5.5 to 8.5	4.0 to 7.0
3/4	4.5 to 7.5	3.5 to 6.5
1	4.5 to 7.5	3.0 to 6.0
1-1/2	4.5 to 7.0	3.0 to 6.0
* For specified compressive strengths greater than 5000 psi, air content may be reduced 1%		

D. Pump Design Criteria

Pumps shall be submersible, non-clog, explosion-proof wastewater pumps suitable for pumping sewage.

Pumps shall be specially designed, constructed, and installed for the service intended and shall comply with the following minimum conditions:

Design Conditions	**Wet Well Pumps**

Location:	Mystic Hills
Use:	Sewer
Number Required:	2
Design Flow: gpm	610
Design TDH: ft.	202
Motor: hp	72
Max. Operating Speed: rpm	3560
Impeller Diameter: in	8 7/16
No. of Blades	2
Discharge Size: in.	4
Motor: Volts/Phase/Hertz	460/3/60

1.7 QUALITY ASSURANCE

The precast concrete producer shall demonstrate adherence to the standards set forth in the plant Quality Control Manual. The precast concrete producer shall meet the requirements written in subparagraph 1.7.A. The Precast Concrete Pump Station Manufacturer shall have a minimum of ten (10) years successful experience in the design and the assembly of factory-built, prefabricated, pre-assembled Pump Stations. In addition, the Manufacturer shall have made no less than ten (10) Pump Stations similar to the one on this project. Evidence shall be submitted to verify these requirements are met prior to being deemed an acceptable manufacturer.

A. Qualifications, Quality Control and Inspection

1. The precast producer shall maintain a permanent quality control department.
2. The precast concrete producer shall have a quality control program which is audited for compliance annually by persons outside that plant's employee structure.
3. Upon request, the precast concrete producer shall supply a copy of their quality control manual.

B. Quality Control

1. The precast concrete producer shall show that the following quality control tests are performed as required and in accordance with the ASTM International standards indicated
    i. Concrete Testing
        a) Slump: A slump test shall be performed at least once per day per mix design used. Slump tests shall be performed in accordance with ASTM C 1611 for self-consolidating concrete.
        b) Temperature: The temperature of fresh concrete shall be measured each time a slump, air content, or compressive strength tests are made. Temperature shall be measured in accordance with ASTM C 1064.
        c) Compressive Strength: At least four compressive strength specimens shall be made each day for each mix design unless otherwise specified. In accordance with ASTM C 31, C 39, C 192.
        d) Air Content: Tests for air content shall be performed if the mix

design specifies air entrainment. The air content will be measured in accordance with ASTM C 231. The Air Content shall be measured once per day per mix design.

e) Density (Unit Weight): Tests for Density (Unit Weight) shall be performed monthly for each mix design used at a minimum. Tests shall be in accordance with ASTM C 138

ii. Aggregate Testing

a) A full set of aggregate tests shall be performed on each aggregate at least annually by an independent testing agency or an in house test lab. These tests will include gradations (ASTM C136), Soundness (ASTM C 88), Organic Impurities (ASTM C 40), Sand Equivalent for fine aggregates only (ASTM D 2419)

b) Potential reactivity shall be performed once per each aggregate source, and when aggregate sources change (ASTM C 1260 or C 1293)

c) Monthly, at a minimum, gradations shall be performed per ASTM C 33.

d) Aggregate Moisture tests: Moisture tests on aggregates shall be performed in accordance with ASTM C 70 or ASTM C 566. Fine aggregate moisture content tests shall be performed at least once per day if there are no moisture meters, otherwise it shall be performed once per month. Alternatively, the speedy moisture test is acceptable (ASTM D 4944).

iii. Preplacement Check

a) All products shall be inspected for accuracy prior to placing concrete. Checks shall include, but not be limited to, form condition and cleanliness, form dimensions, joints, release agent, blockouts, inserts and locations, lifting devices, reinforcing steel size, spacing, clearances and proper placement.

b) Preplacement checks shall be documented and initialed by the inspector. A drawing with verifications of the above criteria can be used as documentation.

iv. Postplacement Check

a) All products shall be inspected for accuracy after the concrete forms have been removed. Checks shall include, but not be limited to, dimensional checks, finishing, insert locations, squareness, honeycombing, cracking, marking, coatings, racking, hole size and location. Postplacement checks may require a corrective action report.

b) Postplacement checks shall be documented and initialed by the inspector. A drawing with verifications of the above criteria can be used as documentation.

2. Copies of the test results and Inspections above shall be available upon request.

C. Wet Well Corrosion Protection Liner

1. Once hardened surface is achieved, a holiday tester shall be utilized to ensure a continuous pinhole-free lining.
2. Test results for the holiday test shall be submitted to the engineer for approval.

3. Any holes shall be repaired per the lining manufacturers recommendation.

D. Outside Inspection
   1. The customer or customer's agent (specifier) may place an inspector in the plant when the units covered by this specification are being manufactured. The precast concrete producer shall give notice of 3 days prior to the time the precast concrete units will be available for plant inspection

E. All equipment and materials furnished in the pump station shall be new and free of defects. All equipment shall be the manufacturer's latest and proven design.

F. All electrical materials, devices, and equipment shall be UL listed wherever applicable.

G. All equipment and installations shall meet the National Electric Code.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Handling
   1. Precast concrete units shall be handled and transported in a manner to minimize damage. Lifting devices or holes shall be consistent with industry standards. Lifting shall be accomplished with methods or devices intended for this purpose as indicated on the shop drawings. Upon request, the precast concrete producer shall provide documentation on acceptable handling methods for the product.

   2. Pumps shall be handled and transported per the manufacturers recommendation to prevent damage.

B. Storage
   1. Precast concrete units shall be stored in a manner that will minimize potential damage.

   2. Pumps shall be stored per the manufacturers recommendation to prevent damage.

C. Delivery
   1. Precast concrete units shall be delivered to the site in accordance with the delivery schedule. Upon delivery to the jobsite, all precast concrete units shall be inspected by the contractor for quality and final acceptance.

D. Final Acceptance
   1. Upon final acceptance, the contractor acknowledges and understands the appropriate methods for handling the accepted precast concrete unit(s). Upon acceptance by the contractor, the precast concrete manufacturer is not responsible for replacing damaged product resulting from improper handling practices on the job site. Damage due to improper handling at the job site will be repaired or replaced by the Contractor at no cost to the customer.

1.9 PLANT CONDITIONS

Any plant producing precast concrete units for this specification shall have a written, implemented, comprehensive safety and environmental program. Upon request, documentation shall be provided to show the safety program meets the following minimum requirements.

A. Safety Program Requirements

The safety program shall include the following written and documented parts as a minimum.

1. Housekeeping
2. Lock-Out Tag-Out
3. Machine Guarding
4. Risk Assessment
5. Personal Protective Equipment
6. Contractor and Visitor Safety
7. Cranes and Lifting Equipment Safety
8. Ergonomics and handling Safety
9. Fall Protection

B. Health and Safety Management System Requirements

The health and safety management system shall be used to manage the safety program and all measurable aspects.

C. Environmental Management System Requirements
The Environmental Management System shall encompass the following:
1. Air Pollution Control
2. Water and Wastewater Management

D. Recordable rate
1. The recordable rate shall be below the industry average. If the industry average is not readily available, assume a value of 6 recordable injuries per 200,000 hours worked as the industry average.

1.10 Single Source Responsibility

A. To ensure that all equipment required for the installation of the pre-package pump station is properly coordinated and will function as a unit in accordance with the intent of these specifications, the Contractor shall obtain all the equipment specified under this section, from a single supplier with whom the responsibility for the proper function of all equipment, regardless of manufacturer, as an integrated and coordinated system shall be vested. This requirement is to establish unit responsibility for all the equipment with the equipment supplier. The use of the word responsibility relating to the equipment supplier is in no way intended to relieve the Contractor's ultimate responsibility for equipment coordination, installation, operation, and guarantee.

B. Factory pre-assembly: During fabrication and before shipment, all equipment shall be fully factory installed to verify all proper clearances. All installed equipment, except for pumps and equipment unless crossing structural joints, shall remain in the precast structure during travel to the jobsite and final re-assembly.

C. The manufacturer shall furnish the services of an experienced service technician to check the installation, and provide to the Owner, a certificate indicating that the pre-packaged submersible

pump station has been installed in accordance with the manufacturer's recommendations.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. PRECAST WETWELL AND VALVE VAULT

1. Acceptable Manufacturer: Oldcastle Precast Inc.

2. Substitutions: Not permitted.

   a. Alternative systems based upon a built-in-place, field erected pump station utilizing separate precast structures, or cast-in-place concrete shall not be accepted.

B. WET WELL CORROSION PROTECTION LINER

1. Acceptable Manufacturer: Sauereisen

2. Substitutions: Not permitted.

C. LIFT STATION PUMPS

1. Acceptable Manufacturer: Flygt Pumps

2. Substitutions: Not permitted.

2.2 PRODUCTS

A. Precast Concrete Pump Station Sections with Valve Vault

1. The Pump Station with Integral Valve Vault shall be composed of precast reinforced concrete units, rectangular in shape with rounded corners. The precast structures shall be monolithically cast, and have minimum interior dimensions of 6' wide by 11' long with 3' radius corners (RC611). The precast base section will be supplied with an extended buoyancy collar to withstand upward buoyant forces with ground water at grade. Overall structure heights shall be as shown on the contract drawings, and range from 10'-10" to 22'-10", in product-standard 2', 3' & 4' increments.
2. Exterior Walls shall be a minimum of 6 inches thick, integral valve vault common wall and floor shall be a minimum or 4 inches thick, station floor and buoyancy footing shall be a minimum of 8 inches thick, and the roof slab with hatches shall be a minimum of 12 inches thick.
3. The Integral Valve Vault shall be located in the pump station structure as shown on the contract drawing, to conserve site space and to eliminate the possibility of differential settlement. Conventional means, utilizing two (2) separate structures for the pump station and the valve vault **will not be accepted as an equal**.

4. The Precast Structures shall be comprised of product-standard: base, riser sections, integral valve vault, optional vault riser shims as required, and station cover.
5. The Pump Station Manufacturer shall have a production facility in which all work associated with structural fabrication, mechanical/electrical pre-assembling and product final inspection of the pump station will be performed. The building shall keep the pump station components protected from the elements and kept at an ambient temperature of at least 45 degrees Fahrenheit. No concrete shall be batched and placed when the ambient temperature is below 50 degrees Fahrenheit.
6. All wall penetrations shall be formed utilizing hole-formers or cored drilled holes for manhole boots, and galvanized threaded couplings with waterstops for electrical connection.
7. All cast wall openings for ductile iron, PVC or galvanized steel pipe shall incorporate adjustable rubber manhole boots for a watertight seal.
8. All Precast components shall be fabricated on steel forms with machined rings to form accurate bell and spigot joint surfaces to ensure watertight joints.
9. The Horizontal joints between precast sections shall be sealed with a vulcanized butyl rubber joint material conforming to AASHTO M-198. The joint material shall be "Conseal CS-102" as manufactured by Concrete Sealants, or approved equal.
10. All surfaces of the precast structures shall be smooth, even, and free from roughness, irregularities and other defects. The surfaces shall be suitable for receiving exterior treatments as specified elsewhere herein.

B. Pump Removal Rail System
1. The pump station shall be supplied with a stainless steel guide rail pump removal system, to facilitate emergency and routine maintenance in removing and re-installing the submersible pumps from the top of the station. The guide rail system will include lower guide brackets incorporated in the pump base elbow, 316-stainless upper guide brackets, 316-stainless intermediate guide brackets as may be required per the pump manufacture, and 304stainless steel Sch40 guide rails of size and quantity as dictated by the select pump manufacturer and model.
2. Guide rail components shall be assembled and installed plumb to the pump station structure, and shall allow for pump removal and re-installation without interfering with the access hatch or frame. All assembly hardware shall be 316-stainless steel.

C. Hazardous Location Compliance
1. The wet well and the area within 2 feet of the wet well has been classified as a Class 1, Division 1, A Hazardous Location as defined by the National Electrical Code. All electric wiring and motors located within the subject area shall be in strict compliance with these standards. The shop drawings carry the manufacturer's certification that all equipment located in the subject area meets the requirements of NEC Class 1, Division 1 Criteria and the Underwriter's Laboratory (UL).

D. Pump Station Access Frame and Cover
1. Furnish and install (1) aluminum pump access hatch, 36" x 54" nominal interior dimension, flush with precast cover, 300psf load rating with 316-stainless steel hardware. Cover will be minimum ¼" diamond plate with stainless steel slam lock and weather plug, lift handle which sits flush with cover, recessed pad lock clip (pad lock by others), hold open arm to lock cover in 90-degree position, heavy duty stainless hinges. Frame to be angle style with continuous 1 ½" anchor flange and

full slab-height skirt to show no exposed concrete when hatch is open, exterior surfaces in contact with concrete to receive one coat bituminous paint.

2. Pump access hatch to be supplied with integral safety grating system. The safety grate shall be made of 6061-T6 aluminum and designed per the "Specifications for Aluminum Structures". The grating shall be designed to withstand 300psf loading. Each grate shall be supplied with a heavy duty, stainless steel pneu-spring for ease of operation when opening. Each grate shall be provided with a permanent hinging system; which will lock the grate in the 90-degree position once opened. Grate shall be coated with an OSHA type safety orange color, base coat is a thermosetting epoxy powder coat finish with a minimum thickness of 2-4 mils. The top coat is a mar-resistant, TGIC polyester powder coating with a minimum thickness of 2-4 mils. Each coat shall be baked at 350-375 degrees F until cured.
3. Access hatches to be manufactured by EJ, East Jordan, MI, or approved equal.

E. Valve Vault Access Frame and Cover

1. Furnish and install (1) aluminum valve vault access hatch, 30" x 36" nominal interior dimension single door, flush with precast cover, 300psf load rating with 316 stainless steel hardware. Cover will be minimum ¼" diamond plate with stainless steel slam lock and weather plug, lift handle which sits flush with cover, recessed pad lock clip (pad lock by others), hold open arm to lock cover in 90-degree position, heavy duty stainless hinges. Frame to be channel style with 1 ½" NPT drain port in the bottom of the channel, continuous 1 ½" anchor flange and full slab-height skirt to show no exposed concrete when hatch is open, exterior surfaces in contact with concrete to receive one coat bituminous paint. Hatch will be supplied with a heavy duty, stainless steel pneu-spring, for ease of operation when opening cover.
2. Valve Vault access hatch to be supplied with integral safety grating system. The safety grate shall be made of 6061-T6 aluminum and designed per the "Specifications for Aluminum Structures". The grating shall be designed to withstand 300psf loading. Each grate shall be supplied with a heavy duty, stainless steel pneu-spring for ease of operation when opening. Each grate shall be provided with a permanent hinging system; which will lock the grate in the 90-degree position once opened. Grate shall be coated with an OSHA type safety orange color, base coat is a thermosetting epoxy powder coat finish with a minimum thickness of 2-4 mils. The top coat is a mar-resistant, TGIC polyester powder coating with a minimum thickness of 2-4 mils. Each coat shall be baked at 350-375 degrees F until cured.
3. Access hatches to be manufactured by EJ, East Jordan, MI, or approved equal.

F. Polyvinyl Chloride (PVC) Piping and Fittings

1. All PVC pressure piping and fittings for water and wastewater treatment are to be Sch80. Unless stated otherwise in the drawings. Corrosion resistant pressure pipe, IPS sizes, for use at temperatures up to and including 140°F. Pressure rating (120 psi to 1230 psi) varies with schedule, pipe size, and temperature.
2. The material used in the manufacture of the pipe and fittings shall be domestically produced rigid polyvinyl chloride (PVC) compound, Type 1 Grade 1, with a Cell Classification of 12454 as defined in ASTM D1784, trade name designation H707 PVC. This compound shall be gray in color, and shall be approved by NSF International for use with potable and non-potable water (NSF Std 61). All sizes of PVC Schedule 80 pipe & fittings shall be manufactured in strict accordance to

the requirements of ASTM D1785 for physical dimensions and tolerances, and all performance test requirements of ASTM D1785.

G. Polyvinyl Chloride (PVC) Ball Valves (Standard 2" & 3" PVC)
   1. All ball valves shall be of the flanged model with one-piece capsule and shall open counterclockwise. The valves shall be rated for 250psi at 73 degrees F.
   2. The ball valve shall be of full-port design to minimize flow restriction to the lowest possible pressure drop. Full flange face gaskets having a 50to 70 durometer A hardness shall be used.
   3. Ball valve bodies shall be constructed of PVC, with Teflon seats and Viton seals.
   4. PVC ball valves shall be manufactured by Haward, Nibco Inc., or approved equal.

H. Polyvinyl Chloride (PVC) Check Valves (Standard 2" & 3" PVC)
   1. All check valves shall be of the flanged model with one-piece capsule. The valves shall be rated for 150psi at 73 degrees F.
   2. Free oscillation of ball in guide ribs facilitates full port flow with minimum of turbulence and chatter. Full flange face gaskets having a 50to 70 durometer A hardness shall be used.
   3. Check valve bodies and ball shall be constructed of PVC, with EPDM seals.
   4. PVC check valves shall be manufactured by Hayward, Nibco Inc., or approved equal.

I. Ductile Iron Pipe and Fittings
   1. All ductile iron pipe shall be designed in accordance with ANSI A21.50, and shall be manufactured in accordance with ANSI A21.51. Pipe for use with grooved end couplings shall have grooved ends in accordance with AWWA C606.
   2. Pipe thickness class shall be Class 53 for use with threaded flanges, unless specified otherwise on the product drawings.
   3. Flanged joints shall conform with ANSI A21.15, utilizing long-hub flanges which shall be screwed on tight by the foundry before they are faced and drilled.
   4. Fittings shall conform to the requirements or ANSI A21.10 and shall be of a pressure classification at least equal to that of the pipe with which they are used. Flanged fittings shall be faced and drilled in accordance with ANSI A21.10.
   5. All ductile iron piping and fittings shall Novocat SP-200W, by ErgonArmor, or Series 431 Perma-Shield PL, by Tnemec, on the inside and a bituminous seal coat on the outside, all in accordance with ANSI/AWWA A21.4/C104.

J. Flange Type Couplings
   1. Flange couplings shall be mounted on each pump base elbows to ensure proper pressure seal while providing a minimum of assembly flexibility. The flange couplings shall be fusion bond epoxy coated and supplied with 304-stainless assembly and mounting hardware for harsh & wet environments. The pipe gasket and O-ring seal shall be Nitrile (Buna N) NFS 61 Listed.
   2. To ensure correct fitting of pipe and couplings, all flange couplings shall be furnished by the pipe supplier and shall be of the pressure rating of at least that of the pipeline in which they are to be installed.
   3. The flange couplings shall be Smith-Blair Inc., model 912 or approved equal.

K. Grooved Couplings
   1. Grooved couplings shall be supplied where shown on the product drawings and shall conform to AWWA C606. The couplings are designed for use on radius cut grooved pipe with minimum wall thickness of ANSI/AWWA C151/A21.51, Class

53 DIP, or a transition coupling may be required for connection of grooved end IPS steel pipe to grooved end AWWA ductile iron pipe.

2. The housing coating shall be coal tar epoxy, the gasket shall be Nitrile (red color code), and bolting hardware of 304-stainless steel.
3. The grooved coupling shall be Victaulic style 31/307, or approved equal.

L. Pipe supports

1. Piping shall be supported in the valve vault by means of horizontal supports that attach to the sides of the valve vault. No portion of the pipe support shall rest on the floor of the valve vault. The pipe support shall be 304-stainless steel with 316-stainless steel hardware. Where piping enters and exits the vault structure; aluminum wall supports angles with 304-stainless U-bolts and 316-stainless expansion bolt wall-mounting hardware shall be utilized in (3) locations.
2. Piping shall be supported in the pump station by means of a common 304-stainless fabricated angle brace spanning the width of the station and mounted with wall brackets and 316-stainless hardware. Both vertical discharge pipes shall be supported from the brace by means of individual 316-stainless U-bolts and bolting hardware.
    i. (1) Common pipe support assembly at mid length shall be required when the vertical discharge pipe lengths exceed 10'-0".
    ii. (2) Common pipe support assemblies at equal spacing shall be required when the vertical discharge pipe lengths exceed 14'-0".

M. Wall/Lid Penetrations

1. Where wall penetrations are called for on the plans; mechanical piping shall utilize cast or cored openings with flexible manhole boots. Flexible rubber boots shall consist of EPDM polymer compounds meeting ASTM C923 material performance requirements. Expansion banding and strap shall be 304-stainless material and the connection between boot and structure shall utilize an expansion wedge system with 304-stainless wedge and hardware components.
2. Where penetrations through the concrete lid of the wet well are called out in the plans; mechanical seals shall be used. Mechanical seals shall be Link Seal by GPT and shall utilize 316-stainless assembly hardware
3. Electrical conduit penetrations will utilize galvanized electrical couplings assemblies with 2" wide minimum waterstop embedded in the structure at casting, or cored openings with mechanical rubber seals to fill the annular spacing between electrical conduit and precast wall structure. Mechanical seals shall be Link Seal by GPT and shall utilize 316-stainless assembly hardware. Mechanical seals shall be employed when pump control panel or exterior junction box option is factory mounted to the station.

N. Check Valves Outside L&W (Standard)

1. The check valve shall have a heavy-duty body of ASTM A126 Class B cast iron with integral flanges faced and drilled to ANSI B16.1 Class 125 for horizontal installation as listed in the schedule or shown on plans. Valve clapper shall swing completely clear of the waterway when valve is full open, permitting a full flow through the valve equal to the nominal pipe diameter. Check valves shall comply with AWWA Standard C-508 latest revision. The valve shall have a bolted and gasketed cover to allow for clapper access without removing the flanged valve from line.

2. Pressure ratings: Class 125 flanged valve body shall be rated for a shell pressure of 250 PSI.
3. The check valve shall be supplied with adjustable outside lever and weight.
4. Manufacturer-paint all interior & exterior ferrous surfaces with fusion bonded epoxy coating, AWWA C550 Manufacturer standard color only applies.
5. Manufactured valve shall be Matco-Norco, mod. 120WC or approved equal.

O. Plug Valve (Standard)

1. Plug valves shall be of the non-lubricated, quarter-turn, eccentric type with flanged ends and lever operated, in full conformance with the latest revision of the AWWA C517 Standard.
2. Valves sizes 3" to 6" shall have a minimum 175 PSI pressure rating. Plug Valves shall be round ported for reduced pumping costs and improved flow characteristics. The valves shall have the following minimum full open flow coefficients (Cv): 3"=569, 4"=982, 6"=1997.
3. Flange diameter, thickness, and drilling shall conform to ANSI B16.1 Class 125.
4. Valve shaft seals shall be of the self-adjusting U-cup design for reduced maintenance and replaceable without removing the cover from the valve.
5. Valves shall have bodies and covers of ductile iron per ASTM A536 for superior strength. Valve sizes 3" and larger shall have body seats of 95% welded nickel applied directly to the body and machined to a smooth finish. Sprayed, plated or removable seats are not acceptable. Valves shall have plugs made from ductile iron per ASTM A536 with a vulcanized synthetic rubber seat facing tested per ASTM D429 for all sizes.
6. Valves shall be provided with stainless steel thrust bearings on the upper and lower plug shaft to eliminate plug-to-body contact and ensure long lasting plug-to-seat alignment. Grit seals shall be provided on the upper and lower bearing journals to minimize the entrance of grit into the shaft seal and bearing areas.
7. Valves shall be coated internally and externally with 6-8 mils NSF approved two part epoxy paint for corrosion protection.
8. Valves shall be Golden Anderson Figure 517 "ECO-Centric" or approved equal.

P. Gaskets, Bolts, Nuts

1. For flange joints, gaskets shall be a minimum of 1/8" thick full faced gaskets. Gaskets shall be of composition suitable for exposure to fluids within the pipe. Gaskets shall meet AWWA C110, C111, and C115 performance standards.
2. Flange joints shall be bolt-assemble utilizing the full faced gasket. Bolting hardware, number & size, shall conform to the same ANSI standards as the flange. Bolts and nuts shall be 316-stainless steel, heavy hex Grade B conforming to ASTM A493/494.

Q. Station Vent

1. Valve Vault - A passive station vent shall be supplied using 4" DIP piping & fittings, and a #14 stainless steel insect screen. The vent will be factory assembled and mounted to the exterior of the station, where the venting will rise above the station, and turn downward (gooseneck), and end with insect screen minimum 12" above top of wet well.
2. Wet Well - A passive station vent shall be supplied using 4" DIP pipe with flange, and a top mounting carbon canister unit. The vent will be factory assembled and mounted to the exterior of the station, where the venting will rise above the station

12"- above top of wet well, and end with a top mounted carbon canister unit with rain shield. The canister housing shall be aluminum with 4" mounting flange, rain shield, with power coat finish. The replaceable canister shall contain a minimum of 12 pounds of activated carbon, and shall be safe for recyclable disposal.

i. The carbon canister assembly shall be Wager 1800 Vent Scrubber 4-1800FAPC Vertical Mounted with rain shield or approved equal.

R. Interior Pump Cable Support

1. The SJO jacketed pump power/control cables shall run un-cut from the submersible pumps to the pump control panel and not require any interior junction boxes. The weight of the pump cables shall be supported within the pump station via stainless strain relief (Kellums Grip), so that cable weight is not transferred to the associated conduit bushings.
2. Where submersible or ultrasonic type level control transducer device is used instead of, or in conjunction with, level control/emergency floats, the transduce cable shall have a dedicated conduit entrance to the station with dedicated conduit and cord bushing. All final transducer positioning and connection to pump control panel shall be completed on site by the site electrician.
3. Conduit seal fittings shall be supplied outside of the pump station and prior to the control panel on site by site electrician.

S. Wet Well Corrosion Protection Liner

1. The corrosion protection liner shall be Sewergard – Trowelable No. 210 by Sauereisen. Liner shall be factory applied and tested in a controlled environment per the manufacturer's recommendation.
2. Field Coring shall be coated with the corrosion protection liner as recommend by the manufacturer.
3. Any damage to the liner during installation or coring shall be repaired per the manufacturer's recommendation.

T. Lift Station Pumps

Requirements

Furnish and install two (2) submersible, non-clog, explosion-proof wastewater pump(s). Each pump shall be equipped with a 72 HP submersible electric motor, connected for operation on 460 volts, 3 phase, 60 hertz, with 50 feet of submersible cable (SUBCAB) suitable for submersible pump applications. The power cable shall be sized according to NEC and ICEA standards and also meet with P-MSHA Approval.

Pump Design Configuration

The pump shall be supplied with a mating cast iron four (4) inch discharge connection and be capable of delivering 610 GPM at 202 FT. TDH. The pump(s) shall be automatically and firmly connected to the discharge connection, guided by no less than two guide bars extending from the top of the station to the discharge connection.

There shall be no need for personnel to enter the wet-well. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact. Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable. No portion of the pump shall bear directly on the sump floor. Each pump shall be fitted with FLYGT Grip-Eye Lifting System. The working load of the lifting system shall be

50% greater than the pump unit weight.

Pump Construction

Major pump components shall be of grey cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities. The lifting handle shall be of stainless steel. All exposed nuts or bolts shall be of stainless steel construction. All metal surfaces coming into contact with the pump, other than stainless steel or brass, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

Sealing design shall incorporate metal-to-metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile O-rings. Fittings will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific torque limit.

Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.

Cooling System

Each unit shall be provided with an integral motor cooling system. A stainless steel motor cooling jacket shall encircle the stator housing, providing for dissipation of motor heat regardless of the type of pump installation. An impeller, integral to the cooling system and driven by the pump shaft, shall provide the necessary circulation of the cooling liquid through the jacket. The cooling liquid shall pass about the stator housing in the closed loop system in turbulent flow providing for superior heat transfer. The cooling system shall have one fill port and one drain port integral to the cooling jacket. The cooling system shall provide for continuous pump operation in liquid or ambient temperatures of up to 104°F (40°C). Operational restrictions at temperatures below 104°F are not acceptable. Fans, blowers or auxiliary cooling systems that are mounted external to the pump motor are not acceptable.

Cable Entry Seal

The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of dual cylindrical elastomer grommets, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter. The grommets shall be compressed by the cable entry unit, thus providing a strain relief function. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be sealed from each other, which shall isolate the stator housing from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered equal.

Motor

The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with

moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable.

The use of pins, bolts, screws or other fastening devices used to locate or hold the stator and that penetrate the stator housing are not acceptable.

The motor shall be designed for continuous duty while handling pumped media of up to 104°F. The motor shall be capable of no less than 30 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of aluminum. Three thermal switches shall be embedded in the stator end coils, one per phase winding, to monitor the stator temperature. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the motor control panel.

The junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression type terminals. The use of wire nuts or crimp-type connectors is not acceptable. The motor and the pump shall be produced by the same manufacturer.

The motor service factor (combined effect of voltage, frequency and specific gravity) shall be 1.15. The motor shall have a voltage tolerance of +/- 10%. The motor shall be designed for continuous operation in up to a 40°C ambient and shall have a NEMA Class B maximum operating temperature rise of 80°C. A motor performance chart shall be provided upon request exhibiting curves for motor torque, current, power factor, input/output kW and efficiency. The chart shall also include data on motor starting and no-load characteristics.

Motor horsepower shall be sufficient so that the pump is non-overloading throughout its entire performance curve, from shut-off to run-out. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

Refer to Section 26_05_09 of the Electrical Specifications for additional requirements.

Bearings

The integral pump/motor shaft shall rotate on two bearings. The motor bearings shall be sealed and permanently grease lubricated with high temperature grease. The upper motor bearing shall be a two row angular contact ball bearing to handle radial loads. The lower bearing shall be a two row angular contact ball bearing to handle the thrust and radial forces. The minimum L10 bearing life shall be 50,000 hours at any usable portion of the pump curve.

Mechanical Seals

Each pump shall be provided with a positively driven dual, tandem mechanical shaft seal system

consisting of two seal sets, each having an independent spring. The lower primary seal, located between the pump and seal chamber, shall contain one stationary and one positively driven rotating corrosion and abrasion resistant tungsten-carbide ring. The upper secondary seal, located between the seal chamber and the seal inspection chamber shall be a leakage-free seal. The upper seal shall contain one stationary and one positively driven rotating corrosion and abrasion resistant tungsten-carbide seal ring. The rotating seal ring shall have small back-swept grooves laser inscribed upon its face to act as a pump as it rotates, returning any fluid that should enter the dry motor chamber back into the lubricant chamber. All seal rings shall be individual solid sintered rings. Each seal interface shall be held in place by its own spring system. The seals shall not depend upon direction of rotation for sealing.

Mounting of the lower seal on the impeller hub is not acceptable. Shaft seals without positively driven rotating members or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces are not acceptable. The seal springs shall be isolated from the pumped media to prevent materials from packing around them, limiting their performance.

Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and shall provide capacity for lubricant expansion. The seal lubricant chamber shall have one drain and one inspection plug that are accessible from the exterior of the motor unit. The seal system shall not rely upon the pumped media for lubrication.

The area about the exterior of the lower mechanical seal in the cast iron housing shall have cast in an integral concentric spiral groove. This groove shall protect the seals by causing abrasive particulate entering the seal cavity to be forced out away from the seal due to centrifugal action.

A separate seal leakage chamber shall be provided so that any leakage that may occur past the upper, secondary mechanical seal will be captured prior to entry into the motor stator housing. Such seal leakage shall not contaminate the motor lower bearing. The leakage chamber shall be equipped with a float type switch that will signal if the chamber should reach 50% capacity.

Pump Shaft

The pump and motor shaft shall be a single piece unit. The pump shaft is an extension of the motor shaft. Shafts using mechanical couplings shall not be acceptable. The shaft shall be stainless steel – ASTM A479 S43100-T. Shaft sleeves will not be acceptable.

Impeller

The impeller shall be of Hard-Iron™ (ASTM A-532 (Alloy III A) 25% chrome cast iron), dynamically balanced, semi-open, multi-vane, back swept, screw-shaped, non-clog design. The impeller leading edges shall be mechanically self-cleaned automatically upon each rotation as they pass across a spiral groove located on the volute suction.

The leading edges of the impeller shall be hardened to Rc 60 and shall be capable of handling

solids, fibrous materials, heavy sludge and other matter normally found in wastewater. The screw shape of the impeller inlet shall provide an inducing effect for the handling of up to 5% sludge and rag-laden wastewater. The impeller to volute clearance shall be readily adjustable by the means of a single trim screw. The impeller shall be locked to the shaft, held by an impeller bolt and shall be coated with alkyd resin primer.

Volute/Suction Cover

The pump volute shall be a single piece grey cast iron, ASTM A-48, Class 35B, non-concentric design with smooth passages of sufficient size to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified. The volute shall have a replaceable suction cover insert ring in which are cast spiral-shaped, sharp-edged groove(s). The spiral groove(s) shall provide trash release pathways and sharp edge(s) across which each impeller vane leading edge shall cross during rotation so to remain unobstructed. The insert ring shall be cast of Hard-Iron™ (ASTM A-532 (Alloy III A) 25% chrome cast iron) and provide effective sealing between the multi-vane semi-open impeller and the volute housing.

Protection

Each pump motor stator shall incorporate three thermal switches, one per stator phase winding and be connected in series, to monitor the temperature of the motor. Should the thermal switches open, the motor shall stop and activate an alarm. A float switch shall be installed in the seal leakage chamber and will activate if leakage into the chamber reaches 50% chamber capacity, signaling the need to schedule an inspection.

The thermal switches and float switch shall be connected to a Mini CAS control and status monitoring unit. The Mini CAS unit shall be designed to be mounted in the pump MCC. The Mini CAS unit shall be provided by the pump manufacturer to the MCC manufacturer.

2.3 MATERIALS

Except as otherwise specified, material shall conform to the following section.

A. Materials

Cement	ASTM C 150 (Type I, II, III, or V)
	ASTM C 595 (for Blended Cements)
Silica Fume	ASTM C 1240
Fly Ash and Pozzolans	ASTM C 618
Ground Granulated Blast-Furnace Slag	ASTM C 989

Water	ASTM C 1602 (the use of reclaimed/recycled water shall be permitted)
Aggregates	ASTM C 33 (and aggregate specifications)
Air Entraining Admixtures	ASTM C 260
Accelerating, Retarding, Water Reducing Admixtures	ASTM C 494
Corrosion Inhibitors	ASTM C 1582
Reinforcing Bars	ASTM A 615 or ASTM A 706
Plain, Welded Wire Reinforcement	ASTM A 185
Deformed, Welded Wire Reinforcement	ASTM A 497
Epoxy Coated Reinforcing Bars	ASTM A 775
Epoxy Coated Welded Wire Reinforcement	ASTM A 884
Hot-Dipped Galvanizing for Inserts	ASTM A 152
Rubber Gaskets for Circular Pipe	ASTM C 443
External Sealing Bands for Pipe	ASTM C 877
Preformed Flexible Joint Sealants for Concrete Pipe, Manholes, and Manufactured Box Sections	ASTM C 990
Elastomeric Joint Sealants	ASTM C 920
Pipe Entry Connectors	ASTM C 923, ASTM C 1478
Nonshrink Grout	ASTM C 1107

2.4 MANUFACTURE

Manufacture shall conform to the producer's acceptable quality control manual

A. Forms

1. Forms for manufacturing precast concrete units shall be of the type and design consistent with industry standards and practices. They should be capable of consistently providing uniform products and dimensions. Forms shall be constructed so that the forces and vibrations to which the forms will be subjected cause no damage to the precast concrete unit.
2. Forms shall be cleaned of concrete build-up after each use.
3. Form release agents shall be applied according to the manufacturer's recommendations and shall not be allowed to build up on the form casting surface.

B. Reinforcement

1. Cages of reinforcement shall be fabricated by tying the bars, wires or welded wire reinforcement. The tolerances for concrete cover shall be 3/8 in. or as specified in the design. Welding shall be allowed only for ASTM A 706 rebar.
2. Positive means shall be taken to assure that the reinforcement does not move significantly during the casting operations

C. Embedded Items

1. Embedded items shall be positioned at locations specified in the design documents. Inserts and other embeds shall be held rigidly in place so that they do not move significantly during casting operations.

D. Concrete

1. Concrete Mixing
   i. Mixing operations shall produce batch-to-batch uniformity of strength, consistency and appearance
   ii. Batching weight and volume measurement devices shall be annually calibrated by an independent testing laboratory or more frequently if batching irregularities or concrete inconsistencies are observed
2. Concrete placing
   i. Concrete shall be placed in a manner in which it flows and consolidates without segregation or air entrapment. The freefall of concrete shall be kept to a minimum.
   ii. Cold Weather Concreting
      1. Recommendations for cold weather concreting are given in detail in ACI 306 R. Adequate equipment shall be provided for heating concrete materials and protecting concrete during freezing or near-freezing temperatures. All concrete materials, reinforcement, and forms shall be free from frost. In cold weather, the temperature of the concrete at the time of placement shall not be below 45 degrees F. Concrete that freezes before it reaches a compressive strength of 500 psi shall be discarded.
   iii. Hot Weather Concreting
      1. Recommendations for hot weather concreting are given in detail in ACI 305 R. During hot weather excessive concrete temperatures and water evaporation shall be minimized. The temperature of concrete at the time of placing shall not exceed 95 degrees F.
3. Concrete Curing
   i. Curing operations shall commence immediately following the initial set of the concrete and completion of surface finishing.
   ii. Curing by moisture retention

1. Precast products shall be protected from drafts and wind to prevent plastic shrinkage cracking.
2. Moisture shall be prevented from excessively evaporating from exposed surfaces until adequate strength for stripping the precast concrete unit from the form is reached.

iii. Curing with Heat and Moisture
1. Concrete shall not be subjected to steam or hot air until after the concrete has attained its initial set. If hot air is used, precautions shall be taken to prevent moisture loss from the concrete. The temperature of the concrete shall not be permitted to exceed 150 degrees F. The temperature gain shall not exceed 40 degrees F per hour.

4. Surface Finish
i. The surface finish shall be as specified on the contract documents and/or approved shop drawings.

5. Stripping Precast Concrete Units from Forms
Precast concrete units shall not be removed from the forms until the concrete reaches the compressive strength for stripping required by design. Stripping strengths shall be routinely measured to ensure product has attained sufficient strength for safe handling.

6. Patching and Repair
i. Repairing Minor Defects
1. Defects that will not impair the functional use or expected life of the precast concrete unit may be repaired by any method that does not impair the product

ii. Repairing Honeycombed Areas
1. When honeycombed areas are to be repaired, all loose material shall be removed, and the areas cut back into essentially horizontal or vertical planes to a depth at which coarse aggregate particles break under chipping rather than being dislodged. Proprietary repair materials shall be used in accordance with the manufacturer's instructions. Otherwise, the area shall be saturated with water. Immediately prior to repair, the area should be damp, but free of excess water. A cement-sand grout or an approved bonding agent shall be applied to the chipped surfaces, followed immediately by consolidating an appropriate repair material into the cavity.

iii. Repairing Major Defects
1. Defects in precast concrete products which impair the functional use, or the expected life of products shall be evaluated by qualified personnel to determine if repairs are feasible and, if so, to establish the repair procedure.

7. Shipping Precast Concrete Units
i. Precast concrete units shall not be shipped until they have reached at least 70% of their specified 28-day design strength, unless damage will not result, impairing the performance of the product.

2.5 WARRANTY

A. The manufacturer of the lift station shall guarantee for one (1) year from the date of installation, or 15-months from the date of factory completion (whichever occurs first), that the structure and all equipment will be free from defects in design, material and workmanship.
B. Warranties and guarantees by the suppliers of various components in lieu of a single source

responsibility by the manufacturer will not be accepted. The manufacturer shall be solely responsible for the warranty of the station and all components.

C. In the event a component fails to perform as specified or is proved defective in service during the warranty period, the manufacturer shall provide a replacement part without cost to the Owner. The Contractor shall further provide, without cost to the Owner such labor as may be required to replace, repair or modify major components such as the station structure, pumps, pump motors sewage piping manifold, etc.
D. The pumps warranty shall be 5 year prorated as follows.
    1. 1 - 18 Months: 100% Replacement
    2. 19 - 39 Months: 50% Replacement
    3. 40 - 60 Months: 25% Replacement
E. Wet Well Corrosion Protection Liner Warranty shall be 25 years or longer.

PART 3 EXECUTION

3.1 SURVEY

F. The installation area shall be surveyed using the work print and a checklist to identify the work to be done and to determine that the plans are correct
G. All underground facilities and structures such as gas, water, sewer, power, telephone cable, and so forth shall be located and identified. Location markings shall be placed by the affected utilities before construction
H. The survey shall identify and obstacles such as overhead wires, building structures that will interfere with crane operations, work progress, or create a safety hazard.
I. The survey shall give consideration to the soil structure so that proper shoring, sloping, or both may be planned in advance of the excavation work

3.2 PLANNING

A. Permits required to do work in accordance with the detail plans shall be secured before starting the job. All permits or a record of the permits shall be retained on the job for immediate reference
B. All utilities and owners of surface and subsurface facilities and structures in the area shall be given advance notification of proposed excavation. Every effort shall be made to avoid damage to the facilities of others. If any damage occurs, the owner of the damaged facility shall be notified immediately.
C. Planning shall include the coordination of all responsible parties to ensure that arrangements for removal of excess and damaged material have been made.
D. Should it appear that a structure location will interfere with traffic, review the situation with the engineer and notify appropriate authorities.
E. Provide for access to call boxes, fire hydrants, etc.

3.3 SAFETY REQUIREMENTS

A. Safety requirements for construction shall be in accordance with all federal, state, and local regulations.

3.4 EXCAVATING

A. If unforeseen facilities or obstructions are encountered, stop excavation operations immediately. Expose the obstruction with wood handled digging tools and investigate them with caution. If there is any doubt as to the type of obstruction exposed, request positive identification from those suspected of owning the facility and then proceed as circumstances dictate.
B. Inspect excavations after every rainstorm or other hazard-increasing occurrence, and increase the protection against slides and cave-ins, if necessary
C. In dewatering excavations, make certain that the discharge is carried to a suitable runoff point. Also verify that the design accounts for the level of groundwater encountered.
D. Excavation size shall be large enough to allow access around the structure after it is installed.
E. All excavating shall be under the full guidelines for on-site OSHA regulations, and shall be under the supervision of an OSHA-certified safety coordinator.

3.5 SHORING

A. Shoring for construction shall be in accordance with all federal, state, and local regulations

3.6 INSTALLATION

A. General
Installation of the pump chamber sections and related equipment shall be done in accordance with written instructions supplied by the manufacturer. Installation oversight service (1-day) can be provided by the pump station manufacture (as may be required by the owner), when specifically stated as necessary site service. Additional days for factory technicians shall be paid for at the standard daily rate.

B. Assembly
1. The pump station shall be factory assembled and shipped to the job site as follows:
    i. Wet well precast base assembly with interior fillet and extended base. Pump base elbow & slide couplings will be factory mounted.
    ii. Precast concrete riser shims as required, shall include holes and factory installed rubber boots as required.
    iii. Integral valve pit assembly shall include factory installed: piping, valves, supports, gauges, bypass, hatch drain to pump station – as required. Valve pit assembly my incorporate riser sections of 2' & 4' as may be required.
    iv. Precast pump station top slab shall include aluminum access covers (300# or HS20 loading as required).
    v. Miscellaneous items provided, and field installed shall include: pumps, floats, vertical discharge piping, dresser couplings, leak seals, and pump guide rails.

C. Site Access
The general contractor shall be responsible for providing adequate access to the site to facilitate hauling, storage, and proper handling of the precast concrete units.

D. Subgrade Bedding Materials and compaction

The installation contractor shall be responsible for ensuring that the subgrade is compacted to 95% of ASTM D558 density. The subgrade shall be a minimum of 6" in depth. A granular material shall be used to create a level surface for placing the precast concrete unit.

E. Installation

Precast concrete units shall be installed: to the lines and grades shown on the contract documents or otherwise specified; be lifted by suitable lifting devices at points provided by the precast concrete producer; in accordance with applicable industry standards. Upon request, the precast concrete producer shall provide installation instructions

Field modifications to the product shall relieve the precast producer of liability and warranty regardless if such modifications result in the failure of the precast concrete unit.

F. Leak Resistance

Where leak resistance is a necessary performance characteristic of the precast concrete unit's end use, joint sealant, pipe-entry connectors and other penetrations shall be sealed according to manufacturer's requirements to ensure the integrity of the system.

G. Lift Station Pumps

The Lift Station pumps and equipment shall be installed as shown on the Drawings.

The pumps shall be accurately aligned as specified by the use of steel shims or other approved methods so no binding in any moving parts or distortion of any member occurs before equipment is finally secured in place. After completion of alignment, equipment shall be carefully secured in place by anchor bolts.

3.7 BACKFILLING AND RESTORATION

A. Do the backfilling as soon as possible after the structure has been placed.
B. Backfill material shall be granular and free from large stones, rocks, and pavement. Expansive soil material shall not be used as backfill around the structure.
C. Backfilling shall be achieved by lifts (layers) to the required compaction.
D. Follow up inspections for settlements are required. Should settlement occur, the contractor shall be responsible for all necessary repairs.

3.8 FIELD QUALITY CONTROL

A. Inspection
    1. Final field elevations and compaction properties shall be verified and documented.

3.9 SPARE PARTS

A. Spare parts shall include the following:
    - Upper and lower bearings
    - Upper and lower mechanical seals
    - o-ring kit

3.10 O&M MANUALS

A. Four (4) sets of Operation and Maintenance Manuals shall be furnished for the pump station along with a pdf digital copy. The digital copy shall be searchable with bookmarks for easy navigation. The manuals shall contain instructions that are comprehensive, and sufficiently detailed for the intended use.
B. The Operation and Maintenance Manuals shall be assembled in a permanent binder, complete with index and cover clearly identifying the pump station name. The manuals shall be compiled in a logical and organized manner.
C. The Manuals shall contain specific pump station instructions which will enable personnel to operate and maintain the pump station and all equipment associated with each individual system installed within the station.
D. Manuals that are a compilation of generalized manufacturer's literature that are not solely applicable to the particular pumping station will not be accepted.
E. The Manuals shall contain, but not be limited to:
F. Pump service and maintenance instructions to include the following:
    1. Instructions on operation of the pump and pump control in all intended modes of operations.
    2. Written instruction to enable an operator to properly operate and maintain the equipment supplied. Content of the instructions shall assume the operator is familiar with pumps, motors, piping and valves but that he has not previously operated and/or maintained the exact equipment supplied.
    3. Instruction for all adjustments which must be performed at initial start-up of pump equipment, adjustments required after the replacement of liquid level control system components, and adjustments as required in the course of preventative maintenance as specified by the manufacturer.
    4. Electrical schematic diagram of the pump and control package prepared in accordance with NMTBA and JIC Standards. Schematics shall illustrate, to the extent of authorized repair, pump motor branch, control and alarm system circuits, and interconnections among the circuits. Wire numbers shall be shown on the schematic. Schematic diagrams for individual components, not normally repairable by the station operator, need not be included and details for such parts shall not be substituted for an overall system schematic. Partial schematics, block diagrams, and simplified schematics shall not be provided in lieu of an overall system diagram.
    5. Operation and maintenance instructions shall be specific to the equipment supplied in accordance with these specifications. Instruction manuals applicable to many different configurations of pump stations and which require the operator to selectively read portions of the manual shall not be acceptable.
G. Duplex pump control panel programing and maintenance instruction and wiring diagrams, as detailed in the control panel specification section
H. All pump station equipment service and maintenance instructions for equipment supplied in the package pump station product.
I. AS-BUILT fabrication and assembly drawings.
J. Start-up & training reports
K. Product warranties

L. Product contact information and project reference information.

3.11 Leak Testing

The wet well shall be leak tested to ensure a water tight seal. The leak test shall be a negative air pressure test per ASTM C1244.

3.12 Start-Up and Testing

A. The contractor shall have a pump manufacturer rep onsite to aid in the start-up and testing of the system.

B. The start-up must be done in the presence of the City Inspector and Wastewater Operations personnel before the City will accept the installation.

C. The contractor shall make adjustments required to place system in proper operating condition. The equipment shall be field tested and calibrated to assure that the system operates in accordance with these Specifications and to the satisfaction of the Owner.

After completion of installation, the system shall be completely tested to ensure compliance with the operating requirements as specified and indicated on the Drawings.

The Contractor shall initially start-up and place all equipment installed into successful operation according to manufacturer's written instructions and as instructed by manufacture's field representative. Start-up must demonstrate and test the full functionality/range of all equipment. The Contractor shall provide all materials, labor, tools, equipment, chemicals, lubricants and expendables required to complete start-up.

No system or sub-system shall be started up for continuous operation unless all components of that system or subsystem, including instrumentation, have been tested and proven to be operable as intended by the Contract Documents.

3.13 Method of Measurement

Method and measurement shall be per Section 01019.3.

3.14 Basis of Payment

Basis of payment shall be lump sum per Section 01019.3.

END OF SECTION

15010.1 DESCRIPTION

15010.1.1 WORK INCLUDED

A. Basic requirements common to the work in general of Division 15 and other Divisions and Sections of the Specification where referenced.

B. Provide, unless specified otherwise, all labor, materials and equipment necessary for completely finished and operational mechanical systems described and specified under other Sections of this Division 15.

C. Provide all minor incidental items such as offsets, fittings, and accessories required as part of the work even though not specified or indicated.

D. Inspection: Inspect work preceding or interfacing with work of Division 15 and report any known or observed defects that affect the Work to the Construction Manager/General CONTRACTOR. Do not proceed with the work until defects are corrected.

E. Existing Utilities: Are indicated as accurately as possible on the Drawings. Close openings and repair damage in acceptable manner to utilities encountered. This CONTRACTOR shall be responsible for field surveying all aspects of existing conditions prior to bid date. Change orders will not be issued for a failure to review existing conditions which affect division 15000 work.

15010.1.2 RELATED WORK

Requirements: Provide Basic Requirements in accordance with the Contract Documents.

15010.1.3 UTILITIES, EXTENSIONS, CONNECTIONS AND FEES FOR WATER AND SEWER

A. Provide all building services extensions and connections to off-site and on-site utilities.

B. Sewer connection charges, typically based on fixture units, that in principle allow the right to obtain the sewer services from the utility will be arranged and paid for by the Division 15 CONTRACTOR.

C. Water system development fees, typically based on meter size, that in principle allow the right to obtain the water services from the utility will be arranged and paid for by the Site Utilities CONTRACTOR.

D. Sewer tap fees as they are known to the trade and are the charges for actual materials and labor for tapping, inspection and recording of the tap shall be arranged and paid for by the Site Utilities CONTRACTOR.

E. Water tap fees as they are known to the trade and are the charges for actual materials and labor for tapping, inspection and recording of the tap shall be arranged and paid for by the Site Utilities CONTRACTOR.

F. In the event that the serving utility company installs their own taps, service, meters, etc., all costs imposed by this action shall be paid for by the Division 15 CONTRACTOR. Extensions from termination points to connection with building services and systems will be the responsibility of the Division 15 CONTRACTOR.

G. Be responsible for all pads, vaults, manholes, manhole covers, meter enclosures, valves, services boxes, and the like, all in conformance with requirements of the serving utility company.

H. In the event that the water service to the building is a combination domestic and fire protection service, the responsibility of said "combination service" to the point of domestic connection shall be that of a licensed Fire Protection CONTRACTOR, including tap, valves, excavation, backfill, compaction and meters, if any. After point of domestic connection, responsibility for separate fire and domestic services is with appropriate trades including all labor and materials as herein before mentioned.

1. CONTRACTOR shall coordinate with other trades all interface piping and types of connections to be provided for interface.
2. Provide fire hydrant, auxiliary gate valve, tapping sleeve and valve or tee, service boxes, and anchor or swivel couplings, thrust blocks, deadmen, rods, and the like, all in conformance with the requirements of serving utility company.

15010.1.4 REFERENCES

General:

1. For products or workmanship specified by association, trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

2. The date of the standard is that in effect as the date of the Contract Documents, except when a specific date is specified.

3. When required by individual Specifications section, obtain copy of standard. Maintain copy at job site during work until substantial completion.

15010.1.5 DEFINITIONS

A. Specification Language Explanation: These Specifications are of abbreviated, simplified or streamlined type and include incomplete sentences. Omissions of words of phrases such as "the CONTRACTOR shall", "in conformity therewith", "shall be", "as noted on the drawings", "a", "the", are intentional. Supply when "NOTE" occurs on Drawings. Supply words "shall be" or "shall" by inference when colon is used with sentences or phrases. Supply words "on the Drawings" by inference when "as indicated" is used with sentences or phrases. Singular words will be interpreted as plural and plural words will be interpreted as singular where applicable and where full context of the Contract Documents so indicates.

B. Furnish: Except as otherwise defined in greater detail, term "furnish" is used to mean supply and deliver to project site, ready for unloading, unpacking, assembly, installation, etc., as applicable in each instance.

C. Install: Except as otherwise defined in greater detail, term "install" is used to describe operations at Project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations, as applicable in each instance.

D. Provide: Except as otherwise defined in greater detail, term "provide" means furnish and install, complete and ready for intended use, as applicable in each instance.

E. Indicated: The term "Indicated" is a cross-reference to graphics, notes or schedules on Drawings, to other paragraphs or schedules in the Specifications, and to similar means of recording requirements in contract documents. Where terms such as "shown", "noted", "scheduled", and "specified" are used in lieu of "indicated", it is for purpose of helping reader locate cross-reference, and no limitation of location is intended except as specifically noted.

F. General CONTRACTOR: The term "General CONTRACTOR" used in Division 15 and elsewhere in the Contract Documents means the party with whom the OWNER has executed the OWNER-CONTRACTOR Agreement.

G. Approved equal: Except as otherwise defined in greater detail, term "approved equal" means that any materials, equipment, work procedures and techniques shall be either addressed on the drawing, specifications or addendum by manufacturer or by detailed material description. When brand names are referenced it implies that only the manufacturers listed are approved. All approved material, equipment, work procedures, and

techniques will be noted in the specifications, drawings, or by addendum prior to bid date. Items not approved in this manner will not be considered.

15010.1.6 QUALITY ASSURANCE

A. Quality Control

1. Materials and apparatus required for the work to be new and of first-class quality; to be furnished, delivered, erected, connected and finished in every detail; and to be so selected and arranged so as to fit properly into the appropriate spaces. Where no specific kind or quality of material is given, a first-class standard article shall be furnished.

2. Furnish the services of an experienced superintendent, who will be constantly in charge of the installation of the work, together with all skilled workmen, fitters, metal workers, certified welders, plumbers, millwrights, sprinkler fitters, drain layers, helpers, and labor required to unload, transfer, erect, connect, adjust, start, operate and test for each system.

3. Unless otherwise specifically indicated, equipment and materials to be installed in accordance with the recommendations of the manufacturer. This includes the performance of tests as recommended by the manufacturer.

B. Proof of Performance

1. Division 15 CONTRACTOR shall provide proof of performance certification of all Mechanical Equipment and Systems to demonstrate that all Mechanical Equipment and Systems are operating to the intent of the design. This proof of performance shall include, but shall not be limited to, actual demonstration of all temperature/pressure control loops, operation of all heating/cooling equipment and other required tests upon request by the Engineer or OWNER. A signed certificate from the piping, sheetmetal, control, and balancing subcontractors stating that they have personally checked the operation of all equipment and control loops and that everything under their subcontract is operating as specified. These certificates shall be furnished to the 15000 CONTRACTOR for inclusion in the Operation and Maintenance Manual.

15010.1.7 REGULATORY REQUIREMENTS

A. Execute Work per Underwriters, Public Utility, Local and State Codes, Ordinances and applicable regulations. Obtain and pay for required permits, inspections, and certificates. Notify Architect of items not meeting said requirements.

B. Comply with editions of all applicable codes, ordinances and regulations in effect at the time of bid opening including but not necessarily limited to the following:

International Mechanical Code
International Plumbing Code
State Department of Health Requirements
Model Energy Code
National Fire Protection Association Standards
International Fire Code
International Building Code
National Electrical Code NFPA-70
State Boiler Code
Jurisdictional County Health Department
Jurisdictional City Wastewater Management Division or District
Jurisdictional City Water Department
Jurisdictional Water Conservation Standards

C. If discrepancies occur between the Contract Documents and any applicable codes, ordinances, acts, or standards, the most stringent requirements shall apply.

D. Where hourly fire ratings are indicated or required, provide components and assemblies meeting requirements of the UBC, and listed by Underwriters Laboratories, Inc.

15010.1.8 SUBMITTALS

A. CONTRACTORs are required to submit Mechanical Cost Breakdown to Engineer when submitting shop drawings. Shop drawings will not be accepted without a complete Mechanical Cost Breakdown. See last page of this Section for requested breakdown. If your standard compilation of bids is different than our requested breakdown, please send it in your format. We need the data to keep our cost estimating files up to date. Just fill-in blanks with a pencil, typing is not required.

B. Submit Samples, Shop Drawings and Product Data as required by various Sections of Division 15 in accordance with The General Conditions of the Contract. The CONTRACTOR agrees that these Submittals processed by the Engineer are not Change Orders; that the purpose of these Submittals by

the CONTRACTOR is to demonstrate to the Engineer that the CONTRACTOR understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install and by detailing the fabrication and installation methods he intends to use. CONTRACTOR further agrees that if deviations, discrepancies, or conflicts between these Submittals and the Contract Documents in the form of design drawings and specifications are discovered either prior to or after these Submittals are processed by the Engineer, the Design Drawings and Specifications shall control and shall be followed.

C. The submittals shall be submitted in a single package with all mechanical equipment for the project enclosed. The submittals shall be enclosed in a stiff back, 3-ring binder. All mechanical equipment shall be separated with tabbed index cards with an indexed legend provided in the front of the binder.

D. Test Reports: Submit certified test reports as required by various Sections of Division 15 showing compliance in accordance with General Conditions of the Contract. Signed copies shall be included in the Operation and Maintenance Manual.

E. Operating Instructions and Maintenance Data: Prepare and submit printed operating instructions and maintenance data in accordance with Operating and Maintenance Data paragraph in this Section.

15010.1.9 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Substitutions and Prior Approvals: Substitutions and prior approvals will be acceptable only when the proposed substitute has been submitted to the Engineer and approved through an addendum or change order. Request for prior approval shall be submitted a minimum of 10 calendar days prior to bid.

B. Some materials and equipment are specified by manufacturer and catalog numbers. The manufacturer and catalog numbers are used to establish a degree of quality and style for such equipment and material.

C. NOTE: When alternate or substitute materials and equipment are used Division 15 CONTRACTOR shall be responsible for engineering/redesign costs, space requirements, configurations, performance, changes in bases, supports, structural members and openings in structure, electrical changes and other apparatus and trades that may be affected by their use. Notification of General CONTRACTOR and other affected subcontractors shall be the responsibility of the Division 15 CONTRACTOR.

15010.1.10 PROJECT RECORD DOCUMENTS

A. General: Comply with Division 1.

B. Job Site Documents: Maintain at the job site, one record copy of the following:

1. Drawings
2. Specifications
3. Addenda
4. Reviewed Shop Drawings
5. Field Test Records

Do not use record documents for construction purposes. Maintain documents in clean, dry legible condition, apart from documents used for construction.

C. Record Information: Label each document "Record Document". Mark information with red ink. Keep each record current. Do not permanently conceal any work until required information is recorded.

D. Record following information on Drawings:

1. Horizontal and vertical location of underground utilities to be dimensioned from column lines.

2. Dimensioned location of internal utilities and appurtenances concealed in construction.

3. Field changes of dimension and detail.

4. Changes by change order or field order.

5. Details not on original contract drawings.

6. Manufacturer, trade name, catalog number and supplier of each product and item of equipment actually installed shall be indicated on equipment schedules.

E. Record the following information on Specifications.

1. Changes by change order or field order.
2. Other matters not originally specified.

F. Shop Drawings: Maintain shop drawings as record documents recording changes made after review as specified for drawings above.

G. Submittal: At completion of project, deliver record documents to OWNER's representative and transmit a copy of signed receipt from OWNER to the Engineer.

15010.1.11 OPERATING AND MAINTENANCE DATA

A. Division 15 CONTRACTOR shall submit O&M manual in pdf format for review. Once approved, three (3) typed and bound copies of the final manual, 8-1/2" x 11" in size, shall be submitted to the OWNER. These approved copies will be returned to the CONTRACTOR and shall then be transmitted to the OWNER. A table of contents shall be provided which indicates all equipment in the O&M manuals. Additionally, a bookmarked PDF copy of all O&M manuals must be provided to the owner.

B. Organization of the manuals shall follow the recommendations in ASHRAE Guideline 4-1993.

C. The manual shall be enclosed in a stiff-back, three-ring binder and shall have:

1. Alphabetical list of all system components including the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year's operation.

2. Operating instructions for complete system, including emergency procedures for fire or failure of major equipment and procedures for normal starting/operating/ shutdown and long-term shutdown.

3. Maintenance instructions, including valves, valve tag and other identified equipment lists, proper lubricants and lubricating instructions for each piece of equipment and necessary cleaning/replacing/adjusting schedules.

4. All test reports and proof of performance certificates.

5. Manufacturer's data on each piece of equipment, including the following. Provide original printed material in each book, faxes and photocopies are NOT acceptable.

a. Installation instructions.
b. Drawings and specifications (final shop drawings).
c. Parts lists.
d. Complete "as-built" wiring and temperature control diagrams. (Shop drawings are not acceptable.)
e. Lubrication and other preventative maintenance data.
f. Equipment warranties.

D. In addition to the maintenance manual, and keyed to it, the equipment shall be identified and tagged as specified on drawings. Insert a copy of the Equipment List or Equipment Schedules in manual.

1. Identify all starters, disconnect switches, and manually operated controls, except integral equipment switches. Label with permanently applied, legible markers corresponding to operating instructions in the "Maintenance Manual".

2. Tag all manual operating valves per requirements in Section 15010.

3. Provide a typed tag list or schedule mounted under glass in the equipment room stating number, location, and function of each tagged item. Insert a copy of tag list in each "Maintenance Manual".

E. Division 15000 CONTRACTOR shall be responsible for scheduling instructional meetings for maintenance personnel on the proper operation and maintenance of all mechanical systems, using the maintenance manual as a guide. These meetings must be scheduled through the Architect, Construction Manager/General CONTRACTOR and far enough in advance so that all necessary personnel can be adequately notified.

15010.1.12 DELIVERY, STORAGE AND HANDLING

A. General: Deliver and store materials and equipment in manufacturer's unopened containers fully identified with manufacturer's name, trade name, type, class, grade, size and color.

B. Protection: Store materials and equipment off the ground and under cover, protected from damage. Maintain caution labels on hazardous materials.

C. Large Items: Make arrangements with other contractors on the job for introduction into the building of equipment too large to pass through finished openings.

D. Handling of Materials: Materials shall be handled, sorted and distributed using appropriate handling methods to protect all materials from damage. Dented, rusted, corroded or otherwise damaged materials shall be removed from the project site. Determination of materials deemed unusable or inappropriate for installation shall be made by the Architect/Engineer.

15010.1.13 PROJECT CONDITIONS

A. Accessibility:

1. Division 15 CONTRACTOR shall be responsible for the sufficiency of the size of shafts and chases and the adequate clearance in double partitions and hung ceilings for proper installation of his work. He shall cooperate with CONTRACTORs of other Divisions of the Work whose work is in the same space and shall advise the Construction Manager/General CONTRACTOR of his

requirements. Such spaces and clearances shall, however, be kept to the minimum size required.

2. Division 15 CONTRACTOR shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include (but not be limited to) valves, shock absorbers, traps, cleanouts, motors, controllers, switchgear, filters, VAV boxes, control valves, balancing valves, and drain points. If required for better accessibility, furnish access doors for this purpose. Minor deviations from Drawings may be allowed to provide for better accessibility. Any changes shall be approved by the Architect/Construction Manager/General CONTRACTOR prior to making the change.
3. Division 15 CONTRACTOR shall provide the Construction Manager/General CONTRACTOR with the exact locations of access doors for each concealed valve, shock absorber control, damper, or other device requiring service. Locations of these doors shall be submitted in sufficient time to be installed in the normal course of work.

B. Fabrication: Before any ductwork is fabricated and before running and/or fabricating any lines of piping or ductwork, the CONTRACTOR shall assure himself that they can be run as contemplated in cooperation with CONTRACTORS of other Divisions of the Work and the physical constraints of the Structural and Architectural Work.

C. Freeze Protection: Do not run lines in outside walls, or locations where freezing may occur. Piping next to outside walls shall be in furred spaces with insulation between the piping and the outside wall. Insulation of piping shall not be considered freeze protection.

D. Scaffolding, Rigging and Hoisting: Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of any equipment and apparatus furnished; remove same from premises when no longer required.

15010.1.14 COORDINATION

A. General: Coordinate and order the progress of mechanical work to conform to the progress of the work of the other trades. Complete the entire installation as soon as the condition of the building will permit.

B. Coordination with Electrical Work: Section 15010.

C. Utility Interruptions: Coordinate mechanical utility interruptions with the OWNER and the Utility Company. Plan work so that duration of the interruption is kept to a minimum.

D. Cutting and Patching: Section 15010.

E. Drawings and Specifications: The Mechanical Drawings indicate the general design and arrangement of lines, equipment, systems, etc. Information shown is diagrammatic in character and does not necessarily indicate every required offset, fitting, etc. Do not scale the Drawings for dimensions. Take dimensions, measurements, locations, levels, etc., from the Architectural Drawings and equipment to be furnished.

F. Each Division 15 subcontractor shall coordinate with other contractors to make certain that any of his equipment; piping or ductwork which is mounted on isolators or flexibly connected does not become "grounded" by another contractors work (e.g. walls, ceiling, etc.).

G. Discrepancies: Examine Drawings and Specifications for other parts of the work, and if any discrepancies occur between the plans for the work of this Division and the plans for the work of others, report such discrepancies to the Construction Manager/General CONTRACTOR and obtain written instructions for any changes necessary.

H. Order of Precedence: The precedence of mechanical construction documents are as follows:

1. Addenda and modifications to the Drawings and Specifications take precedence over the original Drawings and Specifications.

2. Should there be a conflict within the Specifications or within Drawings of the same scale, the more stringent or higher quality requirements shall apply.

3. In the Drawings, the precedence shall be Drawings of larger scale over those of smaller scale, figured dimensions over scaled dimensions and noted materials over graphic indications.

4. Should there be a conflict in dimensions or locations between Mechanical Drawings and Architectural Drawings, the Architectural Drawings shall have precedence.

15010.1.15 START-UP PROCEDURES

A. Before start-up, each piece of equipment comprising a part of the system shall be checked for proper lubrication, drive rotation, belt tension, proper control sequence, and any other condition which may cause damage to equipment or endanger personnel.

B. Insure that all control systems are fully operational in automatic mode. Individually test each control loop to make certain it is operating as intended and is communicating properly with other devices.

C. If systems are not to continue in use following the start-up procedures, steps should be taken to insure against accidental operation or operation by unauthorized personnel. Provide padlocks on disconnect switches where applicable.

D. Factory personnel shall be notified as appropriate to start systems requiring their services.

E. Notify Engineer at least 2 weeks prior to the scheduled start-up date of all major mechanical equipment and systems.

15010.1.16 SCHEDULE OF TESTING

A. Provide testing in accordance with the Division 15 and General Conditions of the Contract.

B. A schedule of testing shall be drawn up by the Division 15 CONTRACTOR in such a manner that it will show areas tested, test pressure, length of test, date, time and signature of testing personnel.

C. All testing must be performed in the presence of the Architect's/Construction Manager's/General CONTRACTOR's representative; his signature for verification of the test must appear on the schedule.

D. All testing must be performed in accord with the procedures set forth in Division 15 and other Sections of the Specifications where referenced. At completion of testing, the completed schedule shall then be submitted in triplicate to the Architect and a copy shall be forwarded to the 15000 CONTRACTOR for inclusion in Operation and Maintenance Manual.

E. Make all specified tests on piping, ductwork and related systems as specified in this specification.

F. Make sure operational and performance tests are made on seasonal equipment.

G. Complete all tests required by Code Authorities, such as smoke detection, life safety, fire protection and health codes.

H. After test runs have been completed and systems have been demonstrated to be satisfactory and ready for permanent operation, all permanent pipeline strainers and filters shall be cleaned, air filters cleaned or replaced, valve and

pump packings properly adjusted, belt tensions adjusted, drive guards secured in place, lubrication checked and replenished if required.

15010.1.17 CLEANING AND FINISHING

A. Provide cleaning in accordance with the General Conditions of the Contract and Division 1.

B. Cleaning shall include but not be limited to removing grease, dirt, dust, stains, labels, fingerprints and other foreign materials from sight-exposed piping, ductwork, equipment, fixtures and other such items installed under Division 15 of the work. If finishes have been damaged, refinish to original condition and leave everything in proper working order and of intended appearance.

15010.1.18 WARRANTIES

A. Warranty: Provide a written warranty to the OWNER covering the entire mechanical work to be free from defective materials, equipment and workmanship for a period of one year after Date of Acceptance.

B. During this period provide labor and materials as required to repair or replace defects. Provide certificates for such items of equipment which have warranties in excess of one year. Submit to the Construction Manager/General CONTRACTOR for delivery to the Architect. Include a copy of all warranties in the Operation and Maintenance Manual.

C. This warranty will be superseded by the terms of any specific equipment warranties or warranty modifications resulting from use of equipment for construction heat or ventilation.

D. All refrigeration compressors shall have a (4) four year extended warranty from the manufacturer of the equipment in addition to the standard one-year warranty.

15010.1.19 PROJECT CLOSEOUT

Project Observation Reports: At or near the completion of the construction phase of this project, the Engineer will generate one or more Project Observation Reports for the owner. These reports will list the items of construction observed by the Engineer which are not in compliance with the Contract Documents. The Mechanical CONTRACTOR and/or subcontractors shall certify completion of each listed item in writing and forward copies to the Architect, Engineer and General CONTRACTOR. The Engineer will not recommend the payment of retainage until this compliance certification has been received. Each item on the Project Observation Report shall have a signature/date in the margin of the report indicating completion of that item.

15010.1.20 CERTIFICATES AND KEYS

A. Certificates: Upon completion of the work, deliver to the Construction Manager/General CONTRACTOR one copy of Certificate of Final Inspection.

B. Keys: Upon completion of work, submit keys for mechanical equipment, panels, etc. to the Construction Manager/General CONTRACTOR.

15100 PIPING

15100.1 DESCRIPTION

This section covers piping materials for the project.

15100.1.1 REFERENCES

MAG Section 615 – Sanitary Sewer Line Construction
MAG Section 745 – PVC Sewer Pipe and Fittings
MAG Section 750 – Iron Water Pipe and Fittings
MAG Section 753 – Galvanized Pipe and Fittings
Section 01300 – Submittals

15100.1.2 SUBMITTALS

The Contractor shall submit for review complete information, showing all pipe, materials, fittings, gaskets, couplings, coatings, linings, supports, mechanical restraints, and configuration prior to the delivery of any components to the project. All information shall be provided in accordance with Section 01300 and written evidence of compliance from the manufacturer shall accompany each delivery of material.

15100.2 MATERIALS

15100.2.1 Ductile Iron Pipe (DIP) – DIP pipe and fittings shall be per MAG 750. Approved manufacturers are McWane Ductile, US Pipe, or American.

Interior and Exterior corrosion protection for pipes and fittings shall per Section 09910.2.3.2.

15100.2.2 Polyvinyl Chloride Pipe (PVC)

- PVC Schedule 80 Piping and Fittings - Piping shall meet the requirements of ASTM D1785 of the schedule and size shown on the Drawings. Fittings shall meet the requirements of ASTM D2467. Fittings and piping will be glued with appropriate adhesives.

- PVC C900 Piping – Piping shall meet the requirements of ANSI/AWWA Standard C900 (latest revision). The pressure class or the dimensional ratio and the size shall be as shown on the Drawings. Approved manufacturers are Diamond Plastics Corporation, North American Specialty Products, JM Eagle, of Vinyltech Corporation.

- Fittings for PVC C900 Piping – C900 lines shall have DIP fittings shown on the Drawings. Fittings per MAG 750.

- PVC SDR-35 – Gravity sewer piping shall be per MAG 745.

15100.2.3 Stainless Steel (SS) Pipe – SS pipe and fittings shall be 316L stainless steel per ASTM A312

Size	Description
1 inch and smaller	Schedule 80, seamless
>1 inch to 3 inch	Schedule 80, seamless
3 inch and larger	Schedule 40, welded or seamless

All welding procedures and qualifications of the welding procedures shall conform to Section IX of the ASME Boiler and Pressure Vessel Code. Al welders and welding operators shall be qualified under Section IX of the ASME Boiler and Pressure Vessel Code. Provide full penetration welds, free of cracks, overlap and cold laps.

SS Fittings - Fittings 3 inches and smaller shall be forged butt welded per ASTM A-182 or cast threaded and socket welded per ASTM A-351

15100.2.4 Galvanized Pipe and Fittings shall be per MAG 753.

15100.3 CONSTRUCTION REQUIREMENTS

Construction requirements shall be per MAG, these Specifications, and the Drawings.

15100.4 METHOD OF MEASUREMENT

The method of measurement shall be per Section 01019.3.

15100.5 BASIS OF PAYMENT

The basis of payment shall be per Section 01019.3.

15240 FORCE MAIN

15240.1 DESCRIPTION

This section is for the materials, construction, restraining, and testing of the force main.

15240.1.1 REFERENCES

MAG Section 601 – Trench Excavation, Backfilling, and Compaction
MAG Section 610 – Water Line Construction
MAG Section 611 – Water, Sewer, and Strom Drain Testing
MAG Section 615 – Sanitary Sewer Line Construction
MAG Section 750 – Iron Water Pipe and Fittings
Section 01300 – Submittals

15240.1.2 SUBMITTALS

Submittals shall be in accordance with Section 01300 and these Specifications.

15240.2 MATERIALS

15240.2.1 DIP - Piping and fittings shall be DIP per MAG 750.

15240.2.2 C900 – C900 pipe shall be per AWWA C900-07 and have a pressure rating of DR14.

15240.2.2 Joint Restraints – Joint restraints shall be mechanical restraints, no thrust blocks will be allowed. Approved manufacturers are Star Pipe Product, Tyler Union Tuf Grip, EBAA Iron Inc Megalug, Romac Industries RomaGrip, or Sigma Corporation PV-LOK. Appropriate model shall be selected for PVC and DIP as required. No other restrain systems will be allowed.

15240.2.3 All DI pipe, fittings, and valves shall have a polyethylene wrap per MAG 610.

15240.2.4 Interior Corrosion Protection – Interior corrosion protection for DI pipes, fittings, and valves shall be Novocoat SP-2000W by ErgonArmor or Series 431 Perma-Shield PL by Tnemec.

15240.2.4 1" Stainless Steel Ball Valve – The ball valve shall be ANSI Class 150 and can be full bored or reduced bored.

15240.2.5 Plug Valve – Plug valve shall be DeZurik 100% port eccentric plug valve with accessories as shown on the plans.

15240.3 CONSTRUCTION REQUIREMENTS

15240.3.1 Piping, valves, and fittings shall be installed per MAG 610.

15240.3.2 Joint restraints shall be used at all bends, elbows, tees, crosses, dead ends, stubs, taps, fire hydrants, and valve locations. Fittings shall be either flange or Mechanical Joints. Where required, mechanical restraints shall be installed.

15240.3.3 Polyethylene wrap shall be installed per MAG 610 for DIP.

15240.3.4 Interior corrosion protection for DIP shall be applied according to manufacturer recommendation.

15240.3.5 Trenching and Backfill shall be per MAG 601 and the Drawings. Cover shall be 36" unless stated otherwise in the Drawings.

15240.3.6 The plug valve shall be orientated as shown on the plans. The seat of the DeZurik valve shall be field adjusted by a DeZurik rep.

15240.4 TESTING

The force main shall be pressure tested per MAG 611 hydrostatic test.

15240.5 METHOD OF MEASUREMENT

The method of measurement shall be per Section 01019.3.

15240.6 BASIS OF PAYMENT

The basis of payment shall be per Section 01019.3.

CITY OF SEDONA

SEDONA, ARIZONA

CHAPEL LIFT STATION IMPROVEMENT PLANS

TECHNICAL SPECIFICATIONS
DIVISIONS 26 & 40

100% SUBMITTAL

January 2019

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CHAPEL LIFT STATION IMPROVEMENT PLANS

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SECTION 26_05_00

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 as specified in Section 00700 - General Requirements.
   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. The General and Supplementary Conditions of the Contract Documents govern the Work.
      b. 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 Section 00700 - General Requirements for substitute item provisions.

F. Changes and change orders:
1. As specified in Section 00700 - General Requirements.

1.02 REFERENCES

A. Code compliance:
1. 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.
2. 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).
2) 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
k. National Institute of Standards and Technology (NIST).
l. Underwriters' Laboratories, Inc. (UL).

B. Compliance with laws and regulations:
1. As specified in Section 00700 - General Requirements.

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. Demolition:
    a. Where demolition is specified or indicated on the Drawings, disconnect all associated electrical equipment and render the equipment safe.
    b. Remove and dispose of all conduit, wire, electrical equipment, controls, etc. associated with the items and/or areas to be demolished as indicated on the Drawings unless otherwise indicated.
    c. Salvage electrical equipment as indicated on Drawings or indicated herein.
    d. For each piece of equipment to be removed, remove all ancillary components (e.g. instruments, solenoid valves, disconnect switches, etc.).
    e. Conduit:
        1) Where conduit removal, other than associated with equipment to be removed, is indicated on the Drawings:
            a) Remove exposed conduit to the point of encasement or burial.
            b) Cut conduit flush and plug or cap encased or buried conduit.
        2) Where conduits are to remain in place and removal is not indicated on the Drawings:
            a) Cap conduit open ends.
            b) Re-label empty conduits as spare.
    f. Remove all wire back to the source for all conduits to be removed or abandoned in place.
    g. Provide new nameplates for modified electrical distribution equipment, motor control centers etc. to identify equipment and circuits that are no longer used as spares.
6. 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.
7. 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.
8. Utility coordination: Coordinate with the electric utility as required by Section 26_05_03 - Utility Coordination.

B. Existing system:
    1. Chapel Lift Station:
        a. Demolish existing electrical equipment as indicated on the Drawings.
        b. Salvage existing generator to Sedona WTP.

C. New system:
    1. Chapel Lift Station:
        a. Coordinate the installation of new electric utility transformer and meter with the Electric Utility.

b. Install new Motor Control Center and service entrance disconnect as indicated on Drawings.
c. Install the relocated 60 kW generator and fuel tank from Mystic Lift Station as indicated on Drawings.
d. Install new lighting and receptacles, and associated cable and conduit as indicated on Drawings.
e. Install cable and conduit associated with new Lift pumps.
f. Install new instruments and associated cable and conduit as indicated on the Drawings.
g. Bid Alternate: In addition to the above work,
    1) Install magnetic flow meter as indicated on drawings.
    2) Install cable associated with the magnetic flowmeter, and generator apparent power.
    3) In lieu of relocating the 60kW generator noted under base bid, install a new 80 kW generator. In Bid Alternate, the existing fuel tank from Mystic Lift Station shall be used similar to Base bid.

1.05 SUBMITTALS

A. Furnish submittals as specified in 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 26_05_53 - 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.
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 01090 - Abbreviations & Reference Standards, 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.

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. Submittal organization:
1. First page:
a. Specification section reference.
b. Name and telephone number of individual who reviewed submittal before delivery to Engineer.
c. Name and telephone number of individual who is primarily responsible for the development of the submittal.
d. Place for Contractor's review stamp and comments.
2. Next pages:
a. Provide confirmation of specification compliance:
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.
b. Include a response in writing to each of the Engineer's comments or questions for submittal packages which are re-submitted:
1) In the order that the comments or questions were presented throughout the submittal.
2) Referenced by index section and page number on which the comment appeared.
3) Acceptable responses to Engineer's comments are either:
a) Engineer's comment or change is accepted and appropriate changes are made.
b) Explain why comment is not accepted or requested change is not made.
c) Explain how requirement will be satisfied in lieu of comment or change requested by Engineer.
4) Any re-submittal, which does not contain responses to the Engineer's previous comments shall be returned for Revision and Re-submittal.
5) No further review by the Engineer will be performed until a response for previous comments has been received.

3. Remaining pages:
    a. Actual submittal data:
        1) Organize submittals in exactly the same order as the items are referenced, listed, and/or organized in the specification section.
        2) 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 intended to be used.

E. Submittal requirements:
1. Furnish submittals that are fully indexed with a tabbed divider for every component.
2. Sequentially number pages within the tabbed sections. Submittals and operation and maintenance manuals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.
3. Edit all submittals and operation and maintenance manuals so that the submittal specifically applies to only the equipment furnished.
    a. 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.
4. Submit copies of shop drawings, and product data:
    a. Show dimensions, construction details, wiring diagrams, controls, manufacturers, catalog numbers, and all other pertinent details.
5. Where submittals are required, provide a separate submittal for each specification section. 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. (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.)
6. Exceptions to Specifications and Drawings:
    a. Include a list of proposed exceptions to the Specifications and Drawings along with a detailed explanation of each.
    b. If there is insufficient explanation for the exception or deviation, the submittal will be returned requiring revision and re-submittal.
    c. Acceptance of any exception is at the sole discretion of the Engineer.
        1) Provide all items (materials, features, functions, performance, etc.) required by the Contract Documents that are not accepted as exceptions.
    d. Replace all items that do not meet the requirements of the Contract Documents, which were not previously accepted as exceptions, even if the submittals contained information indicating the failure to meet the requirements.
7. Specific submittal requirements:
    a. Shop drawings:
        1) Required for materials and equipment listed in this and other sections.

2) Furnish sufficient information to evaluate the suitability of the proposed material or equipment for the intended use, and for compliance with these Specifications.
3) Shop drawings requirements:
a) Front, side, and, rear elevations, and top and bottom views, showing all dimensions.
b) Locations of conduit entrances and access plates.
c) Component layout and identification.
d) Schematic and wiring diagrams with wire numbers and terminal identification.
e) Connection diagrams, terminal diagrams, internal wiring diagrams, conductor size, etc.
f) Anchoring method and leveling criteria, including manufacturer's recommendations for the Project site seismic criteria.
g) Weight.
h) Finish.
i) Nameplates:
(1) As specified in Section 26_05_53 - Identification for Electrical Systems.
j) Temperature limitations, as applicable.

b. Product data:
1) Submitted for non-custom manufactured material listed in this and other sections and shown on shop drawings.
2) Include:
a) Catalog cuts.
b) Bulletins.
c) Brochures.
d) Quality photocopies of applicable pages from these documents.
e) Identify on the data sheets the Project name, applicable specification section, and paragraph.
f) Identify model number and options for the actual equipment being furnished.
g) Neatly cross out options that do not apply or equipment not intended to be supplied.

c. Detailed sequence of operation for all equipment or systems.

F. Operation and maintenance manuals:
1. Furnish the Engineer with a complete set of written operation and maintenance manuals 8 weeks before Functional Acceptance Testing.
2. Additional operation and maintenance manual requirements:
a. Completely index manuals with a tab for each section:
1) Each section containing applicable data for each piece of equipment, system, or topic covered.
2) Assemble manuals using the approved shop drawings, and include, the following types of data:
a) Complete set of 11-inch by 17-inch drawings of all equipment.
b) Complete set of control schematics.
c) Complete parts list for all equipment being provided.
d) Catalog data for all products or equipment furnished.

G. 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.

H. Record Documents:
    1. Provide Record Documents of all Electrical Drawings.
    2. Record Drawing requirements:
        a. Update Record Drawings weekly.
        b. Record Drawings must be fully updated as a condition of the monthly progress payments.
        c. Submit Record Drawings upon completion of the Work for final review.
        d. Clearly and neatly show all changes including the following:
            1) All existing pipe, conduit, wire, instruments or other structures encountered or uncovered during construction.
    3. Shop drawings:
        a. Upon completion of the Work, update all shop drawings to indicate the final as-built configuration of the systems:
            1) Provide as-built shop drawings for all electrical equipment on 11-inch by 17-inch paper.
                a) Size all drawings to be readable and legible on 11-17 inch media.
            2) Provide electronic copies of these documents on CD-ROM or DVD disks in PDF format.
    4. Review and corrections:
        a. Correct any record documents or other documents found to be incomplete, not accurate, of poor quality, or containing errors.
        b. Promptly correct and re-submit record documents returned for correction.

I. Test reports:
    1. Include the following:
        a. A description of the test.
        b. List of equipment used.
        c. Name of the person conducting the test.
        d. Date and time the test was conducted.
        e. All raw data collected.
        f. Calculated results.
        g. Each report signed by the person responsible for the test.
    2. Additional requirements for field acceptance test reports are specified in Sections 01200 - Contract Closeout and 26_08_50 - 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. Shipping precautions:
   1. After completion of shop assembly and successful factory testing, pack all equipment in protective crates, and enclose in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture.
   2. Place dehumidifiers, when required, inside the polyethylene coverings.
   3. Skid-mount the equipment for final transport.
   4. Provide lifting rings for moving without removing protective covering.
   5. Display boxed weight on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.

B. 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.

C. Special instructions:
   1. Securely attach special instructions for proper field handling, storage, and installation to each piece of equipment before packaging and shipment.

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.
   3. Wind load resistance:
      a. Provide electrical equipment with construction and anchorage to supporting structures designed to resist site wind loads.
   4. Altitude, temperature and humidity:
      a. Provide all electrical components and equipment fully rated for continuous operation at this altitude, with no additional derating factors applied.
      b. 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 Division 1 and 2 specifications.

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 materials 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. Provide specific materials as specified or indicated on the Drawings.
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. NEMA Type 6: Rated for submergence.
6. NEMA Type 6P: Rated for prolonged submergence.
7. NEMA Type 7: Intended for installation in locations where explosive or combustible gas or vapors may be present (Class I Division 1 or Class I Division 2) meeting the requirements outlined in Section 26_05_02 - Hazardous Classified Area Construction.

C. Plant area Electrical Work requirements:
1. Provide all Electrical Work in accordance with the following table, unless otherwise specifically indicated on the Drawings:

PLANT AREA	NEMA ENCLOSURE TYPE	EXPOSED CONDUIT TYPE	ENVIRONMENT W = WET D = DAMP C = CLEAN/DRY X = CORROSIVE H = HAZARDOUS	SUPPORT MATERIALS
Wet Well Interior	NEMA 7	PCS	W, X, H	316 SS
Wet Well Exterior 3 ft from wet well hatch and 1.5 ft above wet well hatch, and Metering vault	NEMA 4X SS	PCS	D, X	316 SS
Other areas except Generator and Motor Control Center	NEMA 4X SS	PCS	D, X	316 SS

2. Modify exposed conduit runs as specified in Section 26_05_33 - Conduits.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING

A. General:
   1. As specified in Sections 01030 - Project Meetings and 01200 - Contract Closeout.
   2. Testing requirements are specified in Sections 01200 - Contract Closeout, 26_08_50 - Field Electrical Acceptance Tests, and other sections.
   3. Work restrictions and other scheduling requirements are specified in Section 01400 MAG Section 105 and 106 - Quality Control.
   4. Commissioning requirements as specified in Section 01200 - Contract Closeout.

B. Pre-submittal conference:
   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. Contractor, electrical subcontractor, all suppliers, and individual equipment manufacturers furnishing major pieces of equipment must attend.

C. Factory acceptance testing (FAT):
   1. Where FAT is required for equipment covered by these Specifications, notify the Engineer in writing when the equipment is completed and ready for factory inspection and testing:
      a. Indicate the desired dates for inspection and testing.
      b. Schedule the FAT after approval of the FAT procedures submittal:
         1) Submit a copy of the test procedures including all forms at least 21 days before any scheduled test date.
         2) Notify the Engineer of the scheduled tests a minimum of 15 days before the date of the test.

1.11 WARRANTY

A. Warrant the Electrical Work as specified in MAG Section 108:
   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 as specified in Section 00700 - General Requirements.

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. 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. Terminations:
   1. Provide and terminate all conductors required to interconnect power, controls, instruments, panels, and all other equipment.

G. Miscellaneous installation requirements:
   1. In case of interference between electrical equipment indicated on the Drawings and the other equipment, notify the Engineer as specified in Section 00700 - General Requirements.
   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.

H. Labeling:
   1. Provide all nameplates and labels as specified in Sections 26_05_53 - Identification for Electrical Systems and 26_05_74 - Electrical System Studies.

I. 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.
   2. All control panels, VCPs, LCPs, RTUs, PCMs, etc., 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 01200 - Contract Closeout.

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 01200 - Contract Closeout.

C. Owner training:
   1. As specified in Section 01200 - Contract Closeout and in this Section.

D. Source testing (FAT):
   1. Provide source testing and owner training on electrical equipment as defined in the table below:

Table1: 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)
26_32_14	Single Diesel Fueled Engine Generator	Non-Witnessed	6	4
26_29_05	Motor Starters	Non-Witnessed	8	8
26_24_20	Low Voltage Motor Control Centers	Non-Witnessed	8	8

3.08 FIELD QUALITY CONTROL

A. Inspection:
   1. Allow for inspection of electrical system installation as specified in Section 01400 - MAG Section 105 and 106 - 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.

4. Inspection activities conducted during construction do not satisfy inspection or testing requirements specified in Section 26_08_50 - 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 26_08_50 - 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. Remove all foreign material and restore all damaged finishes to the satisfaction of the Engineer and Owner.

B. 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.

C. Clean and re-lamp all new and existing luminaries that were used in the areas affected by the construction, and return all used lamps to the Owner.

D. 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 26_05_02

HAZARDOUS CLASSIFIED AREA CONSTRUCTION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Executing and completing Work in hazardous and/or classified areas as defined by the NEC Articles 500 through 516, NFPA 820, and as indicated on the Drawings and specified in the Specifications.

1.02 REFERENCES

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Specific definitions:
   1. For the purposes of these Specifications, the terms "Hazardous" and "Classified" will be considered synonymous.

1.04 SYSTEM DESCRIPTION (NOT USED)

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26_05_00 - Common Work Results for Electrical.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Regulatory requirements:
   1. All wiring in hazardous and/or classified locations shall comply with all applicable articles of the NEC, in particular Articles 500 through 516.
   2. Except as modified in Articles 500 through 516, all other applicable rules contained in the NEC shall apply to electric equipment and wiring installed in hazardous and/or classified locations.
   3. All devices used in Class I Division 1 or Division 2 areas must have visible manufacturer installed nameplates specifically stating the Class, Division, and Group for which the device is approved.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. A list of hazardous areas is specified in Section 26_05_00 - Common Work Results for Electrical.

B. The following areas are classified Class I, Division 1:
   a. Interior of the wet well.

C. The following areas are classified Class I, Division 2:
   a. Area extending 3 feet beyond the hatch opening of the wet well.
   b. Area extending 1.5 feet above the hatch.

1.09 SEQUENCING

A. Conduit seals shall be filled during start-up and commissioning after verification of field wiring. Conduit seals shall be filled prior to the introduction of process or gas to the equipment/area.

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 (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

A. Conduit and sealing fittings:
   1. As specified in Section 26_05_33 - Conduits.

B. Conduit boxes and bodies:
   1. As specified in Section 26_05_34 - Boxes.

C. Wiring devices:
   1. As specified in Section 26_27_26 - Wiring Devices.

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 26_05_00 - Common Work Results for Electrical.

B. Conduit installation:
   1. As specified in Section 26_05_33 - Conduits.
   2. Wrench tighten all conduit joints to minimize sparking when fault current flows through the conduit system.
   3. Make all conduit connections so that there are a minimum of 5 threads fully engaged in the connection.
   4. Flexible conduit:
      a. Class I Division 1 hazardous areas:
         1) Approved and marked suitable for Class I Division 1.
         2) Listed for compatibility with the group type atmosphere where used.
      b. Class I Division 2 areas:
         1) Liquidtight metal conduit with approved fittings.
      c. Maximum length as specified in Section 26_05_33 - Conduits.

C. Sealing fittings:
   1. Provide an approved seal, no more than 12 inches from the enclosure, for all conduits entering an enclosure containing switches, circuit breakers, fuses, relays, resistors, or any other apparatus which may produce arcs, sparks, or high temperatures:
      a. Only explosion proof unions, couplings, elbows, capped elbows, and conduit bodies similar to "L", "T", and "X" may be installed between the sealing fitting and the enclosure.
   2. Provide entire assemblies approved for Class I locations for self-sealing or factory sealed assemblies where the equipment that may produce arcs, sparks, or high temperatures is located in a compartment separate from the compartment containing splices or taps, and an integral seal is provided where conductors pass from one compartment to the other:
      a. Seals are required in all conduit connections to the compartment containing splices and must be within 12 inches of the enclosure.
   3. Install a conduit seal within 12 inches of the boundary in each conduit run entering or leaving a classified location. No union, coupling, box, or fitting is allowed in the conduit between the sealing fitting and the point at which the conduit leaves the classified location.

4. For underground conduits entering or leaving a classified location or between Class I Division 1 and Division 2 locations:
    a. Provide a conduit seal at both points where the conduit emerges from the ground:
        1) Place the conduit seal within 18 inches of finished grade.
        2) No union, coupling, box, or fitting is allowed in the conduit system between the seal fitting and the point at which the conduit enters the ground.
5. Separate all conductors within the conduit system and seal using an approved packing dam installed to both hold the sealing compound and to maintain the separation between the wires:
    a. Remove the outer jacket of multi-conductor non-shielded cables in the area of the sealing fitting and separate each conductor from the cable and seal individually.
6. Install seals with drains in all electrical control stations, low points of conduit or any place where moisture may condense and accumulate.
7. Install the sealing compound with a minimum thickness of 5/8 inch or the trade size of the conduit, whichever is greater.

D. Boxes and fittings:
1. Class I Division 1 areas:
    a. Utilize threaded connections for all metallic boxes, fittings, and joints to the conduit system.
2. Class I Division 2 areas:
    a. Provide approved grounding bushings on conduits entering and exiting metallic boxes to bond the conduits together.

E. Outlet boxes and bodies:
1. Provide conduits bodies and boxes suitable for the conduit system as specified in Section 26_05_33 - Conduits.
2. Class I Division 2 areas:
    a. Boxes not containing arcing parts:
        1) Material and NEMA ratings as specified in Section 26_05_00 - Common Work Results for Electrical.
        2) Pressed metal boxes are not allowed.
    b. Provide heavy duty cast construction type conduit fittings and joints:
        1) Explosion proof rated fittings and joints are not necessary.
    c. Any enclosure containing arcing parts, etc. shall have all construction associated with the enclosure, conduit system, etc. conforming to Class I Division 1 construction.

F. Motor connections:
1. Conduit installation in Class I Division 1 and Class I Division 2 locations for motors that contain arcing parts, shall proceed as follows:
    a. First - Conduit.
    b. Second - Explosion proof flexible coupling.
    c. Third - Sealing fitting.
    d. Fourth - Explosion proof union.
    e. Fifth - Connection to the motor terminal box.
2. Wiring connections to motor leads shall be as specified in Section 26_05_21 - Low Voltage Wire Connections.
3. Bond the non-current-carrying metal parts of equipment, raceways and other enclosures as required by the NEC to ensure electrical continuity.

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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Obtain inspection and approval from the Engineer before and after each seal is poured.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_05_03

UTILITY COORDINATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Coordination with the utility companies to provide service.
   2. Contractor's responsibilities for connecting to utilities and providing utility service to the facilities.
   3. Descriptions of utility services required.

1.02 REFERENCES

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Utility contacts:
   1. Electric utility:
      a. Name: Jonathan Meyer.
      b. Utility: APS.
      c. Phone number: 928-646-8462, 928-592-2364.
      d. E-mail: Jonathan.Meyer@aps.com

1.04 SYSTEM DESCRIPTION

A. Electrical service:
   1. Provide all Work and materials and bear all costs for providing temporary construction power and the permanent electrical service, including but not limited to:
      a. All Work and materials not provided by the electric utility.
      b. All permits and fees required by the electric utility.
   2. Provide electrical ducts, raceways, conductors and connections indicated on the Drawings, and all other Work and materials required for a complete electrical service, including but not limited to the following:
      a. Electrical service conduits and conductors from the point of electric utility connection to the service entrance equipment.
      b. Metering conduits from the instrument transformers to the meter.

B. General:
   1. Coordinate and obtain inspections and final installation approval from the serving utilities and other authorities having jurisdiction.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26_05_00 - Common Work Results for Electrical.

B. Certification:
   1. Submit certification that the intended installation has been coordinated with the utility companies.
   2. Include a narrative description of the utility's requirements and points of connection, names and telephone numbers for contacts at the utilities.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Materials and equipment used in performance of Electrical Work shall be listed or labeled by UL, or other equivalent recognized independent testing laboratory, for the class of service intended.

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING

A. General:
   1. Before start of Site Work, make arrangements for electrical service as required.

B. Electrical systems:
   1. Before bidding, the electrical contractor shall contact the utilities to determine the Work and materials that will be required from the Contractor, and all fees and permits that will be required, so that all utility systems furnished by the Contractor will be included in the bid.
   2. Coordinate Work with Engineer to minimize downtime of existing operating equipment and electrical distribution systems and to preclude unsafe operation:
      a. Notify Owner 10 days before power interruptions.
      b. Coordinate downtime with Owner and local electric utility.
   3. Before commencing Work, coordinate electric service entrance requirements with local electric utility to ensure that the installation will be complete as specified in these Contract Documents:
      a. Ensure power transformer size, electrical characteristics, and location are consistent with the design and service voltage provided by the electric utility coordinated with other trades.
      b. Arrange for utility revenue meter.
      c. Coordinate installation of metering CTs and PTs furnished by the electric utility.
      d. Pay any charges required by the electric utility for connection and turn-on.

C. Before commencing Site Work, coordinate underground conduit installations with other Work to eliminate conflicts and avoid interferences with other underground systems.

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS (NOT USED)

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Furnish materials in accordance with the applicable requirements of the utilities and as specified in these Specifications.

B. Refer to APS "Electric Service Requirements 2018" for additional utility requirements.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. Furnish equipment in accordance with the applicable requirements of the utilities and as specified in these Specifications.

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 26_05_00 - Common Work Results for Electrical.

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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_05_09

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 26_05_00 - 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 - Vibration, Axial Position, and Bearing Temperature Monitoring 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. 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).

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 26_05_00 - 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 Section 26_05_00 - 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. Additional data for motors installed in classified areas:
      a. Temperature code.
      b. Hazardous area approval indicating Class, Division, and Group:
   6. Accessories data:
      a. Power factor correction capacitors:
         1) Size in KVAR, for all motors not connected to variable frequency drives.
   7. Mechanical data:
      a. Bearing design and bearing life calculations.

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. Calculations:
   1. Where site conditions specified in Section 26_05_00 - Common Work Results for Electrical exceed manufacturer's ratings, provide derating calculations for each motor.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - 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. Explosion-proof:
        1) Tapped drain holes with corrosion resistant plugs for frames 286 and smaller and automatic breather and drain devices for frames 324 and larger.
    d. 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.
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 installed in hazardous locations:
1. Class I, Division 1 or Class II, Division 1 areas:
    a. Enclosures:
        1) Explosion proof for 3-phase motors.
        2) UL listed in conformance with UL-674.
        3) UL approval with nameplate and serial number.

D. Motors installed in corrosive environments:
   1. Nameplate indicating conformance to IEEE 841.
   2. Stator double dipped in varnish and baked.
   3. Stator and rotor coated with corrosion resistant epoxy.
   4. Frame, brackets, fan guard and conduit box coated with minimum of 2 coats of epoxy paint.
   5. Withstand salt spray tests in accordance with ASTM B117.

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 26_05_00 - Common Work Results for Electrical.

B. Install motors in accordance with 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 01200 - Contract Closeout.

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 26_05_00 - 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 26_08_50 - Field Electrical Acceptance Tests.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26_05_00 - 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 26_05_18

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 26_05_00 - 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 Nonshielded 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.

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 Tests for Fire Resistive Cables.
   6. 2225 - Standard for Cables and Cable-Fittings for Use in Hazardous (Classified) Locations.

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - 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. 9XHHW: 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 Section 26_05_00 - 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 26_05_00 - 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 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - 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.

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 26_05_53 - Identification for Electrical Systems:
      a. Use integral color insulation for #2 AWG and smaller wire.
      b. Wrap colored tape around cable larger than #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 #12 AWG minimum for power conductors.
         3) Provide #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.
      b. 90-degree Celsius rating.

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. #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. #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.

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 26_05_53 - 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 26_05_00 - 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. Wires in intrinsically safe circuits shall be light blue.
   8. 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 #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 #1 AWG and smaller, install cables by hand.
   3. For cables larger than #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. Use smooth-rolling sheaves and rollers when pulling cable into cable tray to keep pulling tension and bending radius within manufacturer's recommendations.

G. Install and terminate all wire in accordance with manufacturer's recommendations.

H. 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.

I. 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.

J. Lighting circuits:
   1. Each circuit shall have a dedicated neutral.

K. 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 26_05_00 - 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.

L. Apply wire markers to all wires at each end after being installed in the conduit and before meg-ohm testing and termination.

M. 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 26_05_26 - Grounding and Bonding.

N. Submersible cable in wet wells:
1. Provide Kellem's grip or stainless steel wire mesh to support cable weight and avoid stress on insulation.

O. 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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Grounding:
   1. As specified in Section 26_05_26 - Grounding and Bonding.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_05_21

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 26_05_00 - 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 26_05_00 - 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 Section 26_05_00 - Common Work Results for Electrical.

B. Product data:
   1. Catalog cut sheets.
   2. Installation instructions.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. All materials shall be UL listed.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - 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 and 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 and 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 26_05_00 - 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 26_05_18 - 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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_05_26

GROUNDING AND BONDING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Grounding materials and requirements.

1.02 REFERENCES

A. As specified in Section 26_05_00 - 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. 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 26_05_00 - Common Work Results for Electrical.

1.04 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 26_08_50 - Field Electrical Acceptance Tests, shall be:
   1. 5 ohms or less for industrial systems.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26_05_00 - Common Work Results for Electrical.

B. Product data:
   1. Catalog cut sheets.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. All grounding components and materials shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Compression connectors: One of the following or equal:
   1. FCI Burndy.
   2. Thomas & Betts.

B. Ground rods: One of the following or equal:
   1. Erico.
   2. Harger.
   3. Conex.

C. Ground cable: One of the following or equal:
   1. Nehring.
   2. Harger.
   3. 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 EXISTING PRODUCTS (NOT USED)

2.03 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.
   2. Size is as indicated on the Drawings, but not less than required by the NEC.

C. 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.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Precast ground well boxes:
   1. Minimum 10 inch interior diameter.
   2. Traffic-rated cast iron cover.
   3. Permanent "GROUND" marking on cover.

2.08 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 26_05_00 - 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:

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. 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.

I. 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.

J. 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.

K. Shield grounding:
   1. Shielded instrumentation cable shall have its shield grounded at one end only unless shop drawings indicate otherwise:
      a. The grounding point shall be at the control panel or at the power source end of the signal carried by the cable.
   2. Terminate the shield drain wire on a dedicated terminal block.
   3. Use manufacturer's terminal block jumpers to interconnect ground terminals.
   4. Connection to the panel main ground bus shall be via a green No. 12 conductor to the main ground bus for the panel.

L. 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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_05_29

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 26_05_00 - 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 26_05_00 - 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 Requirements 01090 - Abbreviations & Reference Standards.
   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 26_05_00 - 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 26_05_00 - 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 Section 26_05_00 - 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, wall supports for all equipment in excess of 200 pounds, and all freestanding supports:
a. 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 26_05_00 - Common Work Results for Electrical.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM STARTUP

A. As specified in Section 26_05_00 - 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. Thomas & Betts.
   2. Power-Strut.
   3. Unistrut.
   4. Cooper B-Line.
   5. Robroy.
   6. Aickinstrut.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Use materials appropriate for the area as specified in Section 26_05_00 - Common Work Results for Electrical.

B. Hot dip galvanized steel:
   1. Supports:
      a. In accordance with ASTM A123 or A153.
      b. Minimum zinc coating thickness of 2.5 mils.
   2. Hardware:
      a. Electro-galvanized.
      b. In accordance with ASTM A153.

C. Stainless steel:
   1. Supports:
      a. In accordance with ASTM A240.
      b. ANSI Type 316 material.
   2. Hardware:
      a. ANSI Type 316 material.

D. PVC coated galvanized steel:
    1. Supports:
        a. Hot dip galvanized steel as specified in this Section.
        b. PVC coating thickness of 10 to 20 mils.
    2. Hardware:
        a. 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 Division 5 specifications.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Paint and finish all supporting structures as specified in Section 09910 - Painting.

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 26_05_00 - Common Work Results for Electrical.

B. Mount all raceways, cabinets, boxes, fixtures, instruments, and devices on Contractor-fabricated racks unless otherwise indicated on the Drawings.
    1. Provide the necessary sway bracing to keep trapeze type structures from swaying under seismic events or wind loading.

C. Brace and anchor freestanding equipment supports using methods that provide structural support based on the seismic loads and wind loads:
    1. Lateral deflection at top of supports not to exceed support height divided by 240 unless otherwise approved by the Engineer.

D. Provide fabricated steel support pedestals for wall mounted panels that weigh more than 200 pounds:
   1. Fabricate pedestals out of welded angle, tube sections, or preformed channel.
   2. If the supported equipment is a panel or cabinet, match the supported equipment in physical appearance and dimensions.
   3. Provide auxiliary floor supports for transformers hung from stud walls and weighing more than 200 pounds.

E. Mount all equipment, cabinets, boxes, instruments, and devices in damp or wet locations on minimum of 7/8-inch preformed mounting channel.
   a. Mount channel vertically along the length of the device so that water or moisture may run freely behind the device.

F. Corrosion protection:
   1. Isolate dissimilar metals, except where required for electrical continuity.
      a. Use neoprene washers, 9-mil polyethylene tape, or gaskets for isolation.

G. Raceway:
   1. Furnish all racks and trapeze structures needed to support the raceway from the structure.
      a. Group raceway and position on racks to minimize crossovers.
      b. Provide the necessary bracing to keep trapeze type structures from swaying under loads from cable installation, seismic forces, or wind forces.

H. Anchoring methods:
   1. Solid concrete: Anchor bolts, anchor rods or post-installed anchors as specified in Section Division 5 specifications.
   2. Metal surfaces: Machine screws or bolts.
   3. Hollow masonry units: Post-installed anchors as specified in Section Division 5 specifications.

I. When supporting devices on metal or wood stud construction, bridge studs with preformed channel, and mount the devices to the channel.

J. 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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_05_33

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 26_05_00 - 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 and 80 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 26_05_00 - 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. NPT: National pipe thread.

1.04 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.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26_05_00 - 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.

E. Installation drawings: Installation drawings, including individual conduit numbers, routing, sizes, cable sizes, and circuit numbers for each conduit.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - 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.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - 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.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 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.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. PVC-coated rigid steel conduit:
   1. One of the following or equal:
      a. Robroy Ind.
      b. Ocal, Inc.
      c. Calbond.

B. Sealtight-liquidtight flexible conduit:
   1. One of the following or equal:
      a. Southwire.
      b. AFC Cable Systems.
      c. Electri-Flex Co.
      d. Anaconda.

C. Rigid nonmetallic PVC conduit:
    1. One of the following or equal:
        a. Carlon.
        b. Cantex.
        c. Triangle Conduit and Cable.

D. 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.

E. Joint compound:
    1. The following or equal:
        a. Thomas and Betts.

F. Conduit seals:
    1. One of the following or equal:
        a. Appleton.
        b. Crouse-Hinds.
        c. O-Z/Gedney.

G. Conduit hangers and supports:
    1. As specified in Section 26_05_29 - Hangers and Supports.

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. 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 longitudinal 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 moisturetight seal at every connection.

B. 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 inches.

C. 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.

D. Conduit bodies:
   1. Material consistent with conduit type:
      a. Malleable iron bodies and covers when used with Type GRC.
      b. PVC bodies and covers when used with Type PVC.
      c. 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 #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.

2.07 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. Sealing fittings:
   1. Construction:
      a. 40-percent wire fill capacity.
      b. PVC-coated when used in corrosive areas.
      c. Malleable ductile iron with steel conduit.
      d. Type EYDX where drains are required.
      e. Type EYSX where drains are not required.
      f. UL listed for use in Class I, Division 1, Groups A, B, C, D; Class I, Division 2, Groups A, B, C, D; and Class II, Divisions 1 and 2, Groups E, F, and G.
   2. Sealing compound:
      a. Fiber filler and cement as recommended by the sealing fitting manufacturer.
      b. Approved for the conditions and use.
         1) Not affected by surrounding atmosphere or liquids.
      c. Melting point shall be 200 degrees Fahrenheit minimum.

H. PVC fittings:
   1. Shall include the following:
      a. Couplings.
      b. Terminal adapters.
      c. Female adapters.
      d. Caps.
      e. Reducer bushings.
      f. Duct couplings.
      g. End bells.
      h. Expansion couplings.

i. Duct couplings: 5 degree.
j. C-Type pull fittings.
k. E-Type pull fittings.
l. LB-Type pull fittings.
m. LL-Type pull fittings.
n. LR-Type pull fittings.
o. T-Type pull fittings.
p. X-Type pull fittings.
q. Service entrance caps.

2. Materials:
   a. All devices shall be made of PVC, using the same materials as used for Type PVC conduit.
   b. All metal hardware shall be stainless steel.

I. Conduit markers:
   1. As specified in Section 26_05_53 - 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. As specified in Section 26_05_00 - 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 26_05_00 - 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:
2) Perform any changes resulting in additional conduits, or extra work from such deviations.
3) Incorporate any deviations on the Record Documents.

c. Owner reserves the right to deduct the amount of applicable reimbursement, equivalent to the cost of the engineering effort required to show those unauthorized changes on Record Drawings.

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. Conduits may be run in concrete members or slabs with permission of the Engineer or as indicated on the Drawings:
   a. Refer to the typical details for conduit spacing and size requirements.
10. 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.
11. Plug conduits brought into pull boxes, manholes, handholes, and other openings until used to prevent entrance of moisture.
12. Install conduits through wall and floor seals where indicated on the Drawings.
13. 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.
14. 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.
15. Install complete conduit systems before conductors are installed.
16. 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.
17. Underground conduits:
    a. Make underground conduit size transitions at handholes and manholes.
    b. 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 26_05_00 - Common Work Results for Electrical.

D. Hazardous areas:
   1. As specified in Section 26_05_00 - Common Work Results for Electrical for hazardous areas and specific Class and Division.
   2. As specified in Section 26_05_02 - Hazardous Classified Area Construction for hazardous area conduit installation requirements.

E. Conduit usage:
   1. Exposed conduits:
      a. Rigid conduit:
         1) Install the rigid conduit type for each location as specified in Section 26_05_00 - 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. Type PVC Schedule 40 and PVC-coated rigid metallic conduit as specified below:
      1) Use Type PCS in underground and embedded installation as follows:
         a) Stub-up and risers to grade floor or equipment from nonmetallic conduits.
         b) Entering and exiting underground or embedded conduit runs a minimum 12 inches above and below grade of finished floor.
         c) For any and all bends where the total deflection is greater than 45 degrees.
   b. Minimum size:
      1) 2-inch in duct banks unless otherwise indicated on the Drawings.
      2) 1-inch for in-slab conduits unless otherwise indicated on the Drawings.
3. PVC:
   a. Conduit terminations shall be via threaded adapters into threaded hubs on the junction boxes or conduit bodies.
   b. Conduit terminations into boxes without threaded hubs shall utilize a threaded adapter and a flat neoprene washer on the outside of the box.
      1) Use a locknut on the inside of the box to tighten the adapter to the box.

c. Route conduit to afford it the maximum physical protection.
    1) If necessary, cover conduit to afford additional protection when it cannot be shielded by the structure or machinery frames.
        a) Use Schedule 80 where exposed runs may be subject to physical damage.

F. 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.
    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.

G. 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.

H. Conduit supports:
   1. General:
      a. Provide appropriate hangers, supports, fasteners, and seismic restraints to suit applications:
         1) As specified in Section 26_05_29 - Hangers and Supports.
         2) Provide support materials consistent with the type of conduit being installed as specified in Section 26_05_00 - 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 conduit supports:
    a. Mount all conduits with hangers specifically designed for use with PVC to minimize the problems of bowing resulting from the expansion and contraction of conduits caused by varying temperatures:
        1) Hangers to be constructed of PVC incorporating serrated teeth to grip the conduit securely and yet allow for conduit movement due to thermal considerations:
        2) Manufacturers: The following or equal:
            a) Carlon; Models E978D, E, F, G, H, and J.
6. 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.

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. 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.
2. Replace any conduits installed that the Engineer determines do not meet the requirements of this Specification.
3. 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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_05_34

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 26_05_00 - 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 26_05_00 - 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 Section 26_05_00 - 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 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - 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. Cast device boxes:
      a. Appleton.
      b. Crouse - Hinds.
      c. OZ/Gedney.
   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. 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.

B. Class I Division 1 areas:
   1. Provide boxes designed and listed for Class I Division 1 locations and group type atmosphere in which they will be used:
      a. The approval ratings must be permanently marked on each item.

C. Class I, Division 2 areas:
    1. For boxes not containing arcing parts:
        a. As specified in Section 26_05_00 - Common Work Results for Electrical.
        b. Pressed metal boxes are not allowed.
    2. For boxes containing arching parts provide:
        a. Boxes designed and listed for Class I Division 1 locations and group type atmosphere in which they will be used:
            1) The approval ratings must be permanently marked on each item.
    3. Cast iron box and cover.
    4. Precision machined flame path between box and cover with neoprene O-ring.
    5. Cast-in-place mounting feet for horizontal or vertical mounting.
    6. For applications requiring hinged cover, provide flexible hinge mounting either left or right side.
    7. External flange.
    8. Provisions for mounting pan.
    9. Ground lug.

D. Stainless steel enclosures:
    1. NEMA Type 4X:
        a. Boxes in locations subject to flooding or temporary submersion:
            1) NEMA Type 6.
    2. Fabricated from 14-gauge Type 316 stainless steel.
    3. All seams continuously welded.
    4. Door:
        a. Rolled lip around 3 sides.
        b. Attached to enclosure by means of a continuous stainless steel hinge and pin.
    5. Neoprene door gasket to provide a watertight seal:
        a. Attached with an adhesive.
        b. Retained by a retaining strip.
    6. Fabricate all external removable hardware for clamping the door to the enclosure body from heavy gauge stainless steel:
        a. With a hasp and staple for padlocking.
    7. Provide large enclosures with door and body stiffeners for extra rigidity.
    8. No holes or knockouts.
    9. Finish:
        a. Brushed.
    10. Stainless steel external mounting brackets when surface mounted.

E. Cast iron junction boxes:
    1. NEMA Type 4.
    2. Recessed cover boxes.
    3. Suitable for use outdoors where subject to rain, dripping, or splashing water.
    4. Designed for flush mounting in walls or floors:
        a. Can be surface mounted using mounting lugs.
    5. Construction:
        a. Cast iron box.
        b. Covers:
            1) Checkered plate covers suitable for foot traffic.
            2) When used in areas subject to vehicular traffic, design to support an AASHTO Standard Specifications for Highway Bridges, H-20 vehicle loading.

c. Hot dip galvanized.
d. Neoprene gasket.
e. Stainless steel screw covers.

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.

D. Floor stand kit when shown:
1. Fabricated from 12-gauge steel.
2. Bottom plate 11-gauge.
3. Heights:
a. 18 inches.

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 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

2. Provide outlet box materials to match the conduit system:
    a. 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 26_05_00 - 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.

F. Hazardous locations:
1. All metallic boxes, fittings, and joints shall utilize threaded connections to the conduit system.
2. All threaded connections shall be wrench tightened so that at least 5 threads are fully engaged.
3. Conduits entering and exiting metallic boxes in Class I Division 2 areas shall utilize approved grounding bushings to bond the conduits together.
4. Provide the following types of conduit bodies and boxes:
    a. Malleable iron bodies and boxes with GRC or IMC conduit systems.
    b. PVC coated conduit bodies and boxes with PCS conduit systems.

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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_05_53

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 26_05_00 - Common Work Results for Electrical.

B. Occupational Safety and Health Administration (OSHA).

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

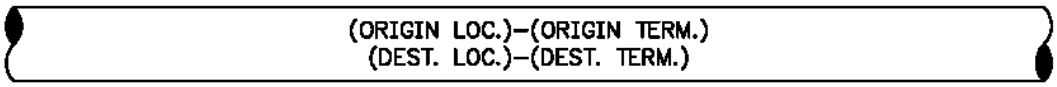
1.04 SYSTEM DESCRIPTION

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 26_05_33 - 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.

OR



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**: 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

4. **Case 2**: 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

5. **Case 3**: 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

6. 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 Section 26_05_00 - 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 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - 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. Non-metallic, one of the following or equal:
      a. Almetek: Mini Tags.
      b. Lapp Group: Maxi System.
   2. Stainless steel, one of the following or equal:
      a. Panduit: Pan Steel.

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. Non-metallic:
      a. UV resistant holder and letters.
      b. Black letters on yellow background.
      c. Minimum letter height: 1/2-inch.
      d. Adhesive labels are not acceptable.
   2. Stainless steel:
      a. Type 304 or 316.
      b. 3/16-inch character height.

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 26_05_00 - 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, or NEMA Type 7 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 non-metallic conduit markers with nylon cable ties:
    a. Provide ultraviolet resistant cable ties for conduit markers exposed to direct sunlight.
6. Attach stainless steel tags with stainless steel cable ties.
7. Mark conduits before construction review by Engineer for punch list purposes.
8. Label intrinsically safe conduits in accordance with the requirements of the NEC.

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 01200 - Contract Closeout.

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 26_05_74

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 26_05_00 - Common Work Results for Electrical.

B. Institute of Electrical and Electronics Engineers (IEEE):
   1. 1584 - IEEE Guide for Performing Arc Flash Hazard Calculations.

C. National Fire Protection Association (NFPA).

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.04 SYSTEM DESCRIPTION

A. General study requirements:
   1. Scope:
      a. The study shall be performed in an Electrical system study software noted herein. The software model of the Electrical system study shall be provided to the Owner at the end of the project.
      b. The short-circuit fault analysis, protective device coordination, and arc-flash hazard studies shall include all 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.

c. 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.
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 and generator 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) 6 copies of the project one-line diagrams for the initial meeting.
         3) 6 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 Section 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.
    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. At least 3 of the copies shall be in color.
            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 26_05_00 - 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 an independent firm.

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 and no equal:
   1. Operation Technology, Inc., ETAP.

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. Arc-flash protection boundary.
    d. Shock hazard boundary:
        1) The Contractor may provide separate labels for indication of the shock hazard boundary.
    e. Description of the combined level of personnel protective equipment.
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 26_05_00 - 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 accessible auxiliary or conductor compartment.
        c. Each accessible rear or side vertical section.
        d. Each motor control center vertical section.
        e. Each panelboard covered by the study.
        f. 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 subfed 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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - 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 26_06_01

CONDUIT SCHEDULE

PART 1 GENERAL

1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 26_05_00 and Section 26_05_33.

B. Cable requirements and definitions:
   1. As defined in Section 26_05_00 and Section 26_05_18.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. MFR: Manufacturer or vendor furnished cable.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.01 CONDUIT SCHEDULE

A. Conduit Schedule is presented on the following pages.

CONDUIT SCHEDULE

CHAPEL LIFT STATION IMPROVEMENTS

CHAPEL LS

ENGINEER	**SAI**
REVISION	**0**
DATE	1/29/19

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-051	E-6	1"	10	#14	XHHW-2	1	#14	XHHW-2	FR: GEN-0201 TO: MCC-0201 10 #14 >> GEN-0201 CONTROL	
C-052	E-6	1"	6	#14	XHHW-2	1	#14	XHHW-2	FR: GEN-0201 TO: MCC-0201 CONTROL PANEL SECTION 6 #14 >> GEN-0201 CONTROL	
C-110	E-6	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: JUNCTION BOX TO: MCC-0201 6 #14 >> PMP-0201 CONTROL 6 #14 >> PMP-0202 CONTROL	
C-120	E-6	2"	10	#14	XHHW-2	1	#14	XHHW-2	FR: LEVEL FLOATS - 0201 TO: MCC-0201 CONTROL PANEL SECTION 2 #14 >> LSLL-0201 CONTROL 2 #14 >> LSL-0201 CONTROL 2 #14 >> LSH1-0201 CONTROL 2 #14 >> LSH2-0201 CONTROL 2 #14 >> LSHH-0201 CONTROL	
L-011	E-6	1"	2	#12	XHHW-2	1	#12	XHHW-2	FR: FE-0201 TO: FIT-0201 CONTROL PANEL SECTION 2 #12 >> FE-0201 POWER	
L-051	E-6	1"	2 2	#8 #10	XHHW-2 XHHW-2	1	#10	XHHW-2	FR: GEN-0201 TO: LP-0201 2 #8 >> GEN JACK WATER HEATER POWER 2 #10 >> GEN BATTERY CHARGER	
P-011	E-6	2"	4	#2/0	XHHW-2	1	#4	XHHW-2	FR: SERVICE ENTRANCE DISCONNECT MEANS TO: UTILITY METER PANEL 3 #2/0 >> SERVICE ENTRANCE POWER 1 #2/0 >> SERVICE ENTRANCE NEUTRAL	
P-021	E-6	2"	3	#2/0	XHHW-2	1	#4	XHHW-2	FR: MCC-0201 TO: SERVICE ENTRANCE DISCONNECT 3 #2/0 >> MCC-0201 POWER	
P-051	E-6	1.5"	3	#3	XHHW-2	1	#8	XHHW-2	FR: GEN-0201 TO: MCC-0201 3 #3 >> GEN-0201 POWER	
P-081	E-6	1.5"	3	#3	XHHW-2	1	#8	XHHW-2	FR: EX PORTABLE GEN CONNECTION TO: MCC-0201 3 #3 >> EX PORT GEN CONNECTION POWER	
P-101	E-6	1"	1	MFR	CABLE	1	#14	XHHW-2	FR: PMP-0201 TO: JUNCTION BOX 1 MFR >> PMP-0201 POWER	
P-105	E-6	1"	1	MFR	CABLE	1	#14	XHHW-2	FR: PMP-0202 TO: JUNCTION BOX 1 MFR >> PMP-0202 POWER	
P-111	E-6	1"	3	#10	XHHW-2	1	#10	XHHW-2	FR: JUNCTION BOX TO: MCC-0201 3 #10 >> PMP-0201 POWER	
P-115	E-6	1"	3	#10	XHHW-2	1	#10	XHHW-2	FR: JUNCTION BOX TO: MCC-0201 3 #10 >> PMP-0202 POWER	
S-001	E-6	1"	1	2/CS-#16		1	#14	XHHW-2	FR: LT-0201 TO: LI-0201 CONTROL PANEL SECTION 1 2/CS-#16 >> LT-0201 SIGNAL	
S-011	E-6	1"	1	MFR	CABLE	1	#14	XHHW-2	FR: FE-0201 TO: FIT-0201 CONTROL PANEL SECTION 1 MFR >> FE-0201 SIGNAL	
S-051	E-6	1"	1	2/CS-#16		1	#14	XHHW-2	FR: GEN-0201 TO: CONTROL PANEL SECTION 1 2/CS-#16 >> GEN-0201 APPRANT POWER SIGNAL	

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 26_08_50

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 26_05_00 - Common Work Results for Electrical.

B. American National Standards Institute (ANSI).

C. ASTM International (ASTM):
   1. D877 - Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
   2. D923 - Standard Practices for Sampling Electrical Insulating Liquids.
   3. D924 - Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
   4. D971 - Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method.
   5. D974 - Standard Test Method for Acid and Base Number by Color-Indicator Titration.
   6. D1298 - Standard Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
   7. D1500 - Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).
   8. D1524 - Standard Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field.
   9. D1816 - Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using VDE Electrodes.
   10. D2285 - Standard Test Method for Interfacial Tension of Electrical Insulating Oils of Petroleum Origin Against Water by the Drop Weight Method.
   11. D3612 - Standard Test Method for Analysis of Gases Dissolved in Electrical Insulating Oil by Gas Chromatography.

D. 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.

E. Insulated Cable Engineer's Association (ICEA).

F. InterNational Electrical Testing Association (NETA):
1. ATS- Standard for Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.

G. International Electrotechnical Commission (IEC).

H. Manufacturer's testing recommendations and instruction manuals.

I. National Fire Protection Association (NFPA):
1. 70 - National Electrical Code (NEC).
2. 110 - Standard for Emergency and Standby Power Systems.

J. National Institute of Standards and Technology (NIST).

K. Specification sections for the electrical equipment being tested.

L. Shop drawings.

1.03 DEFINITIONS

A. As specified in Sections 01_75_17 - Commissioning and 26_05_00 - 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 Section 26_05_00 - Common Work Results for Electrical.

B. Manufacturers' testing procedures:
   1. Submit manufacturers' recommended testing procedures and acceptable test results for review by the Engineer prior to beginning testing.

C. 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.

D. 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.

E. 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.

F. 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 26_05_00 - 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 26_05_00 - 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 26_05_00 - 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.

C. Engine generator tests:
   1. The following individuals must be present and remain at the site during the entire field testing of the engine generator:
      a. Manufacturer's field engineer for the voltage regulator.
      b. Manufacturer's field engineer for the governor and governor controller.
      c. Manufacturer's field engineer for the switchgear.
      d. Load bank operator.
      e. Electrical contractor.

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 01200 - Contract Closeout.

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 Contractor.
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) Perform turns ratio tests at all tap positions.
    5) 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. Low voltage molded case case circuit breakers:
a. Visual and mechanical inspection:
1) Compare equipment nameplate data with the Contract Documents.
2) Inspect physical and mechanical condition.
3) Inspect anchorage and alignment.
4) Verify the unit is clean.
5) Operate the circuit breaker to ensure smooth operation.
6) 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.
7) Perform adjustments for final protective device settings in accordance with the coordination study.

b. Electrical tests:
1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
2) Perform insulation-resistance tests for 1 minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed and across each open pole:
   a) Apply voltage in accordance with manufacturer's published data.
   b) Refer to NETA ATS tables in the absence of manufacturer's published data.
3) Perform a contact/pole-resistance test.
4) Determine long-time pickup and delay by primary current injection.
5) Determine short-time pickup and delay by primary current injection.
6) Determine ground-fault pickup and delay by primary current injection.
7) Determine instantaneous pickup value by primary current injection.

8) Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data.
9) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, anti-pump function and trip unit battery condition:
a) Reset all trip logs and indicators.
10) Verify operation of charging mechanism.

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 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.
4) Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data:
a) If manufacturer's data is not available, investigate any values which deviate from adjacent poles or similar breakers by more than 50 percent of the lowest value.
5) Long-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band including adjustment factors:
a) If manufacturer's curves are not available, trip times shall not exceed the value shown in NETA ATS tables.
6) Short-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
7) Ground fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
8) Instantaneous pickup values shall be as specified and within manufacturer's published tolerances:
a) Refer to NETA ATS tables in the absence of manufacturer's published data.
9) Pickup values and trip characteristics shall be within manufacturer's published tolerances.
10) Breaker open, close, trip, trip-free, anti-pump, and auxiliary features shall function as designed.
11) The charging mechanism shall operate in accordance with manufacturer's published data.

6. Instrument transformers - current transformers:
a. Visual and mechanical inspection:
1) Compare equipment nameplate data with the Contract Documents.
2) Inspect physical and mechanical condition.

3) Verify correct connection of transformers with system requirements.
4) Verify that adequate clearances exist between primary and secondary circuit wiring.
5) Verify the unit is clean.
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 calibrated torque wrench method:
        (1) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
7) Verify that all required grounding and shorting connections provide contact.
8) Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

b. Electrical tests:
1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
2) Perform insulation-resistance test of each current transformer and its secondary wiring with respect to ground at 1,000 VDC for 1 minute:
    a) For solid state devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.
3) Perform a polarity test of each current transformer in accordance with IEEE C57.13.1.
4) Perform a ratio verification test using the voltage or current method in accordance with IEEE C57.13.1.
5) Perform an excitation test on current transformers used for relaying applications in with accordance with IEEE C57.13.1.
6) Measure current circuit burdens at transformer terminals in accordance with IEEE C57.13.1.
7) When applicable perform insulation-resistance tests on the primary winding with the secondary grounded:
    a) Test voltages shall be in accordance with NETA ATS tables.
8) Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data.
9) Verify that current transformer secondary circuits are grounded and have only 1 grounding point in accordance with IEEE C57.13.3:
    a) That grounding point should be located as specified by the Engineer in the Contract Documents.

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 of instrument transformers shall be in accordance with manufacturer's published data:
    a) Refer to NETA ATS tables in the absence of manufacturer's published data.

4) Polarity results shall agree with transformer markings.
5) Ratio errors shall be in accordance with IEEE C57.13.
6) Excitation results for current transformers shall match the curve supplied by the manufacturer or be in accordance with IEEE C57.13.1.
7) Measured burdens shall be compared to instrument transformer ratings.
8) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the primary winding is considered to have passed the test.
9) Power-factor or dissipation-factor values shall be compared to manufacturer's published data:
   a) In the absence manufacturer's published data, use the test equipment manufacturer's published data.
10) Test results shall indicate that the circuits have only 1 grounding point.

7. Instrument transformers - voltage transformers:
   a. Visual and mechanical inspection:
      1) Compare equipment nameplate data with the Contract Documents.
      2) Inspect physical and mechanical condition.
      3) Verify correct connection of transformers with system requirements.
      4) Verify that adequate clearances exist between primary and secondary circuit wiring.
      5) Verify the unit is clean.
      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 calibrated torque wrench method:
            (1) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
      7) Verify that all required grounding and connections provide contact.
      8) Verify correct primary and secondary fuse sizes for voltage transformers.
      9) Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
      10) Perform as-left tests.
   b. Electrical tests - voltage transformers:
      1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
      2) Perform insulation-resistance tests winding-to-winding and winding-to-ground:
         a) Test voltage shall be applied for 1 minute in accordance with NETA ATS requirements.
         b) For solid state devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.
      3) Perform a polarity test on each voltage transformer to verify the polarity marks on H_1- X_1 relationship as applicable.
      4) Perform a turns ratio test on all tap positions.
      5) Measure voltage circuit burdens at transformer terminals.

6) Perform a dielectric withstand test on the primary windings with the secondary windings grounded:
    a) The dielectric voltage shall be in accordance with NETA ATS tables.
    b) Apply the test voltage for 1 minute.
7) Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturers published data.
8) Verify that voltage transformer secondary circuits are grounded and have only 1 grounding point in accordance with IEEE C57.13.3:
    a) That grounding point should be located as specified by the Engineer in the Contract Documents.

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 of instrument transformers shall be in accordance with manufacturer's published data:
    a) Refer to NETA ATS tables in the absence of manufacturer's published data.
4) Polarity results shall agree with transformer markings.
5) Ratio errors shall be in accordance with IEEE C57.13.
6) Measured burdens shall be compared to instrument transformer ratings.
7) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the primary winding is considered to have passed the test.
8) Power-factor or dissipation-factor values shall be compared to manufacturer's published data:
    a) In the absence manufacturer's published data, use the test equipment manufacturer's published data.
9) Test results shall indicate that the circuits have only 1 grounding point.

8. Metering devices, microprocessor based:
a. Visual and mechanical inspection:
1) Compare equipment nameplate data with the Contract Documents.
2) Inspect meters and cases for physical damage.
3) Clean front panel.
4) Verify tightness of electrical connections.
5) Record the following:
    a) Model number.
    b) Serial number.
    c) Firmware revision.
    d) Software revision.
    e) Rated control voltage.
6) Verify operation of display and indicating devices.
7) Record passwords.

8) Verify the unit is grounded in accordance with the manufacturer's instructions.
9) Set all required parameters including instrument transformer ratios, system type, frequency, power demand methods/intervals, and communications requirements.

b. Electrical tests:
1) Apply voltage or current as appropriate to each analog input and verify correct measurement and indication.
2) Confirm correct operation and setting of each auxiliary input/output feature including mechanical relay, digital and analog.
3) After initial system energization, confirm measurements and indications are consistent with loads present.

c. Test values:
1) Nameplate data shall match the Contract Documents.
2) Tightness of electrical connections shall ensure a low resistance connection.
3) Display and indicating devices shall operate per manufacturer's published data.
4) Measurement and indication of applied voltages and currents shall be within the manufacturer's published tolerances for accuracy.
5) All auxiliary input/output features shall operate per settings and manufacturer's published data.
6) Measure and indications shall be consistent with energized system loads.

9. 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 26_05_26 - Grounding and Bonding.
5) Investigate point-to-point resistance values that exceed 0.5 ohm.

10. 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.
       10) Perform vibration test while machine is running under load.

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.

11. Motor starters, low voltage:
    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) Verify the unit is clean.
        5) Inspect contactors:
            a) Verify mechanical operation.
            b) Verify contact gap, wipe, alignment, and pressure is in accordance with manufacturer's published data.
        6) Motor-running protection:
            a) Verify overload element rating/motor protection settings are correct for its application.
            b) If motor running protection is provided by fuses, verify correct fuse rating.
        7) 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.
        8) Lubrication requirements:
            a) Verify appropriate lubrication on moving current-carrying parts.
            b) Verify appropriate lubrication on moving and sliding surfaces.
    b. Electrical tests:
        1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
        2) Perform insulation-resistance tests for 1 minute on each pole, phase-to-phase and phase to ground with the starter closed, and across each open pole for 1 minute:
            a) Test voltage shall be in accordance with manufacturer's published data.
            b) Refer to NETA ATS tables in the absence of manufacturer's published data.
        3) Test motor protection devices in accordance with manufacturer's published data.
        4) Test circuit breakers as specified in this Section.
        5) Perform operational tests by initiating control devices.
    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 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.
4) Motor protection parameters shall be in accordance with manufacturer's published data.
5) Circuit breaker test results shall as specified in this Section.
6) Control devices shall perform in accordance with system design requirements.

12. 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 an 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.

13. Surge arresters, 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 clearances.
      4) Verify the arresters are clean.
      5) 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.
      6) Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
      7) Verify that stroke counter is correctly mounted and electrically connected, if applicable.
      8) Record stroke counter reading.
   b. Electrical tests:
      1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
      2) Perform an insulation-resistance test on each arrester, phase terminal- to- ground:
         a) Apply voltage in accordance with manufacturers published data.
         b) Refer to NETA ATS tables in the absence of manufacturer's published data.
      3) Test grounding connection 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 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.
    4) Resistance between the arrester ground terminal and the ground system shall be less than 0.5 ohm.

14. Single Engine generator:
    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.
    b. Electrical and mechanical tests:
        1) Perform insulation-resistance tests in accordance with IEEE 43:
            a) Machines larger than 150 kilowatts: Test duration shall be 10 minutes. Calculate polarization index.
            b) Machines 150 kilowatts and less: Test duration shall be 1 minute. Calculate the dielectric-absorption rate.
        2) Test protective relay devices as specified in this Section.
        3) Verify phase rotation, phasing, and synchronized operation as required by the application.
        4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
        5) Conduct performance test in accordance with NFPA 110.
        6) Verify correct functioning of governor and regulator.
        7) Load bank testing:
            a) Provide a resistive load bank to test the operation of the engine generator.
            b) Load bank shall be capable of loading the engine generator to its full nameplate kilowatt rating at unity power factor.
            c) Load steps shall simulate the plant load steps used in sizing the engine generator.
            d) Test run at full nameplate kilowatt rating for a minimum of 4 hours:
                (1) Record at 10 minute intervals:
                    (a) Voltage.
                    (b) Frequency.
                    (c) Current.
                    (d) Power factor.
                    (e) Engine oil pressure.
                    (f) Engine oil temperature.

(g) Air inlet temperature.
(h) Radiator discharge temperature.
(i) Engine coolant temperature.
(j) Vibration levels at each main bearing cap.

c. Test values:
1) Anchorage, alignment, and grounding should be in accordance with manufacturer's published data and system design.
2) The dielectric absorption ratio or polarization index shall be compared to previously obtained results and should not be less than 1.0. The recommended minimum insulation ($IR_{1\ min}$) test results in megohms shall be corrected to 40 degrees Celsius and read as follows:
a) $IR_{1\ min}$ equals kilovolt + 1 for most windings made before 1970, all field windings, and others not described below.
(1) Kilovolt is the rated machine terminal-to-terminal voltage in rms kilovolt.
b) $IR_{1\ min}$ equals 100 megohms for most dc armature and ac windings built after 1970 (form-wound coils).
c) $IR_{1\ min}$ equals 5 megohms for most machines and random-wound stator coils and form-wound coils rated below 1 kilovolt.
(1) Dielectric withstand voltage and surge comparison tests shall not be performed on machines having lower values than those indicated above.
3) The polarization index value shall not be less than 2.0.
4) The dielectric absorption ratio shall be greater than 1.0.
5) Protective relay device test results shall be as specified in this Section.
6) Phase rotation, phasing, and synchronizing shall be in accordance with system design requirements.
7) Low oil pressure, over temperature, over speed, and other protection features shall operate in accordance with manufacturer's published data and system design requirements.
8) Vibration levels shall be in accordance with manufacturer's published data and shall be compared to baseline data.
9) Performance tests shall conform to manufacturer's published data and NFPA 110.
10) Governor and voltage regulator shall operate in accordance with manufacturer's published data and system design requirements:
a) Steady state voltage regulation shall be within 0.5 percent of setpoint.
b) The output voltage of the generator shall not fall below 10 percent of the power system nominal rating for more than 5 seconds.
c) The output voltage of the generators shall not exceed the power system nominal rating at any time.
d) Steady state frequency regulation shall be within 59.5 hertz to 60.5 hertz.
e) Frequency variations shall not exceed 2 hertz from 60 hertz for more than 2 seconds.

15. Automatic transfer switches:
    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.
        5) Lubrication requirements:
            a) Verify appropriate lubrication on moving current-carrying parts.
            b) Verify appropriate lubrication on moving and sliding surfaces.
        6) Verify that manual transfer warnings are attached and visible.
        7) Verify tightness of all control connections.
        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 calibrated torque wrench:
                (1) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
        9) Perform manual transfer operation.
        10) Verify positive mechanical interlocking between normal and alternate sources.
    b. Electrical tests:
        1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
        2) Perform insulation-resistance tests on all control wiring with respect to ground. Applied potential shall be 500 VDC for 300-volt rated cable and 1,000 VDC for 600-volt rated cable. Apply the test voltage for 1 minute:
            a) For units with solid-state components or for control devices that cannot tolerate the applied voltage, follow manufacturer's recommendation.
        3) Perform a contact/pole-resistance test.
        4) Verify settings and operation of control devices.
        5) Calibrate and set all relays and timers as specified in this Section.
        6) Verify phase rotation, phasing, and synchronized operation as required by the application.
        7) Perform automatic transfer tests:
            a) Simulate loss of normal power.
            b) Return to normal power.
            c) Simulate loss of emergency power.
            d) Simulate all forms of single-phase conditions.
        8) Verify correct operation and timing of the following functions:
            a) Normal source voltage-sensing and frequency-sensing relays.
            b) Engine start sequence.
            c) Time delay upon transfer.
            d) Alternate source voltage-sensing and frequency-sensing relays.
            e) Automatic transfer operation.
            f) Interlocks and limit switch function.
            g) Time delay and retransfer upon normal power restoration.
            h) Engine cool down and shutdown feature.

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:
    3) Refer to NETA ATS tables in the absence of manufacturer's published data.
    4) Insulation resistance values of transfer switches shall be in accordance with manufacturer's published data:
        a) Refer to NETA ATS tables in the absence of manufacturer's published data.
        b) Values of insulation resistance less than this table or manufacturer's recommendations shall be investigated.
    5) Insulation-resistance values of control wiring shall not be less than 2 megohms.
    6) Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data:
        a) If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
    7) Control devices shall operate in accordance with manufacturer's published data.
    8) Relay test results shall be as specified in this Section.
    9) Phase rotation, phasing, and synchronization shall be as specified in the system design specifications.
    10) Operation and timing shall be in accordance with manufacturer's and system design requirements.

3.08 FIELD QUALITY CONTROL (NOT USED)

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_09_13

ELECTRICAL POWER MONITORING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Power meters.

1.02 REFERENCES

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. American National Standard Institute (ANSI):
   1. C12.20 - Electricity Meters - 0.2 and 0.5 Accuracy Classes.

C. Institute of Electrical and Electronics Engineers (IEEE):
   1. C57.13.6 - Standard for High Accuracy Instrument Transformers.

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Specific definitions:
   1. FS - Full Scale.
   2. RDG - Of Reading.
   3. SSM - Solid State Multifunction Power Meter.
   4. THD - Total Harmonic Distortion.

1.04 SYSTEM DESCRIPTION (NOT USED)

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26_05_00 - Common Work Results for Electrical.

B. Product data:
   1. Power meter data including but not limited to:
      a. Power requirements.
      b. Communications protocols.
      c. Input/outputs.
      d. Dimensions.
      e. Measurement functions.
      f. Front panel controls.
      g. Display characteristics.

C. Operation and maintenance manuals:
   1. Descriptive and technical bulletins and sales aids edited to reflect only the equipment to be provided and covering each of the components in the system.
   2. A maintenance section including all instruction leaflets and technical data necessary to setup, change setup and maintain the power meters.
   3. Original licensed copies of all software and software manuals.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Same manufacturer as Motor Control Center.

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. Power meters:
   1. Power meter type 2 (SSM2) device which shall include at a minimum:
      a. Individual phase currents, plus or minus 0.3 percent FS.
      b. Phase-to-phase and phase-to-neutral voltages, plus or minus 3 percent FS.
      c. Watts, VARs, VA, plus or minus 6 percent FS.
      d. Watt-hours 0.6 percent FS; VAR-hours 0.6 percent FS; VA-hours 0.6 percent FS.
      e. PF apparent 1 percent FS; PF displacement 1 percent FS.
      f. Frequency 0.17 percent FS.
      g. THD:
         1) Voltage - 31st harmonic.
         2) Current - 31st harmonic.
      h. Demand:
         1) Ampere, plus or minus 0.3 percent FS.
         2) Watt, VAR, VA, plus or minus 0.6 percent FS.
      i. Minimum and maximum values:
         1) Volts (L-L), volts (L-N), current (L), watts, VARs, VA.
         2) PF (apparent and displacement).
         3) Frequency.
         4) THD-amps, THD-volts.
         5) Demand:
            a) Ampere, watt, VAR, VA.
      j. Trend analysis:
         1) 2 selectable parameters.
      k. Other features:
         1) 3 form C relays, rated 10 amps.
      l. Kilowatt hour pulse initiator.
      m. Synch-input kilowatt utility.
      n. Graphic LCD with LED backlight:
         1) Seven lines, 147 characters.

2.07 ACCESSORIES

A. Current transformers:
   1. Ring type current transformers:
      a. Suitable for service within low or medium voltage equipment as indicated on the Drawings.
      b. Designed to have a mechanical and thermal rating to withstand short-circuit current, stresses, and heating effects equal to the rating of the equipment of the application.
   2. Current ratio: As indicated on the Drawings, for use as a guideline:
      a. It is the manufacturer's responsibility to size the current transformers to ensure that they will not saturate under the maximum available fault current at the installed location based upon the fault current study as specified in Section 26_05_74 - Electrical System Studies.
   3. Rated in accordance with IEEE C57.13.6 with accuracy of the current transformers suitable for relay accuracy class and rated for 200 percent burden for the required connected devices.
   4. Identify polarity with standard marking or symbols.

5. Capable of carrying rated primary current continuously without damage.
6. Install secondary wiring from current transformers in a suitable wiring trough, or conduit to proper short-circuiting type terminal blocks for connection to relays, instruments, and other devices.

B. Potential transformers:
1. Indoor dry type, single-phase, 60 hertz, with a minimum thermal capacity of not less than 400 volt-amperes at 55 Celsius rise above 40 Celsius ambient.
2. Accuracy classification determined in accordance with IEEE C57.13.6, suitable for relay accuracy class, and 200 percent burden, for the required connected devices, with the secondary voltage 120 volts.
3. Insulation levels as required for the equipment system voltage but not less than:
   a. 600 VAC, 10 kV BIL for 480 VAC systems.
   b. 5.6 KV, 60 kV BIL for 2300 and 4160 VAC systems.
   c. 15.5 KV, 110 kV BIL for 12.47 kV and 13.2 kV systems.
4. Identify polarity with standard markings or symbols.
5. Connect transformer secondary to potential buses as required.
6. Protect medium voltage potential transformers on the primary side with medium voltage current-limiting fuses.
7. Protect low voltage potential transformers on the primary side and secondary side with current-limiting fuses.
8. Mount medium voltage potential transformers in a separate compartment on a drawout device which, when in the FULLY WITHDRAWN position, disconnects both primary and secondary terminals of the transformer and grounds the primary potential fuses.

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 26_05_00 - Common Work Results for Electrical.

B. Install power meters in the electrical equipment as 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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 26_05_00 - Common Work Results for Electrical

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_22_14

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 26_05_00 - 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. C57.96 - 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 26_05_00 - 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 26_05_00 - 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 Section 26_05_00 - 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 26_05_00 - 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 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Same manufacturer as Motor Control Center.

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. 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. 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 26_05_00 - 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 liquidtight 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 3-1/2-inch 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 01200 - Contract Closeout.

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 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_24_16

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 26_05_00 - Common Work Results for Electrical.

B. Underwriter's Laboratories, Inc. (UL):
   1. 67 - Standard for Panelboards.

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - 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 Section 26_05_00 - 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 26_28_01 - 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 26_05_00 - 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 26_05_00 - 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 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Same manufacturer as Motor Control Center.

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 26_05_00 - 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. Interior design such that replacement of circuit breakers does not require disturbing adjacent units or removal of the main bus connectors.
   10. NEMA Type 1 interior panelboard, unless otherwise indicated.

B. Bus:
   1. General:
      a. Tin-plated copper.
   2. Phase bus:
      a. Full size and height without reduction.
      b. Sized in accordance with UL standards to limit temperature rise on any current carrying part to a maximum of 50 degrees Celsius:
         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. 200 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 26_28_01 - 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. Surge protective devices:
   1. Furnish panelboards with surge protective devices as indicated on the Drawings.
   2. As specified in Section 26_43_14 - Surge Protective Devices.

B. Nameplates:
   1. As specified in Section 26_05_53 - Identification for Electrical Systems.
   2. Install on outside of door.
   3. Indicating:
      a. Panel designation.
      b. Voltage.
      c. Number of phases and configuration.

C. 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.

D. 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 26_05_00 - 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, flush or MCC 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. In all NEMA Type 4 and NEMA Type 4X locations, mount panelboards on 7/8-inch deep stainless steel preformed channel, with channel running vertically from top to bottom of panelboard:
      a. Use only stainless steel mounting hardware.
   6. 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 01200 - Contract Closeout.

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 26_05_00 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.11 PROTECTION

A. As specified in Section 26_05_00 - 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 26_24_20

LOW VOLTAGE MOTOR CONTROL CENTERS

PART 1GENERAL

1.01 SUMMARY

A. Section includes:
   1. Low voltage motor control centers.

1.02 REFERENCES

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. National Electrical Manufacturer's Association (NEMA):
   1. ICS 18-2001 - Motor Control Centers.

C. Underwriters Laboratories (UL):
   1. 845 - Motor Control Centers.

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.04 SYSTEM DESCRIPTION

A. Factory assembled, factory wired and factory tested motor control centers:
   1. Motor control centers and major components to be products of a single manufacturer.

B. The Motor Control Center shall have service entrance rated Auto Transfer Switch.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26_05_00 - Common Work Results for Electrical.

B. Product data:
   1. Manufacturer of motor control center.
   2. Manufacturer of motor control center parts.
   3. Nameplate schedule.
   4. Bill of material.
   5. Enclosure:
      a. NEMA rating.
      b. Finish color.
   6. Ratings:
      a. Voltage.
      b. Phase.

c. Current:
    1) Horizontal bus ampacity.
    2) Vertical bus ampacity.
    3) Ground bus ampacity.
d. Short circuit withstand rating.
e. Protective device interrupting rating.

7. List of recommended spare parts.
8. Catalog cut sheets:
    a. Submit complete manufacturer's catalog information:
        1) Clearly indicate the features of the equipment including any options necessary to meet the required functionality.
9. Furnish component submittals as specified in the appropriate Section.
10. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 26_05_00 - 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. Layout drawings:
    a. Provide fully dimensioned and to scale layout drawings which include:
        1) Dimensions:
            a) Overall length.
            b) Overall width.
            c) Overall height.
            d) Overall weight and weight of individual shipping splits.
2. Interfaces to other equipment.
3. Shipping splits.
4. Allowable top and bottom conduit windows.
5. Complete component and unit layout drawings.
6. Indicate lug sizes, type, and manufacturer based on the cable size specified in the Contract Documents and as indicated on the Drawings.
7. Elementary schematics:
    a. Provide one custom schematic diagram for each compartment:
        1) Include all remote devices.
        2) Show wire numbers on the schematics:
            a) Provide wire numbering as specified in Section 26_05_53 - Identification for Electrical Systems.
8. External connection diagram showing the wiring to the external controls and devices associated with the motor control center.
9. One-line diagrams:
    a. Provide complete one-line diagrams for each motor control center, including but not limited to: protective devices, starters, drives, metering, and other equipment.
    b. Indicate electrical ratings of the equipment shown on the one-line diagrams.

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 26_05_00 - 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. Provide complete operating and maintenance instructions presenting full details for care and maintenance of all types of equipment furnished and/or installed under this Section. Include the following:
    a. Electrical ratings:
        1) Phase.
        2) Wire.
        3) Voltage.
        4) Ampacity.
        5) Bus bracing and protective device interrupting ratings.
    b. Manufacturer's operating and maintenance instructions for the motor control center and all component parts, including:
        1) Starters.
        2) Overload relays and heater elements.
        3) Variable frequency drives.
        4) Protective devices including, but not limited to, fuses, circuit breakers and protective relays.
        5) Pilot devices.
    c. Complete renewal parts list.

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. Record Documents:
1. Elementary schematics:
    a. Furnish as-built elementary schematics indicating final:
        1) Wire numbers.
        2) Interfaces with other equipment.
    b. Provide one custom schematic diagram for each compartment:
        1) Include all remote devices.
        2) Show wire numbers on the schematics.
    c. Layout drawings: Provide complete dimensioned component and unit layout drawings.
2. The Record Documents shall reflect all modifications made during the submittal review process and during construction.

I. Calculations:
   1. Detailed calculations or details of the actual physical testing performed on the motor control center to prove the motor control center is suitable for the seismic requirements at the Project Site.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. All portions of the motor control center, vertical bays, and components shall be UL listed and labeled.
   1. Where indicated as service entrance equipment, the motor control center shall be UL labeled and listed "Suitable for Service Entrance".

1.07 DELIVERY, STORAGE AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Ship the motor control center and associated equipment to the job site on a dedicated air ride vehicle that will allow the Contractor to utilize onsite off-loading equipment.

C. Furnish temporary equipment heaters within the motor control center to prevent condensation from forming.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING

A. Conduct the initial fault current study as specified in Section 26_05_74 - Electrical System Studies and submit results for Engineer's review.

B. After successful review of the initial fault current study, as specified in Section 26_05_74 - Electrical System Studies, submit complete equipment submittal.

C. Conduct factory acceptance test.

D. Submit Manufacturer's Certificate of Installation and Functionality Compliance.

E. Ship equipment to the Project Site after successful completion of factory acceptance test.

F. Assemble equipment in the field.

G. Conduct field acceptance test and submit results for Engineer's review.

H. Submit manufacturer's certification that the equipment has been properly installed and is fully functional for Engineer's review.

I. Conduct Owner's training sessions.

J. Commissioning and process start-up as specified in Section 01200 - Contract Closeout.

1.10 SCHEDULING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - 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. Allen-Bradley.
   2. Eaton.
   3. General Electric.
   4. Schneider Electric.

2.02 EXISTING PRODUCTS

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. General:
   1. Furnish motor control centers as specified in the Contract Documents and indicated on the Drawings.
   2. Arrange the equipped sections to form continuous motor control center lineups as indicated on the Drawings:
      a. Identify any deviations from the Drawings in writing and submit for approval.
   3. Provide wire markers at each end of every wire as specified in Section 26_05_53 - Identification for Electrical Systems.
   4. Provide complete and functional motor control centers.
   5. Provide devices or accessories not specified in this Section but necessary for the proper installation and operation of the equipment.

B. Design and construct motor control center to operate at the voltage level and configuration indicated on the Drawings.

C. Bus system:
    1. Material:
        a. Tin-plated copper.
        b. Short-circuit rating:
            1) As indicated on the Drawings.
        c. Bus bar supports:
            1) High impact strength, non-tracking glass-polyester material that is impervious to moisture and gases.
    2. Horizontal power bus:
        a. Current-carrying capacity as indicated on the Drawings.
        b. Mounting:
            1) Mount horizontal bus bars edgewise, one above the other, and fully isolated from all wireways and units.
        c. Temperature rise:
            1) In accordance with UL 845.
            2) De-rate the temperature rating of the bus for the specified conditions of ambient temperature and altitude as specified in Section 26_05_00 - Common Work Results for Electrical.
    3. Vertical power bus:
        a. Current-carrying capacity of not less than 600 amps.
        b. Mounting:
            1) Enclose the vertical bus in a polyester-glass cover with small openings to permit unit stabs to mate with the bus:
                a) Provide a shutter mechanism to cover the stab openings when plug-in units are removed.
            2) Provide top and bottom bus covers for insulation and isolation of the ends of the bus.
        c. Isolated from the unit compartments by a full height barrier.
    4. Ground bus:
        a. Horizontal ground bus:
            1) Current-carrying capacity:
                a) 300 amps when the horizontal bus is 2,000 amps or less.
                b) 600 amps when the horizontal bus is greater than 2,000 amps.
            2) Mounting:
                a) Full-width, firmly secured to each vertical section structure:
                    (1) Located in the top or bottom wireway.
                b) Pre-drilled and furnished with lugs for connection to equipment ground wires:
                    (1) Furnish a minimum of 10 lugs per vertical section of MCC.
        b. Vertical ground bus.
            1) Mounting:
                a) Furnish in each vertical section.
                b) Bolted to the horizontal ground bus.
                c) Install parallel to the vertical power bus.
                d) Mount vertical ground bus such that plug-in units engage the ground bus before any connection to the power bus is made. Upon removal of plug-in units, ground stabs are disconnected from the ground bus after the power stabs have been disconnected.
    5. Bus splice bars:
        a. Provided to join the bus at the splits.
        b. Connected to each horizontal bus bar with a minimum of two bolts.

c. Employ conical or spring washers at connections, designed to maintain constant pressure against the splice joint.
d. Same ampacity rating as the horizontal bus.

6. Provide bus system configured for back-to-back MCCs, where required.

D. Enclosures:
1. Each motor control center shall consist of 1 or more vertical sections bolted together:
a. Freestanding.
b. Totally enclosed.
c. Dead-front assembly.
d. Designed for modification and/or addition of future vertical sections.
e. Form each vertical section of heavy gauge steel.
f. Designed for back-to-back arrangement installation, where required and/or as indicated on the Drawings.
2. Enclosure rating:
a. Outdoor:
1) NEMA Type 3R non-walk-in with separate interior enclosure:
a) Interior enclosure:
(1) NEMA Type 1 gasketed.
3. Standard section dimensions:
a. Nominal height: 90 inches.
b. Nominal depth: 20 inches.
c. Vertical section width as indicated on the Drawings.
4. Wireways:
a. Provide each vertical section with a horizontal wireway at the top and bottom of the section:
1) Arranged to provide a full-width metal enclosed wiring trough across the entire motor control center assembly.
b. Provide each vertical section with a full-height vertical wireway.
c. Completely isolated from the vertical and horizontal bus bars.
d. Provide a removable, hinged door.
5. Shipping splits:
a. No more than 3 vertical sections and not more than 60 inches in width.
b. Solid bussing between vertical sections in a shipping split is not acceptable.
6. Lifting angles:
a. Furnish each vertical section and/or shipping split with a removable lifting angle mounted to the top of the enclosure:
1) Extending the entire width of the shipping split.
7. Mounting channels:
a. Mount each vertical section and/or shipping split on an external 1.5-inch by 3-inch mounting channel.

E. Units:
1. A plug-in unit consists of:
a. Unit assembly.
b. Unit support pan.
c. Unit door assembly.
2. Completely enclosed and isolated from adjacent units, buses, and wireways, except for conductor entries into the unit, by a metal enclosure.
3. Constructed so that any fault will be contained in the unit compartment.

4. Supported and guided by a removable unit support pan:
    a. Re-arrangement of units and the removal of a unit so that a new and possibly larger unit can be added without the removal of an in-service unit to gain access to the unit support pan.
5. Held in place by screws or other positive locking means after insertion.
6. Provide a test position with the unit supported in the structure but disengaged from the bus.
7. Integral plug-in ground stab.
8. Stabs:
    a. Free floating.
    b. Self-aligning.
    c. Backed by spring steel clips to ensure high pressure contacts.
    d. Electrolytically tin-plated copper.
9. Handle:
    a. Provide a flange mounted handle mechanism to operate each disconnect switch or circuit breaker.
    b. Door mounted operators or operator handles are not acceptable.
    c. Engaged with the disconnect device at all times as an integral part of the unit independent of the door position.
    d. Lockable in the "OFF" position with up to 3 padlocks.
    e. Mechanically interlocked so that the door cannot be opened with the handle in the "ON" position.
        1) Provide a means for qualified personnel to defeat this interlock.
    f. Interlocked so the unit cannot be inserted or withdrawn with the handle in the "ON" position.
    g. Lockable in the "ON" position:
        1) This shall not prevent the circuit breaker from operating and opening the contacts in the event of a fault condition.
    h. Color-coded to indicate position.
    i. Located so the center of the grip when it is in its highest position is not more than 6 feet 7 inches above the finished floor, including the height of the housekeeping pad and mounting channels.
10. Where indicated on the Drawings, provide units for spaces and future equipment:
    a. Equip these units to accept a future plug-in unit without modification to the vertical sections.

2.06 COMPONENTS

A. Provide components contained within the motor control center as specified in:
1. Section 26_05_53 - Identification for Electrical Systems.
2. Section 26_05_18 - 600-Volt or Less Wires and Cables.
3. Section 26_05_21 - Low Voltage Wire Connections.
4. Section 26_09_13 - Electrical Power Monitoring.
5. Section 26_22_14 - Dry-Type Transformers.
6. Section 26_43_14 - Surge Protective Devices.
7. Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.
8. Section 26_29_05 - Motor Starters.
9. Section 26_24_16 - Panelboards.
10. Section 26_36_24 - Transfer Switches.

2.07 ACCESSORIES

A. Wiring:
   1. Wire the motor control center in accordance with the following NEMA Class and Type as defined by NEMA ICS 18-2001:
      a. NEMA Class II-S:
         1) Furnish wiring diagrams for individual units consisting of drawings that identify electrical devices, electrical connections, and indicate terminal numbering designations.
         2) Furnish individual unit diagrams with each unit and include inter-wiring between units, i.e. electrical interlocking, etc., as specifically specified in the Contract Documents.
         3) Provide custom drawings with unique terminal numbering designations in lieu of standard manufacturer drawings.
      b. NEMA Type B wiring:
         1) Control wiring:
            a) Type B-T pull-apart terminal blocks.
         2) Power wiring:
            a) Type B-T for Size 1 starters.
            b) Type B-T or B-D for Size 2 and 3 starters.
            c) Type B for Size 4 and larger starters and feeder units.

B. Lugs and terminals:
   1. For all external connections of No. 6 AWG wire or larger:
      a. UL listed for copper or aluminum conductors.
   2. Compression type, requiring a hydraulic press and die for installation.
   3. Provide 20 percent spare control block terminals.

C. Nameplates:
   1. Provide nameplates as specified in Section 26_05_53 - Identification for Electrical Systems:
      a. Identifying the motor control center designation as indicated on the Drawings.
   2. Identifying each vertical section:
      a. Mounted and centered on the top horizontal wireway of the vertical section.
   3. Furnish individual nameplates for each unit indicated on the Drawings:
      a. 1 nameplate to identify the unit designation.
      b. 1 nameplate to identify the load served.
      c. Furnish space units with blank nameplates.
   4. Manufacturer's labels:
      a. Furnish each vertical section with a label identifying:
         1) Serial number.
         2) Bus rating.
         3) Vertical section reference number.
         4) Date of manufacture.
         5) Catalog number of section.

D. Overcurrent protection device - 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.
3. Provide circuit breakers as specified in Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.

E. Selection and ratings of protective devices:
1. Interrupting ratings: Not less than the system maximum available fault current at the point of application.
2. Voltage rating: Not less than the voltage of the application.
3. Select current rating and trip characteristics to be suitable for:
   a. Maximum normal operating current.
   b. Inrush characteristics.
   c. Coordination of the protective devices to each other and to the source breaker feeding the panel.

F. Provide a separate protective device for each powered electrical device:
1. An individual circuit breaker for each 120-VAC instrument installed within its respective control panel and clearly identified for function.
2. An individual fuse for each PLC discrete output. Provide with individual blown fuse indication external of the I/O card:
   a. Size external fuse to open before any I/O-card-mounted fuses.
   b. Individual discrete inputs shall use a 0.5-ampere fuse.
3. Control loops can use individual 5-ampere fuse for the loop.
4. Install protective devices on the back mounting panel and identify by a service nameplate in accordance with the wiring diagrams.

G. Fuses for 4 to 20 milliamperes signals:
1. Provide durable, readily visible label for each fuse, clearly indicating the correct type, size, and ratings of replacement fuse:
   a. Label shall not cover or interfere with equipment manufacturer's instructions.
2. An individual 1/2-ampere fuse for each 4 to 20 milliamperes analog loop powered from the control panel.
3. Provide fuses rated for the voltage and available short-circuit current at which they are applied.
4. Manufacturers: One of the following or equal:
   a. Ferraz Shawmut.
   b. Littelfuse.
   c. Bussmann.

H. Fuse holders:
1. Modular type:
   a. DIN rail mounting on 35-millimeter rail.
   b. Touch-safe design: All connection terminals to be protected against accidental touch.
   c. Incorporates blown-fuse indicator.
   d. Plug-in style fuse terminals and fuse plugs are not acceptable.
2. Provide nameplate identifying each fuse:
   a. As specified in Section 26_05_53 - Identification for Electrical Systems.
3. Manufacturers: One of the following or equal:
   a. Phoenix Contact, UT4-HESI Series.
   b. Allen-Bradley, 1492-FB Series B.

I. Control circuit breakers:
   1. DIN rail mounting on 35-millimeter rail.
   2. Manual OPEN-CLOSE toggle switch.
   3. Rated for 250 VAC.
   4. Interrupting rating: 10 kiloampere (kA) or available fault current at the line terminal, whichever is higher.
   5. Current ratings: As required for the application.
   6. Provide nameplate identifying each circuit breaker:
      a. As specified in Section 26_05_53 - Identification for Electrical Systems.
   7. Manufacturers: One of the following or equal:
      a. Phoenix Contact, TMC Series.
      b. ABB.
      c. Allen-Bradley.
      d. Square D.

J. Electronic circuit protectors:
   1. Used where equipment is equipped with a NEC Class 2 power supplies requiring 100 watts to 8 amps.
   2. DIN rail mounting on 35-millimeter rail.
   3. Rated for 24 VDC.
   4. 4 channels to feed 4 independent power feeds to separate devices.
   5. Output current ratings: As required for the application.
   6. LED input status indication.
   7. LED failure status of each channel indication.
   8. Fail contacts.
   9. Provide nameplate identifying each circuit breaker:
      a. As specified in Section 26_05_53 - Identification for Electrical Systems.
   10. Manufacturers: One of the following or equal:
      a. Rockwell Automation 1692-TD014.
      b. Puls PISA11 series.

K. 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.

L. 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. 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.
5. 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.

M. 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 continuous (minimum).
        3) 7,200 volt-amperes make.
        4) 720 volt-amperes 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. Alternating Relay:
    a. Manufacturer: One of the following or equal:
        1) Allen Bradley 700-HTA Alternating relay- 700-HTA-3-A12-7.
        2) Control voltage 120VAC.
        3) Power - 4 VA.
        4) Duty cycle - Continuous.
        5) Contact ratings
            a) 3-30 amps, 1/3 hp @ 120 VAC.
            b) 1-15 amps, 1/2 hp @ 240 VAC.
            c) 10A @ 30VDC.

N. Intrinsic safety barriers:
    1. Transformer isolated barrier:
        a. Containing a transformer to provide complete:
            1) Isolation between the safe and hazardous areas for loop-powered devices.
            2) 3-way isolation between the safe area, hazardous area, and power supply powered devices.
        b. Resistor for current limitation.
        c. Fuses for short-circuit protection.
        d. Provide barriers with pluggable connectors that are coded for easy replacement.
        e. Transmission error shall be less than or equal to 0.1 percent of full-scale.
        f. DIN rail mounting on 35-millimeter rail.
        g. Approvals:
            1) FM.
            2) UL 913.
    2. Types:
        a. Switch isolators:
            1) Designed and approved for use with discrete inputs.
            2) Supply power: 20 to 30 VDC.
            3) Output to track input.
            4) LED in the cover to indicate the status of the input.
            5) Selector switch to change the logic of the input.
            6) Input: Dry contact.
            7) Output: SPDT relay.
        b. Transmitter and converters for use with 4- to 20-milliampere signals without Hart® communications capability:
            1) Designed and approved for use with 4- to 20-milliampere analog signals.
            2) Designed for powering 2- and/or 3-wire transmitters in hazardous locations and repeating and/or generating the current to the safe area.
            3) Supply voltage: 20 to 30 VDC.
        c. Transmitter and converters for use with 4- to 20-milliampere signals with Hart® communications capability:
            1) Designed and approved for use with 4- to 20-milliampere analog signals.
            2) Designed for powering 2- and/or 3-wire transmitters in hazardous locations and repeating and/or generating the current to the safe area.
            3) Transfer digital signals from the hazardous area to the safe area.
            4) Complete bi-directional communication between a smart transmitter located in the field and the suitable equipment located in the safe area.
            5) Supply voltage: 20 to 30 VDC.
    3. Manufacturers: One of the following or equal:
        a. Phoenix Contact, MACX Series.
        b. Pepperl + Fuchs.

O. Terminal blocks:
    1. DIN rail mounting on 35-millimeter rail.
    2. Suitable for specified AWG wire.

3. Rated for 15 amperes at 600 volts.
4. Screw terminal type.
5. 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.
6. Finger-safe protection for all terminals for conductors.
7. Construction: Polyamide insulation material capable of withstanding temperature extremes from - 40 to 105 degrees Celsius.
8. Terminals: Plainly identified to correspond with markings on the diagrams:
    a. Permanent machine-printed terminal identification.
9. Disconnect-type field signal conductor terminals with socket/screw for testing.
10. Identify terminals suitable for use with more than 1 conductor.
11. Position:
    a. So that the internal and external wiring does not cross.
    b. To provide unobstructed access to the terminals and their conductors.
12. Provide minimum 25-percent spare terminals.
13. Manufacturers: One of the following or equal:
    a. Phoenix Contact, UT4 Series.
    b. Allen-Bradley, 1492 Series.

P. Panel meters:
1. Manufacturers: One of the following or equal:
    a. Yokogawa UM33A series - UM33A-0-3-0-1-1-/LP.
    b. No. of analog inputs (4-20mA) - 1.
    c. No. of analog outputs (4-20mA) - 1 (Retransmission).
    d. No of digital inputs - 2.
    e. No. of digital outputs - 5 minimum and programmable.
        1) Low Low level alarm set point - 1.25-ft.
        2) Low level setpoint - 1.5-ft.
        3) High level 1 setpoint - 4.5-ft.
        4) High level 2 setpoint - 5-ft.
        5) High High level alarm setpoint - 5.25-ft.
        6) Coordinate the setpoints in the field during startup
    f. Power Supply - 100-240 VAC, 24AC/DC.
    g. Power Consumption - 15VA @ 120VAC.
    h. 24 VDC loop power supply is required.

Q. 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.

R. 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.

S. Surge protection devices:
    1. 120-volt control power for panels:
        a. Panels without a UPS:
            1) Provide surge protection device (SPD) for panel power entrances:
                a) Nominal 120-VAC with a nominal clamping voltage of 200 volts.
                b) Non-faulting and non-interrupting design.
                c) A response time of not more than 5 nanoseconds.
            2) Control panel power system level protection, non-UPS powered:
                a) Designed to withstand a maximum 10-kA test current of an 8/20 µs waveform according to IEEE C62.41.1 Category C Area.
                b) For panels receiving power at 120 VAC, provide surge protection at secondary of main circuit breaker.
                c) Provide both normal mode noise protection (line to neutral) and common mode (neutral to ground) surge protection.
                d) DIN rail mounting.
                e) Attach wiring to the SPD by means of a screw-type cable-clamping terminal block:
                    (1) Gastight connections.
                    (2) The terminal block: Fabricated of non-ferrous, non-corrosive materials.
                f) Visual status indication of MOV status on the input and output circuits.
                g) Dry contact rated for at least 250 VAC, 1 Amp for remote status indication.
                h) Meeting the following requirements:
                    (1) Response time: Less than or equal to 100 ns.
                    (2) Attenuation: Greater than or equal to -40 dB at 100 kilovolt-hertz as determined by a standard 50-ohm insertion test.
                    (3) Safety approvals:
                        (a) UL 1283 (EMI/RFI Filter).
                        (b) UL 1449 2nd Edition.
                i) Manufacturers: One of the following or equal:
                    (1) Phoenix Contact, Type SFP Filter.
                    (2) Schneider Electric:
                        (a) ASCO, Model 277 (formerly Islatrol IE Series) Surge Protection Device.

T. Lighting:
    1. Provide 1 luminaire for each section, on the interior of the panel, spaced evenly a long 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.

U. Receptacles:
   1. Provide 1 duplex receptacle located every 4 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.

V. Grounding:
   1. Provide the following:
      a. Grounding strap between enclosure doors and the enclosure.
      b. Equipment grounding conductor terminals.
      c. Provide equipment ground bus with lugs for connection of all equipment grounding wires.
      d. Bond multi-section panels together with an equipment grounding conductor or an equivalent grounding bus.
   2. Identify equipment grounding conductor terminals with the word "GROUND," the letters "GND," the letter "G," or the color green.
   3. Signal (24 VDC) grounding: Terminate each drain wire of a signal (shielded) cable to a unique grounding terminal block, or common ground bus at the end of the cable as shown on the Loop Drawings.
   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. 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.
   10. Bond together all remote and local control panels, processor racks, and conductive enclosures of power supplies and connect to the equipment-grounding circuit to provide a common ground reference.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Finish metal surfaces and structural parts with phosphatizing, or equal, treatment before painting.

B. Finish interior surfaces including bus support angles, control unit back plates, and top and bottom barrier plates with baked white enamel.

C. Finish exterior of enclosure with manufacturer's standard gray.

D. Finish NEMA Type 3R exterior cabinets with ultraviolet resistant enamel paint that is UL recognized for outdoor use.

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 26_05_00 - 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 necessary to completely install the motor control center for the line, load, and control connections.
   2. Assemble and install the motor control center in the locations and with the layouts as indicated on the Drawings.
   3. Make bus splice connections.
   4. Perform work in accordance with manufacturer's instruction and shop drawings.
   5. Furnish all components, and equipment necessary to complete the installation.
   6. Replace hardware, lost or damaged during installation or handling, in order to provide a complete installation.
   7. Install the MCC on a 3-1/2-inch raised concrete housekeeping pad:
      a. Provide structural leveling channels in accordance with the manufacturer's recommendations to provide proper alignment of the units.
         1) Remove the manufacturer's supplied mounting channels as required by the manufacturer's installation instructions.
      b. Weld and/or bolt the motor control center frame to leveling channels.

D. Provide openings in the top or bottom of the motor control center for conduit only.
   1. No additional openings will be accepted:
      a. Miscut holes will require that the entire vertical section or removable panel be replaced.
      b. No hole closers or patches will be accepted.

E. Bundle circuits together and terminate in each unit:
   1. Tie with nylon wire ties as specified in Section 26_05_18 - 600-Volt or Less Wires and Cables.
   2. Label all wires at each end with wire markers as specified in Section 26_05_53 - Identification for Electrical Systems as shown on the approved elementary schematics.

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 01200 - Contract Closeout.

B. Source testing (Factory Acceptance Tests):
   1. Owner and Engineer will witness the factory acceptance test as specified in Section 26_05_00 - Common Work Results for Electrical.
   2. Test the complete motor control center at the manufacturer's establishment. Completely assemble, wire and test the motor control center:
      a. Detailed inspections before and after assembly to ensure correctness of design and workmanship.
      b. Provide groups of wires leaving the shipping-assembled equipment with terminal blocks with suitable numbering strips.
   3. Provide Manufacturer's Certificate of Installation and Functionality Compliance.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Provide the services of a manufacturer's representative to:
   1. Inspect, verify, and certify that the motor control center installation meets the manufacturer's requirements.

3.09 ADJUSTING

A. Make all adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

3.10 CLEANING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_27_26

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 26_05_00 - 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. 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 26_05_00 - 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 Section 26_05_00 - 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 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - 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.

C. Plates:
    1. General location:
        a. One of the following or equal:
            1) Pass and Seymour.
            2) Cooper Wiring Devices.
    2. In-use covers:
        a. One of the following or equal:
            1) TayMac.
            2) Cooper Wiring Devices.
            3) Pass and Seymour.
            4) Thomas and 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) Ivory in finished areas.
            2) Brown in all other areas.
    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.

C. Plates:
1. General location:
    a. Type 302 or 304 stainless steel.
    b. Brushed satin finish.
    c. Minimum thickness: 0.032 inch.
    d. Rectangular or square shape.
    e. Engraving:
        1) Engrave each switch plate with the following:
            a) Area served.
            b) Panelboard and Circuit.
        2) Engrave each receptacle plate with the following:
            a) Panelboard and Circuit.
        3) Treat engraving to improve visibility.
        4) Characters shall be block letter pantograph engraved with a minimum character height of 1/8 inch.
    f. Coordinate the number of gangs, number, and type of openings with the specific location.
2. Outdoor and wet areas requiring NEMA Type 4 or NEMA Type 4X enclosures:
    a. General:
        1) UL listed for wet locations.
        2) Gasketed.
        3) Die cast metal:
            a) Match material to box material.
    b. Switches:
        1) Lever operated:
            a) Provide toggle switch.
    c. Receptacles:
        1) Weather proof in-use cover:
            a) Die cast metal construction with electrostatic powder coating for corrosion resistance.
            b) Gasketed.
            c) Lockable.
            d) UL listed and in accordance with NEC.
3. 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 26_05_00 - 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.

C. 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 26_05_00 - Common Work Results for Electrical, or in accordance with the NEC.
   2. Mount weatherproof receptacles horizontally:
      a. Neutral slot up.

D. 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 0101200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_28_01

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 26_05_00 - 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 26_05_00 - 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 Section 26_05_00 - 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 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - 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.

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 26_05_74 - 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. Provide ground fault trip devices as indicated on the Drawings**.**

E. 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

A. Key interlocks:
   1. Provide key operated interlocks to ensure safe switching procedures 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

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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_29_05

MOTOR STARTERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Motor starters and contactors.

1.02 REFERENCES

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. International Electrotechnical Commission (IEC):
   1. 60 947-4 - Low-Voltage Switchgear and Control Gear.
   2. 801-1 - Electromagnetic Compatibility for Industrial-Process Measurement and Control Equipment - Part 1: General Information.

C. National Electrical Manufacturer's Association (NEMA):
   1. ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 V.

D. Underwriters Laboratories (UL):
   1. 508 - Standard for Industrial Control Equipment.
   2. 508A - Standard for Industrial Control Panels.

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Specific definitions and abbreviations:
   1. FVNR: Full voltage non-reversing.
   2. Overload relay class: A classification of an overload relay time current characteristic by means of a number which designates the maximum time in seconds at which it will operate when carrying a current equal to 600 percent of its current rating.

1.04 SYSTEM DESCRIPTION

A. General requirements:
   1. Starters for motor control centers, individual enclosed starters, or control panels.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26_05_00 - Common Work Results for Electrical:
   1. Submit motor starter data with equipment submittal.

B. Product data:
    1. Manufacturer.
    2. Catalog cut sheets.
    3. Technical information.
    4. Complete nameplate schedule.
    5. Complete bill of material.
    6. List of recommended spare parts.
    7. Confirmation that the overload relay class for each starter meets the requirements of the equipment and motor supplier.
    8. Electrical ratings:
        a. Phase.
        b. Wire.
        c. Voltage.
        d. Ampacity.
        e. Horsepower.
    9. Furnish circuit breaker submittals as specified in Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.

C. Shop drawings:
    1. Elementary and schematic diagrams:
        a. Provide 1 diagram for every starter and contactor.
        b. Indicate wire numbers for all control wires on the diagrams:
            1) Wire numbering as specified in Section 26_05_53 - Identification for Electrical Systems.
        c. Indicate interfaces with other equipment on the drawings.

D. Operation and maintenance manuals:
    1. Submit complete operating and maintenance instructions presenting full details for care and maintenance of equipment furnished or installed under this Section. Including but not limited to:
        a. Electrical ratings:
            1) Phase.
            2) Wire.
            3) Voltage.
            4) Ampacity.
        b. Complete bill of material.
        c. Manufacturer's operating and maintenance instructions starter and/or contactor component parts, including:
            1) Protective devices (fuses, breakers, overload relays, heater elements, etc.).
            2) Pilot devices.
        d. Complete renewal parts list.
        e. As-built drawings:
            1) Furnish as-built drawings for each starter and contactor indicating final:
                a) Wire numbers.
                b) Interfaces with other equipment.
            2) 11-inch by 17-inch format.

E. Certifications:
   1. Provide manufacturer's certification that the reduced voltage solid state starter will reliably control the acceleration and deceleration of the driven load at the installed conditions:
      a. Failure of the manufacturer to provide said certification will be interpreted to mean that the manufacturer has agreed that the reduced voltage solid state starter is matched to the driven load at the installed conditions and will function without fault.
      b. If the reduced voltage solid-state starter fails to perform as desired, replace or modify the reduced voltage solid-state starter in order to achieve the desired operational conditions, as directed by the Engineer.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Regulatory requirements:
   1. All starters and components shall be UL listed and labeled:
      a. UL 508 - Industrial Control Equipment.
      b. UL 508A - Industrial Control Panels.
   2. NEMA ICS 2 - Industrial Control and System Controllers; Contactors and Overload Relays Rated: 600 Volts.
   3. Combination starters shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE

A. Spare parts:
   1. Provide the following spare parts, suitably packaged and labeled with the corresponding equipment number:
      a. 1 spare fuse of each size and type per starter.

b. 1 of each type of circuit board used in the RVSS starters, including but not limited to:
    1) Control board.
    2) Power board.
    3) Bridge rectifier.
    4) Inverter module.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
    1. NEMA starters and contactors:
        a. Same manufacturer as Motor Control Center.
    2. Reduced voltage solid state starters:
        a. Same manufacturer as Motor Control Center.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. General:
    1. Provide combination type starters with motor circuit protector or thermal-magnetic circuit breaker and control power transformer with ratings as indicated on the Drawings.
    2. NEMA size, design, and rated:
        a. NEMA Size 1 minimum.
    3. Coordinate motor circuit protector, thermal magnetic circuit breaker, or fusible disconnect, and overload trip ratings with nameplate horsepower and current ratings of the installed motor:
        a. If motors provided are different in horsepower rating than those specified or indicated on the Drawings, provide starters coordinated to the actual motors furnished.
    4. Provide starters NEMA Size 2 and larger with arc quenchers on load breaking contacts.
    5. Mount extended overload reset buttons to be accessible for operation without opening starter enclosure door.

B. Full voltage starters (FVNR):
    1. Across-the-line full voltage magnetic starters.
    2. Rated for 600 volts.
    3. Electrical characteristics as indicated on the Drawings.
    4. Provide positive, quick-make, quick-break mechanisms, pad lockable enclosure doors.
    5. Furnish starter with solid state electronic overload relays.
    6. Double-break silver alloy contacts.
    7. Reversing starters provided with both mechanical and electrical interlocks to prevent line shorts and energizing both contactors simultaneously.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

A. Molded case circuit breakers:
   1. Circuit breaker type and ratings as indicated on the Drawings.
   2. Provide as specified in Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.

B. Contactors:
   1. NEMA size as indicated on the Drawings.
   2. Electrically held:
      a. For lighting loads designed to withstand the initial inrush currents of ballast and lamp loads.
   3. Factory adjusted and chatter free.
   4. Auxiliary contacts:
      a. Contact ratings as per NEMA A 600 rating:
         1) Auxiliary contacts rated 10 amps at 600 volts.
      b. Provide all contacts indicated on the Drawings, and any additional contacts required for proper operation.
      c. Provide at least 1 normally open and 1 normally closed spare auxiliary contact.
   5. Constructed in accordance with the following standards:
      a. UL 508.
      b. IEC 947-4:
         1) Type 1 coordination when protected by a circuit breaker.
         2) Type 2 coordination when protected by a suitable UL listed fuse.
      c. IEC 801-1 parts 2 through 6.

C. Overloads:
   1. Solid state electronic:
      a. Selectable Class 10, 20, 30 protection.
      b. Ambient insensitive:
         1) Operating temperature: -20 to 70 degrees Celsius.
      c. Thermal memory.
      d. Protective functions:
         1) Motor overcurrent.
         2) Phase unbalance (adjustable.)
         3) Phase loss.
         4) Ground fault protection.
      e. Self-powered.
      f. Provide current transformers for metering of motor current.
      g. Visible trip indicator.
      h. Push-to-trip test.
      i. Isolated normally open alarm contact.
      j. Normally closed trip contact.
      k. Manual reset.

D. Control power transformer:
   1. Furnish integral control power transformer capacity to power:
      a. All motor controls; Motor and starter accessories indicated on the Drawings or specified.

2. Primary and secondary fusing as indicated on the Drawings:
    a. Fusing sized by the manufacturer for the rating of the transformer furnished.
3. Control power transformer secondary voltage:
    a. As indicated on the Drawings.

2.07 ACCESSORIES

A. Lugs and terminals:
    1. For all external connections of No. 6 AWG and larger.
    2. UL listed for either copper or aluminum conductors.

B. Surge protective devices:
    1. Furnish surge protection devices across the coil of each starter, contactor, and relay.

C. Pilot devices:
    1. Provide pilot lights, switches, elapsed time meters, and other devices as specified or as indicated on the Drawings.

D. Nameplates and wire markers:
    1. As specified in Section 26_05_53 - Identification for Electrical Systems.

E. Conformal coating:
    1. Provide conformal coating material applied to electronic circuitry and printed circuit boards to act as 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 (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 26_05_00 - 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. Starters in motor control centers:
    1. Install as specified in Section 26_24_20 - Low Voltage Motor Control Centers.

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 01200 - Contract Closeout.

B. Factory testing:
   1. Owner and Engineer will witness the factory acceptance test as specified in Section 26_05_00 - Common Work Results for Electrical.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.09 ADJUSTING

A. Make all adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

B. Set all overloads and motor circuit protectors based on the nameplate values of the installed motor.

3.10 CLEANING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_32_14

SINGLE DIESEL FUELED ENGINE GENERATOR

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Packaged automatic "standby" diesel engine generator systems.

1.02 REFERENCES

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. ASTM International (ASTM):
   1. A106 - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.

C. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 Volts Maximum).
   2. MG-1 - Motor and Generators.

D. National Fire Protection Association (NFPA):
   1. 30 - Flammable and Combustible Liquids Code.
   2. 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
   3. 110 - Standard for Emergency and Standby Power Systems.
   4. 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

E. Underwriters Laboratories (UL):
   1. 142 - Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids.
   2. 2200 - Standard for Stationary Engine Generator Assemblies.

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. NEMA:
   1. Type 4X enclosure in accordance with NEMA 250.

C. Specific definitions:
   1. Standby rated duty: Continuous operation for the duration of any power outage of a utility power source.

1.04 SYSTEM DESCRIPTION

A. Provide a complete automatic diesel engine driven generator system, with all necessary components and accessories to make a complete and operating standby power supply.
   1. Coordinate the generator control system with the transfer equipment specified in the Electrical Specifications and as indicated on the Drawings.

B. Provide such minor details of electrical, plumbing, or mechanical work not specified or indicated on the Drawings, which are necessary for the successful operation of the diesel engine-driven generator required by these Specifications.

C. A new generator shall be installed at Mystic Lift Station as indicated on the Drawings.

D. Under Base bid, the existing 60kW generator and fuel tank from Mystic Lift Station shall be relocated to Chapel Lift Station. The relocated generator shall be installed as indicated on the Drawings and tested in field per Section 26_08_50 - Field Electrical Acceptance Tests. Under Bid Alternate, a new 80 kW generator with remote fuel tank shall be installed at Chapel Lift Station, and the existing fuel tank from Mystic Lift Station shall be reused.

E. Description of operation:
   1. As specified in Section 26_36_24 - Transfer Switches.

F. Step sequence:
   1. Chapel Lift Station generator, GEN-0201:
      a. Base Bid:
         1) Step 1:
            a) 15 kVA Transformer load and PANEL-0201.
         2) Step 2:
            a) Lift Pump 1 (only one pump), PMP-0201 or Lift Pump 2, PMP-0202.
      b. Bid Alternate:
         1) Step 1:
            a) 30 kVA Transformer load and PANEL-0201.
         2) Step 2:
            a) Lift Pump 1, PMP-0201.
         3) Step 3:
            a) Lift Pump 2, PMP-0202.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26_05_00 - Common Work Results for Electrical.

B. Product data:
   1. General:
      a. Manufacturer of:
         1) Engine.
         2) Generator.
         3) Governor.
         4) Voltage regulator.

5) Generator control panel.
6) Radiator.
7) Battery charger.
8) Batteries.
9) Silencer.

b. Wet weight of engine generator system:
1) List weight of fuel separately.

c. Dimensions of engine generator system:
1) Length.
2) Width.
3) Height.

d. Type and grade of fuel recommended.

e. Fuel oil consumption at:
1) 50 percent load.
2) 75 percent load.
3) 100 percent load.

f. Type and grade lubricating oil recommended.

g. Amount of lubricating oil required per oil change.

h. Normal lubricating oil consumption.

i. Recommended lubricating oil change periods:
1) By hours run.
2) By time.

j. Heat rejection by engine generator to the room area.

k. Time interval from start-up contact closure until full load capabilities are available.

2. Engine:
a. Number of cylinders, bore, stroke, and piston speed.
b. Displacement in cubic inches.
c. Compression ratio.
d. Engine RPM at 60 hertz.
e. Combustion air required.
f. Cooling air required.
g. Size of exhaust outlet.
h. Gauges.
i. Jacket water heater:
1) Rating.
2) Voltage and phase requirements.

3. Emissions:
a. Certification of EPA compliance.
b. Other exhaust emissions as required by the local air quality management district issuing the permit for the engine generator system.
c. Reported at rated speed and load as measured by SAE J177 and J215 or ISO 8178 recommended practices.

4. Generator (alternator):
a. Rated output:
1) kW standby.
2) Power factor.
3) Voltage.
4) Current.

b. Number of poles.
c. Number of leads and wires per lead.
d. Pitch.

e. Stator and field ratings including temperature rise at full and overload conditions.
f. Insulation system:
    1) Insulation class.
    2) Stator rise.
    3) Rotor rise.
    4) Heat dissipated (kW).
    5) Air flow (m^3/min).
g. Impedances (per unit and ohms):
    1) Synchronous reactance: Direct axis (X_d).
    2) Synchronous reactance: Quadrature axis (X_q).
    3) Transient reactance: Saturated (X'_d).
    4) Subtransient reactance: Direct axis (X''_d).
    5) Subtransient reactance: Quadrature axis (X''_q).
    6) Negative sequence reactance (X_2).
    7) Zero sequence reactance (X_0).
h. Time constants:
    1) Open circuit transient: Direct axis.
    2) Short circuit transient: Direct axis.
    3) Open circuit subtransient: Direct axis.
    4) Short circuit subtransient: Direct axis.
    5) Open circuit subtransient: Quadrature axis.
    6) Short circuit subtransient: Quadrature axis.
    7) Exciter time constant.
    8) Armature short circuit.
i. Short circuit ratio.
j. Stator resistance.
k. Field resistance.
l. I^2t or K (heating time constant).
m. Voltage and frequency variation and duration with the step application and removal of 25 percent, 50 percent, 75 percent, and 100 percent of resistive load maximum.
n. Generator efficiency at:
    1) 25 percent load.
    2) 50 percent load.
    3) 75 percent load.
    4) 100 percent load.
o. Generator output characteristic curves:
    1) Open circuit.
    2) Short circuit.
    3) Zero power factor.
    4) Air gap.
p. Reactive capability curve.
q. Certified published engine horsepower curves showing manufacturer's engine rating for generator set standby and prime power application.
r. Decrement curve.
s. Thermal damage curve.

5. Governor.
6. Voltage regulator.
7. Generator control panel:
    a. Dimensions:
        1) Length.
        2) Width.

3) Height.
4) Weight.
b. Power requirements.
c. Controls.
d. NEMA enclosure rating.
8. Space and ambient temperature requirements.
9. Battery system:
a. Battery charger:
1) Dimensions:
a) Length.
b) Width.
c) Height.
d) Weight.
2) Input power requirements.
b. Batteries:
1) Number.
2) Dimensions:
a) Length.
b) Width.
c) Height.
d) Weight.
3) Amount of electrolyte.
4) Enclosure or rack.
10. Silencer:
a. Grade.
b. Dimensions:
1) Length.
2) Width.
3) Height.
4) Weight.
11. Free field mechanical noise level at 23 feet. Provide overall decibels (dBA) rating referenced at 20 µPa.
12. Exhaust sound level in dBA at 5 feet from discharge end of silencer.
13. Recommended spare parts and special tools lists, specifying quantity of each item.
14. Weatherproof acoustical housing:
a. Dimensions:
1) Length.
2) Width.
3) Height.
4) Weight.
b. Materials.
c. Acoustic rating.
d. Door locations and access requirements.
e. Finish.

C. Shop drawings:
1. Provide detailed dimensional and to-scale layout drawings including:
a. A single drawing incorporating all equipment furnished:
1) Submittals that consist solely of individual drawings for each component and require that these sheets be compiled by the Engineer, in order to view the entire piece of equipment, are not acceptable.
b. Conduit stub-out locations.

2. Detailed electrical wiring diagrams of the engine and generator including:
    a. Engine interconnection terminal box.
    b. Generator interconnection terminal box.
    c. Fuel system.
    d. All interfaces between the engine driven generator skid and the transfer equipment.
    e. All wire numbers and terminal block identifications:
        1) Wire numbers are to correspond to the wire number on the equipment.
        2) All wires are to be numbered.
    f. Complete interior and exterior control panel layout:
        1) Scaled.
        2) With device descriptions.
        3) With nameplates.
3. Piping connection and instrumentation diagrams.
4. Mounting and installation drawings:
    a. Detailing mounting requirements for the Project Site seismic requirements as specified in Section 26_05_00 - Common Work Results for Electrical.
    b. Prepared and sealed by a registered structural professional engineer in the state where the Project is being constructed.

D. Operation and maintenance manuals:
1. Submit operating instructions and a maintenance manual presenting full details for care and maintenance of equipment of every nature furnished and/or installed under this Section.
2. Operating manual:
    a. The manual must detail the operational functions of all normally used controls that have been placed on the front of the control equipment.
    b. Standard operational manuals normally furnished by the manufacturer.
3. Maintenance manual:
    a. Printed and bound instructions covering all details pertaining to care and maintenance of all equipment as well as data identifying all parts.
    b. These manuals must include but are not limited to the following:
        1) Electrical controls:
            a) Adjustment and test instructions covering the steps involved in the initial test, adjustment, and start-up procedures.
            b) Detailed control instructions, which outline the purpose and operation of every control device used in normal operation.
            c) Description of the sequence of operation that outlines the steps the controls follow during normal power failure and normal power return conditions.
            d) All schematic, wiring, and external diagrams. Also, internal device wiring and schematic diagrams for all sub-assemblies used in the equipment:
                (1) Drawing to be furnished in a reduced 11-inch by 17-inch format and shall be fully legible at that drawing size.
        2) Engine and generator:
            a) Repair parts manuals normally furnished by the manufacturer.
                (1) Detailing all parts and sub-assemblies, which are available as repair parts.

3) Shop maintenance manuals:
a) Provide 1 shop manual on-site that is equivalent to the manual used by factory-authorized shop repair personnel.
b) Manuals for the following equipment:
(1) Engine.
(2) Radiator.
(3) Generator.
(4) Engine generator control panel.

c. Material safety data sheets:
1) Complete MSDS forms for all substances.
2) Located in O&M manual.
3) Include separate manual labeled MSDS with additional copies of all MSDS forms.

4. Warranty Data.
5. Maintenance Contract information (if applicable).

E. Test reports:
1. Furnish complete test reports as specified in this Section.

F. Certificates:
1. Certification of the emissions performance of the generator set engine by the engine manufacturer.
2. Certification that a torsional analysis between the engine and generator has been completed.
3. Seismic certification, as required.
4. Certification letter from the Generator manufacturer that the generator(s) has been inspected and installed in accordance with the manufacturer's requirements.
5. Upon completion of installation, manufacturer must issue a certification of compliance with the Contract Documents.

G. Calculations:
1. Complete loading calculations to support the recommended size of the engine-generator based upon actual facility loads and specified maximum allowable voltage drop.
2. Supply documentation identifying the maximum static pressure acceptable for the radiator fan. It is the manufacturer's responsibility to then provide calculations as part of the layout drawings, to ensure that the transition ductwork at the discharge of the radiator does not exceed the maximum static pressure acceptable for the radiator fan.
3. Submit exhaust system silencer noise attenuation curves.
4. Structural support system, mounting, and seismic calculations to be signed and stamped by a licensed structural professional engineer, registered in the state where the Project is located:
a. Vibration isolator selection calculations.
b. Vibration isolator anchoring calculations.
c. Exhaust silencer structural support calculations on indoor applications.
5. Submit factory certification of the radiator ambient capability.
6. Submit exhaust system pressure loss calculations:
a. Include piping, fittings, silencer, and rain cap in loss calculations on indoor applications.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Manufacturer qualifications:
   1. The manufacturer of the engine, generator, and all major items of auxiliary equipment must be in current production of such equipment.
   2. A factory authorized parts and service facility located within 100 miles of the Project Site.
   3. Manufacturer is responsible for furnishing, testing, installation supervising, testing, and guaranteeing the system.

C. Regulatory requirements:
   1. In accordance with NFPA-110 Type 10 (ten second) transfer requirements.
   2. Fuel tanks:
      a. UL listed.
      b. Primary and secondary tanks shall be tested under pressure per the manufacturer's recommendation to check for leaks.
      c. Comply with the following, if applicable:
         1) NFPA 30 - Flammable and Combustible Liquids.
         2) NFPA 37 - Standard for Installation and Use of Stationary Combustible and Gas Turbines.
         3) NFPA 110 - Standard for Emergency and Standby Power Systems.
   3. Regulations of the Fire Prevention Bureau of the fire department having jurisdiction.
   4. Fire Code as specified in Section 01090 Abbreviations & Reference Standards.
   5. Other applicable state and local codes.
   6. EPA approved.
   7. Requirements of local Air Quality Management District or Air Pollution Control District.
   8. Comply with the Specifications that may be in excess of, and not contrary to, the regulations.

D. The generator set(s) shall be manufactured to the applicable specifications on file with UL and labeled with the UL 2200 mark.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Furnish the generator skid with removable lifting and jacking angles, eye bolts, etc., attached to the structural base to facilitate unloading and move-in operations.

C. Provisions on skid for the use of "Multiton" type rollers for moving the generator skid into position and then removal of the "Multiton" rollers and then for setting the engine generator skid in place.

D. Provide the services of a manufacturer's authorized representative to:
   1. Be present at the jobsite when the engine-driven generator arrives:
      a. Act as an advisor in assisting the Contractor regarding the unloading and move-in operations.
   2. Coordinate the delivery of the shipment with the Contractor.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING

A. Complete factory prototype and factory production tests in accordance with NFPA 110 before equipment is shipped.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE

A. Furnish the following spare parts:
   1. 3 sets of lube oil filters, fuel filters, and gaskets.
   2. 2 sets of air filters.
   3. 2 spare lamps of each different lamp type.
   4. 2 fuses (for each control circuit).
   5. 1 set of crankcase breather filters, when used.

B. Special tools: Furnish a set of specialty tools necessary for routine maintenance of the equipment.
   1. Special tools are those that only the manufacturer provides, for special purposes, or to reach otherwise inaccessible parts.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following list of manufacturers is a general guideline and makes no statement as to the capability of the manufacturer to meet the Specification requirements. The burden of proof of conformance with these Specifications lies with the Contractor and manufacturer. The Contractor must make special written application to use other than these named manufacturers:
   1. Engine generators:
      a. One of the following, no equal:
         1) Caterpillar.
   2. Governor:
      a. One of the following or equal:
         1) Woodward.
         2) Isochronous electronic by engine manufacturer.

3. Engine starting battery:
    a. One of the following or equal:
        1) Auto Start.
        2) East Penn - Deka.
        3) Hawker.
4. Diesel fuel maintenance system:
    a. The following or equal:
        1) Fuel additive:
            a) Fuel Technologies International, LTSA-35A.

B. Exhaust system:
1. One of the following or equal:
    a. Silencer:
        1) GTE Ind.
        2) Harco Manufacturing.
        3) Silex Innovations.
    b. Corrugated, flexible engine connector:
        1) DME.
        2) GTE Ind.
        3) Engine-generator manufacturer's equivalent.
    c. Expansion joint:
        1) DME, Inc.
        2) GTE Ind.
    d. Exhaust pipe insulation:
        1) As specified in Section 40_05_06.55 - Piping Insulation.
    e. Expansion joint insulation:
        1) Pittsburgh-Corning/JPS Composite Materials Corp., Temp-Mat.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. Characteristics of assembled unit:
1. The engine-driven generator consists of a diesel engine directly coupled to an electric generator providing electric power.
2. The engine shall start, attain full speed, voltage, and assume full load within a maximum of 10 seconds, with jacket water at 85 degrees Fahrenheit.
3. Furnish the engine-driven generator on a steel sub-base to support engine, generator, and accessories as a unit:
    a. Base: Welded construction.
    b. Engine direct connected through a flexible coupling to a single bearing generator.
    c. System free of injurious torsional and bending vibrations within a speed range from 10 percent below to 10 percent above synchronous speed.
    d. Engine-driven generator balanced such that the peak-to-peak amplitude of vibration velocity in any direction does not exceed the engine or generator manufacturer's published limits.
    e. If shims are required under the feet of the generator for alignment purposes, use 1-piece laminated shim stock that covers at least 90 percent of the foot.

f. Provide a complete assembled engine-driven generator skid requiring only field electrical and mechanical connections.

4. Connections to engine-driven generator skid:
   a. Flexible connections are required on all connections to the engine generator.
   b. These connections include but are not limited to:
      1) Exhaust.
      2) Fuel lines.
      3) Radiator discharge air ductwork.
   c. The length of all flexible connections to exceed the flexible connector manufacturer's minimum length recommendations for the diameter used and for the misalignment as measured after installation.

B. Generator system performance requirements:
   1. Power output rating:
      a. Minimum kilowatts and voltage as indicated on the Drawings.
      b. 0.8 power factor.
      c. 3-phase, 4-wire, 60 hertz.
      d. In accordance with NEMA MG-1 temperature rise limits.
   2. It is the manufacturer's responsibility to properly size the engine generator based upon site conditions and actual loads:
      a. Allowable voltage drop: 10 percent.
      b. The Drawings and Specifications indicate a minimum size that the Engineer has determined based upon non-certified information.
      c. No increase in Contract amount will be considered if the equipment size needs to be increased to meet the load requirements after bids have been submitted.
      d. Provide all changes to the electrical system as required as a result of manufacturers sizing including but not limited to:
         1) Conduit.
         2) Wire: Provide Nehr-McGrath calculations to verify appropriate cable sizing in accordance with NEC when additional wire is required.
         3) Circuit breakers.
         4) Transfer equipment.
   3. Regulatory requirements:
      a. Specifically designed to meet the discharge of gaseous pollutants to the atmosphere as required by the EPA statute and local agency issuing the permit for the engine generator system.

2.06 COMPONENTS

A. Engine generator base:
   1. Support system:
      a. Bolt the engine-driven generator to steel pads that are an integral part of structural support base.
      b. Vibration isolators shall be provided with the engine-driven generator and be installed between the engine generator and structural support base or between the base and the floor:
         1) As recommended by the isolator manufacturer.
         2) Located for equal load distribution and deflection per isolator.
         3) Designed for the load and seismic conditions as identified for the site.

B. Engine:
   1. Full compression ignition, 4-cycle, turbocharged, and aftercooled meeting the required emissions rating.
   2. The rated net horsepower of the engine with all accessories, including radiator fan, must not be less than that required to produce the minimum specified generator capacity at site altitude and maximum ambient temperature.
   3. Equipped and designed as follows:
      a. Spin-on type replaceable lube oil filters.
      b. Spin-on type replaceable fuel filters.
      c. Heat treated forged steel crankshaft:
         1) Dynamically balanced.
      d. Forged steel connecting rods.
      e. Crankshaft driven gear type lubricating pump.
      f. Electric fuel shut-off valve.
      g. Engine air cleaner: Dry type replaceable filter.
      h. 12- or 24-VDC positive engagement solenoid shift-starting motor:
         1) The starting equipment must include the necessary devices to prevent an overcrank and lockout if the starter pinion fails to engage the flywheel ring gear on the initial crank attempt.
         2) This starter disconnect shall electronically sense the speed of the flywheel and when the flywheel setpoint speed has been reached, the electronic control signals the starter disconnect to disengage.
      i. Oil level dip stick and oil drain pipe with valve and pipe plug:
         1) Oil drainpipe and valve are to extend 3 inches beyond edge of engine base.
      j. Engines requiring glow plugs are not acceptable.
      k. Crankcase breather filter for engines not equipped with EPA Tier certified engine's crankcase emissions control equipment:
         1) Provide crankcase ventilation system with coalescing filter/trap for blowby:
            a) Coalescing filter to be replaceable.
         2) If engine manufacturer recommends an open crankcase breather system, route outlet of breather filter to outside at 3 inches above grade and away from engine components:
            a) Provide on breather outlet Nelson "EcoVent" or equal, sized to match engine breather flow.
         3) If engine manufacturer recommends a closed crankcase breather system, provide integral crankcase pressure regulator with an automatic internal filter bypass and bypass indicator:
            a) Racor Model CCV 4500 or equal.
      l. Equipped with fuel heater mounted on the fuel filters:
         1) Thermostatically controlled.

C. Governor:
   1. Isochronous type to maintain engine speed:
      a. Within 0.5 percent for steady state conditions.
      b. Within 5 percent for a no load to full load step with recovery to within 2 seconds of step load application.
      c. Suitable for use on diesel engines.
      d. Electronic governor control of fuel.
      e. Suitable for automatic, unattended starts.

f. Speed sensing failure circuit to signal actuator to close if speed pick-up signal is lost.
g. With speed pick-up sensor.
h. With capabilities of local speed settings.
i. Adjustable acceleration rate control from 0 to 8 seconds.
j. Personnel guards over all exposed moving parts.
k. Equipped with a continuous duty shutdown system for normal remote stopping.

D. Engine jacket water heater:
1. Provide an in-line thermostat that disconnects power when coolant temperature exceeds the manufacturer's suggested setpoint.
2. Contacts from an oil pressure switch or control panel contacts disconnect the heater power when the engine is running.
3. Provided with shutoff valves and unions to allow heater replacement without draining the cooling system.
4. Make all water heater connections with high temperature silicon type hoses and constant torque hose clamps.
5. Size heater such that the engine block temperature is maintained at 85 degrees Fahrenheit at the specified minimum ambient temperature.
6. Connect water heater and thermostat to the engine to minimize heated water circulation through the radiator circuit.
7. Power supply:
a. Water heaters smaller than 3,000 watts shall be 120 volts, 1-phase.
b. Heaters 3,000 watts and larger shall be 460 volts, 1-phase.

E. Alternator (generator):
1. Brushless synchronous alternator.
2. Re-connectable 12 lead if available.
3. Self-ventilated.
4. Full amortisseur windings.
5. 2/3 pitch windings, skewed for smooth voltage waveform.
6. With permanent magnet generator pilot exciter.
7. Drip-proof enclosure.
8. Protected against corrosion.
9. Single bearing design.
a. Alternators over 2,000 kW may be 2 bearing design.
10. Insulation:
a. Insulated for continuous operation at 40 degrees Celsius ambient temperature.
b. Class H (125 degrees Celsius rise by resistance) for low voltage generators.
c. Vacuum impregnated with epoxy varnish to be fungus resistant per MIL I-24092.
d. Multiple dipped and baked with a non-hygroscopic varnish with a final dip of epoxy.
11. Terminate alternator power leads using compression lugs on an insulator and bus bar system within the alternator junction box:
a. These terminations must not require any taping to complete the connection.

b. Provide a ground terminal inside the junction box to terminate the ground cables between the alternator to the automatic transfer equipment ground bus:
1) Minimum size of the equipment-grounding conductor: 12-1/2 percent of the size of the phase conductors.

12. 120 VAC integral alternator winding heaters.
13. Maximum balanced telephone interference factor not to exceed 50.
14. Designed to supply power to the non-linear loads as specified and as indicated on the Drawings:

F. Alternator digital voltage regulator:
1. Located in the engine control panel.
2. Performance requirements:
a. Maintain the steady state voltage within 1 percent:
1) From 40 degrees Fahrenheit to 120 degrees Fahrenheit.
2) From no load to full load conditions.
3. Constant volts per hertz characteristics with under frequency roll-off for better transient response.
4. Static type.
5. Sized to match the power requirements of the exciter circuit and power from the permanent magnet generator pilot exciter.
6. Include manual control to adjust voltage drop, voltage level, and voltage gain.
7. With 3-phase sensing.
8. Sealed from the environment and isolated from the load to prevent tracking when connected to SCR loads.
9. Include loss of sensing shutdown to protect the generator against uncontrolled voltage output when the sensing circuit to the regulator is opened.
10. Shut down regulator when the sensing circuit to the regulator does not have continuity.
11. Include over-excitation shutdown to protect the generator against thermal damage caused by prolonged field forcing.

G. Exhaust system:
1. General:
a. Provide a complete exhaust system following as indicated on the Drawings and as specified.
b. Back pressure:
1) Provide components such that the maximum back-pressure in the exhaust system including piping and silencer is less than the maximum allowable back-pressure published by the engine manufacturer, measured at the exhaust manifold header:
a) Reduce back-pressure when recommended by the engine manufacturer.
c. Provide each exhaust manifold header with a plugged, tapped connection for the attachment of a test manometer.
2. Exhaust silencer:
a. Heavy-duty industrial type fabricated of welded steel with ported tubes and snubbing chambers, and a rating meeting the specified sound attenuation.
b. Mounting: As indicated on the Drawings.
c. End connections: Steel flanges with Class 150-pound drilling pattern.

d. Shell:
    1) Sufficiently heavy and reinforced to eliminate excessive vibration, stress, or deflection and to support all operating loads with the silencer at elevated temperatures and insulated as specified.
    2) Loads include insulation weight and connecting piping.
e. Drain: Provide threaded, plugged condensate drain.
f. Sound attenuation: Attain the following minimum sound attenuation at the listed octave band center frequencies with the engine at full load:
g. Supports: Provide shell lug supports suitable for supporting and mounting the silencer as indicated on the Drawings; support design to account for elevated temperatures under insulated shell.
h. Pressure drop not to exceed manufacturer's recommendation at maximum engine rating.

H. Radiator and cooling system:
1. Unit mounted:
    a. Furnish a skid mounted closed type radiator system for the engine driven generator:
    b. Sized and selected by engine manufacturer to cool the engine and turbo charge aftercooler under ambient conditions.
    c. Provide all necessary coolant specifically suitable for the location and conditions of service throughout the year:
    d. Ship both the engine and the radiator with the coolant installed.

I. Generator control panel:
1. Microprocessor-based control system that is designed to provide automatic starting, monitoring, protection and control functions for the generator set.
2. Mounted on the generator set:
    a. Provide vibration isolation:
        1) Prototype tested to verify the durability of all components in the system under the vibration conditions encountered.
3. Control system features and functions:
    a. Control switches:
        1) Mode selector switch:
            a) Provide a rotary switch or control panel keypads with status indicators.
            b) The mode select switch initiates the following control modes:
                (1) RUN or Manual position:
                    (a) Generator set starts, and accelerates to rated speed and voltage.
                (2) OFF or STOP position:
                    (a) Generator set immediately stops, bypassing all time delays.
                (3) AUTO position:
                    (a) Generator set accepts a signal from a remote device to start and accelerate to rated speed and voltage.
        2) EMERGENCY STOP switch:
            a) Red "mushroom-head" pushbutton.
            b) Activating the emergency stop switch causes the engine to immediately stop, and be locked out from automatic restarting.

3) RESET switch:
    a) Clears all faults and allow restarting the engine generator after it has shut down for any fault condition.
4) PANEL LAMP switch or automatic display panel illumination.

b. AC output metering: Provide the control system with metering including the following features and functions:
1) Provide digital metering:
    a) 1.0 percent accuracy.
2) Voltmeter:
    a) RMS voltage.
    b) Line-to-line.
    c) Line-to-neutral.
3) Ammeter:
    a) RMS current.
4) Frequency.
5) Power Factor.
6) Kilowatts (kW):
    a) kW-hours.
    b) Output kW.
7) Kilovars (kVars):
    a) kVar-hours.
    b) Output kVar.

c. Generator alarm and status display:
1) Provide high-intensity LED alarm and status indication lamps. Functions indicated include:
    a) Red alarm-indicating lamps.
    b) Red common shutdown lamp.
    c) Green lamp to indicate the engine generator is running at rated frequency and voltage based on actual sensed voltage and frequency on the output terminals of the generator set.
    d) Flashing red lamp to indicate that the control is not in automatic state.
    e) Amber common warning indication lamp.
2) Display the following alarm and shutdown conditions on an alphanumeric digital display panel:
    a) Low oil pressure (alarm).
    b) Low oil pressure (shutdown).
    c) Oil pressure sender failure (alarm or indication).
    d) Low coolant temperature (alarm).
    e) High coolant temperature (alarm).
    f) High coolant temperature (shutdown).
    g) High oil temperature (warning).
    h) Engine temperature sender failure (alarm or indication).
    i) Low coolant level (alarm or shutdown - selectable).
    j) Fail to crank (shutdown).
    k) Fail to start/overcrank (shutdown).
    l) Overspeed (shutdown).
    m) Low DC battery voltage (alarm).
    n) High DC battery voltage (alarm).
    o) Low fuel-day tank (alarm).
    p) High AC voltage (shutdown).
    q) Low AC voltage (shutdown).

r) Under frequency (programmable for alarm or shutdown).
s) Overcurrent (programmed for warning or shutdown).
t) Short circuit - circuit breaker function (trip).
u) Ground fault (alarm).
v) Emergency stop (shutdown).

d. Engine status monitoring:
1) Display the following status conditions on an alphanumeric digital display panel:
a) Engine oil pressure (pounds per square inch or kilopascal).
b) Engine coolant temperature (degrees Fahrenheit or Celsius).
c) Engine speed (revolutions per minute).
d) Number of start attempts.
e) Battery voltage (DC volts).

e. Data logging and display provision:
1) Log the last 10 warning or shutdown indications on the engine generator.
2) Monitor the total load on the generator:
a) Maintain data logs of total operating hours at specific load levels ranging from 0 to 110 percent of rated load, in 10 percent increments.
b) Display total hours of operation at less than 30 percent load and total hours of operation at more than 90 percent of rated load.
3) The control system to log:
a) Total number of operating hours.
b) Total kW hours.
c) Total control operational hours.

f. Engine control functions:
1) Provide a cycle cranking system, which allows for user selected crank time, rest time, and number of cycles:
a) Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.
2) Provide an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this Specification, including adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting.
3) Provide time delay start (adjustable 0 to 300 seconds) and time delay stop (adjustable 0 to 600 seconds) functions.

g. Battery monitoring system:
1) Initiate alarms when the DC control and starting voltage is outside the manufacturers tolerances.
2) Disable the low voltage limit during engine cranking (starter engaged).
3) Monitor DC voltage as load is applied to the battery, to detect impending battery failure or deteriorated battery condition.

h. Remote control interface:
1) Provide a minimum of 4 programmable output relays:
a) Configurable for any alarm, shutdown, or status condition.
2) Provide a minimum of 4 programmable inputs:
a) Label as indicated on the Drawings.
b) Labels shall match other control labels.

J. Battery system:
   1. Installed on the engine-driven generator skid.
   2. Provide extra flexible minimum 4/0 welding cable to make the connection between the battery and the engine:
      a. Proper compression lugs and tooling must be used to terminate these cables.
   3. Provide a 12- or 24-volt lead acid recombination no maintenance engine start battery system:
      a. The battery shall have sufficient capacity, at the minimum and maximum temperature specified, to provide the specified cranking periods.
      b. Provide battery capacity in order to supply power to the following:
         1) DC lighting.
   4. Charger:
      a. Sized to provide sufficient power to both fully charge a drained battery.
      b. Location: On the engine skid.
      c. DC ammeter and DC voltmeter.
      d. On-Off switch.
      e. Solid-state device with adjustable float voltage control.
      f. Constant voltage design with current limit.
      g. With an equalize switch which will allow the battery to be overcharged for maintenance purposes or an automatic charging cycle that has an equalize period.
      h. Designed to meet the charge, float, and equalize requirement of the battery furnished.
      i. Overload and short circuit protection.

2.07 ACCESSORIES

A. Weatherproof acoustical housing:
   1. Provide engine enclosure to protect engine, generator, starting system, batteries, and other specified accessories from weather exposure.
   2. Meet seismic and wind requirements at the Project Site.
   3. Construction:
      a. Minimum 14 gauge steel panel thickness.
      b. All panels and members hot dip galvanized after fabrication.
      c. Enclosure removable to allow for maintenance.
      d. Fitted with lockable latches.
      e. Stainless steel latches and hinges.
   4. Noise reduction:
      a. Provide acoustical insulation and acoustical enclosure ventilation louvers and fan discharge silencers as necessary to achieve a measured sound pressure level of 75 dBA when measured at 23 feet from the enclosure.
      b. Protect acoustical insulation with perforated metal covers and plastic bagging to prevent damage from abrasion or weather elements.
      c. Provide an exhaust silencer matched to the enclosure to reduce the overall noise emissions level of the engine/generator assembly to the levels required above.

B. Wiring:
   1. All external wiring connections to and from the engine and alternator shall be made via 2 engine mounted junction boxes:
      a. One box shall be used for all control and DC power connections.

b. The other box shall be used for the alternator output connections:
1) The alternator output breaker may be used for these connections.
2. Enclose wiring in an NEC approved and recognized conduit system selected and sized by the engine generator manufacturer:
a. Suitable for the temperatures, vibrations, and conditions on the engine-driven generator skid.
3. Control wiring shall terminate on terminal blocks in the control junction box:
a. All connections shall be made to terminal blocks:
1) 600 volt rated.
2) Wires terminated on box with compression type ring type lugs, installed with proper tooling.
3) Terminal blocks shall be numbered.
4) All wiring in terminal box both internal and field connections shall be routed in plastic wire duct.
4. Terminate alternator output connection wires using solderless compression type lugs when connecting to bus bar:
a. Lug manufacturer's termination methods and tools must be used.
5. Splices are not allowed:
a. All connections are to be made at the terminal blocks in the control junction boxes.

C. Miscellaneous engine generator skid items:
1. Provide the following items:
a. Sectionalized drip pans.
b. Rain shields for exhaust lines.
c. Roof jacks.

D. Generator output circuit breaker
1. Engine generator skid mounted and line side connected to alternator.
2. Manually resettable.
3. Line current sensing.
4. Inverse time versus current response.
5. Sized and coordinated to protect the generator from damage from overload and/or short circuit:
a. Coordinated with downstream devices:
1) As specified in Section 26_05_74 - Electrical System Studies.
6. Breakers shall be as specified in Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.
7. Provide breakers with proper number of lugs to match cables 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 26_05_00 - Common Work Results for Electrical.

B. General:
   1. Install the equipment as indicated on the Drawings.
   2. Perform all Work in accordance with manufacturer's instructions and shop drawings.
   3. Before start-up, furnish written certification that the entire installation and all connections, both mechanical and electrical, have been inspected and are proper and consistent with the Drawings and Specifications.

C. Installation shall be by personnel experienced and regularly engaged in field installation of power generation systems:
   1. Make all field mechanical and electrical connections.

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 01200 - Contract Closeout.

B. Design prototype tests as follows:
   1. Use design prototypes similar to the equipment specified in this Section for testing, and not the actual equipment for the Project.
   2. Minimum testing requirements:
      a. In accordance with NFPA.
      b. Maximum power in kW.
      c. Maximum starting kilovolt-ampere at 35 percent instantaneous voltage dip.
      d. Alternator temperature rise:
         1) By embedded thermocouple.
         2) By resistance method.
         3) In accordance with NEMA MG1-22.40 and 16.40.
      e. Governor speed regulation under steady state and transient conditions.
      f. Fuel consumption at 25 percent, 50 percent, 75 percent, and 100 percent load.
      g. Harmonic analysis, voltage wave form deviation, and telephone influence factor.
      h. Cooling airflow.
      i. Torsional analysis testing to verify that the generator set is free of harmful torsional stresses.
      j. Endurance testing.
      k. A certified copy of the test results will be furnished to the Owner.

C. Test each engine generator under varying loads with all machine safety guards and exhaust system in place.

D. Test the complete engine generator system at full load and rated power factor with a reactive load bank in the manufacturer's factory:
   1. Tests shall include:
      a. Radiator.
      b. Engine control panel.
      c. Single-step load pickup.
      d. Transient and steady-state governing.
      e. Safety shutdown device testing.
      f. Rated power.
      g. Maximum power.
   2. During the tests, re-circulate the radiator cooling air through the radiator as necessary to test the system under the maximum ambient conditions specified in this Section.
   3. Run the unit for 2 hours with the following recordings made hourly:
      a. Frequency.
      b. Voltage.
      c. Amperage.
      d. Kilowatts.
      e. Room temperature measured at the generator end of the unit.
      f. Radiator air inlet temperature.
      g. Coolant temperature.
      h. Oil pressure.
   4. Record the following items:
      a. Time required for the engine/generator to start and reach rated voltage and frequency in seconds.
      b. Maximum block load capabilities of the unit.
      c. Point at which overtemperature shutdown occurs.
      d. Point at which overspeed shutdown occurs.
      e. Point at which low oil pressure shutdown occurs.
      f. Point at which overcrank shutdown occurs.
      g. Low water temperature alarm.
      h. Low fuel level alarm.
      i. Fuel leak alarm.
      j. Overvoltage alarm and shutdown.
      k. Undervoltage alarm and shutdown.
      l. Under frequency alarm and shutdown.
      m. Low battery voltage alarm.
   5. Furnish a certified copy of the test results to the Owner:
      a. Record any minor adjustments made during the test.
      b. If major changes, as determined by the Engineer, are made, the 2-hour test must be repeated.

E. Owner training:
   1. As specified in Sections 01200 - Contract Closeout and 26_05_00 - Common Work Results for Electrical.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Provide the services of a manufacturer's representative for the following:
   1. Before start-up, furnish written certification that the entire installation and all connections, both mechanical and electrical, have been inspected and are proper and consistent with all Drawings and Specifications.
   2. Furnish the services of factory-certified technicians during the start-up and adjustment period to make sure all items furnished are in proper operating condition:
      a. Engine technician must be completely knowledgeable in the operation, maintenance, and start-up of the mechanical system.
      b. Electrical technician must be completely knowledgeable in the operation, maintenance, and start-up of the electrical system.
      c. These technicians to instruct the Owner's personnel regarding the operation and maintenance of all items supplied:
         1) Supply written handouts during the training period, and these handouts should be suitable for future reference after the training period is completed.
      d. Furnish a written report after the start-up:
         1) Report must state that the installation is complete and satisfactory.
         2) List the items requiring additional attention.

C. Manufacturer to perform installation check, start-up, and load test.

D. Certify that fuel, lubricating oil, and antifreeze conform to the manufacturer's recommendations under the environmental conditions present.

E. Check accessories that normally function while the equipment is in standby mode for proper operation, before cranking the engine:
   1. These accessories include but are not limited to:
      a. Jacket water heaters.
      b. Fuel heaters, when used.
      c. Battery charger.
      d. Generator strip heaters, when used.

F. Start-up under manual mode:
   1. Check for the following items:
      a. Exhaust leaks.
      b. External path for exhaust gases.
      c. Cooling airflow.
      d. Movement during starting and stopping.
      e. Vibration during running.
      f. Normal and emergency line-to-line voltage and phase rotation.

G. Perform field acceptance tests as specified in Section 26_08_50 - Field Electrical Acceptance Tests.

3.09 ADJUSTING

A. Make adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_36_24

TRANSFER SWITCHES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Transfer switches.

1.02 REFERENCES

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Underwriters Laboratories (UL):
   1. UL 1008 Transfer Switch Equipment.

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Specific definitions:
   1. ATS: Automatic transfer switch.
   2. MTS: Manually initiated, electrically operated transfer switch.

1.04 SYSTEM DESCRIPTION

A. Provide transfer switches capable of transferring load circuits from utility power to standby power and back.

B. ATS sequence of operation:
   1. When the voltage of any normal source phase drops below 80 percent and after an adjustable time delay (0 to 6 seconds minimum), the transfer switch shall start the standby generator.
   2. When standby voltage reaches 90 percent of nominal, and frequency is within 2 hertz of nominal, following an adjustable time delay (0 to 10 seconds), the switch shall transfer to standby power.
   3. When normal power has been restored to 90 percent of nominal on all phases, following an adjustable time delay (0 to 30 minutes), the switch shall retransfer to normal power.
      a. If the standby source fails during this time delay, the switch shall automatically retransfer to normal power.
      b. The switch shall have an adjustable delay transition timer (0 to 5 minutes) for the load disconnect position.
         1) An alarm shall be initiated if the switch fails to retransfer in a pre-set period of time.
   4. Following an adjustable generator cool-down timer (0 to 60 minutes), the switch shall stop the generator.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26_05_00 - Common Work Results for Electrical.

B. Product data:
   1. Manufacturer of transfer switch.
   2. Manufacturer of all component parts of the ATS.
   3. Dimensions:
      a. Width.
      b. Length.
      c. Height.
      d. Weight.
   4. Bill of material.
   5. Description of operation.
   6. Ratings:
      a. Voltage.
      b. Phase.
      c. Current.
      d. Number of poles.
   7. Overcurrent devices:
      a. As specified in Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.
   8. List of recommended spare parts.
   9. For equipment installed in structures designated as Seismic Design Category C, D, E, or F, submit the following as specified in Section 26_05_00 - 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. Layout drawings:
      a. Furnish full-dimension and to-scale equipment layout drawings which include:
         1) Plan, front, and side views.
         2) Sub-panels.
         3) Interior panels.
         4) Top and bottom conduit windows.
   2. Complete electrical wiring diagrams:
      a. Point-to-point connections.
      b. Indicate wire numbers.
   3. Complete interface and connection diagrams.

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 26_05_00 - 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. Operating instructions:
        a. Printed and framed instruction chart suitable for wall hanging.
        b. Detail the operational functions of all transfer switch controls.
    2. Maintenance manual:
        a. Furnish maintenance manuals with instructions covering maintenance of all equipment and data identifying all parts.
        b. Furnish all information needed to maintain the transfer switch including, but not limited to, the following:
            1) Instructions for testing, adjustment, and start-up.
            2) Detailed control instructions that outline the purpose and operation of every control device used in normal operation.
            3) Description of the sequence of operation that outlines the steps that follow normal power failure, transfer to standby power, return to normal power, and fault conditions.
            4) Schematics and wiring:
                a) Furnished in a reduced 11-inch-by-17-inch fully legible format.
            5) Report listing the installed setting of all adjustable parameters for the automatic transfer system.

F. Test forms and reports:
    1. Submit complete factory acceptance test procedures and all forms used during the test.
    2. Manufacturer to furnish certified report after the factory tests.
    3. Manufacturer to furnish written report after start-up:
        a. Report must state that the installation is complete and satisfactory, or list items requiring additional attention and a proposal for the corrective actions.
        b. If the items require attention after the initial start-up, a final report is required stating that the installation is complete and satisfactory.

G. Calculations:
    1. Detailed calculations or details of the actual physical testing performed on the transfer switch to prove the transfer switch is suitable for the seismic requirements at the Project Site.

H. Warranty.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Transfer switches shall be UL listed and labeled.
   1. Where indicated on the Drawings the transfer switch shall be UL labeled and listed "Suitable for Service Entrance."

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Transfer switch: One of the following, no equal:
   1. ASCO.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. General:
   1. Capable of switching all classes of load.
   2. Rated for continuous duty when installed in a non-ventilated enclosure.
   3. Provide circuit breakers or contactors rated for continuous duty.
   4. Minimum transfer time for delayed transition ATS: 1 second.

5. Capable of transferring successfully in either direction with 70 percent of rated voltage applied to the terminals.
6. Provide automatic transfer switches with provisions for manual operation under no load.

B. Electrical ratings:
   1. Voltage, configuration, and amp ratings as indicated on the Drawings.
   2. Withstand and close into fault ratings in accordance with UL 1008.

C. Contacts:
   1. Mechanically held.
   2. Mechanically interlocked to prevent normal and standby sources from being closed at the same time.
   3. Silver alloy construction.
   4. Neutral contact, when indicated on the Drawings:
      a. Same ratings as the phase contacts.
      b. Break last and make first operation.

D. Controls:
   1. ATS shall have 3-phase over-voltage, under-voltage, over-frequency, and under-frequency on both normal and standby sources.
   2. Control panel:
      a. Microprocessor based.
      b. 4-line, 20-character LCD display. Displayed data shall include:
         1) Normal and standby source parameters.
         2) Diagnostic information.
         3) Switch and timer status.
      c. Keypad for making all ATS settings and operating parameters.
         1) All settings shall be password protected.
      d. LED display of the following:
         1) Normal source available.
         2) Connected to normal source.
         3) Standby source available.
         4) Connected to standby source.
      e. Provisions for testing ATS operation by simulating a normal source failure.
      f. Generator exerciser:
         1) Programmable to start the generator on a daily, weekly, monthly, or yearly basis for an adjustable period of time.
         2) Load or no load selectable.
            a) When load is selected, ATS will transfer to the generator for the duration of the exercise period. Re-transfer back and cool down the generator.
            b) When no load is selected, the ATS will run the generator for the duration of the exercise period and then stop the generator.
   3. Status and control contacts:
      a. Generator start/stop contact:
         1) Single-pole, double-throw.
         2) Rated for 5 amps at 30 VDC.
      b. Status contacts:
         1) Single-pole, double-throw.
         2) Rated for 10 amps at 250 VAC.

3) Provide contacts for the following:
   a) Normal source available.
   b) Normal source failure.
   c) Connected to normal source.
   d) Standby source available.
   e) Standby source failure.
   f) Connected to standby source.

E. Enclosure:
   1. Open type for mounting in electrical equipment as indicated on the Drawings.

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Overcurrent device:
   1. As specified in Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.

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 26_05_00 - 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.

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 01200 - Contract Closeout.

B. Factory testing:
   1. Complete factory test to verify proper operation of all timers, settings, and operation.
   2. In accordance with UL-1008.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_43_14

SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. High-energy surge protective devices.

1.02 REFERENCES

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

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. C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
   3. C62.45 - Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.
   4. C62.62- Standard Test Specifications for Surge Protective Devices (SPDs) for Use on the Load Side of the Service Equipment in Low Voltage (1000 V and less) AC Power Circuits.

C. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

D. Underwriters Laboratory:
   1. 1449, 4th Edition, Standard for Surge Protective Devices.

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. NEMA:
   1. Type 1 enclosure in accordance with NEMA 250.
   2. Type 4 enclosure in accordance with NEMA 250.
   3. Type 4X enclosure in accordance with NEMA 250.
   4. Type 12 enclosure in accordance with NEMA 250.

C. Specific definitions:
   1. SPD: Surge protective device.
   2. SAD: Silicon avalanche diode.
   3. MOV: Metal oxide varistor.
   4. MCOV: Maximum continuous operating voltage.
   5. I_n: Nominal discharge current.
   6. VPR: Voltage protection rating.
   7. SCCR: Short circuit current rating.

1.04 SYSTEM DESCRIPTION

A. Surge protective devices as an integral component of the electrical equipment or externally mounted as indicated on the Drawings.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26_05_00 - Common Work Results for Electrical.

B. Product data:
   1. Furnish complete product data confirming detailed compliance or exception statements to all provisions of this Section.
   2. Manufacturer's catalog cut sheets indicating:
      a. Manufacturer and model numbers.
      b. Ratings of each SPD including but not limited to:
         1) Short circuit current rating.
         2) Nominal discharge current.
         3) Maximum continuous operating voltage.
         4) Voltage protection rating.
         5) System voltage.
         6) System frequency.
         7) Surge current capacity.
   3. Submit independent test data from a nationally recognized testing laboratory verifying the following:
      a. Overcurrent protection.
      b. UL 1449.

C. Shop drawings:
   1. Provide electrical and mechanical drawings by the manufacturer that detail:
      a. Unit dimensions.
      b. Weights.
      c. Components.
      d. Field connection locations.
      e. Mounting provisions.
      f. Connection details.
      g. Wiring diagram.

D. Operation and maintenance manuals:
   1. Provide the manufacturer's manual with installation, start-up, spare parts lists, and operating instructions for the specified system.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Provide SPD units that are designed, manufactured, tested and installed in compliance with the following codes and standards:
   1. Institute of Electrical and Electronics Engineers (IEEE C62.41.1, C62.41.2, C62.45, C62.62).
   2. Federal Information Processing Standards Publication 94 (FIBS PUB 94).
   3. National Electrical Manufacturer Association.
   4. National Fire Protection Association (NFPA 20, 75 and 780).

5. National Electric Code (NFPA 70).
6. Underwriters Laboratories (UL 1449 4th Edition and UL 1283).
7. International Electrotechnical Commission (IEC 801).

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING

A. Coordinate with and provide SPD equipment to the electrical equipment manufacturer before final assembly and factory testing.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Extended warranty:
   1. Furnish a manufacturer's full 5-year parts and labor warranty from date of shipment against any part failure when installed in compliance with manufacturer's written instructions, UL listing requirements, and any applicable national, state, or local electrical codes.
   2. Warranty shall include:
      a. Direct, factory trained employees must be available within 48 hours for assessment of the problem.
      b. A 24-hour toll-free 800-number for warranty support.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Same manufacturer as Motor Control Center.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. Provide Type 1 or Type 2 SPD units as required for the locations indicated on the Drawings.

B. Electrical requirements:
   1. SPD ratings are to be consistent with the nominal system operating voltage, phase, and configuration as indicated on the Drawings.
   2. MCOV:
      a. For the SPD and all components in the suppression path (including all MOVs, SADs, and selenium cells): Greater than 115 percent of the nominal system operating voltage.
   3. Operating frequency:
      a. 47 to 63 hertz.
   4. SCCR:
      a. 65 kAIC minimum, but not less than the equipment it is connected to as indicated on the Drawings.
      b. The SCCR shall be marked on the SPD in accordance with UL 1449 and the NEC.
   5. Nominal discharge current I_n:
      a. 20 kA.
   6. Maximum VPR:

Modes	240/120	208Y/120	480Y/277
L-N, L-G, N-G	900	900	1,500
L-L	1,200	1,200	2000

   7. Peak surge current:
      a. Service entrance locations:
         1) 240 kA per phase minimum.
         2) 120 kA per mode minimum.
      b. Branch locations:
         1) 120 kA per phase, minimum.
         2) 60 kA per mode minimum.

C. Protection modes:
   1. Provide SPD protection modes as follows:
      a. Line to Neutral (L-N) where applicable.
      b. Line to Ground (L-G).
      c. Neutral to Ground (N-G), where applicable.

D. Environmental requirements:
   1. Storage temperature:
      a. -40 degrees to +50 degrees Celsius.
   2. Operating temperature:
      a. -0 degrees to +60 Celsius.
   3. Relative humidity:
      a. 5 percent to 95 percent.
   4. Audible noise:
      a. Less than 45 dBa at 5 feet (1.5 m).
   5. Operating altitude:
      a. Zero to 12,000 feet above sea level.

E. Provide surge protective devices that are suitable for application in IEEE C62.41.1, C62.41.2 Category A, B, and C3 environments, as tested to IEEE C62.45.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

A. Enclosure:
   1. Located in electrical equipment as indicated on the Drawings.

B. Internal connections:
   1. Provide low impedance copper plates for intra-unit connections:
      a. Attach surge modules using bolted connections to the plates for low impedance connections.
   2. Size all connections, conductors, and terminals for the specified surge current capacity.

C. Surge diversion modules:
   1. MOV:
      a. Where multiple MOVs are used in parallel, utilize computer matched MOVs to within 1 volt variance and tested for manufacturer's defects.

D. Overcurrent protection:
   1. Individually fuse all components, including suppression, filtering, and monitoring components:
      a. Rated to allow maximum specified nominal discharge current capacity.
      b. Overcurrent protection that limits specified surge currents is not acceptable.

E. Connections:
   1. Provide terminals to accommodate wire sizes up to #2 AWG.

2.07 ACCESSORIES

A. Unit status indicators:
   1. Provide red and green solid-state indicators, with printed labels, on the front cover to redundantly indicate on-line unit status:
      a. The absence of the green light and the presence of the red light indicate that surge protection is reduced and service is needed to restore full operation.
      b. Indicates the status of protection on each mode or phase.

B. Dry contacts for remote monitoring:
   1. Electrically isolated Form C dry contacts (1 A/125 VAC) for remote monitoring of system integrity, and indication of under voltage, phase and/or power loss.

C. Provide an audible alarm which activates under any fault condition.
   1. Provide an alarm On/Off switch to silence the alarm.
   2. A visible LED will confirm whether alarm is On or Disabled.
   3. Locate both switches and the audible alarm on the unit's front cover.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. Permanently affix surge rating to the SPD.

B. Perform manufacturer's standard factory test:
   1. Perform testing in accordance with UL 1449.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Follow the manufacturer's recommended installation practices and comply with all applicable codes.

C. Special techniques:
   1. Do not subject SPD to insulation resistance testing.

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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_08_50 - Field Electrical Acceptance Tests.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_50_10

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 26_05_00 - 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 26_05_00 - 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: Footcandles - 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 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.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26_05_00 - 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) Dimensioned drawings:
    a) Effective projected area rating for pole mounted luminaires.
12) Weight.
13) 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.
14) 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 26_05_00 - 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.

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:

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.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 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.

1.11 WARRANTY

A. As specified in Section 26_05_00 - 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.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 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. 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 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 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.

B. 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.

2.06 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 26_05_00 - 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.

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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - 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 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES

A. Refer to the Luminaire Schedule in the Drawings.

END OF SECTION

SECTION 40_61_00

COMMON WORK RESULTS FOR PROCESS CONTROL AND INSTRUMENTATION SYSTEMS

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 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. Submit all such changes and additions to the Engineer for acceptance as specified in Document 00_72_00 - General Conditions.
   4. Review the complete set of Drawings and Specifications in order to ensure that 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. The Owner is not responsible for any additional costs due to the failure of the Contractor to notify all subcontractors and suppliers of the Instrumentation and Control 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. Section 00700 - General Requirements.
      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 Section 00700 - General Requirements.

F. Changes and change orders:
    1. As specified in Division 1 specifications.

1.02 REFERENCES

A. Code compliance:
    1. 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 Section 00700 - General Requirements.

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 24VDC 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 24VDC signal, a digital bus communications signal, or both.
   8. System supplier - As specified in ICSC Qualifications in the Quality Assurance article of this Section.

C. NEMA:
   1. Type 1 enclosure in accordance with NEMA 250.
   2. Type 3R enclosure in accordance with NEMA 250.
   3. Type 4X enclosure in accordance with NEMA 250.

4. Type 6 enclosure in accordance with NEMA 250.
5. Type 6P 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. 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.
28. SPDT: Single-pole, double-throw.
29. SPST: Single-pole, single-throw.
30. UPS: Uninterruptible power supply.

1.04 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 bench calibration and verify calibration after installation.
      g. Perform testing as indicated in Section 40_80_01 - Commissioning for Instrumentation and Controls.
      h. Prepare operation and maintenance manuals.
      i. Conduct training classes.
      j. Integrate the PCS with instrumentation and control devices provided under other sections.

k. 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.
l. Resolve signal, power, or functional incompatibilities between the PCS and interfacing devices.
m. 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 will provide the configuration and programming for SCADA/HMI and all PLCs with the exception of the vendor-furnished PLCs.
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. 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.
7. Defective Work:
    a. As specified in Section 00700 - General Requirements.

B. Existing system:
1. Enusre the existing OMNI system XR50 is salvaged to the Owner for re-use as part of Base Bid.

C. New system:
1. There is no PLC in this project or any automatic controls. There is a control system called OMNI system which is used for monitoring. The OMNI system will transmit the information via cellular transmission. The cellular transmission is not part of Contractor's scope of work. Contractor scope of work is to wire the cables to OMNI system.
2. There are two types of OMNI system – XR 50 capable of monitoring up to 10 DIs and Crystalball capable up to 12 DIs, 4 AIs and 4 AOs.
3. Base Bid:
    a. Reinstall the existing OMNI XR50 in base bid.
    b. Provide and install new instruments as indicated on the Drawings.
4. Bid Alternate: In addition to the above work,
    a. Provide and install a OMNI Crystalball, in lieu of XR50.
    b. Install magnetic flowmeter, and the flow meter indicator in control panel section.

1.05 SUBMITTALS

A. Furnish submittals as specified in 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 26_05_53 - 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 organization:
   1. First page:
      a. Specification section reference.
      b. Name and telephone number of individual who reviewed submittal before delivery to Engineer.
      c. Name and telephone number of individual who is primarily responsible for the development of the submittal.
      d. Comments.
      e. Contractor's review certification statement and signature.
   2. Next pages:
      a. Provide confirmation of specification compliance:
         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.
      b. Include a response in writing to each of the Engineer's comments or questions for submittal packages which are re-submitted:
         1) In the order that the comments or questions were presented throughout the submittal.
         2) Referenced by index section and page number on which the comment appeared.
         3) Acceptable responses to Engineer's comments are either:
            a) Engineer's comment or change is accepted and appropriate changes are made.
            b) Explain why comment is not accepted or requested change is not made.
            c) Explain how requirement will be satisfied in lieu of comment or change requested by Engineer.
         4) Any re-submittal, which does not contain responses to the Engineer's previous comments shall be returned for Revision and Re-submittal.
         5) No further review by the Engineer will be performed until a response for previous comments has been received.

3. Remaining pages:
    a. Actual submittal data:
        1) Organize submittals in exactly the same order as the items are referenced, listed, and/or organized in the specification section.
        2) 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 intended to be used.

D. Submittal requirements:
1. Furnish submittals that are fully indexed with a tabbed divider for every component.
2. Sequentially number pages within the tabbed sections. Submittals and operation and maintenance manuals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.
3. Furnish submittals in the following general order, each in a separate bound set:
    a. Schedule of Values.
    b. Product Data.
    c. After Engineer acceptance of the Product Data, submit the Project Shop Drawing submittals.
    d. Loop Description Submittal.
    e. The Process Control Hardware and Software Submittal including, control system software, programming, and screens.
    f. Testing, Calibration and Process Start-Up procedures.
    g. Operation and Maintenance Data.
    h. Training Submittals.
    i. Record Documents.
4. Edit all submittals and operation and maintenance manuals so that the submittal specifically applies to only the equipment furnished.
    a. 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.
5. Submit copies of shop drawings, and product data:
    a. Show dimensions, construction details, wiring diagrams, controls, manufacturers, catalog numbers, and all other pertinent details.
6. Where submittals are required, provide a separate submittal for each specification section. 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. (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.)
7. Exceptions to Specifications and Drawings:
    a. Include a list of proposed exceptions to the Specifications and Drawings along with a detailed explanation of each.
    b. If there is insufficient explanation for the exception or deviation, the submittal will be returned requiring revision and re-submittal.

c. Acceptance of any exception is at the sole discretion of the Engineer.
    1) Provide all items (materials, features, functions, performance, etc.) required by the Contract Documents that are not accepted as exceptions.
d. Replace all items that do not meet the requirements of the Contract Documents, which were not previously accepted as exceptions, even if the submittals contained information indicating the failure to meet the requirements.

E. 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.

F. 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 26_05_53 - 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 26_05_53 - 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 26_05_53 - 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. Submit preliminary sets of these manuals to the Engineer for review of format and content:
        1) Engineer will return 1 set with comments.
        2) Revise and/or amend as required and submit the requisite number of copies to the Engineer 15 days before Functional Testing of the systems.
    b. Incorporate changes that occur during process start-up and submit as part of the final manuals.
    c. Provide comprehensive information on all systems and components to enable operation, service, maintenance, and repair.
    d. Include Record Documents and the accepted shop drawing submittals, modified for conditions encountered in the field during the work.
    e. Include signed results from Functional Testing and Process Operational Period.
    f. Provide installation, connection, operating, calibration, setpoints (e.g., pressure, pump control, time delays, etc.), adjustment, test, troubleshooting, maintenance, and overhaul instructions in complete detail.
    g. Provide exploded or other detailed views of all instruments, assemblies, and accessory components together with complete parts lists and ordering instructions.
    h. Spare parts list:
        1) Include a priced list of recommended spare parts for all the equipment furnished under this Contract:
            a) Include recommended quantities sufficient to maintain the furnished system for a period of 5 years.
        2) Annotate the list to indicate which items, if any and quantity are furnished as part of this Contract.
    i. Provide the name, address, and phone number of manufacturer and manufacturer's local service representative of these parts.
    j. Additional operation and maintenance manual requirements:
        1) Completely index manuals with a tab for each section:
            a) Each section containing applicable data for each piece of equipment, system, or topic covered.
            b) Assemble manuals using the accepted shop drawings, and include, the following types of data:
                (1) Complete set of 11-inch by 17-inch drawings of equipment.
                (2) Complete set of 11-inch by 17-inch drawings of the control system.
                (3) Complete set of control schematics.
                (4) Complete parts list for all equipment being provided.
                (5) Catalog data for all products or equipment furnished.
    k. 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.
    l. 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.

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.
      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. Installation recommendations:
    a. Submit the manufacturer's printed recommendations for installation of instrumentation equipment.
10. 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 01200 - Contract Closeout.
    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.

11. Project Record documents:
    a. Furnish as specified in Section 01200 - Contract Closeout.
    b. Record Drawing requirements:
        1) Provide Project Record Drawing of all Instrumentation Drawings.
        2) Update Record Drawings weekly.
        3) Record Drawings must be fully updated as a condition of the monthly progress payments.
        4) Clearly and neatly show all changes including the following:
            a) All existing pipe, conduit, wire, instruments or other structures encountered or uncovered during construction.
    c. Shop drawings:
        1) General:
            a) Coordinate all aspects of the Work so that a complete, instrumentation, computer, and control system for the facility is supported by accurate shop and record drawings:
                (1) Clearly show every wire, circuit, and terminal provided under this contract on one or more submitted wiring diagrams.
            b) Show all interfaces between any of the following: instruments, vendor control panels, motor control centers, motor starters, variable speed drives, control valves, flow meters, chemical feeders, and other equipment related to the PCS.
            c) Generate all drawings developed for this project utilizing AutoCAD by Auto Desk Version 2012 or later:
                (1) Furnish on CD-ROM disks containing the following for each drawing:
                    (a) Original CAD files in DWG format.
                    (b) PDF version.
                (2) Provide hard copies on 11-inch by 17-inch plain bond paper.

d) Upon completion of the Work, update all shop drawings to indicate the final as-built configuration of the systems:
(1) Should an error be found in a shop drawing during installation or process start-up of equipment, note the correction, including any field changes found necessary, on the drawing and submit the corrections in the Record Documents.
(2) Update, check, and revise all wiring drawings and other submitted drawings and documents to show final installed conditions.
(3) Provide as-built shop drawings for all instrumentation equipment on 11-inch by 17-inch using plain bond paper.
(4) Provide electronic copies of these documents on CD-ROM disks in AutoCAD DWG 2010 format or later and PDF format. Size all drawings to be readable and legible on 11-inch by 17-inch media.
e) Submittal Documents:
(1) Provide an interim submittal of Record Documents after the PCS system Functional Testing.
(2) Submit final Record Documents before Substantial Completion.
f) Review and Corrections:
(1) Correct any Record Documents or other documents found to be incomplete, not accurate, of poor quality, or containing errors.
(2) Promptly correct and re-submit Record Documents returned for correction.

2) Furnish written information prepared specifically for this Project using Microsoft Word and PDF formats and printed on 8.5-inch by 11-inch plain bond paper:
a) Provide electronic copies of these documents on CD-ROM disks.

d. Review and corrections:
1) Correct any record documents or other documents found to be incomplete, not accurate, of poor quality, or containing errors.
2) Promptly correct and re-submit record documents returned for correction.

12. 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.

13. 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.

14. 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.
15. 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.

16. 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.
17. 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.
18. 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.
19. Test reports:
    a. Include the following:
        1) A description of the test.
        2) List of equipment used.
        3) Name of the person conducting the test.
        4) Date and time the test was conducted.
        5) All raw data collected.
        6) Calculated results.
        7) Each report signed by the person responsible for the test.

1.06 QUALITY ASSURANCE

A. Manufacture instruments at facilities certified to the quality standards of ISO 9001.

B. 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. Store all equipment and materials delivered to the job site in a location that will not interfere with the construction or the Owner's operations.

B. Shipping precautions:
   1. After completion of shop assembly, successful Source Test, pack all equipment, cabinets, panels, and consoles in protective crates and enclose in heavy-duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture.
   2. Place dehumidifiers when required, inside the polyethylene coverings.
   3. Skid-mount the equipment for final transport.
   4. Provide lifting rings for moving without removing protective covering.
   5. Display boxed weight on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.

C. Special instructions:
   1. Securely attach special instructions for proper field handling, storage, and installation to each piece of equipment before packaging and shipment.

D. 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.

E. 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.

1.08 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. Altitude, temperature and humidity:
      a. Provide all equipment and instrumentation fully rated for continuous operation at this altitude, temperature and humidity conditions with no additional derating factors applied.
      b. 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.
   3. Area classifications:
      a. Furnish enclosures that match the area classifications as specified in Section 26_05_00 - Common Work Results for Electrical.
   4. Site security:
      a. Abide by all security and safety rules concerning the Work on the Site.

1.09 SEQUENCING

A. General:
   1. As specified in Sections 01030 - Project Meetings and 01200 - Contract Closeout
   2. Testing requirements are specified in Sections 01200 - Contract Closeout, 40_80_01 - Testing, Calibration, and Commissioning and other sections.
   3. Work restrictions and other scheduling requirements are specified in Section 01400 - MAG Section 105 and MAG Section 106 - Quality Control.
   4. Commissioning requirements as specified in Section 01200 - Contract Closeout.

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.

C. General Field Start-Up and testing procedures:
   1. As specified in Section 01200 - Contract Closeout.

D. Installation testing:
   1. As specified in Section 01200 - Contract Closeout.
   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.

E. Training:
   1. As specified in Section 01200 - Contract Closeout.

F. 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.

G. 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.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. Provide additional warranty as specified in the individual Instrumentation and Control Specifications that extends beyond the Correction Period, as specified in Documents 00700 - General Requirements.

1.12 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.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 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 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 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.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 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. Analog signals within enclosures may be 1 to 5 VDC.
      d. Electrically or optically isolate all analog signals from other signals.
      e. Furnish regulated analog signals that are not affected by changes in supply voltage or load resistance within the unit's rating.
      f. Maintain the total 4 to 20 milliamperes loop impedance to 10 percent below the published value at the loop operating voltage.
      g. Where necessary, reduce loop impedance by providing current-to-current (I/I) isolation amplifiers for signal re-transmission.
   2. Discrete input signals:
      a. As indicated in the controller hardware specification.
   3. 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.
   4. 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. Provide control panels with a signal ground bus, isolated from the power ground bus:
        a. Provide multiple panels in one location with a common point for signal ground bus connection to ground.
    2. Ground single-point ground shields and measurement loops at the source panel external terminals, unless otherwise noted, by bonding to the control panel signal ground bus.
    3. Provide isolating amplifiers within control panels for field equipment possessing a grounded input or output, except when the panel circuit is galvanically isolated.

2.07 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, 120VAC).
        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.

2.08 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 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.

PART 3 EXECUTION

3.01 EXAMINATION

A. The Contractor is encouraged to visit the site and examine the premises completely before bidding. It is the Contractor'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 exposed to direct sunlight.
   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 26_05_00 - 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. Use proper tool.
      b. Make bends for parallel lines symmetrical.
      c. 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. Conduit, cables, and field wiring:
   1. Provide all PCS equipment cables, and process LAN communication networks under the Instrumentation and Control Specifications.
   2. Provide terminations and wire identification as specified in the Electrical Specifications.
   3. Protect all wiring from sharp edges and corners.
   4. Provide all conduits, fittings, boxes, etc. in accordance with all the requirements of the Electrical Specifications.

G. 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.

H. Instrument tagging:
   1. As specified in Section 26_05_53 - 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 26_05_00 - 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 1/16 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.

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 01200 - Contract Closeout.

B. Owner training:
   1. Demonstration requirements are specified in Section 40_80_01 - Testing, Calibration, and Commissioning.
   2. General:
      a. Provide system maintenance and operator training courses for all the instrumentation and control systems furnished.
      b. Provide system maintenance and operator training courses for all the instrumentation and control equipment and systems furnished, as described below.
         1) All training described below shall be provided by the Contractor.
         2) The Programmer is not responsible for the training described in this Section.
         3) The Programmer will provide training on software provided by the Programmer.
      c. Conduct all training at the Project Site unless another location is accepted by the Engineer and Owner:
         1) Include instruction on the use of all maintenance equipment and special tools provided under the Contract.
      d. Tailor training classes to the specific needs of the class participants:
         1) Develop separate courses for operators, maintenance staff, and supervisors:
            a) The specific categories and number of personnel in each category are identified below.
         2) Furnish training courses that are a combination of classroom and hands-on training:
            a) To the greatest extent possible, utilize components from the Owner's PCS system.
            b) Limit classes that include extensive hands-on activities to a maximum of 5 students per class.
         3) Present the minimum number of sessions, specified in Table 1, for each course in order to satisfy class size restrictions and limitations scheduling Owner staff.
         4) Furnish additional sessions if required to accommodate the total number of personnel identified for each course.
      e. Temporarily install a test PLC and 2 user workstations in the training area for PCIS system training classes conducted on-site:
         1) Configure the workstations as full-function operator stations during the training classes.
         2) Connect these components with a LAN in order to fully simulate system operation.
      f. Schedule individual training classes:
         1) Coordinate with the Owner at least 3 weeks before the start of the class.
         2) Schedule training classes Monday - Friday between 7:30 a.m. and 3:30 p.m.
         3) Each individual daily training session, travel time excluded:
            a) Minimum duration of 4 hours.
            b) Maximum duration of 7 hours.
            c) Breaks scheduled at least every 90 minutes and 1 hour for lunch.

4) Complete training for maintenance personnel 90 days before Process Operational Period.
5) Complete operator training classes before process start-up of the control system software, or any part of it:
a) As specified in the Sequencing article of this Section.
6) Schedule follow-up training classes after the PCS start-up on a schedule determined by the Owner.

g. Instructor qualifications:
1) Highly qualified training instructors for technical training with demonstrated expertise in not only control system functionality but also professional training techniques:
a) Instructor qualifications are subject to the approval of the Engineer.
2) Furnish training instructors thoroughly familiar with the PCIS system, who are members of the implementation team.
3) One of the individuals conducting the PCIS training course must be the same individual responsible for the majority of the programming that was performed for the instrumentation and control system.

3. Training manuals and materials:
a. Furnish training manuals and other materials for training courses.
b. Manuals are to be professionally written to present the course material in a format that is easy to comprehend.
c. The manuals are to serve as teaching aids during presentation of the training classes.
d. Manuals are to serve as reference material after the training has been completed.

Table 1

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
Follow-Up Training	8	5	5
Instrument Training	16	3	1

4. Training course requirements:
a. System overview training:
1) Furnish training courses that give the Owner's supervisory level personnel an overview of all elements of the PCIS system that focus on the overall functional aspect of elements of the control system and provide an understanding of the interaction of the various components.
2) Furnish a training course that gives the Owner's supervisory level personnel an overview of the new Contractor-provided elements of the PCIS system. Focus on the overall functional aspects of each new elements of the control system, particularly the mechanical system vendor-provided control packages.

b. Operator training:
    1) Furnish training courses that instruct system operators in the efficient operation of all aspects of the PCIS that include not only the general operation of the control system but also the operation of specific system features.
c. 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.
d. 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.

5. 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.

3.08 FIELD QUALITY CONTROL

A. Inspection:
    1. Provide any assistance necessary to support inspection activities.
    2. 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.

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. Additional general requirements are specified in Section 01200 - Contract Closeout.

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. Vacuum clean all control panels and enclosures before process start-up and again after final completion of the project.

B. Clean all panel surfaces.

C. Return to new condition any scratches and/or defects.

D. Wipe all instrument faces and enclosures clean.

E. 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.

F. 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 40_71_15

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 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SUBMITTALS

A. Furnish submittals as specified in Section 40_61_00 - 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 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.08 WARRANTY

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.09 MAINTENANCE

A. As specified in Section 40_61_00 - 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 L400.

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.
        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 6P 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) As noted in the instrument data sheets.
        2) For all instruments with 4 to 20 mA HART or digital bus protocol, provide a Device Type Manager (DTM) certification by FDT group.
    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.

D. Electronic tester for calibration verification and diagnostics.
   1. Transmitter shall have continuous internal meter verification method comparing current meter system values to base line value.
   2. Should variance in readings be determined exceeding a preset limit the transmitter will provide an alarm condition via a configurable discrete output.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 40_61_00 - 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 40_61_00 - 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 40_61_00 - 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 flowmeter 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 40_61_00 - 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 40_61_00 - 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

A/E:	Carollo Engineers	MAGNETIC FLOWMETERS				INSTRUMENT DATA SHEETS		
						Spec. No.		Rev.
Contractor:		No	By	Date	Revision	40_71_15		
Project:	Chapel Hills Lift Station Improvements					Contract		Date
Customer:	City of Sedona							
Plant:						Req.		P.O.
Location:								
BOM No.:						By	Chk	App
File:								

	1		Instrument Tag No.			FE/FIT-0201						
	2		Service									
	3		P&ID			N-9						
	4	C	Line Size / Schedule			6”						
	5	O	Line Material			Class 350 DIP						
	6	N	Connection Type/ Pressure Rating			Flange						
	7	N	Connection Materials			Carbon Steel						
	8		Tube Size									
E	9		Tube Material			DIP						
L	10		Liner Material									
E	11	M	Electrode Type			Mfg Standard						
M	12	E	Electrode Material									
E	13	T	Meter Casing									
N	14	E	Power Spply	Phase								
T	15	R	Grounding Type & Matl.									
	16		Enclosure Class			NEMA 6P						
	17		Other									
	18		Fluid			WasteWater						
	19	F	Max Flow			750 gpm						
	20	L	Min Velocity			4.3 fps						
	21	U	Min Flow	Norm Flow		400 gpm	445 gpm					
	22	I	Min Temp	Max Temp		50 F	70 F					
	23	D	Min Press	Max Press		70 feet	80 feet					
	24		Vacuum Possibility									
	25		Conductivity									
T	26		Function									
R	27		Mounting			Remote						
A	28		Enclosure Class			NEMA 4X						
N	29		Length Signal Cable									
S	30		Type Span Adjustment									
M	31		Power Supply			120 VAC, 1P						
I	32		Transmitter Output			4-20 mA HART						
			Relay Outputs			Form C						
T	33		Accuracy			0.25%						
T	34		Calibrated Range									
E	35		Empty Pipe Detection									
R	36		Bi-Directional Flow									
	37		Display Scale Size	Range								
	38		Alarm Contact No.	Form								
	39		Manufacturer									
	40		Element (Meter) Model No.									
	41		Transmitter (Inst.) Model No.									

Notes:

SECTION 40_72_76

LEVEL MEASUREMENT: SWITCHES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Ball float level switch.

B. Provide all instruments identified in the Contract Documents.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.03 DEFINITIONS

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SUBMITTALS

A. Furnish submittals as specified in Section 40_61_00 - 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 40_61_00 - 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 instrument 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 40_61_00 - 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 40_61_00 - 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. Ball float level switch:
      a. E+H, Liquifloat T FTS20.
      b. Evoqua Water Technologies, 9G-EF.
      c. ITT Flygt, Model ENM-10.
      d. Anchor Scientific Inc., Ecofloat/Solofloat.

2.02 MANUFACTURED UNITS

B. Ball float level switch:
   1. General:
      a. Free hanging, encapsulated body with a switch to determine position of float.
   2. Element:
      a. Mechanical switch encapsulated in waterproof floating ball of nominal diameter, supported by flexible PVC cable and jacket or heavy neoprene.
      b. The length of the PVC cable shall be, at a minimum, equal to sump depth plus 5 feet.
      c. Float: Provide Type 316 stainless steel or polypropylene, maximum 3 inches in diameter.
      d. An operating temperature rating: -30 degrees Fahrenheit to +150 degrees Fahrenheit.
      e. Mercury switches are not acceptable.

f. Lead wires: Mounted in flexible waterproof PVC cable from switch to junction box terminals without splices.

3. Switch:
   a. Single pole double throw contacts rated 10 amps resistive at 120 VAC.
   b. Provide the number of floats per level system as indicated on the Drawings.
   c. Suspend ball float and adjust for level setpoint as required.
4. Components:
   a. Floats shall include Type 316 stainless steel clamp and brackets and 1/4-inch cable to allow testing of the float without entering the basin or wet well.
   b. Provide strain relief at both ends of the float cable.
   c. Float anchors:
      1) Furnish 15-pound PVC coated anchor kit with 10 feet of Type 316 stainless steel chain.
      2) Provide stainless steel shackles and float clamps.
      3) Manufacturers: The following or equal:
         a) Conery Mfg. Inc.

2.03 ACCESSORIES

A. Provide sunshades for outdoor installation.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 40_61_00 - 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. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.05 ADJUSTING

A. As specified in Section 40_80_01 - Testing, Calibration, and Commissioning.

3.06 CLEANING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.08 PROTECTION

A. As specified in Section 40_61_00 - 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, as specified in the Specifications or both.

END OF SECTION

A/E:	Carollo Engineers	LEVEL SWITCHES				Spec. No.	Rev.
Contractor:		No	By	Date	Revision	40_72_76	
Project:	Chapel Hills Lift Station Improvements					Contract	Date
Customer:	City of Sedona						
Plant:						Req.	P.O.
Location:							
BOM No.:						By	Chk. App.
File:							

	1	Type	Conductance:	Capacitance:	Tuning Fork:	Ball Float: X	Displacement:
	2	Setting	Field Set:	Factory Set: X			
G	3	Dead Band	Fixed: X	Adj:	Other:		
E	4	Material					
N	5	Dimensions	Field Set:				
E	6	Mounting	Flange:	Threaded:	Other: Suspended		
R	7	Operating Pressure /Temperature					
A	8	Connection	MFR STD: X	Other:			
L	9	Manufacturer					
	10	Other					
	11	Other					

S	12	Type	Mechanical: X	Reed:	Other:	
W	13	Quantity	Single: X	Dual:	Other:	
I	14	Form	SPST:	SPDT: X	DPDT:	Other:
T	15	Rating: Amps Volts Hertz				
C	16	Load	Inductive:		Non-Inductive: X	
H	17	Other				
	18	Other				

Rev.	Tag Number	Model No.	Setpoint	P&ID	Service	Notes
	LSLL-0201		1.25 - FT	N-9		
	LSL-0201		1.5 - FT	N-9		
	LSH1-0201		4.5 - FT	N-9		
	LSH2-0201		5 - FT	N-9		
	LSHH-0201		5.25 - FT	N-9		

Notes: Refer to Section 40_72_76 for additional level switch requirements.

SECTION 40_73_13

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 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SUBMITTALS

A. Furnish submittals as specified in Section 40_61_00 - 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 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.08 WARRANTY

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.09 MAINTENANCE

A. As specified in Section 40_61_00 - 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 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 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. Hermetically sealed.
    h. Connection and mounting:
        1) Direct mounted and suitable for outdoor installation.
        2) 1/2-inch NPT.
        3) Connection material: Stainless steel.
    i. 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 diaphragm seals as specified in the Contract Documents and in Section 40_73_63 - Pressure/Vacuum Measurement: Diaphragm Seal:
    1. Diaphragm seal and pressure gauge shall be assembled by manufacturer and shipped as an assembly.

C. Provide means for gauge isolation as specified in Section 40_73_64 - 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.

D. 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 40_61_00 - 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 40_61_00 - 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 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.08 PROTECTION

A. As specified in Section 40_61_00 - 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

A/E:	**Carollo Engineers**		**PRESSURE GAUGES**								
								Spec. No.		**Rev.**	
Contractor:			**No**	**By**	**Date**	**Revision**		40_73_13			
Project:	Chapel Hills Lift Station Improvements							**Contract**		**Date**	
Customer:	City of Sedona										
Plant:								**Req.**		**P.O.**	
Location:											
BOM No.:								**By**	**Chk**	**App**	
File:											

1	**Type**	Direct Rdg.: √		Receiver:		Other:
2	**Mounting**	Surface: Local: √				Flush:
3	**Dial**	Diameter: 4.5"			Color:	
4	**Case**	**Cast Iron:**	**Aluminum:**	**Phenolic:** √	**Polished SS**	**Other:**
5	**Ring**	Screwed:	Hinged:	Slip:	Std:	Other:
6	**Blowout Protection**	None:	Disc:	Front:	Other:	Mfr. Std.
7	**Lens**	Glass: √			Plastic:	
8	**Options**	Siphon: N/A			Material:	
9	**Other**	Snubber:				
10	**Other**	Pressure Limit Valve: N/A				
11	**Other**	Movement Damping: N/A				
12	**Nominal Accuracy Required**					
13	**Pressure Element**	Bourdon®: √		Bellows:		Other:
14	**Element Material**	Bronze:	Steel:		Type SS: 316 √	Other:
15	**Socket Material**	Bronze:	Steel:		SS: 316	Other:
16	**Connection**	¼ in.:	½ in.: √		Bottom:	Other:
17	**Movement**	Dampened:	Standard: √		Other:	
18	**Diaphragm Seal**	Mfr.:		Wetted Part Mat'l:		Type:
19	**Other**	Other Mat'l:		Fill Fluid:		Model:
20	**Manufacturer**					
21	**Model No.**					

Rev	Tag Number	Range	P&ID	Service	Notes
	PI-0201	**0-60 PSIG**	**N-9**		

Notes:
Refer to Section 40_73_64 - Pressure/Vacuum Measurement: Instrument Valves for additional instrument valve requirements.

SECTION 40_73_63

PRESSURE/VACUUM MEASUREMENT: DIAPHRAGM SEALS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Diaphragm seals.

B. Provide all seals identified in the Contract Documents.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.03 DEFINITIONS

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SUBMITTALS

A. Furnish submittals as specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Additional requirements:
   1. Product data:
      a. Manufacturer's installation instructions.
      b. Seal type.
      c. Body materials.
      d. Diaphragm material.
      e. Fill fluid type.
      f. Seal size.
      g. Options.
      h. Process connection.

1.05 QUALITY ASSURANCE

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify the compatibility 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 manufacturer's recommendations or specifications.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.08 WARRANTY

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.09 MAINTENANCE

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide spare annular seal for every size indicated in the project.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Diaphragm seals:
   1. For chemical applications, liquids containing solids, and liquids with pulsating flow having pressures greater than or equal to 15 pounds per square inch gauge: One of the following or equal:
      a. Ashcroft:
         1) Flushing connection: Type 201.
      b. Mansfield and Green:
         1) Flushing connection: Type SG.
      c. Wika.

2.02 MANUFACTURED UNITS

A. Diaphragm seals:
   1. General:
      a. Diaphragm seal and pressure instrument shall be assembled by pressure instrument manufacturer and shipped as an assembly.
   2. Requirements:
      a. Seal type:
         1) Metallic diaphragm: Welded to upper housing.
         2) Elastomer diaphragm: Bonded to upper housing.
      b. Process connection: 1 inch NPT.
      c. Instrument connection: 1/2 inch NPT.
      d. Material Construction: Type 316 Stainless Steel.

e. Provide 1/4-inch flushing connection in diaphragm lower housing or provide flushing ring.
f. Flush port plug: Same material of construction as diaphragm lower housing.
g. Provide fill/bleed connection.
h. Mounting: As indicated in the Contract Documents.
i. Provide Type 316 stainless steel armored capillary for all remote installations.
j. Nuts and bolts: Type 316 stainless steel.
    1) Sewage, sludge, liquids containing solids, and liquids with pulsating flow having pressures greater than 15 pounds per square inch:
        a) Diaphragm: Type 316 stainless steel.
        b) Lower housing: Type 316 stainless steel.
        c) Upper housing: Manufacturer's standard.
        d) Fill fluid: Silicon oil.

2.03 ACCESSORIES(NOT USED)

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation System.

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.

C. Do not use Teflon thread seal tape on pressure instruments with silicon oil fill fluid.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.05 ADJUSTING (NOT USED)

3.06 CLEANING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.08 PROTECTION

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.09 SCHEDULES (NOT USED)

END OF SECTION

SECTION 40_73_64

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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.03 DEFINITIONS

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SUBMITTALS

A. Furnish submittals as specified in Section 40_61_00 - 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 40_61_00 - 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 40_61_00 - 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 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.09 MAINTENANCE

A. As specified in Section 40_61_00 - 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. Gauge valve:
   1. One of the following or equal:
      a. Anderson Greenwood.
      b. Hex Valve.

2.02 MANUFACTURED UNITS

A. 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.

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 40_61_00 - 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 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.05 ADJUSTING

A. As specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.

3.06 CLEANING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.09 SCHEDULES (NOT USED)

END OF SECTION

SECTION 40_73_65

PRESSURE MEASUREMENT: SUBMERSIBLE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Submersible pressure transmitters.

B. Provide all instruments identified in the Contract Documents.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.03 DEFINITIONS

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SUBMITTALS

A. Furnish submittals as specified in Section 40_61_00 - 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 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 40_61_00 - 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 40_61_00 - 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. Submersible level measurement with 2-wire integral transmitter:
   1. One of the following, and no equal:
      a. Endress+Hauser, Waterpilot FMX21 with 1.65-inch outer diameter probe.
      b. Measurement Specialties, KPSI 700 Series.

2.02 MANUFACTURED UNITS

A. Submersible level measurement with 2-wire integral transmitter:
   1. General:
      a. Pressure is measured through a diaphragm-type measuring cell and converted to linear pressure measurement.
      b. Each submersible pressure transmitter system shall include:
         1) Signal cable, including pressure compensation tube.
         2) Transducer probe with integral transmitter.
         3) Transmitter cable termination box.
   2. Performance requirements:
      a. Accuracy:
         1) 0.3 percent of range.
      b. Repeatability:
         1) 0.25 percent of full scale.
      c. Rangeability:
         1) 3:1.
      d. Range:
         1) As indicated on the contract documents.

3. Element:
    a. Sensor housing shall be Type 316L stainless steel or titanium with ceramic, teflon-coated, or titanium diaphragm.
    b. Protective cap shall be manufacturer's recommended material, chemically resistant to process fluid.
    c. Slip resistant extension cable with pressure compensation tube with Teflon filter.
    d. Enclosure for probe and transmitter assembly shall be NEMA Type 6P.
4. Transmitter:
    a. Power supply:
        1) 24 VDC: 2 wire loop powered.
        2) Power consumption: 18 VA maximum.
    b. Outputs:
        1) Isolated 4 to 20 milliamperes DC.
    c. Without display.
    d. Ambient operating temperature limits of -10 to 70 degrees Celsius (-14 to 158 degrees Fahrenheit).
    e. Transmitter shall be integral to probe housing.
5. Transmitter cable termination box:
    a. NEMA Type 4X.
    b. Equipped with filter or desiccant chamber to eliminate moisture from the pressure compensation tube.
    c. Termination for signal wires and pressure compensation tube.

2.03 ACCESSORIES

A. Type 316L stainless steel mounting clamp with Type 304 stainless steel mounting screws.

B. Provide guide tube for stillwell mounting.

C. Provide additional Type 316L stainless steel weight to prevent movement.

D. Provide additional anchor to prevent movement.

E. Provide cable clamp and strain relief.

F. Provide computer cable adapter with Windows® software.

G. Provide remote display with backlight or loop indicator with backlight as indicated on the Drawings.

H. Provide sunshade for outdoor installations.

I. Provide integral surge protection.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 40_61_00 - 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 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.05 ADJUSTING

A. As specified in Section 40_80_01 - Testing, Calibration, and Commissioning.

3.06 CLEANING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.08 PROTECTION

A. As specified in Section 40_61_00 - 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

A/E:	Carollo Engineers	SUBMERSIBLE PRESSURE INSTRUMENTS					
						Spec. No.	Rev.
Contractor:		No	By	Date	Revision	40_73_65	
Project:	Chapel Hills Lift Station Improvements					Contract	Date
Customer:	City of Sedona						
Plant:						Req.	P.O.
Location:							
BOM No.:						By	Chk App
File:							

	1	**Instrument Tag Number**	PE/LT-0201		
G	2	**Service**			
E	3	**P&ID**	N-9		
N	4	**Fluid Type**	Waste Water		
	5	**Fluid Specific Gravity**			
	6	**Type**	Submersible		
P	7	**Measuring Cell Material**	Diaphragm		
R	8	**Probe Body Material**			
O	9	**Op. Temp. Range**	40-80 deg F		
B	10	**Op. Pressure Range**	0- 20 ft		
E	11	**Other**			
	12	**Other**			
C	13	**Style**	Mfg. Std		
A	14	**Signal Cable Length**	As Required		
B	15	**Other**			
L	16	**Other**			
E	17	**Other**			
	18	**Type**			
T	19	**Operating Mode**	Continuous		
R	20	**Enclosure**			
A	21	**Mounting**			
N	22	**Temperature Range**			
S	23	**Measurement Range**			
M	24	**Power Supply**	24 VDC		
I	25	**Accuracy**	0.3 % of range		
T	26	**Display**			
T	27	**Output**	4-20 mA		
E	28	**Calibration**			
R	29	**Status Relay**			
	30	**Manufacturer**			
	31	**Model No.**			
	32	**Elect. Entry**			
	33	**Other**			
O	33				
P	34				
T	35				
S	36				

Notes:

SECTION 40_80_01

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.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Electronics Industries Alliance (EIA).

1.03 DEFINITIONS

A. As specified in Sections 01200 - Contract Closeout and 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SYSTEM DESCRIPTION

A. Contractor to initiate, coordinate, supervise, schedule and conduct testing for all Contractor-furnished work and Owner-furnished programming:
   1. Contractor to Conduct testing for all Contractor-furnished work as indicated in this Section.
   2. For all Owner-furnished programming, conduct testing by coordinating with the Owner as indicated in this Section.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. General:
   1. Reference additional detailed test submittal scheduling and prerequisite requirements as specified in the Sequencing article of Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

C. 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.

D. Test forms:
   1. Provide test and calibration forms and checklists for each of the following:
      a. Calibration.
      b. Loop validation tests.
      c. Installation tests.
      d. Functional tests.
      e. Instrumentation Fine-Tuning.
   2. 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.
   3. 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.
   4. Some sample test forms are included at the end of this Section. These test forms show the minimum required test form content. They are not complete, and have not been customized for this Project. The Contractor is to develop and submit test forms customized for the Project and meeting all of the specified test and submittal requirements.

E. 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.

F. 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 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Installation supervision:
   1. Provide as specified in Section 40_61_00 - 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. Owner training:
   1. Demonstration requirements are specified in this Section.

B. Installation testing:
   1. General:
      a. The Owner reserves the right to test any specified function, whether or not explicitly stated in the test submittals.
      b. Failure testing:
         1) In addition to demonstrating correct operation of all specified features, demonstrate how the system reacts and recovers from abnormal conditions including, but not limited to:
            a) Equipment failure.
            b) Operator error.
            c) Communications sub-system error.
            d) Power failure.
            e) Process equipment failure.
            f) High system loading conditions.
      c. Conduct testing Monday through Friday during normal working hours for no more than 8 hours per day.
         1) Testing at other times requires approval of the Engineer.
   2. Sequencing:
      a. See additional requirements specified in the Sequencing article of Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
   3. Calibration:
      a. After installation but before starting other tests, calibrate and adjust all instruments, devices, valves, and systems, in conformance with the component manufacturer's instructions and as specified in these Contract Documents.
      b. Components having adjustable features are to be set carefully for the specific conditions and applications of this installation. Test and verify that components and/or systems are within the specified limits of accuracy.
      c. Replace either individually or within a system, defective elements that cannot achieve proper calibration or accuracy.
      d. Calibration points:
         1) 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.
      e. Field verify calibration of instruments that have been factory-calibrated to determine whether any of the calibrations are in need of adjustment.
      f. 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.
      g. Complete instrument calibration sheets for every field instrument and analyzer.
      h. Calibration tags:
         1) Attach a calibration and testing tag to each instrument, piece of equipment, or system.
         2) Sign the tag when calibration is complete.

4. LAN cable post-testing:
    a. After installing the cable and connectors, test all cables using the LAN certification to confirm the installation meets the requirements of the specification.
    b. 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.
        1) After installing connectors:
        2) 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.
        3) Submit a signed test report presenting the results of the cable testing.
        4) Repair or replace any portions of the system not meeting ANSI/TIA/EIA standards for installation. Repaired sections shall be retested.
    c. Submit 3 copies of all final documentation (including traces), using the approved test form, to the Engineer upon successful completion of the testing.
5. Ultrasonic and radar check out:
    a. Check response under all operating conditions.
    b. Track all responses through trend charts in the SCADA system by working with the Owner.
    c. Provide Echo Transmission and signal quality on all level transmitters including guided and unguided units.
    d. Provide printout of the actual transmission and all parameters.
6. Perform Loop check/validation tests by coordinating with the Owner.
    a. Check all 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 SCADA system. Issue commands from the SCADA system and verify proper responses of field devices. Use actual process inputs wherever available.
    b. Provide "end-to-end" tests as specified below. Invite the Owner for all necessary testing procedures.
        1) Test SCADA system inputs from field device to SCADA system operator workstations.
        2) Test SCADA system outputs from SCADA operator workstations to field devices and equipment.
        3) Observe and record responses at all intermediate devices.
        4) Work with the Owner, test and record operator commands and signal readouts to each operator device where there is more than one operator interface point.
        5) For each signal, perform separate tests for SCADA computer screens, local operator interface (LOI) screens, and local control panels.
    c. Retest any loop following any necessary corrections.
    d. 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.

e. Apply continuously variable up and down analog inputs to verify the proper operation and setting of discrete devices (signal trips, etc.).
f. Apply provisional settings on controllers and alarm setpoints.
g. Record all analog loop test data on test forms.
h. Exercise each field device requiring an analog command signal, through the SCADA system. Vary, during the validation process, the output from the PLC SCADA system and measure the end device position, speed, etc. to confirm the proper operation of the device for the supplied analog signal. Manually set the output from the 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.
i. Exercise each field device providing a discrete input to the SCADA system in the field to 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.
j. Test each device accepting a discrete output signal from the SCADA. Perform the appropriate operator action at the SCADA operator stations (including LOIs, if present) and confirm the proper operation of the field device. Invite the Owner for all necessary test procedures:
    1) Stroke valves through outputs from the SCADA system, and confirm proper directional operation. Confirm travel limits and any feedback signals to the SCADA system.
    2) Exercise motors starters from the SCADA system and verify proper operation through direct field observation.
    3) Exercise solenoids and other field devices from the SCADA system and verify proper operation through direct field observation.
k. Include in the test forms:
    1) Analog input devices:
        a) Calibration range.
        b) Calibration data: Input, output, and error at each test value.
        c) Analog input associated PLC register address.
        d) Value in PLC register at each test point.
        e) Value displayed at each operator interface station (local operator interface displays and SCADA workstations).
    2) Analog output devices:
        a) Calibration range.
        b) Test value at each test point.
        c) Analog output associated PLC register address.
        d) Control variable value at field device at each test point.
        e) Physical device response at each test point:
            (1) Response to be actual valve position, or motor speed, etc.
    3) Discrete instrument input devices:
        a) Switch setting, contact action, and dead band.
        b) Valve position switches:
            (1) Response in the PLC as the valve is stroked from the PLC.
            (2) Field observed actual valve position, and valve indicator position as the valve is stroked from the PLC.

c) Operator interface switches (control stations and other pilot devices) and associated response.
d) Starter and drive auxiliary device contact response.
e) Response of all other discrete inputs to the PLC.

4) Discrete output devices:
a) Observed response of field device to the discrete output from the PLC.
b) Observe the proper operation of Open, Close, Start, Stop, On, Off, etc.
c) Test equipment used and associated serial numbers.

7. 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, and manufacturer's representative 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. Perform loop tuning as mentioned below. Invite the Owner for all necessary testing procedures:
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 01200 - Contract Closeout.
        (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. Perform Instrumentation Fine-Tuning by coordinating with the Owner:
    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. General:
        a. 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.
        b. The complete PLC control and SCADA system must run continuously for the duration of the performance test.
        c. Test and use the entire process control system under standard operating conditions.

d. Exercise all system functions.
e. Log failure, any system interruption and accompanying component, subsystem, or program failure including time of occurrence, duration of each failure, failure classification, and cause:
    1) 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.
        a) Response time to the Project Site: 24 hours or less, for a major failure.
f. 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.

3. 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.
4. 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

	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 ☐ TRANSMITTER ☐ CONTROLLER ☐ INDICATOR

☐ 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 _____

SECTION 40_96_15

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 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

Engineers...Working Wonders With Water™

PLC I/O Listing for OMNI-0201

Drawing	Function	Loop	I/O	Location	Description	(E/F)
C_11115A10N-9.DWG	F	0201	AI	OMNI-0201		
C_11115A10N-9.DWG	L	0201	AI	OMNI-0201		
C_11115A10N-10.DWG	MCC	0201	AI	OMNI-0201	APPARENT POWER	
OMNI-0201 Total AI Points = 3						
C_11115A10N-9.DWG	AUX2	0201	DI	OMNI-0201	FAULT	
C_11115A10N-10.DWG	GAUX1	0201	DI	OMNI-0201	GENERATOR RUNNING	
C_11115A10N-10.DWG	GAUX2	0201	DI	OMNI-0201	GENERATOR FAIL	
C_11115A10N-9.DWG	LSHH	0201	DI	OMNI-0201		
C_11115A10N-9.DWG	LSLL	0201	DI	OMNI-0201		
C_11115A10N-9.DWG	AUX2	0202	DI	OMNI-0201	FAULT	
OMNI-0201 Total DI Points = 6						

TECHNICAL SPECIFICATIONS
(Mystic Hills Lift Station)

SUNRISE
ENGINEERING

City of Sedona
Mystic Hills Lift Station Improvements

Technical Specifications
SEI Project No. 06306 January 31, 2019

TECHNICAL SPECIFICATIONS

For the

City of Sedona

Mystic Hills Lift Station Improvements

Prepared For:
City of Sedona
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Sedona, Arizona 86336
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Section No. of Pages

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FOR
TECHNICAL SPECIFICATIONS

00700.1 GENERAL SPECIFICATIONS/PROJECT REQUIREMENTS

All items of work and associated construction requirements are adequately described and defined in the Uniform Standard Specifications for Public Works Construction sponsored and distributed by the Maricopa Association of Governments (MAG) along with the MAG Uniform Standard Details, latest revisions, and City of Sedona (Sedona) Specifications or Standards and within these special provisions. Copies of the Standard Specifications may be obtained from the Maricopa Association of Governments, 1820 W. Washington Street, Phoenix, AZ 85007 (602) 254-6308.

The information written into these special provisions will:

1. Describe any special or unusual conditions.
2. Explain details of the work not covered in the MAG Specifications and Standard Details.
3. Relate certain work to specific bid items or payment quantities.

00700.2 MAG SPECIFICATIONS (2015) PART 100 – GENERAL CONDITIONS

The order of precedence from Section 104.1 shall be deleted in its entirety and shall be per the contract.

00700.2.1 DEFINITIONS

In addition to the definitions already listed in MAG, the following terms shall have meanings indicated which shall be applicable to both the singular and plural thereof:

ADDENDA - Written or graphic instruments issued prior to the execution of the Agreement which modify or interpret the Contract Documents, Drawings, and specifications, by additions, deletions, clarifications, or corrections.

BID - The offer or proposal of the Bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

BONDS - Bid, Performance, and Payment Bonds and other instruments of security, furnished by the Contractor and its surety in accordance with the Contract Documents.

CONTRACT PRICE - The total monies payable to the Contractor under the terms and conditions of the Contract Documents.

CONTRACT TIME - The number of calendar days stated in the Contract Documents for the completion of the Work.

DRAWINGS - The part of the Contract Documents which show the characteristics and scope of the Work to be performed and which have been prepared or approved by the Engineer.

PROJECT – Synonymous with The Work, i.e., the total construction to be provided under the Contract Documents which may be the whole or a part as indicated elsewhere in the Contract Documents.

RESIDENT PROJECT REPRESENTATIVE - The authorized representative of the Owner who is assigned to the Project 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.

SUPPLIER - Any person or organization who supplies materials or equipment for the Work, including that fabricated to a special design, but who does not perform labor at the site.

00700.3 CONSTRUCTION REQUIREMENTS

00700.3.1 MATERIAL PROCUREMENT

Due to the proximity to neighbors, it is the intention of the City to limit the onsite construction time line of the project. In order to accomplish this, the contractor is required to have 95% of all equipment procured before construction begins. This means that submittals have to be approved and equipment stored and in the physical possession of the contractor. Materials must be dedicated to the job and not shared with other projects. Contractor to provide proof that 95% of equipment and materials is in their possession before construction begins.

00700.3.2 DELIVERY SCHEDULING

The contractor is responsible for efficiently planning deliveries/pickups of equipment and materials to prevent multiple trucks from being onsite at a time and to limit idle time. The contractor shall schedule accordingly to ensure proper spacing between trucks.

00700.3.3 CONSTRUCTION HOURS

Construction shall be per the General Conditions.

007003.4 EXISTING LIFT STATION OPERATION

The contractor shall stage the construction in a way to minimize the use of bypass pumping. All existing lift station equipment shall be protected and kept in operation for as long as possible. The contractor shall notify and get approval of the City before they shut down any component of the lift station.

END OF SECTION

01019.1 DESCRIPTION

Measurement and payment for all pay items in the proposal shall conform to section 109 of the MAG Uniform Standard Specifications for Public Works Construction (MAG Specifications) latest edition, City of Sedona (Sedona) General Conditions and standards as specified in these Technical Specifications. In the event of a conflict between these Technical Special Provisions and the requirements of the plans, detail drawings, or the MAG Specifications, these Technical Special Provisions shall prevail. In the event of a conflict between the Technical Special Provisions and Sedona's General Conditions, the General Conditions shall prevail.

Payment of the contract items shall be compensation in full for furnishing all overhead, labor, material, tools, equipment, and appurtenances necessary to complete the work in a good, neat, and satisfactory manner as indicated on the plans, or as specified, with all necessary connections and appurtenances for the satisfactory use of and/or operation of said item. No additional payment will be made for work related to each item unless specifically noted or specified. Measurement will be in place for the completed work with no allowance for waste.

01019.2 BID FORM DESCRIPTION

Bid form description shall be per the General Conditions.

01019.3 BID ITEMS

The measurement and payments for Section 01019.3 shall govern in the case of a conflict with measurement and payment of any subsequent sections.

Anything shown on the plans, but not specifically detailed in a bid item, is considered to be included in the cost of the project and these costs shall be spread out across other items.

01019.3.1 Item No. 1 - Mobilization

Mobilization shall be per Specification Section 02000 and General Conditions and include all aspects of the section including visual records.

Measurement and payment shall be per the General Conditions Section 33 and Section 901 of ADOT Standard Specifications for Road and Bridge Construction (most current edition) Payment will be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.2 Item No. 2 - Demobilization

Demobilization shall be per the General Conditions and Specification Section 02000 and include all aspects of demobilizing, disposal of debris, and cleanup of the site to bring the site back to the preconstruction condition or better.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.3 Item No. 3 - SWPPP

The Contractor is responsible for providing, submitting, and implementing the Stormwater Pollution Prevention Plan (SWPPP). The Notice of Intent (NOI) form provided by the City will be filled out and submitted to the City. However, the contractor must ensure compliance with AZPDES requirements, and all other applicable federal, state and local laws, ordinances, statutes, rules and regulations pertaining to the stormwater discharge and air, ground water and surface water quality. It must be prepared with the same level of detail and documentation as required by ADEQ and EPA and include all documents required by regulations. This bid item shall include all items required to submit, obtain, and implement the SWPPP.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.4 Item No. 4 - Site Demolition

All site demolition shall be per Specification Section 02500, 02520 and 02900 and shall include, but is not limited to, all materials, equipment and labor for the removal of existing lift station, valve vault, piping, valving, electrical equipment, instrumentation, CMU walls, and concrete slab as depicted on sheet 6 (DEMO Drawing) of the plans. Items listed to be salvaged shall be carefully removed to prevent damages. Some items will be reinstalled, and others transported to the WWRP as dictated in the drawings.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.5 Item No. 5 - Site Work

Site work shall be per MAG Section 201, 505, 725 and Specification Section 02020, 02125, 02510, and 02520. Work shall include all subsurface investigation, clearing and grubbing, material and sampling testing, concrete cutting, reinstallation and extension of the rock wall, ½" crushed rock inside the compound, and concrete work. Concrete pads include those inside the CMU wall and APS transformer pad. The rock wall as called out as Hardscape note 3 and 4 on sheet 7 (LS1 Drawing) shall be installed/reinstalled in kind to match the existing wall.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.6 Item No. 6 – Construction MOPO

The construction MOPO shall be per Specification Section 02553, 02930, the Bypass Pumping Report and all applicable regulations. This work includes keeping the existing lift station online for as long as feasibly possible, switching between the existing lift station and the temporary bypass pumping system, the temporary bypass pumping system and all requirements associated with it, and then switching between the temporary bypass pumping system and the new lift station. The bid item shall include all plans, equipment, piping, fencing and sound dampening devices required. This bid item shall also include the required man power to oversee the MOPO as called for in the Contract Documents and Specifications.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.7 Item No. 7 – Site Compound (Wall, Gates, and Railing)

The site compound shall be per MAG Section 206, 301, 505, 510, 725 and Specification Section 02910, 09910, and 10420. The work includes the CMU wall, sliding gate, manway gate, handrail along with required painting. Existing CMU wall and wood slats shall be painted also. This work includes all excavation and grading required.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.8 Item No. 8 – Gravel Access Road

The gravel access road shall be per Specification Section 02120 and Detail M on Sheet 12 (DT3 Drawing) of the plans. This bid item includes all grading, excavating, soil prep, material and equipment required to install the gravel access road.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.9 Item No. 9 – Water Piping

The site water piping shall be per MAG Section 601, 610, and 753. Work shall include reinstalling the frost-free hydrant, reinstalling the backflow preventer and hot box, extending the existing water line to the backflow preventer and hydrant, and capping the abandoned water line. The existing water line size is unknown, but the water line

extension shall match existing size. Pipe fittings and miscellaneous appurtenances shall be considered incidental to the water piping. Bid item includes all trenching, backfilling, and compaction required. Bid item shall also include all required testing and disinfection.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.10 Item No. 10 – Gravity Sewer Line

The gravity sewer line shall be per MAG Section 615, 745 and Specification Section 15100. Work shall include all the material, trenching, backfilling, compaction, connecting to the existing gravity sewer line, and the abandonment line to the existing lift station. Pipe fittings and miscellaneous appurtenances shall be considered incidental to the sewer line connection. Any procedures required to tie into the existing sewer line, and all testing required, shall be included in this bid item.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.11 Item No. 11 – Package Lift Station System

The package lift station shall be per Specification Section 13105. The bid item shall include all material and equipment listed under the "Lift Station Package" items on Sheet 10 (DT1 Drawing) of the plans and Section 13105. This includes, but is not limited to, the wet well/valve vault, pumps, pump base, guide rails, internal piping and fittings, hydraulic check valve, couplings, odor control unit, DIP vent, wet well hatch and safety grate, valve vault hatch and safety grate, coring and link seals, and stilling well as required to provide a fully functional system that meets the intent of the Contract Documents and Specification. Installation of the package lift station is covered under Item No. 13.

The unit price of the package lift station has been already been negotiated by the City. The cost shall be as listed in the Bid Schedule. Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item as indicated in the Contract Documents and Specifications.

01019.3.12 Item No. 12 – Non-Package Lift Station Equipment

The non-package lift station equipment shall be per Specification Section 15100, Division 26, and Division 40. The bid item shall include all material and equipment associated with the lift station that is not included as part of the package system. This includes but is not limited to, as called out on Sheet 10 (DT1 Drawing) of the plans and Section 13105. This includes but is not limited to, RFCA located inside the valve vault, stainless steel piping, fitting, and ball valves, coring where called for by the contractor, link seals where called for by the contractor, and reinstallation of the safety

harness plate as required to provide a fully functional system that meets the intent of the Contract Documents and Specification. Installation of the non-package lift station equipment is covered under Item No. 13

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.13 Item No. 13 – Lift Station Installation

The lift station installation is per MAG Section 206, 301, 728 and Specification Section 13105, Division 26, and Division 40. This bid item shall include the installation of all items covered under Item No. 11 and 12 above. Items required for installation will include, but not be limited to, excavation, shoring, slurry, backfill, compaction, and coring. A 1 sack slurry will be used around the lift station up to 3 feet below finish grade. The last 3 feet will be backfilled and compacted per MAG and the Specification. Rock exaction is anticipated and shall be included. Bid item shall include all required startup and testing per MAG, the Specifications, and the General Conditions.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.14 Item No. 14 – Force Main

The force main shall be per MAG Section 601, 610, 611, 615, 750 and Specification Section 15240. This bid item includes the piping, RFCA, plug valve and valve box, trenching, backfilling, compaction, connection to existing force main, and abandonment of force main connection to existing lift station as indicated in the plans. The location of the existing force main is an estimate. All fittings, couplings, and miscellaneous appurtenances required shall be considered incidental to the force main. Any procedures required to tie into the existing force main, and all testing required, shall be included in this bid item.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.15 Item No. 15 - Landscaping

The landscaping shall be per Specification Section 02900, Sheet 32 (L01 Drawing), and Sheet 33 (L02 Drawing) of the plans. The bid item shall include the plants, trellises, backflow preventer, remote control valve assembly, controller, and irrigation tubing. All planting and installation shall be included.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.16 Item No. 16 – Backup Generator

The backup generator shall be per Specification Section 09910, 26_32_14 and Sheet 20 (E-6 Drawing) of the plans. The generator will be purchased and installed by the City. Responsibilities of the Contractor shall be as follows:

- Provide crane/equipment to place the generator and ATS
- Coordinate with Empire on deliver, installation, testing, startup, and training
- Housekeeping pads
- All conduit required to connect the generator and ATS
- Pull all wires in conduits
- Install generator and bolt it to the ground
- Install ATS and secure it (bolting, supports, etc)
- Connection of all wiring including the main cabling at the generator and ATS and the DC control wire.
- Painting of the generator.

The bid item shall include the all equipment, materials, and appurtenances, to install the generator, in order to provide a fully functional system that meets the intention of the plans and specifications.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.17 Item No. 17 – Site Electrical

The site electrical shall be per Specifications Section 26_27_26, 26_50_10, Division 26 and Sheet 21 (E-7 Drawing) of the plans. This bid item includes all conduit and wiring not covered elsewhere, light switches, GFCI receptible, Light Fixtures, and all electrical components and work required to provide a fully functional system that meets the intent of the Contract Documents and Specifications.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.18 Item No. 18 – Instrumentation

The instrumentation shall be per Specifications 40_72_76, 40_73_65, 40_73_13, Division 40 and Sheet 32 (N-9 Drawing) of the plans. This bid item includes the pressure transmitter, level floats, level transducer indicator in the MCC, pressure gauge with snubber and diaphragm, and all electrical components and work required to provide a fully functional system that meets the intent of the Contract Documents and Specifications.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.19 Item No. 19 – MCC

The MCC shall be per Specifications Section 09910, 26_24_20 and Sheet 17 and 18 (E-3 and E-4 Drawings) of the plans. This bid item includes the MCC with all of its internal components (not called out elsewhere), the 400 Amp enclosed service entrance breaker, painting of the MCC and all electrical components and work required to provide a fully functional system that meets the intent of the Contract Documents and Specifications.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.20 Item No. 20 – APS Utility Upgrade

The APS utility upgrade shall be per Specifications Section 26_05_03 and the electrical plans. This bid item includes the utility meter cabinet, transformer, cable, conduit, and all electrical components and work required to provide a fully functional system that meets the intent of the Contract Documents and Specifications. This item shall also include any coordination required between the utility and the contractor.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.21 Item No. 21 – Bid Alternate Paved Access Road

The paved access road is a bid alternative and shall be per MAG Section 301, 310, 710, Specification Section 02511 and detail I on Sheet 12 (DT3 Drawing) of the plans. This bid item includes all grading, excavating, soil prep, material and equipment required to install the asphalt access road.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.22 Item No. 22 – Bid Alternative Flow Meter

The flow meter is a bid alternative and shall be per MAG Section 615 and Specification Section 03150, 08122, 15100, 15240, Section 40_71_15, Division 40. This bid section includes all the items listed under "BID ALTERNATIVE ITEMS" on Sheet 10 (DT1 Drawing) of the plans. This includes, but is not limited to the flow meter vault, hatch

with safety grate, flow meter, RFCA, piping, drain fiberglass cover, rubber check valve, link seal, coring, pipe supports, conduit, wiring, electrical components, and electrical work as required to provide a fully functional system that meets the intention of the plans and specifications. All fittings, couplings, and miscellaneous appurtenances required shall be considered incidental to the force main. All excavation, including rock excavation, backfilling, compaction, and grading is included. Bid item shall include all required startup and testing per MAG, the Specifications, and the General Conditions.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

01019.3.23 Item No. 23 – Bid Alternative Omni Crystal Ball

The Omni Crystal Ball is a bid alternate and shall be per Specification Section 40_61_00 and Sheets 32 and 33 (N-9 and N-10 Drawings) of the plans. This bid item shall include the Omni Crystal Ball and all conduit, wiring, electrical components and electrical work required to install it in the MCC to provide a fully functional system that meets the intent of the plans and specifications. Bid item shall include all required startup and testing per MAG, the Specifications, and the General Conditions.

Measurement and payment shall be made at the contract lump sum price and shall be full compensation for the item complete in place as indicated in the Contract Documents and Specifications.

END OF SECTION

01030.1 DESCRIPTION

This section covers project meetings including the pre-construction meeting and other progress and/or work coordination meetings conducted to provide communication and awareness to all parties associated with the Contract.

01030.2 PRE-CONSTRUCTION CONFERENCE

Prior to the commencement of work at the site, a pre-construction conference will be held at a mutually agreed time and place to be arranged by the Owner. The Owner shall also provide notification to all parties expected to attend the meeting. Attendees will include the following:

- Engineer
- Project Inspector
- Owner/Owner's Representative
- Contractor/Contractor's Representative/ Subcontractors as appropriate
- Governmental Representatives as appropriate (State, County, Municipal, etc.)
- Manufacturer/Supplier Representatives/Adjoining Contractors, as appropriate.
- Utility Service Representatives as appropriate.

Additional requirements are located in the General Conditions. If there is a conflict the General Conditions shall supersede this section.

01030.2.1 Unless previously submitted to the Engineer, the Contractor shall bring to the conference one copy each of the following:

- Contract construction schedule in accordance with the General Conditions.
- Procurement schedule of major equipment and materials and items requiring long lead-time.
- Shop Drawings, samples or substitution proposals for items proposed as substitutions or "or equal" items.
- Schedule of work that includes the anticipated monthly payment amounts during the contract.
- A Schedule of Values of work to be paid for as lump sum items where partial payment is anticipated.

Additional requirements are located in the General Conditions. If there is a conflict the General Conditions shall supersede this section.

01030.2.2 The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The agenda may include but not be limited to the following items:

- Contractor's Work Schedule.
- Transmittal, review, distribution and approval of Contractor's submittals.
- Processing of applications for payment.
- Maintaining records and documents.
- Critical work sequencing.
- Field decisions and Change Orders.
- Use of project site, office and storage areas, security, housekeeping, and Owner's needs.
- Major equipment deliveries and priorities.
- Interpretation of Drawings and Specifications.
- Contractor's responsibilities for safety, first-aid and sanitation.

Additional requirements are located in the General Conditions. If there is a conflict the General Conditions shall supersede this section.

01030.2.3 The Engineer will preside at the pre-construction conference and will arrange for keeping minutes and distributing them to all attendees to the meeting.

01030.3 PROGRESS/COORDINATION MEETINGS

01030.3.1 The Contractor shall conduct regular on-site progress and coordination meetings at least weekly and at other times as requested by Engineer or as required by progress of the work. The Contractor, Engineer, and all Subcontractors active on the site shall be represented at each meeting. The Contractor may, at its discretion, request attendance by representatives of its suppliers, manufacturers, and other Subcontractors. The Contractor shall be responsible for providing written notification to those deemed necessary for attendance at least 36 hours prior to the time set for the meeting.

01030.3.2 The Contractor shall preside at the meetings and maintain a file of minutes of the proceedings. The purpose of the meetings will be to review the progress of the work, maintain coordination of effort, discuss changes in scheduling, and resolve other problems which may develop.

01030.3.3 Additional requirements are located in the General Conditions. If there is a conflict the General Conditions shall supersede this section.

01090.1 DESCRIPTION

Wherever in these Specifications references are made to the standards, specifications, or other published data of the various national, regional, or local organizations, such organizations may be referred to by their acronyms or abbreviations only. As a guide to the user of these Specifications, the following acronyms or abbreviations, which may appear herein, shall have the meanings indicated below. Additional abbreviation and reference standards are listed in the General Conditions. If there is a conflict the General Conditions shall supersede this section.

01090.1.1 DEFINITIONS OF ABBREVIATIONS AND ACRONYMS

AAR	Association of American Railroads
AASHTO	American Association of the State Highway and Transportation Officials
ACI	American Concrete Institute
ADC	Air Diffusion Council
AGA	American Gas Association
AGC	Associated General Contractors
AGMA	American Gear Manufacturers Association
AI	The Asphalt Institute
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AMCA	Air Movement and Control Association
ANSI	American National Standards Institute, Inc.
APWA	American Public Works Association
ARI	Air Conditioning and Refrigeration Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASQC	American Society of Quality Control
ASSE	American Society of Sanitary Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
BLM	Bureau of Land Management (U.S. Department of Interior)
CDA	Copper Development Association
CEMA	Conveyor Equipment Manufacturer's Association
CGA	Compressed Gas Association
CFR	Code of Federal Regulations
CISPI	Cast Iron Soil Pipe Institute
CLFMI	Chain Link Fence Manufacturer's Institute
CMA	Concrete Masonry Association
CS	Commercial Standard of NBS (U.S. Dept. of Commerce)
CTI	Cooling Tower Institute
DIP	Ductile Iron Pipe
EIA	Electronic Industries Association
EPA	U. S. Environmental Protection Agency
ETL	Electrical Test Laboratories
FEMA	Federal Emergency Management Administration
FERC	Federal Energy Regulatory Commission
FS	Forest Service (U.S. Department of Agriculture)
FWS	Fish and Wildlife Service
GI	Galvanized Iron
IAPMO	International Association of Plumbing and Mechanical Officials

ICBO	International Conference of Building Officials
ID	Inside Diameter
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
IMC	International Mechanical Code
IME	Institute of Makers of Explosives
IPC	International Plumbing Code
ISA	Instrument Society of America
ISO	International Organization for Standardization
MBMA	Metal Building Manufacturer's Association
MOPO	Maintenance of Plant Operation
NACE	National Association of Corrosion Engineers
NBS	National Bureau of Standards
NEBB	National Environmental Balancing Bureau
NEC	National Electrical Code
NEMA	National Electrical Manufacturer's Association
NFGC	National Fuel Gas Code
NFPA	National Fire Protection Association
NFPA	National Forest Products Association
NRCS	Natural Resources Conservation Service (U.S. Department of Agriculture) (formerly SCS)
NSF	National Sanitation Foundation
OD	Outside Diameter
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PDI	Plumbing and Drainage Institute
PE	Polyethylene
PVC	Polyvinyl Chloride
RWMA	Resistance Welder Manufacturer's Association
SAE	Society of Automotive Engineers
SMACNA	Sheet Metal and Air Conditioning Contractor’s National Association
SSPWC	Standard Specification for Public Works Construction
UBC	Uniform Building Code
UL	Underwriters Laboratories, Inc.
UMC	Uniform Mechanical Code
UPC	Uniform Plumbing Code
UPRR	Union Pacific Railroad
USDARD	Rural Development (U.S. Department of Agriculture) (formerly Farmers Home Administration)
WCRSI	Western Concrete Reinforcing Steel Institute
WRI	Wire Reinforcement Institute, Inc.
WWPA	Western Wood Products Association
WWRP	Wastewater Reclamation Plant

01090.2 REFERENCED WORKS, CODES AND STANDARDS

Whenever references to specifications, codes, standards and other publications are made to these Specifications, the following rules shall apply:

01090.2.1 TITLES OF SECTIONS AND PARAGRAPHS

Titles of sections and/or paragraphs shown in these Specifications are for convenience of reference only, and do not form a part of the Specification.

01090.2.2 APPLICABLE PUBLICATIONS

Whenever references in these specifications are made to published specifications, codes, standards, or other requirements, it shall be understood that unless a date is specified, only the latest edition of these specifications, codes, and/or standards which have been published as of the date that the work is advertised for bids, shall apply; except to the extent that said standards or requirements may be in conflict with applicable laws, ordinances, or governing codes. No requirements set forth herein or shown on the Drawings shall be waived because of any provision of, or omission from, said standards or requirements.

01090.2.3 SPECIALISTS AND SPECIAL ASSIGNMENTS

In certain instances, specification text requires (or implies) that specific work is to be assigned to specialists or expert entities, who must be engaged for the performance of that work. Such direction shall be recognized as special requirements and is not intended to interfere with local union jurisdiction settlements and similar conventions. Such assignments are intended to establish which party or entity involved in a specific unit of work is recognized as "expert" and qualified for the assignment of the work. Nevertheless, the final responsibility for fulfilling this assignment remains with the Contractor.

01090.2.4 BUILDING CODES

Reference herein to "Building Code" shall mean the Uniform Building Code issued by the International Conference of Building Officials (ICBO). The latest edition of the code as approved and used by the local agency as of the date of award, as adopted by the agency having jurisdiction, shall apply to the work herein, including all addenda, modifications, amendments, or other lawful changes thereto.

01090.2.5 OSHA

01090.2.5.1 OSHA REGULATIONS - References herein to "OSHA Regulations for Construction" shall mean Title 29, Part 1926, Construction Safety and Health Regulations, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

01090.2.5.2 OSHA STANDARDS - References herein to "OSHA Standards" shall mean Title 29, Part 1910, Occupational Safety and Health Standards of the U.S. Code of Federal Regulations, including all changes and amendments thereto.

01090.2.6 DOT STANDARDS/SPECIFICATIONS

References to "State DOT Specifications" or "State DOT Requirements" shall mean the Specifications for Excavation on State Highway Right-of-Way and/or Standard Specifications for Road and Bridge Construction, including all amendments thereto, issued by the State agency responsible for highways wherein the Contract is located and any other written requirements or provisions issued by that agency which are contained in these Contract Documents.

01090.2.7 FEDERAL PIPELINE SAFETY STANDARDS

Reference to "Federal Pipeline Safety Standards" shall mean Title 29, Parts 191 and 192, Federal Pipeline Safety Minimum Standards, U.S. Code of Federal Regulations including all changes and amendments thereto.

01090.2.8 STATE GAS PIPELINE SAFETY STANDARDS

References to "State Gas Pipeline Safety Standards" shall mean the appropriate section/s of the legal code or regulations adopted in the State wherein the work is located, including all changes and amendments thereto.

01090.3 STANDARDS IMPOSED BY OTHER AGENCIES OR ORGANIZATIONS

01090.3.1 PROPERTY BELONGING TO OTHER AGENCIES OR ORGANIZATIONS

Construction may occur on property owned or administered by agencies or organizations other than the Owner, such as federal and/or state departments of transportation, the U. S. Forest Service, the U. S. Bureau of Land Management, the U.S. Fish and Wildlife, counties, canal companies, irrigation companies, utility companies, other federal and state agencies, municipal governments, etc. Work which is to take place on such property may be required to be in accordance with special construction requirements of that agency or organization as well as these specifications.

01090.3.2 ADDITIONAL INFORMATION AND SPECIFICATIONS

Information will be provided on the plans to indicate areas of the Work which fall on property owned or administered by agencies and organizations other than the Owner. Specifications from agencies which are affected by the work will be provided in the Appendix to the Contract Documents. Those specifications provided in the Appendix shall be considered part of the Contract Documents and the Contractor shall include sufficient compensation in its bid to cover the work required for compliance thereto.

01090.4 CONFLICTS

In case of conflict between codes, reference standards, Drawings and the other Contract Document, the most stringent requirements shall govern. All conflicts shall be brought to the attention of the Engineer for clarification and directions prior to bidding (pre bid), or ordering and providing any materials or labor required therefrom (post bid). The Contractor shall assume the most stringent requirements apply when preparing bids for this Contract.

01300.1 DESCRIPTION

The Contractor shall submit to the Engineer, for review, a proposed schedule of shop drawings, materials information, samples, operations and maintenance manuals, equipment information, procedures, and construction photography records. The submittals of shop drawings and product data shall conform to the General Conditions, this specification, and section 105.2 of the MAG Specifications with the following exceptions.

Paper copies of submittals for approval are not required. Contractor to submit information in PDF form. Response to submittal will also be provided by PDF. This does not apply to final O&M manuals. Final O&M manuals shall be submitted according to Section 01300.3 of these Specifications.

Submittals will be stamped with either "Approved", "Approved as Noted" or "Not Approved".

01300.2. SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

In addition to MAG 105.2 the following conditions apply to shop drawings and material submittals. Any conflict between MAG and these specifications shall be brought to the attention of the Engineer for final decision.

01300.2.1 ADDITIONAL REQUIREMENTS

1. Shop Drawings, Product Data, Samples and similar submittals are not part of the Contract. The purpose of their submittal is to demonstrate, for those portions of the Work for which submittals are required by the Contract Documents, the way by which the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents.

2. The Contractor shall review for compliance with the Contract Documents, approve and submit to the Engineer/Consultant Shop Drawings, Product Data, Samples and similar submittals required by the Contract Documents in such sequence as to cause no delay in the Work or in the activities of the Owner or of separate contractors. Submittals which are not marked as reviewed for compliance with the Contract Documents and approved by the Contractor will be returned by the Engineer/Consultant without action. Contractor shall submit to Engineer/Consultant for review and approval or for other appropriate action, electronic copies and/or five (5) hard copies, if requested by the Engineer, of all Shop Drawings, Product Data, Samples or similar submittals bearing a stamp or specific written indication that Contractor has satisfied the Contractor's responsibilities under the Contract Documents with respect to his review of his submission.

    a. By approving and submitting Shop Drawings, Product Data, Samples and similar Submittals, the Contractor represents that the Contractor has

determined and verified materials, quantities, specified performance criteria, installation requirements, catalog numbers, field measurements and filed construction criteria related thereto, or will do so, and has checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents.

b. Contractor shall give Engineer specific written notice of each variation that the Shop Drawings, Product Data, Samples and similar submittals may have from the requirements of the Contract Documents, and, in addition, shall cause a specific Contractor notation to be made on each Shop Drawing, Product Data, Sample and similar submittals submitted to Consultant for review, approval, or other appropriate action highlighting each such variation.

c. The Contractor shall perform no portion of the Work for which the Contract Documents require submittal and review of Shop Drawings, Product Data, Samples or similar submittals until the respective submittal has been approved by the Engineer. The Engineer will review and return such submittals within ten (10) working days or within a reasonable period so as to not delay the project.

d. Engineer's review, approval, or other appropriate action regarding Contractor's submissions will be only to check conformity with the design concept of the Project and for compliance with the information contained in the Contract Documents and shall not extend to means, methods, techniques, sequences or procedures of construction (except where a specific means, method, technique, sequence or procedure of construction is indicated in or required by the Contract Documents) or to safety precautions or programs incident thereto. The review and approval of a separate component item will not indicate approval of the assembly into which the item is functionally integrated. Contractor shall make corrections required by Engineer, and shall return the required number of corrected copies of Shop Drawings, Product Data, Samples or similar submittals to the Contractor. Contractor may be required to resubmit as required revised Shop Drawings, Product Data, Samples or similar submittals for further review and approval. Contractor shall direct specific attention in writing to any new revisions not specified by Contractor on previous Contractor submissions.

3. The Work shall be in accordance with approved submittals, except that the Contractor shall not be relieved of responsibility for deviations from requirements of the Contract Documents by the Engineer's approval of Shop Drawings, Product Data, Samples or similar submittals unless the Contractor has specifically informed the Engineer in writing of such deviation at the time of submittal and (1) the Engineer has given written approval regarding the specific deviation as a minor change in the Work, or (2) a Change Order or Field Work Directive has been issued authorizing the deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples or similar submittals by the Engineer's approval thereof.

4. Where Engineer requires by written request an approved Contractor Shop Drawing, Product Data, Sample, or similar submittals any related Work performed

by Contractor prior to Consultant's review and approval of the affected submission will be at the sole risk of Contractor.

5. The Contractor shall not be required to provide professional services which constitute the practice of architecture or Engineering unless such services are specifically required by the Contract Documents for a portion of the Work or unless the Contractor needs to provide such services in order to carry out the Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. The Contractor shall not be required to provide professional services in violation of applicable law. The Contractor shall cause such services or certifications to be provided by a properly licensed design professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional. Professional's must be licensed in the state of Arizona. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to the Engineer. Any changes to the professional's work must be approved, in writing, by the professional. The Owner and the Engineer shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications or approvals performed by such design professionals. The Engineer will review, approve or take other appropriate action on submittals only for the limited purpose of checking of conformance with information given and the design concept expressed in the Contract Documents.

01300.2.2 ENGINEER APPROVAL - When the submittals are reviewed by the Engineer, A pdf copy will be returned to the Contractor marked "Approved", "Not Approved", "Approved as Noted", or similar notification. If changes or corrections are necessary, a pdf will be returned to the Contractor with such changes or corrections indicated by a brief statement, and the Contractor shall correct and resubmit the drawings, as a pdf, to the Engineer.

Fabrication work shall not commence until the Engineer has reviewed the pertinent shop drawing/s and returned copies to the Contractor marked either "Approved" or "Approved as Noted". Corrections indicated on such submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as the basis of claims for extra work.

Approval of shop drawings will not be required for reinforcing steel that is detailed by the Contractor in accordance with the Plans and Specifications. Any change from the Plans and Specifications made by the Contractor in any aspect of the Work shall be approved by the Owner and the Engineer in a written Change Order prior to any work being altered from that already approved for construction.

01300.2.3 SPECIFICATION VERIFICATION

Each submittal shall include a specification section which provides the relevant specification section, including relevant addendum updates.

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.

001300.2.4 MATERIALS INFORMATION SUBMITTALS

In keeping with 01300.2.1 above, the Contractor shall assemble and submit each manufacturer's catalog cuts and materials information sheets pertaining to materials and equipment to be furnished and installed in the Work. Preliminary submittals shall be submitted as pdf for review. The Contractor shall submit two (2) original hard copies. Hard copies shall be enclosed in 3-ring binders. Failure to submit all materials information may result in the Contractor's partial payments to be withheld until submittals are complete. Photocopies of the catalog cuts and information sheets will not be acceptable as submittals without prior authorization from Engineer.

01300.2.5 CONTRACTOR LIABILITY

The Contractor shall assume all responsibility and risk for any re-work or other costs resulting from errors in Contractor submittals. The Contractor shall be responsible for showing accurate dimensions and details of connections required to ensure the function of the equipment and/or component of the Work being illustrated.

01300.3 OPERATIONS AND MAINTENANCE MANUALS

01300.4.1 STRUCTURE OF OPERATIONS AND MAINTENANCE MANUALS

The Contractor shall provide preliminary Operations and Maintenance (O&M) manuals in pdf format for review. The Contractor shall furnish two (2) identical sets of the Final O&M manuals. Each set shall consist of one or more volumes, each of which shall be bound in a standard size, 3-ring, loose-leaf, vinyl plastic, hard cover binder suitable for bookshelf storage. Binder ring size shall not exceed 2.5 inches. A table of contents shall be provided which indicates all equipment in the O&M manuals. Additionally, a bookmarked PDF copy of all O&M manuals must be provided to the owner. Final completion will not be issued until the bookmarked PDF copy of all the O&M manuals have been received and approved by the Engineer and the Owner.

01300.4.2 CONTENTS

The Contractor shall include in the Operations and Maintenance Manuals the following information for each item of mechanical, electrical, and instrumentation equipment:

- Care and maintenance of all finished exposed surfaces.

- Complete operating instructions, including location of controls, special tools or other equipment required, related instrumentation, and other equipment needed for operation.

- Preventive maintenance procedures and schedules.

- Complete parts lists, by generic title, identification number, and catalog number, complete, with exploded views of each assembly.

- Disassembly and reassembly instructions.

- Name and location of nearest supplier and spare parts warehouse.

- Name and location of manufacturer.

- Recommended start-up, testing and troubleshooting procedures.

- Prints of the record drawings, including diagrams and schematics, as required under the electrical and instrumentation portions of these specifications.

01300.4.3 SCHEDULE OF DELIVERY

Operations and Maintenance manuals shall be submitted in final form to the owner before seventy-five (75) percent of the Work is completed. Any discrepancies found by the owner and Engineer in the Operations and Maintenance manuals shall be corrected by the Contractor prior to final acceptance of the project.

01300.5 SCHEDULE OF VALUES

At the time of the pre-construction conference, the Contractor shall submit a Schedule of Values of the Work measured as lump sum bid items. On the Schedule, those items shall be subdivided into component parts in sufficient detail as to form a basis for determining progress payments during construction. Quantities, and/or prices, shown on the Schedule shall equal the total contract price for each lump sum item. Information provided on the Schedule will be reviewed and approved by the Engineer when found acceptable. That information will then be incorporated into the data used for preparing the Application for Payment by the Engineer.

01300.6 CONTRACT CONSTRUCTION SCHEDULE

A construction schedule, prepared in accordance with requirements of the General Conditions, shall be submitted to the Engineer at the pre-construction conference. Unless required otherwise in Special Provisions, such schedule shall show the anticipated time of completion, approximate start dates of identifiable segments of the

Work, and anticipated value of the work expected to be completed in monthly time periods within the contract period.

01300.7 PROCUREMENT SCHEDULE

At the time of the pre-construction meeting (see Section 01030), the Contractor shall submit a procurement schedule to the Engineer. This plan shall include all equipment and materials required for the Work included in the Contract that are not readily available and will require off-site manufacture and lead time which can affect the progress of the Work. The plan shall show at least the following information:

- Equipment/Material Name
- Anticipated amount of time for ordering, manufacturing, and shipping to Work site.
- Anticipated dates for ordering, receiving and installing.

01300.8 CONSTRUCTION PHOTOGRAPHY RECORDS

When required in the Contract Documents and prior to commencement of any of the Work, the Contractor shall prepare colored CD photography records of all areas of the Contract work site and provide copies of such records to the Engineer. Such records shall become the property of the owner and may be used for determining the condition of work site/s and degree of restoration required for completion of the Work (see also Section 2000).

END OF SECTION

01510.1 DESCRIPTION

This section covers measures and instructions for prevention of damage to existing structures and utilities, whether above ground or underground, during execution of the Work of the Contract. The protection of existing improvements shall conform to section 107 of the MAG Specifications, the General Conditions and the following Sections.

01510.2 PROTECTION OF EXISTING UTILITIES

01510.2.1 INTEGRITY OF UTILITIES

The Contractor shall be responsible for safeguarding and maintaining the integrity of all conflicting utilities. This responsibility includes securing the assistance of available utility location services in the area in which the Work is being performed. The Engineer has attempted to show the location of all utilities anticipated to conflict with the Work. However, when a conflicting utility line is discovered that was not shown on the plans, the Contractor shall contact the utility's owner and notify the Engineer immediately for resolution of the conflict. When realignment or relocation of the Work, or relocation of the conflicting utility is deemed necessary, the Engineer shall give direction in writing for the Contractor to proceed. Work resulting from such direction may be treated as a changed condition, and appropriate authorization and payment will be made in accordance with the General Conditions.

01510.2.2 LOCATING UTILITIES

It shall be the responsibility of the Contractor to locate and expose or identify all existing utilities, both underground and overhead, for the purpose of preventing damage to them. The Contractor shall notify all concerned utility offices at least 48 hours in advance of construction operations in which a utility agency's facilities may be involved. This shall include, but not be limited to, irrigation water, culinary water, telephone, gas, and electric.

01510.2.3 CHANGES TO UTILITIES

The Contractor shall be responsible for any and all changes to, or re-connections to, public utility facilities encountered or interrupted during execution of the Work, and all costs related thereto shall be borne by the Contractor. The Contractor shall negotiate with, and pay, the respective utility agency for work it must do in connection with moving, repairing, or restoring its utility(s). The Contractor shall further make all necessary notifications, scheduling, coordination, and management of details related to any such interference. The potential or projected cost of any public utility interference shall be included in the Contractor's price covering the major Contract Item to which the interference or changes are attributable.

01510.2.4 MAINTENANCE OF SERVICE

01510.2.4.1 CONTINUOUS SERVICE - Unless otherwise required in the Contract Documents, all utilities, both underground and overhead, shall be maintained in continuous service throughout the entire contract period. The Contractor shall be responsible and liable for any damages to or interruption of service caused by the construction.

01510.2.4.2 ACCIDENTAL INTERRUPTION OF SERVICE - In the event of interruption of other utility services as a result of accidental breakage, the Contractor shall promptly notify the appropriate responsible authority. The Contractor shall then cooperate with that authority in restoration of service as soon as possible, and shall bear all cost of repair. In no case shall interruption of any water or other utility service be allowed outside working hours unless the Engineer has issued prior authorization. When changeover of service connections to new utility lines becomes necessary, interruptions of individual services for periods of up to 8 hours will be allowed providing 24 hour advance notice has been given to affected users.

01510.2.4.3 TEMPORARY INTERRUPTION AND RELOCATION - If the Contractor desires to temporarily or permanently relocate or shut down any utility or appurtenance, the Contractor shall make the necessary arrangements and agreements with the owner or operator of the respective utility and shall be completely responsible for all costs concerned with the relocation or shutdown and reconstruction. Shutdown and relocation and/or reconstruction shall be subject to inspection and approval by the Engineer and the owner of the utility.

01510.3 PROTECTION OF PROPERTY AND EXISTING STRUCTURES

01510.3.1 REMOVAL OR RELOCATION OF PROPERTY - All property removed or relocated by the Work shall be reconstructed in its original or new location as soon as possible. Restoration of existing property or facilities shall be to a condition as good or better than its original condition.

01510.3.2 DAMAGE TO PROPERTY - All property damaged by the Contractor, whether inside or outside the limits of easements provided by the Owner, shall be the responsibility of the Contractor. All such damages shall be repaired with like material and restored to its original condition, or better. Such repair or restoration shall be accomplished at the Contractor's expense without additional compensation from the Owner.

01510.4 PROTECTION OF PAVED SURFACES

To avoid unnecessary damage to paved surfaces, tracked equipment shall use rubber cleats or paving pads when operating on or crossing all existing paved surfaces unless authorized otherwise in writing by the Engineer.

01510.5 RIGHTS-OF-WAY AND EASEMENTS

01510.5.1 MINIMAL DISTURBANCE OF RIGHTS-OF-WAY - When construction easements have been obtained by the Owner, the Contractor shall take appropriate

measures to minimize disturbances to surface improvements within the easements. The Contractor shall obtain a signed release from each property owner, approving restoration work in the construction easements across its respective property/s.

01510.5.2 CONSTRUCTION AREAS - The Contractor shall confine construction operations to the area within the dedicated rights-of-way for public thoroughfares, or within areas for which construction easements have been obtained, unless the Contractor has made separate special agreements with the affected property owners in advance.

01510.5.3 PROPERTY OWNER NOTIFICATION - The Contractor shall give at least 48 hours advance notification of commencement of construction to property owners having land on which construction will take place. During all construction operations, the Contractor shall construct and maintain such facilities as may be required to provide access by all property owners to their property. No one shall be cut off from access to their property for a period exceeding eight (8) hours unless the Contractor has made special arrangements with the affected persons. The Contractor shall grade all disturbed surfaces required for motor vehicle traffic at least daily unless directed otherwise in the Contract Documents or in writing by the Engineer.

END OF SECTION

01520.1 DESCRIPTION

This Section includes requirements that shall be followed by the Contractor, to protect the environment, while performing work under this contract. The Contractor shall also comply with any applicable additional requirements made by federal, state, or local government agencies.

01520.1.1 RELATED WORK AND REFERENCED SECTIONS

Most current version of MAG Standard Specifications.

01520.1.2 SUBMITTALS

Section 01300 – Submittals.

01520.1.3 DEFINITIONS

Not used.

01520.2 MATERIALS

Not used.

01520.3 CONSTRUCTION REQUIREMENTS

01520.3.1 EXPLOSIVES AND BLASTING

The use of explosives on the work will not be permitted unless approved otherwise in the Contract Documents or in writing by the Engineer.

01520.3.2 DUST ABATEMENT

01520.3.2.1 CONTROL MEASURES - The Contractor shall furnish all labor, equipment, water and means required to provide effective dust control and abatement measures. Control measures shall be applied as often as necessary and wherever directed in writing by the Engineer, to prevent construction operations from producing dust in amounts that may be damaging to property, vegetation, or animals, or detrimental to persons within reasonable proximity of the work site. Dust Control shall conform to section 104.1.4 of the MAG specifications.

01520.3.2.2 HAUL ROUTES AND WORK SITES - The Contractor shall identify haul routes or material handling areas, outside of the Work site, whereon dust may be generated, and shall exercise appropriate measures to abate any dust problem caused by its operation. Such dust abatement measures shall be taken immediately when observed or when required in writing by the Engineer.

01520.3.3 STORM AND GROUND WATER

01520.3.3.1 PERMITS REQUIRED – A storm water NPDES permit may be required. The Contractor is responsible to obtain such permit and comply with the conditions thereof. This includes preparation of a SWPPP (Storm Water Pollution Prevention Plan) and filing a NOI (Notice of Intent) with ADEQ (Arizona Department of Environmental Quality).

01520.3.3.2 CONTROL MEASURES - The Contractor shall provide and maintain, at all times during construction, ample means and devices to promptly remove all water entering the Work, whether the water is surface or ground water. Water removed by the Contractor shall be directed into ponds or areas separated from live streams or drainage ways, to keep sediment from entering live water.

01520.3.3.3 DRAINAGE PATTERNS - In excavation, fill, and grading operations, the Contractor shall take care, to disturb the existing drainage pattern as little as possible. Particular care shall be taken not to direct drainage water onto private property or into streets or drainage ways inadequate for the increased flow.

01520.3.3.4 FORDING OF WATERWAYS - Fording of live streams or any body of live water to accomplish the Work shall not be permitted. Mechanized equipment also shall not be operated in live water to accomplish the Work unless authorized in writing by the Engineer, or in the Contract Documents.

01520.3.3.5 FILLING OF WATERWAYS - The Engineer will not approve the filling of any ditches, washes, drainage ways, streams, wetlands, or other surface waters by the Contractor to accomplish the Work unless specific instructions are included in the Contract Documents which will provide for how the affected drainages or surface waters are to be treated.

01520.3.4 NOISE ABATEMENT

In or near inhabited areas, particularly residential areas, the Contractor's operations shall be performed in a manner to prevent noise from becoming a nuisance or problem. Particular consideration shall be given to noise generated by repair and service activities during the night hours. Noise abatement shall conform to section 107.6.2 of the MAG specifications.

01520.3.5 CHEMICALS

All chemicals and/or petroleum based products used during project construction or furnished for project shall be handled, applied and disposed of in strict accordance with the printed instructions of the manufacturer and shall conform to section 106 of the MAG specifications.

01520.3.6 WASTE AND SURPLUS MATERIALS DISPOSAL

01520.3.6.1 CLEAN WORK SITE - The Contractor shall keep the work site, haul roads and other areas of use in a neat, clean condition, free from any accumulation of surplus materials. It shall be the responsibility of the Contractor, at its own expense, to remove and legally dispose of all surplus materials resulting from all Work activities performed in accordance with the Contract Documents.

01520.3.6.2 SURPLUS MATERIAL - Surplus material includes, but is not limited to, salvaged materials and equipment that otherwise would have been abandoned in place, rocks too large to be used as backfill, wood and other organic or unsuitable materials, trash, rubbish, and waste products of any nature, and any other debris generated by the Work.

01520.3.6.3 REGULATORY COMPLIANCE - Disposal of surplus materials shall be accomplished in accordance with all local codes, laws, ordinances, and all applicable safety laws (particularly to the requirements of Part 1926 of the OSHA Safety and Health Standards for Construction) in affect at the approved disposal site. In no case shall it be acceptable for any surplus material to be disposed of in streams, marshes or wetlands.

01520.3.6.4 APPROVAL OF DISPOSAL - The Engineer will not approve any disposal operation, which creates an unsightly and/or unsanitary nuisance. The Contractor shall maintain disposal sites in a reasonable condition of appearance during construction. When designated and/or public disposal sites are unavailable, written approval must be obtained from the Engineer to dispose of any surplus materials on any other site. All disposal sites are subject to approval by the Engineer. The Contractor shall secure permission and all permits required for use of any dumpsite not previously arranged and designated by the Owner. The Contractor shall retain copies, and provide copies upon request, of all disposal permits and/or agreements obtained for the Contract Work.

01520.3.6.5 SCHEDULED REMOVAL - The Contractor shall establish regular intervals of collection and disposal of surplus materials during construction. Stockpiling of surplus materials for later disposal will not be approved or allowed.

01520.3.7 OPEN BURNING

Open burning of materials may be allowed only, when approved by the Engineer, in strict accordance with all regulations in effect for the area at which the burning would be performed, and the Contractor shall obtain any necessary permits from the appropriate governing entity prior to the start of burning. The Contractor shall not allow fire to spread beyond the material intended for burning. No accumulation of residue from burning shall remain on or adjacent to the construction site, without written approval of the Engineer.

01520.3.8 SANITATION

01520.3.8.1 TOILETS - The Contractor shall provide fixed or portable chemical toilets for employee use in conformance with the requirements of Part 1926 of the OSHA Standards for Construction and when public toilets are not available or within fifteen (15) minutes walking distance of the Work site.

01520.3.8.2 COLLECTION OF WASTES - The Contractor shall be responsible for daily collection of all sanitary and organic wastes. All wastes and refuse from sanitary facilities provided by the Contractor shall be disposed of away from the site in accordance with all laws and regulations pertaining thereto.

01520.3.9 HAZARDOUS MATERIAL

01520.3.9.1 REGULATORY COMPLIANCE - Disposition of any hazardous material or toxic or hazardous waste shall be made in accordance with the requirements and regulations administered by the State agency wherein the Work site is located.

01520.3.9.2 ABNORMAL CONDITONS - Abnormal conditions include, but are not limited to, the following: buried barrels with liquid or solid contents; buried or above ground tanks with liquid contents; obnoxious odors; excessively hot earth; stained and discolored soils; smoke; unidentifiable powders, sludge, pellets; or any other similar condition.

01520.3.9.3 DISCOVERY AND NOTIFICATION - If any abnormal conditions are encountered during construction, which indicate the presence of a hazardous material, toxic, or hazardous waste, the Contractor shall immediately suspend work in the area of the discovery and notify the Engineer and treat the situation with extreme caution. The Contractor's operation in the area of discovery shall not resume until so directed by the Engineer; however, the Contractor shall continue working in other areas of the project, unless otherwise directed by the Engineer.

01520.3.9.4 DISPOSAL - When it becomes necessary for the Contractor to dispose of discovered materials, the work may be considered a change and administered in accordance with the General Conditions. Should the disposition of discovered waste material require special procedures or handling by certified personnel, the Contractor will make all such arrangements. When it becomes necessary to obtain permits for transporting or handling discovered material, the Owner will obtain the permits.

01520.3.9.5 SPILLS AND NOTIFICATION - In the event of spills of petroleum-based products or hazardous wastes by the Contractor, the Contractor shall immediately notify the Engineer. The Contractor shall also notify the appropriate State environmental enforcement agency, unless the spill consists of less than one (1) gallon of petroleum based products. In no case will notification be made later than 24 hours after the discovery of the spill. In addition, written notification shall also be made within 5 calendar days of the discovery.

01520.3.9.6 COST OF CLEANUP - All costs for cleanup and disposal of hazardous materials due to spills, inappropriate handling, or negligence of the Contractor shall be borne by the Contractor.

01520.3.10 ENVIRONMENTAL COMPLIANCE

01520.3.10.1 REGULATORY COMPLIANCE - The Contractor shall comply with the applicable requirements of the National Historic Preservation Act as it relates to the preservation of ALL environmental resources. Clearance for protection of environmental resources located within the designated Work site is the responsibility of the Owner and such clearance has been obtained for the Contract, unless provided for otherwise in the Contract Documents.

01520.3.10.2 DISCOVERY OF HISTORIC/ARCHEOLOGICAL OBJECTS – The Contractor shall observe the following:

- DISCOVERY AND NOTIFICATION - If a suspected or unsuspected historic, archeological, or paleontological item, feature, or site is encountered, construction operations shall be immediately stopped in the vicinity of the discovery and the Engineer shall be notified of the nature and exact location of the findings. The Contractor shall not damage the discovered objects and shall provide written confirmation of the discovery to the Engineer within two (2) calendar days.

- RESTRICTION OF CONSTRUCTION - Should operations in the vicinity of a discovery be restricted, the Engineer will keep the Contractor informed concerning the status of the restriction. The Contractor should be aware that the time necessary for the Owner to negotiate the handling of the discovered is variable and is dependent on the nature and condition of the circumstances. It is possible that a delay of as much as three weeks in the vicinity of the discovery can be expected. The Engineer will inform the Contractor when the restriction is terminated. Changes required to accommodate delay or Work resulting from the discovery will be authorized in accordance with the General Conditions.

01520.3.11 OPERATIONS OUTSIDE OF THE PROJECT SITE

In the event the Contractor chooses to use any site or means of obtaining resources beyond those provided as part of the Contract, the Contractor shall retain the services of a qualified, certified environmental consultant to produce a research design or plan for obtaining any and all necessary environmental clearances for such use. The Contractor shall provide the plan to the Engineer for review and approval, as required, following which the plan shall be implemented. The Contractor shall submit evidence of environmental clearances and compliance before commencing any activities within the extended use area. At a minimum, clearances will include those listed below. Additional clearances may be required as necessary.

01520.3.11.1 CULTURAL RESOURCES (Archeological and Historic) - Clearance may require consultation with the State Historic Preservation Office.

01520.3.11.2 THREATENED AND ENDANGERED SPECIES - Compliance may require written clearance from the U.S. Fish and Wildlife Service.

01529.3.11.3 FLOOD PLAINS – May require consultation with the Federal Emergency Management Agency (FEMA) or corresponding state agency.

01520.3.11.4 WETLANDS AND OTHER BODIES OF WATER – May require consultation with the Army Corps of Engineers and/or appropriate state agency.

The Contractor is cautioned that obtaining environmental clearances can be costly and time consuming.

01520.4 METHOD OF MEASUREMENT

No separate measurement shall be made for environmental controls. Measurement for this item is included as part of another bid item.

01520.5 BASIS OF PAYMENT

No payment shall be made for environmental control. The environmental control shall be considered incidental to the project.

01560.1 DESCRIPTION

All construction staking shall be supervised by a land surveyor registered in the state in which the Work is located. Surveys will be performed consistent with professional practices and precision generally conducted by surveyors licensed in that state. The construction staking shall conform to section 105.8 of the MAG Specifications with the following exceptions. Construction staking shall be the responsibility of the Contractor and not of the Engineer.

The first two paragraphs of Section 105.8 shall be deleted in their entirety and replaced with the following:

"The Contractor will provide a Registered Land Surveyor (RLS) who will set construction stakes establishing lines and grades for road work, structures and centerlines for utilities and necessary appurtenances as he may deem necessary. The Engineer will furnish the Contractor with all necessary information relating to the lines and grades.

The Contractor provided RLS will be responsible for resetting any survey monuments as required by the plans and/or contract documents.

There will be no separate payment for the construction staking. Construction staking will be considered incidental to the project and other related bid items."

Additional requirements are located in the General Conditions. If there is a conflict the General Conditions shall supersede this section.

END OF SECTION

01580.1 DESCRIPTION

In general, the Contractor is responsible for providing and maintaining access to the Work, handling and storing of materials and equipment, safety and security within the Work site, and coordination and cooperation with the Owner, its representatives, governing authorities and other contractors working for the Owner in accordance with the provisions of the General Conditions. This section contains specific requirements which apply to these responsibilities. Additional requirements are located in the General Conditions. If there is a conflict between the General Conditions and this specification, the General Conditions dictate.

01580.1.1 RELATED WORK AND REFERENCED SECTIONS

Section 02005 – Traffic Control

01580.1.2 SUBMITTALS

Not used.

01580.1.3 DEFINITIONS

Not used.

01580.2 WORK SITE ACCESS

01580.2.1 INVESTIGATION OF WORK SITE AREA

The Contractor shall make its own investigation of the condition of available public and private roads and of clearances, restrictions, bridge load limits, and other limitations affecting ingress and egress to the site of the work.

01580.2.2 HAUL ROADS

It shall be the Contractor's responsibility to construct and maintain any new haul roads required for its construction operations.

01580.2.3 USE OF PUBLIC STREETS AND ALLEYWAYS

Nothing herein shall be construed to entitle the Contractor to the exclusive use of any public street, alleyway, or parking area during the performance of the Work, unless shown otherwise in the Contract Documents.

01580.2.4 CLOSURE OF PUBLIC ROADWAYS

No street, road, or highway shall be closed to the public without first obtaining permission from the proper governmental authorities and the Engineer. Where excavation is being performed in streets or highways, one lane in each direction shall be kept open to traffic at all times, unless otherwise authorized by the Contract Documents or the Engineer. Toe boards, or other measures, may be required by the Engineer to retain excavated material when deemed necessary.

01580.2.5 INTERFERENCE WITH UTILITIES

The Contractor shall so conduct operations as not to interfere unnecessarily with the infrastructure of utility companies or other agencies in such streets, alleyways, or parking areas.

01580.3 PUBLIC SAFETY AND ACCESS

Fire hydrants, approaches to fire stations, police stations and hospitals on or adjacent to the Work shall be kept accessible at all times. Appropriate measures shall be taken by the Contractor, to assure the use of sidewalks, and the proper functioning of all gutters, sewer inlets, water mains, drainage facilities and other infrastructure.

The Contractor's responsibility for Work safety or liability for Work site accidents is not lessened by the presence of the Engineer or his or another inspector performing monitoring of Work site safety conditions.

See also Section 02005 – Traffic Control.

01580.4 CONTRACTOR'S USE OF THE WORK SITE

The Contractor's use of the Work site shall be limited to its construction operations. Written approval by the Engineer will be required for any other use of the site, such as material and equipment storage, personnel vehicle parking, on-site fabrication facilities and field office.

01580.5 OFF-SITE STORAGE

The Contractor shall make arrangements for, bear any use costs associated with, and obtain written permission from the Engineer prior to using any off-site storage or shop areas or facilities determined necessary for execution of the Work. Storage facilities shall be equipped with fences and/or lockable entries that will prevent entry by unauthorized parties. Before off-site storage facilities are placed in use, the Contractor shall provided the Owner keys or combinations to locking devices used to secure the facility.

01580.6 COOPERATION WITH OTHER CONTRACTORS

Prior to authorizing other contractors to work on or adjacent to the Work site, the Owner shall notify the Contractor in writing and provide the name and address of the contractor, the name of its supervisor, a description of the work to be performed, and a schedule which shows the dates and planned segments of the work to be completed by the other contractor. In the event that conflicts or interferences occur between the Contractor and the other contractor's operation, the Engineer shall be notified immediately. The Engineer shall then take appropriate action needed to resolve the problem.

02000.1 DESCRIPTION

This section describes various tasks associated with project execution and close out. Mobilization shall include: preparatory work and materials necessary for obtaining clearances for the Work; moving personnel, equipment, supplies, storage facilities, traffic control plan, and incidentals to and from the Project Site; quality control; clean-up; temporary utilities and quarters; permits, bonds and insurance; dust abatement, storm water control, and noise abatement; waste and rubbish disposal and control; sanitation; and project close-out operations.

02000.1.1 RELATED WORK AND REFERENCED SECTIONS

Contract Closeout Section 107.2 of MAG Standard Specifications
Section 01510 - Protection of Existing Property
Section 01520 - Environmental Controls

Additional requirements are located in the General Conditions. If there is a conflict the General Conditions shall supersede this section.

02000.1.2 SUBMITTALS

02000.1.2.1 VISUAL RECORDS - The Contractor shall furnish at least one copy of all visual records, as described below in 02000.3.2, to the Owner.

02000.1.2.2 SERVICE CONNECTION LOCATION AND DOCUMENTATION – When service connections are included in the scope of work the Contractor shall deliver all signed tie-sheets (see 02000.3.3 below) to the Engineer not less than forty-eight hours prior to when the service connection is to be installed.

02000.1.3 DEFINITIONS

DVD Record - Photography on DVDs of areas potentially liable for disturbance as a result of the Work required by this Contract.

Service Connection Interview & Documentation - Interviews with potential system users and the documentation of location data for service connections to the respective property from utility lines being installed under this Contract.

Tie Sheets - Forms provided by the Engineer for use in documenting the location of service connection/s of system users.

Service Connection - Piping extending from the main utility line to the property line, or designated connecting point, of any user of the system.

02000.2 MATERIALS

02000.2.1 VISUAL RECORD

Records shall be made on professional quality, standard DVD format recording. DVD's shall be provided with protective covers and shall be labeled to indicate the area covered by the photography. Visual record shall have date stamp in video.

02000.3 CONSTRUCTION REQUIREMENTS

02000.3.1 VISUAL RECORDS

Prior to any disturbance of the area, the Contractor shall produce a DVD photography of all areas, including but not limited to right-of-ways, streets and roadways, haul-roads and access routes, storage areas, construction sites, and buildings or structures, which will be, or may be, affected by the Work. Such photography will be of a quality to allow accurate determination of location, size, and condition of existing features and improvements taken prior to any occupancy or execution of Work by the Contractor. Additionally, video for each street shall be separated into different chapters, which should each be accessible from the startup menu. Video footage shall have a date stamp to demonstrate time of recording. Coverage should be taken while the camera is stationary, not from a moving vehicle or other means. DVD's are subject to approval by the engineer and owner. Construction may not begin until the engineer has approved the visual record.

02000.3.2 SERVICE CONNECTION LOCATION AND DOCUMENTATION

Unless called for differently, the Contractor shall contact and interview the owners of all properties indicated on the Drawings and obtain from them sufficient information for location of workable service connections for each property. The Contractor shall document those locations on the tie sheets and obtain a confirmation signature from the connection owner.

02000.4 METHOD OF MEASUREMENT

02000.4.1 MOBILIZATION

Mobilization shall be measured by the lump sum.

02000.4.3 VISUAL RECORDS

Pre-Construction Photography shall be measured by the lump sum.

02000.4.4 SERVICE CONNECTION DOCUMENTATION

Service Connection Documentation shall be measured by the lump sum.

02000.5 BASIS OF PAYMENT

02000.5.1 Payment for Mobilization shall conform to Section 109 of MAG Standard Specifications.

02020.1 DESCRIPTION

Furnish and provide labor and equipment for investigation of existing miscellaneous pipelines, wires or cables, and other miscellaneous sub-surface features as required by the Engineer. Surface Investigation shall conform to MAG Standard Specifications.

02020.1.1 RELATED WORK

Section 01510 - Protection of Existing Improvements

02020.1.2 SUBMITTALS

Not used.

02020.1.3 DEFINITIIONS

Not used.

02020.2 MATERIALS

The Contractor shall provide a backhoe and qualified operator; laborer with hand shovel: appropriate fuel and lubricants, necessary equipment servicing materials; and appropriate equipment for transporting the backhoe to perform the investigation. The backhoe shall be a rubber tired CASE 580 backhoe, or an approved unit of equivalent or greater size and capacity, having accumulated not more than 5,000 hours operating time.

02020.3 CONSTRUCTION REQUIREMENTS

02020.3.1 EXPOSURE BY EXCAVATION

When directed by the Engineer, the Contractor shall excavate and expose miscellaneous pipelines, structural features, soil materials and other underground features which may be present at the work site. The location and extent of exposure shall be determined on site by the Engineer. Designation of such areas shall be made in writing, usually in the form of a Work Order, by the Engineer.

02020.3.2 REPLACEMENT OF EXCAVATED MATERIALS

Work required hereunder shall include replacement of excavated materials sufficiently to restore the site to a safe condition as determined by the Engineer. Full restoration of materials such as pavement, concrete slabwork, sod, etc., in the investigated area will be accomplished in accordance with the Contract Documents and as directed by the Engineer.

02020.4 METHOD OF MEASUREMENT

02020.4.1 MEASUREMENT BY HOURS OF WORK

Measurement of subsurface investigation shall be made by counting the actual number of hours of work completed by the machine and operator to investigate miscellaneous underground features as required by the Engineer. No allowance of time will be made for transporting the backhoe to and from the job site when the backhoe is located on the site of the Contract.

02020.4.2 MEASUREMENT FOR OTHER ITEMS OF WORK

When restoration of the excavated area requires provision of pavement, concrete slabwork, sod, etc., separate measurement will be made for those materials in accordance with the respective requirement(s) for measurement of that item in the Contract Documents.

02020.5 BASIS OF PAYMENT

The accepted quantity of work will be paid for at the contract unit price of:

PAYMENT ITEM	**UNIT**
Subsurface Investigation	Hour

When provision of designated materials is required for restoration of the excavation, payment for such materials shall be made in accordance with the respective provisions of the Contract documents.

END OF SECTION

02105.1 DESCRIPTION

This section covers obtaining permission, permits, clearances, etc.; as necessary to develop source(s), purchasing or manufacturing, loading, hauling, placing and compacting earthwork materials described herein, as shown on the Drawings and/or required by these Specifications. Earthwork Materials shall conform to MAG Standard Specifications.

02105.1.1 RELATED WORK

MAG Section 206 – Structure Excavation and Backfill
MAG Section 220 – Riprap Construction
MAG Section 301 – Subgrade Preparation
MAG Section 601 – Trench Excavation, Backfilling, and Compaction
MAG Section 702 – Base Materials
MAG Section 710 – Asphalt Concrete
Section 1300 – Submittals

02105.1.2 SUBMITTALS

When the Bid Schedule indicates quantities of materials described in this section in excess of 50 cubic yards or 50 tons, or when requested otherwise by the Engineer, the Contractor shall provide test results from a certified independent laboratory which has sampled and performed the prescribed test(s) for those materials.

02105.1.3 DEFINITIONS

Granular Material - Material for which the sum of plasticity index (AASHTO T-90) and the percent of material passing a No. 200 sieve (AASHTO T-27) shall not exceed 23.

Silt - Material which passes the No. 200 (AASHTO T-11) sieve and has a plasticity index not greater than 10.

Clay - Material which passes the No. 200 sieve and has a plasticity index greater than 10.

Bedding - Materials placed immediately around and adjacent to pipe installed in trenches.

Borrow - Material obtained from a source away from the site on which installed and/or excavated and used to supplement insufficient quantities of material required.

02105.2 MATERIALS

02105.2.1 STRUCTURAL BACKFILL

Structural Backfill shall be per MAG 206 and the Drawings.

02105.2.2 "PIPE ZONE" MATERIAL

"Pipe Zone" materials includes all material defined in MAG 601.4: foundation, bedding, haunching, and backfill. "Pipe Zone" materials shall be per MAG 601.

02105.2.3 SAND

Sand shall be graded granular material which passes a 3/8-inch sieve, with not more than 10 percent passing the No. 200 sieve (AASHTO T-27) and free from cinders, ashes, wood, vegetation, frozen or other deleterious material.

02105.2.4 AGGREGATE BASE COURSE

Aggregate base course shall be per MAG 702 and the Drawings.

02105.2.5 BITUMINOUS SURFACING

Plant mix bituminous material shall be per MAG 710.

02105.2.6 DRAIN GRAVEL

Drain gravel consists of washed natural gravel or crushed rock, with a maximum particle size of 1-inch, with not more than 40 percent passing the No. 4 sieve, with 100 percent being retained on the No. 10 sieve, and without any deleterious material.

02105.2.7 RIPRAP

Riprap materials shall be per MAG 220 and the Drawings.

02105.2.8 SUBGRADE GRANULAR FILL

Subgrade granular fill consists of well graded granular soils with a maximum of 50 percent passing the No. 4 sieve and a maximum of 20 percent passing the No. 200 sieve and no materials greater than 4-inches in diameter.

02105.2.9 ½" CRUSHED ROCK

½" Crushed rock shall meet the requirements of the Standard Specifications for Public Works Construction, Section 200-1.2, except that the grading shall be as follows:

Sieve Size	% Passing
1/4"	100
No. 4	50 - 90

Color shall be selected by the Owner.

02105.2.10 GRAVEL SURFACE COARSE MATERIAL

The gravel road extends from West Mallard Dr to the lift station and is the bid base for the project.

a) The surface course shall meet the requirement of ASTM D 1241 for Type I with Gradation C or any other gradation, which will grade within the following limits:

Sieve Size	Percent Passing by Weight
3/4"	100
No. 4	38 - 65
No. 8	25 - 60
No. 30	10 - 40
No. 200	3 - 12

b) The gravel road surfacing shall meet the following requirements:

i. Percentage of Wear: When tested in accordance with ASTM C 131, the percentage of wear shall not exceed 40 percent after 500 revolutions.
ii. Plasticity Index: When tested in accordance with ASTM D 4318, the plasticity index shall not be more than five (5).
iii. Liquid Limit: When tested in accordance with ASTM D 4318, the liquid limit shall not be more than 25 percent. The moisture content of the fill matrix at the time of compaction shall be neither less than one (1) percent below optimum moisture content nor one (1) percent above optimum moisture content.

02105.3 CONSTRUCTION REQUIREMENTS

02105.3.1 LOCAL GOVERNMENT SPECIFICATIONS

Differences may exist between the requirements of these Specifications for sitework materials such as backfill, bedding, untreated base course and bituminous surface course, and those of local government entities. Such differences may affect Contract prices; therefore, when Contract Work falls within the boundaries of any local government, the Contractor shall make himself aware of that entity's specifications for those materials. If differences exist between those specifications and these, unless otherwise approved by the Engineer, the more stringent ones shall apply.

02105.3.2 BORROW AND DISPOSAL SITES

The Contractor shall, at its own expense, secure all necessary access and borrow sites for acquisition or removal and to dispose of excess backfill or waste materials, unless otherwise shown on the Drawings.

02105.3.3 SCALES

When ton weight is to be used to determine quantities of earthwork materials used, the Contractor shall provide his own scales or access to other scales at his own cost. Scales shall be certified accurate. Include certification in submittals.

02105.3.4 MATERIAL PLACEMENT

Unless stated otherwise, material placement shall be per MAG standards. Gravel road shall be installed per Section 02120 and MAG standards.

02105.4 METHOD OF MEASUREMENT

The method of measurement shall be incidental to other bid items.

02105.5 BASIS OF PAYMENT

The basis of payment shall be incidental to other bid items.

END OF SECTION

02120 GRAVEL ROAD (BASE BID)

02120.1 DESCRIPTION

The work shall consist of furnishing, transporting, and placing mineral aggregates for road surfacing. The Gravel road is the base bid for the project. If the asphalt driveway alternative bid is selected this specification will not be used.

02120.1.1 REFERENCES

MAG Section 201 – Clearing and Grubbing
MAG Section 301 – Subgrade Preparation
MAG Section 310 – Placement and Construction of Aggregate Base Course
Section 01300 – Submittals
Section 02105 – Earthwork Materials

02120.1.2 SUBMITTALS

Submittals shall be in accordance with Section 01300 and these Specifications. Contractor shall submit proctor test for the gravel road ABC and subgrade.

02120.2 MATERIALS

02120.2.1 Gravel surface coarse material shall be per Section 02105.

02120.3 CONSTRUCTION REQUIREMENTS

02120.3.1 BASE PREPARATION

The road base will be native soil and shall be scarified minimally to the top 3 inches, mixed with water to within ± 1% optimum moisture and compacted as necessary to provide density of matrix not less than 95% maximum Proctor density (ASTM-698).

02120.3.2 PLACEMENT

Placement shall be per MAG 310, the Drawings and these specifications. The road gravel surface coarse material shall be compacted as necessary to provide density of the road gravel surface coarse matrix not less than 95% maximum Proctor density (ASTM-698).

02120.3.3 TESTING

Compaction testing shall be per MAG 310.

02120.3 METHOD OF MEASUREMENT

The method of measurement shall be per Section 01019.3.

02120.4 BASIS OF PAYMENT

The basis of payment shall be per Section 01019.3.

02125 CRUSHED ROCK

02125.1 DESCRIPTION

This section is for the ½" crushed rock materials and installation. The crush rock is the surface cover inside the lift station compound.

02125.1.1 REFERENCES

MAG Section 201 – Clearing and Grubbing
Section 01300 – Submittals
Section 02105 – Earthwork Materials

02125.1.2 SUBMITTALS

Submittals shall be in accordance with Section 01300 and these Specifications. Contractor shall finish conformance tests and approval of material prior to deliver. Rock samples shall be provided for approval.

02125.2 MATERIALS

02125.2.1 Crushed rock shall be per Section 02105

02125.3 CONSTRUCTION REQUIREMENTS

02125.3.1 PLACEMENT

Clear and grub area and subcut to 2 inches below finish grade. Maintain uniform subgrade slope to drain. Treat grade area with a non-translocating, pre-emergent herbicide. Crushed rock shall be evenly distributed on the designated areas to a depth as indicated on the plans and details. Grade to uniform slope. Thoroughly moisten without flooding and compact to minimum 95%.

02125.3.3 CLEANING

After placing and grading the crushed rock, the Contractor shall water rock with a light spray to settle the to granite and remove fine materials from the surface

02125.7 METHOD OF MEASUREMENT

02125.7.1 The method of measurement shall be per Section 01019.3.

02125.8 BASIS OF PAYMENT

The basis of payment shall be per Section 01019.3.

02500.1 DESCRIPTION

This work includes removal and restoration of existing features, public or private, including but not limited to asphalt or concrete pavement, concrete structures, curb and gutter, sidewalk, gravel surfacing, driveways, crosswalks, landscaping, field crops, irrigation ditches, fences, culverts, buried or exposed utilities, abandoned utilities, small utility buildings and the disposal of resulting waste materials and debris.

02500.1.1 RELATED WORK

Section 01510 - Protection of Existing Properties
MAG Section 201 – Clearing and Grubbing
MAG Section 601 – Trench Excavation, Backfilling and Compaction
Section 02511 - Hot Plant Mix Bituminous Surfacing
Section 02520 - Pavement Cutting
Section 02900 - Landscaping

02500.1.2 SUBMITTALS

When any improvement not owned by the Owner is designated for restoration work, then, upon completion of such restoration, the Contractor shall obtain a written statement of acceptance or release from the responsible owner of the feature. This statement, in turn, will be submitted to the Engineer for his review and approval prior to acceptance of the work for payment.

02500.1.3 DEFINITIONS

Not used.

02500.2 MATERIALS

02500.2.1 GENERAL

When restoration of a feature is indicated in the Contract Documents, such work shall be accomplished so as to restore the feature to its original, or better, condition and/or function as it existed prior to removal.

It is recognized that exact duplication of materials cannot always be achieved, but reasonable effort is expected from the Contractor to restore the feature with materials which will provide the same or better service and appearance as observed prior to removal.

All materials shall be new.

02500.2.2 BITUMINOUS SURFACE

02500.2.2.1 PRIMER OR TACKER COAT – Shall be an approved bituminous material such as type MC-70-250, SS1, or CS-1.

02500.2.2.2 PATCHING AND REPAIR - Plant mix material that meets or exceeds the requirements of Section 02511 herein, or of the local State Department of Transportation for asphalt surface road repair, shall be used for patching and repair.

02500.2.2.3 SURFACING – Shall be hot mix bituminous surfacing, meeting or exceeding the requirements of Sections 02511 herein, or of the local State Department of Transportation for asphalt surface road repair.

02500.3 CONSTRUCTION REQUIREMENTS

02500.3.1 UNCLASSIFIED REMOVAL AND RESTORATION

02500.3.1.1 EXISTING IMPROVEMENTS - All existing facilities disturbed by the Contractor in prosecution of the Work, including but not limited to asphalt or concrete pavement, concrete structures, curb and gutter, sidewalk, gravel surfacing, driveways, crosswalks, landscaping, field crops, irrigation ditches, fences, culverts, buried or exposed utilities, abandoned utilities, small utility buildings or any other structures or obstructions designated to be removed on the Drawings, by the Engineer, or these Specifications, shall be removed, cleaned up, and then restored or replaced in kind by the Contractor in new condition.

02500.3.1.2 ADJACENT IMPROVEMENTS - Care shall be exercised in such removal to assure that adjacent facilities or structures, which are to remain, are not disturbed. Any damage to such existing facilities or structures resulting from carelessness or negligence on the Contractor's part shall be satisfactorily restored to new condition at the Contractor's expense.

02500.3.1.3 VEGETATION - Trees, shrubs, and other landscape plants designated to be saved for replanting shall be carefully removed, bundled, set aside and protected for replanting by the Contractor. Turf Sod to be saved for replanting shall be removed by machine cutting. In lieu of removal and replacement of turf sod or field crops, the Contractor may, upon approval of the property owner, remove and replant the same. Such agreements shall be documented on the final property release to be signed by the property owner.

Replanting of landscape items shall be performed in accordance with Section 2900.

02500.3.2 TOPSOIL

02500.3.2.1 REMOVAL AND PROTECTION - In all construction areas where re-growth of vegetation is desired, and when called for by the Contract Documents, the Contractor shall remove, segregate, stockpile, store, and protect topsoil during excavation in accordance with Section 02900. Topsoil shall be kept free from

contamination from foreign materials and other soils. The Contractor shall arrange construction activities to avoid damage or disturbance to the stockpiled soil.

02500.3.2.2 REPLACEMENT - When backfill operations have been completed, the topsoil shall be replaced and restored to the original contours or as called for on the Drawings, in accordance with Section 2900 of these Specifications.

02500.3.3 GRAVEL SURFACE

02500.3.3.1 REMOVAL - When restoration of graveled driveways, roadways, or parking areas is required, the existing gravel surfacing shall be graded off and stockpiled safely away from ongoing work activities, to prevent contamination with subsurface materials. It may then be reapplied and compacted during restoration activities.

02500.3.3.2 RESTORATION - Areas to be restored shall be backfilled and graded to uniform lines and compacted to the density prescribed for trenching in MAG Section 601. Existing gravel surfacing materials shall then be replaced in uniform 3 inch layers compacted to 95% of maximum density. After compaction, the affected area shall be graded smooth. Sufficient new material of equal or better quality shall be applied and mixed in, to replace materials lost during prosecution of the Work, to ensure a 3-inch minimum gravel cover after compaction and grading.

02500.3.4 BITUMINOUS SURFACE

02500.3.4.1 REMOVAL - Bituminous pavement surface shall be removed and restored in accordance with this paragraph unless provisions for restoration are made in other Sections of these Specifications. The pavement surface, public or private, designated for removal shall be removed to neat lines, which shall be cut in accordance with Section 02520. No ripping or rooting will be permitted outside of the limits of the cut lines.

Existing driveways, sidewalks, etc., which do not match the new finish grade as shown on the Drawings, also shall be removed preparatory to restoration work.

02500.3.4.2 DISPOSAL - Surfacing materials removed shall be disposed of in accordance with Section 1520 of these Specifications, and will not be permitted in the backfill, except as specifically authorized by the Engineer and in accordance with local requirements.

02500.3.4.3 RESTORATION – Restoration of bituminous surface shall proceed according to the following steps:

- First, the sub-grade shall be graded to a uniform surface, and 6 inches of Untreated Base Coarse (UBC) gravel shall be placed over the area in lifts not thicker than 3 inches, compacted to 95% of its maximum density.

- Then, the exposed edges of existing pavement shall be primed with a material approved for this purpose.

- Unless shown otherwise on the drawings or required otherwise by the Engineer, hot or cold mix bituminous surfacing shall be spread and compacted in individual, 3-inch maximum lifts over the base course. Minimum thickness of the new bituminous surfacing layer shall be equal to the adjacent surface thickness, but shall be not less than 3 inches thick when compacted to 95% of its maximum density.

- Rolling operations shall be conducted in such a manner that shoving or distortion will not develop beneath the roller. The surface shall be finished to a smooth, uniform line and grade with surface deviations not exceeding plus or minus 1/4 inch in 10 feet, unless the surface is subject to more stringent State, County, or Municipal requirements. The determination of smoothness compliance may be made with a straight edge or string line at the option of the Engineer. Any irregularities shall be satisfactorily corrected at the sole expense of the Contractor.

- Existing driveways, sidewalks, etc., which were removed because they did not match the new finish grade, shall be replaced and restored to their original or better condition to match the new finish grade shown on the Drawings, or as directed by the Engineer.

02500.3.5 REMOVAL AND RESTORATION OF CONCRETE IMPROVEMENTS.

02500.3.5.1 REMOVAL - Existing concrete pavement in streets, alleys, driveways, sidewalks, etc., public or private, shall be cut in accordance with Section 02520, and removed to the lines indicated on the Drawings, or as directed by the Engineer. No ripping or rooting will be permitted outside of the limits of saw cut lines.

Existing driveways, sidewalks, etc., which do not match the new finish grade as shown on the Drawings, also shall be removed preparatory to restoration work.

02500.3.5.2 DISPOSAL - All materials removed shall be disposed of in accordance with Section 1520 of these Specifications, and will not be permitted in the backfill, except as specifically authorized by the Engineer and in accordance with local codes.

02500.3.5.3 RESTORATION - Sub surface preparations shall be the same as those in paragraph 02500.3.4.3 above.

- Concrete pavement including sidewalks, driveways, roadways, and parking area surfacing shall be replaced by the Contractor in accordance with Division 3 of these Specifications, unless otherwise directed by the Engineer

- Those existing driveways, sidewalks, etc., which were removed because they did not match the new finish grade, shall be replaced and restored to their original or better condition to match the new finish grade shown on the Drawings, or as directed by the Engineer.

- All other concrete improvements shall be restored in accordance with details shown on the Drawings, or as directed by the Engineer, and as required by the provisions of Division 3 of these Specifications.

02500.3.6 REMOVAL AND RESTORATION OF FENCES

When necessary to remove any fence to facilitate its operation, the Contractor shall obtain prior agreement with the owner of the fence for its removal. Temporary containment measures shall be provided, if needed, at no additional expense to the Owner. As soon as practical, the permanent fence shall be restored to its original condition or better.

02500.3.7 RESTORATION OF IRRIGATION DITCHES

Restoration of irrigation ditches shall be made in such a manner that the ditch configuration and size will be equivalent to its original condition and the ditch will be located on its original alignment. Any embankment required to restore the original slope of the ditch will be layer compacted with mechanical compaction equipment to 90% of maximum dry density determined by AASHTO T-99.

02500.3.8 CLEANUP

Areas of construction activity shall be left in a condition of uniform grade, blending into pre-existing contours and concealing, as much as possible, evidence of construction activity by back dragging or raking to conceal tire marks. Cleanup and disposal of surplus materials shall be performed in accordance with Section 1520.

02500.4 METHOD OF MEASUREMENT

02500.4.1 NO BID SCHEDULE LINE ITEM

When the Bid Schedule in the Contract does not contain a line item for "Removal and/or Restoration of Surface Improvements", then this work will be considered incidental to other items included in the Bid Schedule, and no separate measurement shall be made for this work.

02500.4.2 "DESIGNATED AREA" LINE ITEM

Measurement for removal and/or of surface improvements in a designated area shall be the "lump sum" of the work required to remove and properly dispose of materials resulting from removal.

02500.4.3 "DESIGNATED FEATURE" LINE ITEM

Measurement for removal and/or restoration of designated features shall be per unit as described in the Bid Schedule.

02500.4.4 BITUMINOUS SURFACE PAY LIMIT

Measurement for bituminous surface removal and replacement shall be made by multiplying the pay limit by the actual length of removal and replacement in lineal feet as determined using a tape measure or other accurate measuring device.

In general, for pipe trench excavation, the pay limit shall be determined by the formula W = OD + 18 inches (pay limit width equals pipe outside diameter plus 18 inches), rounded up to the nearest standard bucket width. Actual measurement may be modified according to information indicated on the Drawings or as directed by the Engineer.

The pay limit for removal of bituminous surface for other purposes shall be as shown on the Drawings or directed by the Engineer.

02500.4.5 DAMAGED ITEMS

Measurement of items damaged or removed as a result of the Contractor's negligence shall not be allowed and no payment will be made under this contract.

02500.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit prices as follows:

PAY ITEM	UNIT
Removal of Site Surface Improvements	Lump Sum
Removal of (*Name of Structures*)	Each
Removal of Sidewalk	Square Yard
Removal of Fences	Lineal Foot
Removal of Driveway Slabs	Square Yard
Removal of Curb and Gutter	Lineal Foot
Removal of Bituminous Surface	Square Yard
Replace (*Name of Structure*)	Each
Replace (*Thickness*) Sidewalks	Square Yard
Replace (*Thickness*) Driveway Slabs	Square Yard
Replace *(Thickness)* Bituminous Surface	Square Yard
Replace (*Description*) Fence	Lineal Foot
Replace (*Description*	Lineal Foot or Lump sum
Restore (*Description*)	Lineal Foot or Lump Sum

02510.1 DESCRIPTION

This section covers all sampling and testing of all materials used on this project. The materials sampling and testing shall be done by an independent certified testing company and all testing reports shall be submitted to the Engineer within a reasonable time period. All material and sampling shall be in accordance with the General Conditions, these specifications, and MAG Section 106.

If there is a conflict between requirements the order of precedence is as follows: General Conditions, these specifications, then MAG Section 106.

02510.1.1 RELATED WORK AND REFERENCED SECTIONS

MAG Section 106 – Control of Materials
MAG Section 601 – Trench Excavation, Backfilling, and Compaction
MAG Section 725 – Portland Cement Concrete
Section 01300 – Submittals
Section 01400 – Quality Control

02510.1.2 SUBMITTALS

All sampling and test reports shall be submitted in accordance with Section 01300.

02510.1.3 DEFINITIONS

Not Applicable

02510.1.4 MODIFICATION TO MAG

Section 106.2, second paragraph shall be deleted completely and replaced with the following:

The Contractor will pay for the initial or normal test required by the Engineer to guard against unsuitable materials or defective workmanship. Additional tests, required due to failure of the initial or normal test(s), shall be paid for by the Contractor. The Engineer will designate the laboratory which will accomplish the additional test(s).

02510.2 MATERIALS

Not Applicable

02510.3 CONSTRUCTION REQUIREMENTS

02510.3.1 TESTING

The minimum testing requirements are as follows: All Materials sampling and testing shall be done by an independent certified testing company and all testing

reports shall be submitted to the Engineer within a (2) two week time period or sooner.

02510.3.1.1 EMBANKMENT

• Maximum Laboratory Density	1 test in each soil type
• Field Density and Moisture	1 test per 2000 square yards

02510.3.1.2 BACKFILL

• Field Density and Moisture	2 tests per culvert or structure (Refer to Section 02200 for Trench Excavation and Backfill Testing)

02510.3.1.3 UNTREATED BASE COURSE

• Sieve Analysis	1 test per production day
• Maximum Laboratory Density	1 test per 10,000 tons
• Field Density and Moisture	1 test per 2000 square yards

02510.3.1.4 ASPHALT CONCRETE PAVEMENT

• Mix design (ASTM 1559 and AASHTO T-283)	1 mix design for the project
• Asphalt temperature	As necessary to assure compliance
• Gradation and Asphalt Content	2 tests per production day
• Field Density	1 test per 1600 square yards
• Mix and Laydown Temperature	As necessary to assure compliance
• Thickness	1 test per 1600 square yards

02510.3.1.5 PORTLAND CEMENT CONCRETE

• Slump Test	1 test per load of concrete
• Air Test	1 test per load of concrete
• Strength Test	1 compressive strength per 50 cubic yards

02510.4 METHOD OF MEASUREMENT

Measurement for this pay item will be by the lump sum.

02510.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price:

PAY ITEM	UNIT
Materials Sampling and Testing	Lump Sum

END OF SECTION

02511.1 DESCRIPTION

Includes manufacturing, transporting, laying and compacting hot mixtures of bituminous surfacing for roads, parking areas, sidewalks and other traffic surfaces. Hot Plant Mix Bituminous Surfacing shall be according to this specification and in accordance with MAG Section 321 and 710.

02511.1.1 RELATED WORK

MAG Section 321 – Placement and Construction of Asphalt Concrete Pavement
MAG Section 710 – Asphalt Concrete
Section 02500 – Removal and Replacement of Surface Improvements

02511.1.2 SUBMITTALS

Submittals per Section 01300 and MAG Standard Specification 106.

02511.1.3 MODIFICATION TO MAG

Asphalt concrete utilized as surfacing shall be in accordance with specifications in MAG Section 710 with the following stipulations:.

1. Surfacing shall be hot-plant mixed and delivered from the plant to the site at a temperature not greater then 325 degrees Fahrenheit;
2. Cold mix temporary patches shall be utilized, but only until such time that temperature conditions permit as stated below and hot mix asphalt is available;
   a. Asphalt concrete shall be deposited only when the subgrade surface is dry, and when the ambient temperature in the shade is 60 degrees Fahrenheit and is rising.
   b. Asphalt concrete shall not be deposited when it is foggy, rainy or when the base on which the concrete is to be deposited is in a wet or frozen state. By "wet" is meant in excess of optimum moisture
3. Hot mix asphalt shall be placed as soon as temperature conditions and availability allow. For the purpose of this section, "availability" is defined as suitable hot mix asphalt concrete being available within a 40-mile radius and the cumulative hot mix asphalt requirements of any permittee equals being available within a 40-mile radius and the cumulative hot mix asphalt requirements of any permittee equals or exceeds five cubic yards;
4. The gradation requirements of Table 710-2 shall be as shown below:

Table 710-2

Gradation Requirements – Percent by Weight Passing

Seive Size (mm)	Designation (mm)				
	9.5	**12.5**	**19**	**25**	**37.5**
50.0	–	–	–	–	100
37.5	–	–	–	100	90 – 100
25.0	–	–	100	90 – 100	<90
19.0	–	100	90 – 100	<90	–
12.5	100	90 – 100	<90	–	–
9.5	90 – 100	<90	–	–	–
4.75	<90	–	–	–	–
2.36	32 – 67	28 – 58	23 – 49	19 – 45	15 – 41
0.075	5.0 – 10.0	5.0 – 10.0	5.0 – 8.0	1.0 – 7.0	0 – 6.0

5. MAG 710 Table 710-11 requirements are modified to require air voids of 3.0 percent to 5.0 percent with a target of 4.0 percent instead of the 2.8 percent to 6.2 percent as stated. The City retains the right to require removal when air voids exceed 5.0 percent.

02511.2 METHOD OF MEASUREMENT

The method of measurement shall be per Section 01019.3.

02511.3 BASIS OF PAYMENT

The basis of payment shall be per Section 01019.3.

02520.1 DESCRIPTION

This section covers cutting through designated sections of bituminous and/or concrete pavement surface with approved equipment in preparation for pavement removal.

02520.1.1 RELATED WORK

MAG Section 601 – Trench Excavation, Backfill and Compaction
Section 02500 - Removal and Replacement of Surface Improvements

02520.1.2 SUBMITTALS

Not used.

02520.1.3 DEFINITIONS

Not used.

02520.2 MATERIALS

Not used

02520.3 CONSTRUCTION REQUIREMENTS

02520.3.1 SAW CUTTING

02520.3.1.1 NEATNESS IN CUTTING - Pavement cuts shall be made with a saw to produce straight vertical cuts through the full depth of the surfacing layer. The Contractor is responsible to preserve and maintain a neat clean edge on the cut pavement to facilitate pavement repair or replacement under Section 02500.

02520.3.1.2 CUT MATERIALS TO BE LEFT IN PLACE - Cut pavement materials shall be left in place. Removal of cut pavement will be included as part of other work items in this Contract.

02520.3.1.3 BROKEN PAVEMENT - When pavement has deteriorated or is severely cracked and broken, the Contractor shall discontinue cutting operations and obtain direction from the Engineer as to how cutting should proceed.

If pavement is broken after sawcutting and prior to replacement, the Contractor shall re-cut the pavement. Such re-cutting shall not be measured for payment.

02520.3.2 WHEEL CUTTING

With advanced written approval of the Engineer, wheel cutting may be substituted for saw cutting of bituminous pavement surface. Wheel cutting operations shall be subject to the same requirements as those for saw cutting pavement above.

02520.3.3 ROTOMILLING

Rotomilling of existing pavement is an acceptable alternative to saw cutting, providing that the resulting pavement edges are left clean and neat. Rotomilled material may be suitable for trench backfilling or as a substitute for road base. For such use, rotomilled material must meet the following conditions: that: no chunks or pieces larger than one inch in any dimension are used, that it is placed in separate lifts from untreated base course, that it is compacted to 95% of its maximum density, and that it is acceptable to the Engineer and to the Owner.

02520.4 METHOD OF MEASUREMENT

Measurement for pavement cutting shall be made using a tape measure or other accurate measuring device to determine the number of lineal feet of pavement cut. This length shall be multiplied by the actual depth of the cut pavement layer, measured in inches, to give the number of inch feet of cut.

An alternative method of measurement is for the Engineer to determine that all pavement cutting shall be paid for by the measured lineal feet without regard to depth.

02520.5 BASIS OF PAYMENT

The accepted quantities will be paid for at the contract unit price for:

PAY ITEM	**UNIT**
Pavement Sawing	Inch/Foot
Pavement Sawing	Lineal Feet

02553.1 GENERAL

Notice. The site will be without power when APS is upgrading the transformer. The Contractor is responsible for coordinating with APS so the transformer upgrade occurs during the bypass pumping stage of the project.

02553.1.01 SUMMARY

A. Section includes: Requirements for temporary bypass pumping of wastewater flows at the Chapel and Mystic Hills lift stations to complete the Work.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.

02553.1.02 REFERENCES

A. National Fire Protection Association (NFPA):
   1. 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

02553.1.03 GENERAL REQUIREMENTS

A. Provide all necessary labor, tools, materials, and supervision to provide temporary bypass pumping and flow control in accordance with the requirements of this Section.

B. Operate and maintain bypass pumping facilities including, but not limited to, pumps, piping, valves, controls, and monitoring until the involved portion(s) of the Work have been completed to the satisfaction of the Owner/Engineer.

C. Bypassing wastewater in a way that assures that no wastewater is allowed to leak outside of the bypass system or lift station facilities. If leakage does occur, pay all fines and reimburse the Owner for all costs associated with the cleanup of the leakage, as wells as costs associated with legal actions.

D. Accept responsibility for any release of wastewater and for penalties associated with bypass pumping activities, including commissioning, operating, and decommissioning of bypass pumping facilities.

E. Coordinate the placement of the bypass piping and pumping equipment with the Owner.

F. The means and methods of accomplishing and maintaining the temporary bypass pumping and associated facilities shall be the sole responsibility of the Contractor.

Except as otherwise specified or authorized in writing, no interruption of wastewater flow shall be permitted throughout the duration of the project. Contractor is responsible for all wastewater overflows during construction of this work and bypass operations.

H. Take precautions to prevent any potential spillage of wastewater from entering the stormwater system.

I. Temporary bypass pumping operation:
   1. Limited to the months, times, or seasons indicated, unless approved in writing by the Engineer.
   2. Continuous operation for 24 hours per day and 7 days per week is anticipated during the period of Work.

J. Continuously monitor temporary bypass pumping.

K. Provide qualified operators continuously during operation of the bypass systems.

L. Equipment and personnel cannot be located on residential property unless written approval has been provided by the resident and the City.

02553.1.04 SUBMITTALS

A. Prepare and submit a project-specific wastewater bypass pumping plan with completed wastewater bypass pumping checklist for approval.
   1. Be advised that the bypass plan must provide accessibility for Owner operations and vehicular traffic in accordance with Owner requirements.

B. Wastewater bypass pumping plan: Include the following at a minimum:
   1. Capacities and sizes of pumps, standby equipment, and power requirements, if applicable.
   2. Design calculations of the system and selected equipment, including flow, TDH with static head including all friction and minor losses, pump curves showing operating range of flow and TDH at minimum, average, and peak flow.
   3. Standby power generator size and location for electrically-driven bypass pumps (if used).
   4. Downstream discharge plan.
   5. Pipe thrust and restraint types, sizes, and locations.
   6. Temporary pipe supports and anchoring required.
   7. Plans for access to bypass pumping locations.
   8. Schedule that shows duration of temporary bypass pumping including milestones for installation, maintenance, and removal of equipment and accessories.

9. Means and methods of installing, operating, monitoring, and maintaining the temporary bypass pumping.
10. Plan indicating bypass pumping line locations.
    a. Include details showing methods used to protect and identify the bypass pumping lines through the length of the bypass route.
11. Detailed plans of a backup system.
12. Address access for operators and vehicular traffic.
13. Mechanical plan showing equipment, valves, pipe sizes and locations, pipe materials, dimensions, vehicle access (where applicable), pedestrian access (where applicable).
14. Schematic drawings and written description of the control system and its' operating sequence.
15. Proposed type and location of collection system plugs.
16. Catalog cut sheets for pumping equipment, pipe and fittings, valves.
17. Emergency response plan.
18. Staffing plan.
19. Spill prevention and cleanup plan.
20. Noise control system.
21. Health and safety plan.
22. Surge or water hammer calculations and attenuation means.
23. Maintenance history of pumps.
24. Operating permits from jurisdictional air quality agency for each engine.
25. Temporary Bypass Pumping plan must meet the requirements laid out in the Bypass Pumping Report by Carollo.

02553.1.05 QUALITY ASSURANCE

A. Contractor's qualifications:
   1. Minimum 5 years' experience in performing substantially similar temporary bypass operations.
   2. Submit evidence of satisfactory operation of temporary bypass facilities similar to those specified in at least 5 separate projects in accordance with the specifications, including references.

B. Fulfillment of the specified experience requirements shall be a condition of acceptance.

PART 2 PRODUCTS

02553.2.01 CAPACITY

A. Pumps, piping and accessories: Of adequate capacity and size to handle the range of wastewater flows from minimum flow to peak flow.

B. Piping, fittings, and all accessories shall withstand 2.0 times the maximum pressure including surge.

C. Maintain on site sufficient equipment and materials to ensure continuous and successful operation of the bypass system.
   1. Have standby pump(s) on site to provide 100 percent redundancy of the bypass system design Peak Flow.
      a. The redundant pump(s) shall be plumbed, fueled, and ready for operation at all times.
   2. Provide sufficient bypass lines to provide 100 percent redundancy of the bypass system design Peak Flow.
      a. The bypass lines and separate redundant lines shall be connected via a combined header that enables the shutdown and isolation of each individual line should a leak or rupture occurs.
   3. Maintain on site a sufficient number of valves, tees, elbows, connections, tools, pipe plugs, piping, and other parts or system hardware to ensure immediate repair or modification of any part of the bypass system as necessary.

02553.2.02 BYPASS PUMPS

A. Provide a minimum of 2 pumps: 1 duty and 1 standby.

B. Pump capacity: Sufficient to pump the anticipated peak hour flow with the largest pump out of service.

C. Pumps: Packaged units with a skid base or trailer.

D. Pumps: Fully automatic, self-priming, close-coupled centrifugal units that do not require use of foot valves or vacuum pumps for priming.

E. Pumps shall use oil-lubricated mechanical seal. F.

Pump materials: As follows:
1. Volute: Cast iron.
2. Impeller: Cast iron.
3. Pump shaft: Type 431 stainless steel.
4. Mechanical seal faces: Silicon carbide.

G. Pumps shall be capable of passing 3-inch diameter solids, rags, rocks, hair, and other debris encountered in municipal wastewater.

H. Pump driver: Diesel engine or 480-V electric engine and include the following:
   1. Minimum 48-hour capacity diesel fuel tank as defined by fuel consumption during peak pumping rate.
   2. Fuel gauge with red warning light when tank approaches empty.

I. Pumps shall be capable of dry operation for up to 12 hours to accommodate large fluctuations in flow.

J. Maximum pump speed: Not exceeding 2,200 revolutions per minute. K.

The system shall include the following features:
1. START/STOP OPERATION.
2. Variable flow based on water level in suction structure.
3. Instrumentation and controls for operation and monitoring for each pump.

L. Electrical equipment, instrumentation, and accessories: Suitable for Class 1 Division 2 service as defined by NFPA 820.

M. Comply with applicable air quality regulations.

N. Utilize low noise level pumps as size permits manufactured by BakerCorp or Goodwin Quiet Pumps. Due to bypass into existing force mains, sound attenuated pumps may not be available for high head conditions. In this case, sound curtains are to be utilized for noise control.

02553.2.03 BYPASS PIPING

A. Use HDPE piping for the temporary bypass pumping system. B.

Piping integrity: 0 leakage.

1. Include spill containment vessels or 'spillguards' as needed.

C. Provide sewage type air release valve at high point in piping and containment spills from valves.

D. Provide temporary ramps constructed over pipelines 6 inches in diameter or less to allow access to driveways.
1. Bury pipelines larger than 6 inches in diameter crossing driveways, a minimum of 6 inches below the existing ground or pavement surface and backfilled with
temporary asphalt concrete.
2. No driveway access shall be blocked without the written authorization of the Owner.

02553.2.04 PIPE PLUGS IN EXISTING PIPE

A. Pipe diameters 24 inches and smaller: Mechanical plugs with EPDM gaskets.

B. Pipe diameters larger than 24 inches: Inflatable bag stoppers with 2 or more pieces. Provide 2 plugs in series.

02553.2.05 NOISE CONTROL

A. Pumping equipment: Equipped with devices or enclosures for noise attenuation including but not limited to mufflers and/or acceptable noise panels or

enclosures. Due to the high head requirements for bypass of flow into existing force mains, pumps may not be available with noise attenuation. In that case, sound curtains shall be provided around the pumps to meet the noise level requirements of this Specification.

B. The noise level: The City of Sedona sound ordinance requires that the maximum permissible sound level limits be at or below 60 dBa from 7:00 AM to 10:00 PM and at or below 50 dBA from 10:00 PM to 7:00 AM as measured at any location at or within the property line of the receptor property.

02553.2.06 ODOR CONTROL

A. The Contractor shall employ methods and procedures that mitigate the generation and discharge of objectionable odors to the surface environment at all times.

B. Seal all open manholes with plastic or similar material around suction piping that is adequately taped or tied to maintain an odor barrier.

C. All odor control methods shall be routinely inspected for maintaining of installation integrity.

PART 3 EXECUTION

02553.3.01 GENERAL

A. Notify the Owner a minimum of seven (7) days prior to the Work and notify the Engineer at least 48 hours prior to bypassing or diverting flow in any of the pipelines or laterals.

B. Place pumps, generators, and other equipment on a plastic tarp to protect against spills of petroleum products used by the equipment.

C. Before taking process or pipeline out of service, verify that bypass system is fully operational and acceptable to Engineer. Testing of bypass system over a weekend period prior to taking pipeline out of service shall be performed.

02553.3.02 PROTECTION

A. Be responsible for all bypass flows.
   1. Inspect the entire bypass pumping and piping system for leaks or spills at a frequency of not less than 4 times per day.
   2. Do not shutdown the temporary bypass system between shifts, on holidays or weekends, or during work stoppages without written permission from the Engineer.

B. Provide trained and qualified attendants 24 hours per day 7 days per week until the bypassing is no longer required. The attendants shall:

1. Be capable of performing pump and piping maintenance required.
2. Be capable of monitoring flows/levels in suction manhole and any upstream manholes to verify system operations.
3. Have cellular phones for communication with the Contractor and the Owner in the event of emergencies.
4. The person responsible for the bypass pumping may perform other construction duties in the immediate vicinity of the bypass pumping system but must not leave the site for any reason without first handing off responsibilities to another competent person. All responsibilities of this specification apply to the new person until relieved.

5. A list of those responsible for the bypass pumping supervision, and the times they will be onsite, shall be provided to the City and the Engineer.

C. No bypassing to the ground surface, receiving waters, storm drains, or bypassing which results in soil or groundwater contamination or any potential health hazards shall be permitted.
   1. In the event of any wastewater spill, be responsible for the prompt cleanup and disinfecting of the spill as called for in the wastewater bypass pumping plan.
   2. Compensate the Owner for the cost of any fines levied as the result of a spill or unauthorized discharge.

D. Implement measures to prevent interference between Owner operations and the bypass pumping equipment, pipelines and wastewater.

E. Take precautions to protect all bypass lines from damage.
   1. Clearly identify above ground portions of the bypass lines by flashers, fencing, or other means to warn of their presence.

02553.3.03 FIELD QUALITY CONTROL

A. Hydrostatic pressure test:
   1. Prior to operation, test each section of discharge piping with maximum pressure equal to 2.0 times the maximum operating Pressure.
   2. Conduct test for a duration of 2 hours.
   3. Test using non-potable water.
   4. The line in service after test if the pressure has been maintained and there are no observable leaks.
   5. Notify Engineer at least 48 hours prior to testing.

B. Inspection:
   1. Inspect temporary bypass piping system at a minimum of four times per day.

   2. An attendant/operator shall be present to monitor the operation of the bypass pumps at all times 24 hours per day.
   3. Inspection log: Keep at each pumping location.

02553.3.04 CLEAN-UP

A. The temporary bypass pumping system: Flush, clean and drain prior to dismantling. B. Dispose of flushing water in approved manner.

C. Disturbed areas: Upon completion of bypass pumping operation, clean disturbed areas, restoring to original condition, including pavement and landscape restoration, at least equal to that which existed prior to start of Work.

02553.3.05 SYSTEM CONDITIONS

A. Refer to Table below.

Bypass	Route		Flows (gpm)				
Description	From	To	Max	Avg	Min	Time	Conditions
Chapel LS	MH#1 Upstream of LS	Existing 6" Force Main (75' of existing head	153	85	57	Continuous	Max wet condition flow = 392 gpm. Design for no more than 4' of vertical storage in MH#1
Mystic Hills LS	MH#1 upstream of LS	Existing 6" Force Main (202' of existing head)	207	115	20	Continuous	Max wet condition flow = 553 gpm. Design for no more than 4' of vertical storage in MH#1

02900.1 DESCRIPTION

This section covers providing materials, equipment and labor necessary for installing topsoil, turf, trees, shrubs, grasses, forbs, field seeding, re-seeding, fertilizer, mulch, and soil amendments.

02900.1.1 RELATED WORK

Not used.

02900.1.2 SUBMITTALS

The Contractor shall submit for approval product data and seed mixtures in accordance with the requirements of Section 01300.

02900.1.3 DEFINITIONS

Not used.

02900.2 MATERIALS

02900.2.1 TOPSOIL

Topsoil shall be obtained from local sources, and shall have similar soil characteristics to those of the soil at the location where it is to be used. Topsoil shall be obtained from well-drained sites where it occurs to a depth of not less than 4 inches, and it shall not be obtained from bogs or marshes. Topsoil shall be fertile, friable, natural loam, reasonably free of subsoil, clay lumps, brush, weeds, litter, roots, stumps, stones larger than 2 inches in any dimension, or any other material which would inhibit the germination of seeds or the growth of the cover crop.

02900.2.2 TURF SEED

If not otherwise required in the Contract Documents, seed for turf sod shall be composed principally of Kentucky bluegrass (Poa pratensis), testing 99.9% pure live seed (PLS), or as approved. Other acceptable varieties include Merion, Baron, Fylking, Tall Fescue, and Brome.

02900.2.3 TURF SOD

Turf sod shall be vigorous, viable, strongly rooted sod, not dormant or less than 2 years old, free of weeds, undesirable native grasses, insect infestations, and fungus. It shall be machine cut to a pad thickness of 1 inch ($\pm$ 0.33 inch).

02900.2.4 TREES AND SHRUBS

02900.2.4.1 NURSERY GROWN - Trees and shrubs shall be nursery-grown, with botanical and common names of plants true to the approved names given in the latest edition of "Hortus", and shall meet the requirements of the American Standard for Nursery Stock adopted by the American Association of Nurserymen. Plants shall be sound, healthy, vigorous, symmetrically proportioned, well branched, densely foliated when in leaf, free of disease, insect pests, eggs, and larvae and shall have well developed root systems.

02900.2.4.2 ROOT BALLS AND PRUNING - Root balls shall be protected at all times from sun, drying winds and frost. Plants shall not be pruned prior to delivery. If balled and burlapped plants are not installed immediately upon delivery, they shall be set on the ground and protected with moist soil or wet mulch.

02900.2.4.3 WARRANTY - Trees and shrubs shall be warranted for a period of 1 year after Substantial Completion, against death and unsatisfactory growth, except in cases resulting from Owner's neglect, abuse by others or natural phenomena. Unacceptable plant material shall be replaced at end of warranty period. Only one replacement is required.

02900.2.4.4 FIELD SEED MIX

The seed mix listed below is suggested as a standard for field seeding when no other information is available. However, seed mix requirements can vary widely from area to area, and the Contractor shall contact the local office of the Natural Resources Conservation Service (NRCS) to obtain an appropriate seed species mix and application rate for the location in question. The Contractor shall follow the directions of the NRCS, the Engineer, and the property owner in doing field seeding.

SUGGESTED FIELD SEED MIX

Species	**Amount** (%)
Nardan Crested Wheatgrass	30
Russian Wild Rye	20
Y.B. Sweet Clover	15
Slender Wheatgrass	10
Oahe Intermediate Wheatgrass	10
Fairway Crested Wheatgrass	5
Western Wheatgrass	4
Other	6

02900.2.5 RESEEDING AND REVEGETATING

As with the field seed mix, non-field seed mix and/or vegetation requirements are usually area sensitive. Different government agencies, such as the Forest Service or the Bureau of Land Management, may have separate seed mix and vegetation requirements within the same area. The Contractor shall contact the respective property owner at their local office, address, or telephone number to obtain the appropriate reseeding and revegetating requirements and follow the same, in concurrence with the Engineer, in acquiring the appropriate seed and vegetation.

02900.2.6 MULCH

02900.2.6.1 TREE AND SHRUB MULCH - Tree and shrub mulch shall consist of well-aged fibrous or shredded bark, old sawdust, pine needles or leaf mold.

02900.2.6.2 FIELD SEED MULCH - Field seeding mulch shall be certified weed free small grain straw or native hay.

02900.2.6.3 HYDRAULIC MULCH - Hydraulic seeding mulch shall consist of pigments and wood cellulose fiber or paper pulp and shall form a blotter-like ground cover with moisture absorption and percolation properties. It shall have the ability to cover and hold the seed in contact with the topsoil, yet not inhibit the penetration of seedlings through it.

02900.3 CONSTRUCTION REQUIREMENTS

02900.3.1 SCOPE OF REQUIREMENTS

The Contractor shall furnish all equipment, labor, topsoil, seed, seed mixes, turf, shrubs trees or other materials required to landscape, re-seed, or re-vegetate all areas disturbed by the Work, as

required by the Drawings and these Specifications. The disturbed area shall be kept as small as possible.

02900.3.2 EROSION CONTROL

The condition of landscaped, re-seeded and re-vegetated areas shall be checked to determine the effectiveness of erosion control methods and materials. Checks will be made upon project completion, at three months following project completion, and at nine months following project completion. Any modifications or repairs required by the Engineer shall be promptly performed by the Contractor, at no additional cost to the Owner.

02900.3.3 TOPSOIL

02900.3.3.1 REMOVAL OF TOPSOIL - Topsoil to be saved shall be carefully removed to a depth of 24 inches, or to the actual depth of the existing layer, which ever is less, and set aside in a separate location. It shall not be mixed with the remainder of excavated material.

02900.3.3.2 REPLACEMENT OF TOPSOIL - When site work conditions permit, topsoil shall be spread as shown on the Drawings. The minimum depth of topsoil shall be 6 inches over all designated areas. Topsoil shall be fine graded to a firm even surface, matching existing slopes, with no lumps or stones present. The topsoil shall be prepared to a good condition, not muddy or hard, and shall be scarified to a friable condition if it is hard before turf is placed.

02900.3.3.3 PROTECTION AGAINST EROSION - Areas where topsoil has been spread shall be protected against erosion.

02900.3.4 TURF SEED

02900.3.4.1 SEEDBED PREPARATION - Where required, turf seed shall be installed as specified herein. Seedbed preparation shall be accomplished by spreading peat moss or manure uniformly at a rate of 3 cubic yards per 1000 square feet and worked into the soil by light tilling.

02900.3.4.2 APPLICATION - Seed shall be applied at a rate of 2 pounds per 1000 square feet using a drop (band) type spreader unless otherwise approved by the Engineer. The seed shall be divided into two halves and then distributed, half in north/south directions and half in east/west directions. Seed shall be raked into the soil, a layer of mulch shall be applied, and then lightly watered, at least four times daily for two weeks, or until the seed germinates.

02900.3.5 TURF SOD

02900.3.5.1 INSTALLATION - Where required, turf sod shall be laid across slopes such that butt joints alternate. Sod pieces shall be fitted tightly together so no joint is visible and then firmly and evenly hand tamped. The sod shall then be rolled with a 150-pound roller to level and seal all seams.

02900.3.5.2 WATERING - After rolling, sod shall be watered until water soaks into underlying topsoil to a depth of not more than 3 inches. For grades of 50% slope or steeper, the sod shall be secured with wooden pegs driven flush with the soil portion of the sod and 2 feet maximum on center.

02900.3.5.3 MOWING - Prior to Substantial Completion, sod shall be mowed as required to maintain a maximum height of 2 1/2 inches.

02900.3.6 TREES AND SHRUBS

02900.3.6.1 LOCATION - When required trees and shrubs shall be installed, as specified herein, at locations designated on the Drawings. Trees and shrubs to be saved and replanted shall be carefully removed, set aside, protected and preserved until they can be safely replanted.

02900.3.6.2 PREPARATION OF PLANTING PIT - Tree and shrub pits shall be five times the diameter of the root ball. The bed shall be prepared by loosening the soil with a tiller or shovel to a depth of 12 inches. Topsoil and organic matter shall then be added and distributed uniformly within the planting bed as necessary. The Contractor shall not proceed with planting until the pit locations and bedding are approved by the Engineer.

02900.3.6.3 PLANTING - The plant shall be set in the center of a hole of the proper size, plumb and straight. Burlap, ropes and all wire and other materials shall be removed, and then the excavated soil shall be returned to the hole and gently packed around the root ball. The planting shall be flooded with water to promote additional soil consolidation. The Contractor shall give care that, after settling, the top of the root collar shall be even with the adjacent finished grade A 2-inch layer of mulch shall be applied around the base of the tree, to extend 2 feet in radius beyond the root ball.

02900.3.6.4 SUPPORT - Trees shall be guyed with two wires anchored securely to steel posts not less than 5 feet from the trunk, and directly opposite each other. The trees shall be protected from direct contact with the wires.

02900.3.6.5 PRUNING - Each plant shall be pruned with clean, sharp tools, to remove suckers and broken, badly bruised or dead branches. Tree trunks shall be wrapped with Tubex or equivalent translucent material unless directed otherwise by the Engineer.

02900.3.6.6 WATERING - Trees and shrubs shall be watered and maintained until Substantial Completion and defective work shall be corrected as soon as it becomes apparent and as weather and season permit.

02900.3.7 FIELD SEEDING

Field seeding shall be accomplished using one of the following methods.

02900.3.7.1 BROADCAST - Broadcast seeding shall only be applied after October 15 and prior to April 15, unless authorized otherwise and directed in writing by the Engineer. No seed bed preparation will be required for this seeding method.

02900.3.7.2 DRILLING - Drilling shall be set forth in uniform rows with spacing not to exceed 8 inches and the depth set correctly for the type of seed being drilled. The minimum distribution rate shall be 20 pounds per acre, and may be more if so recommended by the local Soil Conservation Service.

02900.3.7.3 HYDRAULIC - For hydraulic seeding the Contractor shall use equipment designed for such work. Seed and water shall be uniformly applied to the areas scheduled to be seeded. Fertilizer, water and approximately 1 ton per acre of hydraulic mulch shall be homogeneously mixed and uniformly applied to seeded areas.

02900.3.8 RESEEDING AND RE-VEGETATING

02900.3.8.1 RE-SEEDING - Reseeding of areas disturbed by the Work shall be accomplished with grasses compatible with the pre-construction vegetation. The Contractor shall consult the local office of the U.S. Forest Service, Bureau or Land Management, Soil Conservation Service, or other applicable affected agency, for appropriate seed species and application rates. Unless otherwise

directed by the Engineer or these Specifications, reseeding shall be accomplished by broadcast seeding in accordance with this section.

02900.3.8.2 RE-VEGETATING - Re-vegetation of areas disturbed by the Work shall be accomplished with started trees and shrubs, compatible with the pre-construction vegetation, and is performed in addition to reseeding as discussed in paragraph 02900.3.8.1 above. When re-vegetation is required, the Contractor shall consult the local office of the applicable affected agency, for appropriate species and instructions.

02900.3.9 MULCH

Mulch shall be incorporated as prescribed on the Drawings and in these Specifications. Where the slope exceeds 10%, the Contractor shall use a tie down mulching material.

02900.4 METHOD OF MEASUREMENT

02900.4.1 LUMP SUM - Lump sum measurement for landscaping shall include all grading, soil preparation, planting, furnishing materials and plants in accordance with the Drawings and these Specifications when shown as a single item in the Bid Schedule.

02900.4.2 SEPARATE MEASUREMENT - When and if applicable, separate measurements for topsoil, turf seeding, turf sod laying, reseeding, re-vegetating, mulching and planting of trees and shrubs shall be made in the units shown and as identified in the Bid Schedule.

02900.5 BASIS OF PAYMENT

The accepted quantity(s) shall be paid for at the contract unit price for:

PAY ITEM	UNIT
Landscaping	Lump Sum
Topsoil	Square Yard
Turf, Seed	Square Foot
Turf Sod	Square Foot
Trees & Shrubs	Each
Field Seeding	Acre
Re-seeding	Acre
Mulch	Acre

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes vehicle and manway gates.

1.2 SUBMITTALS

A. Product literature and data for manufactured items.

B. Shop drawings showing location and fabrication details of posts, wood privacy slats, hardware, accessories, and specific description of material components.

1.3 QUALITY ASSURANCE

A. Fabricator Qualifications: Firm experienced in successfully producing access gates and manways similar in type and style shown in the Drawings. Shall have a minimum three years' experience.

B. Welding Standards: Comply with applicable provisions of AWS D1.1 "Structural Welding Code-Steel". Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.4 FIELD MEASURMENTS

A. It is the contractors responsibility to take field measurements to ensure the shop drawings dimensions will fit in the allotted space.

PART 2 PRODUCTS

2.1 METALS

A. General: Provide metals free from surface blemishes exhibiting pitting, seam marks, roller marks, stains, discolorations, or other imperfections, where exposed to view in the finished unit.

B. Steel and Iron: Provide steel and iron in the form indicated suitable for specified finish, complying with the following requirements:

1. Square Tubing: Cold-formed steel structural tubing conforming to ASTM A 500, Grade B with minimum yield strength of 42,000 psi and not less than 1.8 oz. of zinc per sq. ft. Type A costing inside and outside according to ASTM F 1234, as determined by ASTM A 90.
2. Steel Plate, Shapes, and Bars: ASTM A 36/A 36M.

C. Stainless Steel: Hardware per Drawings.

2.2 WOOD PRIVACY SLATES

A. The wood privacy slats shall be Construction Common Redwood dog-ear pickets. Sized and spaced per the Drawings.

2.3 MISCELLANEOUS MATERIALS

A. Welding Electrodes and Filler Metal: Type and alloy of filler metal and electrodes as recommended by producer of metal to be welded, complying with applicable AWS specifications, and as required for color match, strength, and compatibility in the fabricated items.

B. Fasteners: Use fasteners of same basic metal as the fastened metal, unless otherwise indicated. Do not use metals that are corrosive or incompatible with materials joined. Provide non-corrosive spacers as required.

C. Cast-in-Place and Post-Installed Anchors: Expansion anchors, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

D. Non-shrink, Non-metallic Grout: Premixed, factory-packaged, non-staining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.4 FITTINGS AND ACCESSORIES

A. Material: Per Drawings Comply with ASTM F 626.

1. Post and Line Caps: Provide weather tight closure cap for each post.

2.5 CONCRETE

A. Concrete: Class "AA" Per MAG Section 725 (4,000 psi)

2.6 FABRICATION

A. Form gate frame metals to required shapes and sizes, with true curves, lines, and angles. Provide components to sizes and profiles indicated, but not less than required to comply with requirements for structural performance per shop drawings.

B. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Drill and tap for required fasteners, unless otherwise indicated. Use concealed fasteners wherever possible.

C. Comply with AWS for recommended practices in shop welding and brazing. Provide welds and brazes behind finished surfaces without distortion or discoloration of

exposed side. Clean exposed welded and brazed joints of flux, and dress exposed and contact surfaces.

D. Mill joints to a tight, hairline fit. Cope or miter corner joints. Form continuous weld joints to exclude water penetration.

E. Provide castings that are sound and free of warp, cracks, blow holes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gatemarks, casting flash, and other casting marks.

F. Finish exposed surfaces to smooth, sharp, well-defined lines and arises.

G. Assemble items in the shop to the greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

H. Welded Connections: Use welding method that is appropriate for metal and finish indicated and that develops strength required to comply with structural performance criteria. Finish exposed welds and surfaces smooth, flush and blended to match adjoining surfaces.

I. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect access and manway gate to other work as called for in the Drawings.

2.7 WOOD PRIVACY SLATES FINISHES, GENERAL

A. Wood slates shall be painted according to Specification 09910.

2.8 IRON AND STEEL FINISHES

A. Metal components (excluding hardware unless specified in the Drawings) shall have a powder coated finish. Color per plans. Coating fabrication shall be per the following

1. Sandblast to a "White Finish" removing all trace oil, paint, rust, corrosion, etc.
2. Apply Epoxy Primer
3. Apply Powder coating with an electrostatic spray to a 2-3 mils thickness.

PART 3 EXECUTION

3.1 PREPARATION

A. Coordinate and furnish anchorages and setting drawings, diagrams, templates, instructions, and directions for installing items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

3.2 INSTALLATION

A. Provide anchorage devices and fasteners where necessary for securing metalwork to in-place construction.

B. Perform cutting, drilling, and fitting required to install wood privacy slates. Set products accurately in location, alignment, elevation, plumb, level and true, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

C. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, with uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of fence sections, restore finishes to eliminate any evidence of such corrective work.

D. Do not cut or abrade finishes that cannot be completely restored in field. Return items with such finishes to shop for required alterations, followed by complete refinishing, or provide new units as required.

E. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at the same location.

F. Field Welding: Comply with the applicable AWS specification for procedures of manual shielded metal-arc welding, for appearance and quality of welds made, and for methods used in correcting welding work. Weld connections that are not to be left as exposed joints but cannot be shop-welded because of shipping size limitations. Grind exposed welded joints smooth and restore finish to match finish of adjacent surfaces.

3.3 PROTECTION

A. Protect finishes from damage during construction period with temporary protective coverings approved by gate fabricator. Remove protective covering at time of Substantial Completion.

B. Restore finishes damaged during installation and construction so that no evidence remains of correction work. Return items that cannot be refinished in field to shop; make required alterations and refinished entire unit or provide new units as required at no cost to the client.

3.4 METHOD OF MEASUREMENT

The method of measurement shall be per Section 01019.3.

3.5 BASIS OF PAYMENT

The basis of payment shall be per Section 01019.3

02900 DEMOLITION AND REMOVAL

02900.1 DESCRIPTION

This section is a specification regarding the demolition, removal or abandonment of existing equipment, structures, piping, fencing and appurtenances.

02900.1.1 REFERENCES

Section 01520 – Environmental Control
MAG Section 601 – Trench Excavation, Backfill and Compaction

02900.1.2 Definitions

Not used.

02900.2 REMOVAL OF EQUIPMENT

02900.2.1 Non-Salvaged Equipment – Non-salvaged equipment shall be removed in a manner that produces the least amount of debris as practical. All debris created in the demolition process shall be removed. All removed equipment and debris shall be disposed of according to Section 01520. Non-Salvage equipment includes but is not limited to the following: APS utility meter, MCC, and lighting.

02900.2.2 Salvaged Equipment – Salvaged equipment, unless incorporated in the new work, shall be remain the property of the client and be transported to the WWRP. Such items and materials shall be carefully removed and in such a manner as to permit reuse. Salvaged equipment includes but is not limited to the following: generator (will be installed at the Chapel lift station), generator diesel tank, lift station pumps, lift station float system, valves, manual transfer switch, ATS and access gate.

02900.2.3 Reinstalled Equipment – Some existing equipment will be incorporated in the new work. This equipment shall be removed in such a manner as to permit reuse. It shall be stored in a secure place and protected from the elements. The contractor shall reinstall the equipment in kind. Reinstalled equipment includes but is not limited to the following: portable generator receptacle, backflow preventer and hot box, safety harness plate, and frost-free hydrant.

02900.3 REMOVAL/ABANDONMENT OF PIPING

Pipe removal/abandonment shall be in accordance with these Specifications and the Drawings. All above ground pipe to be abandoned shall be removed. All below ground piping shall be grouted and abandoned in place, unless the piping must be removed for construction of new piping or structures, or if piping is fully exposed during the course of construction and is easily removable. Removal and abandonment of piping includes all fittings, restraints, and appurtenances. All removed piping, unless stated otherwise in the Drawings or by the Engineer shall be

disposed of according to Section 01520.

02900.4 REMOVAL OF STRUCTURES AND PADS

All concrete structures and pads shall be removed according to the Drawings and these Specifications. Demoed structures include but are not limited to the following: Concrete pads, housekeeping pads, wet well, and valve vault. The wet wall shall be demoed according to the plans which involves removing the top 6 feet of the structure and slurry filling the rest. Concrete shall be broken up and removed with appropriate equipment to complete the task in a timely manner. Dust shall be controlled during and after removal and debris barriers shall be set up if deemed necessary by the Contractor or Engineer to protect existing structures and workers. Concrete debris shall be neatly stockpiled and disposed of according to Section 01520.

02900.5 REMOVAL OF EXISTING WALLS

02900.5.1 Flagstone wall – The flagstone wall shall be removed according to the Drawings and these specifications. The contractor shall hand dig and remove the flagstone wall in order to prevent damage to the flagstone. Existing structures shall be protected in place. The flagstones wall shall be reinstalled in kind.

02900.5.2 CMU walls and footing – The CMU wall and footing shall be removed according to the Drawings and these Specifications. The CMU wall and footing shall be broken up and removed with appropriate equipment to complete the task in a timely manner. Dust shall be controlled during and after removal and debris barriers shall be set up if deemed necessary by the Contractor or Engineer to protect existing structures and workers. Care shall be taken to not damage the CMU wall/footing that is not removed as the new CMU wall/footing will tie in with existing wall where applicable. Concrete debris shall be neatly stockpiled and disposed of according to Section 0152.

02900.5 EARTHWORK

Upon completion of removal or abandonment activities soils shall match grading called out in the Drawings. Backfill and compaction shall be completed in accordance with the Drawings and these Specifications.

02900.6 REMOVAL/ABANDONMENT ACTIVITIES CLEANUP

Upon completion of removal or abandonment activities the areas shall be free of debris. Area shall match surrounding areas.

02900.7 METHOD OF MEASUREMENT

02900.7.1 The method of measurement shall be per Section 01019.3.

02900.7.2 DAMAGED ITEMS

Measurement of items damaged or removed as a result of the Contractor's negligence shall not be allowed and no payment will be made under this contract.

02900.8 BASIS OF PAYMENT

The basis of payment shall be per Section 01019.3.

02930.1 DESCRIPTION

This section describes the minimum requirements for maintenance of plant operation (MOPO) during construction until the new lift station is brought online. The purpose of this MOPO is to ensure continues service by:

1. Keeping the existing lift station stays online as long as feasibly possible during construction;
2. Switches to temporary bypass pumping once existing system must be taken offline;
3. Bring the new lift station online.

A full MOPO plan addressing the above items is the responsibility of the Contractor. The Contractor is responsible for providing all equipment and personnel unless stated otherwise in these specifications.

02930.1.1 RELATED WORK AND REFERENCED SECTIONS

Section 01019 – Measurement and Payment
Section 01300 – Submittals
Section 01510 – Protection of Existing Property
Section 01520 – Environmental Control

02930.1.2 SUBMITTALS

02930.1.2.1 A PDF copy of the MOPO must be provided to the Owner and Engineer three (3) weeks before the scheduled work for approval. The MOPO must be approved before work begins. The MOPO must describe in detail how the Contractor will approach construction to ensure the existing system is kept online as long as possible, how the system will transition to bypass pumping, and how the new system will be brought online once complete. A schedule shall be provided that shows when the events will occur. If the MOPO is not approved, it will be the Contractors responsibility to provide an alternative MOPO at no additional cost to the Owner.

02930.2 MOPO REQUIREMENTS

02930.2.1 Keeping Existing Lift Station Online During Construction:

It is the contractor's responsibility to stage construction in order to keep the existing system online for as long as feasible. Work that can be done without impacting the existing lift station shall be done first when reasonable. Existing lift station, valve vault, equipment, piping and electrical crucial to the lift station operation shall be protected in place until the system is switched over to temporary bypass pumping.

02930.2.2 Temporary Bypass Pumping:

Once it is no longer feasible to keep the existing lift station online, the Contractor shall switch over to a temporary bypass pumping system. The Contractor to provide a detail

plan on how the system will be switched over from the existing lift station to the temporary bypass pumping system. The temporary bypass pumping system shall be per Specification Section 02553. Switching of the systems shall be during a low flow period at a time approved by the City.

02930.2.3 Bring New Lift Station Online:

Once the new lift station has been constructed, tested, and approved by the City, it will be brought online and the temporary bypass pumping system will be discontinued. The Contractor is responsible for providing a detail plan on how the switch between the temporary bypass system and the new lift station will occur. Plan shall include the reconnection of all required lines. Switching of the systems shall be during a low flow period at a time approved by the City.

02930.2.5 MOPO Supervision – The Contractor shall be responsible for providing supervision over the MOPO where required. The person in charge of the supervision must be competent and responsible. During working and nonworking hours, one person must be in charge of monitoring the MOPO at all times, where required. This person may perform other construction duties in the immediate vicinity of but must not leave the site for any reason during the MOPO activities. If the person must leave the vicinity they must first handoff the MOPO supervision to another individual with all aspects of this specification applying to the new person. A list of those responsible for the MOPO supervision, and the times they will be onsite, shall be provided to the Owner and Engineer.

02930.2.6 MOPO Duration – The MOPO shall be in place during the duration of construction until the new lift station is successfully brought online. It is the Contractors responsibility to meet these specifications throughout the duration of the MOPO.

02930.2.7 MOPO Implementation – It is solely the responsibility of the Contractor to implement the MOPO successfully throughout the course of construction. If at any point there is an issue with the MOPO, or alternation to the plan is required, all cost associated with meeting the intent of the MOPO is the responsibility of the Contractor.

02930.4 METHOD OF MEASUREMENT

The method of measurement shall be per Section 01019.3.

02930.5 BASIS OF PAYMENT

The basis of payment shall be per Section 01019.3.

03150 PRE-CAST FLOWMETER VAULT

03150.1 DESCRIPTION

This section is for the manufacturing and construction of the pre-cast flowmeter vault.

03150.1.1 REFERENCES

MAG Section 206 – Structure Excavation and Backfill
MAG Section 301 – Subgrade Preparation
MAG Section 506 – Precast Prestressed Concrete Members
Section 01300 – Submittals
Section 08122 – Embedded Access Hatch

03150.1.2 SUBMITTALS

Submittals shall be according to MAG 506 and Section 01300. Drawings and calculations shall be provided for the pre-cast concrete structure. They shall be stamped and signed by a registered professional engineering, licensed in Arizona.

03150.2 MATERIALS AND FABIRCATION

03150.2.1 The pre-cast vault shall meet the requirements of MAG 506 and ASTM C890. The pre-cast vault shall be designed for H-20 loads.

03150.3 CONSTRUCTION REQUIREMENTS

The pre-cast vault shall be constructed according to the Drawings, these Specifications and manufacturers recommendation. Earthwork shall be completed according to the Drawings and MAG 206 and MAG 301.

03150.7 METHOD OF MEASUREMENT

03150.7.1 The method of measurement shall be per Section 01019.3.

03150.8 BASIS OF PAYMENT

The basis of payment shall be per Section 01019.3.

05010.1 GENERAL

This section of the Specifications covers metals and metal work required to furnish, fabricate, and to install the following nonexclusive list of items:

- Aluminum and miscellaneous nonferrous metals
- Anchors and anchor bolts
- Bolts
- Cast-iron frames and covers
- Grating and frames
- Ladders
- Louvers
- Manhole frames and covers
- Metal roof decking
- Miscellaneous metal items shown on the Plans or specified
- Miscellaneous structural steel
- Pipe handrails, pipe sleeves, inserts, and chains
- Platforms
- Sheet metalwork
- Special supports, hangers, and anchors
- Stairs and treads
- Steel lintels
- Supports for mechanical equipment
- Tread plates and frames

05010.1.2 RELATED WORK

Not used.

05010.1.3 SUBMITTALS

Certified copies, in duplicate, of mill tests or reports from a recognized commercial laboratory shall be furnished when requested as to the chemical, tensile, and bending properties of each shipment of structural metal or part thereof having common properties. All tests and analyses shall be made in accordance with the applicable ASTM Specification.

05010.1.4 DEFINITIONS

Not used.

05010.2 MATERIALS

05010.2.1 ALUMINUM

05010.2.1.1 SHEET ALUMINUM - Except as otherwise specified or indicated on the Plans, sheet aluminum shall be alloy 50050H14 conforming to the requirements of ASTM B 209 and shall be not less than 0.025 inch in thickness.

05010.2.1.2 STRUCTURAL ALUMINUM - Structural aluminum shall be 6061-T6, and extruded aluminum shall be 6063-T42.

Aluminum shapes and appurtenant materials shall conform to the requirements of ASTM B 221 and ASTM B 308 and shall be of aluminum alloy known commercially as 6061-T6. Materials not otherwise specified shall conform to the latest applicable Specifications of ASTM.

05010.2.1.3 BOLTS - All bolts for bolting aluminum shall be Type 304 or 316 stainless steel of sizes indicated on the Plans.

05010.2.2 STEEL

05010.2.2.1 SHEET STEEL - Galvanized sheet iron or steel shall conform to ASTM A 525, 1.25-ounce coating; black steel to ASTM A 569.

05010.2.2.2 STRUCTURAL STEEL – Structural steel shall be as follows:

- Unless otherwise specified, structural steel shall conform to ASTM A 36.
- Cast iron shall conform to ASTM A 48, Class 40B.
- Galvanized structural steel or iron shall be "hot dipped" galvanized after fabrication. Electro-galvanizing shall not be used unless specified otherwise.
- All structural steel shall be delivered free from mill scale, rust, or pitting.
- Items not galvanized or protected by a shop coat of paint shall be protected from the weather until erection and painting.

05010.2.2.3 STAINLESS STEEL - Stainless steel, unless specifically specified or indicated on the Plans otherwise, shall be Type 316 or Type 304, nonmagnetic.

05010.2.2.4 STEEL PIPE - Steel pipe shall conform to ANSI B 36.10, Table I.

05010.2.2.5 BOLTS - High tensile bolts shall conform to ASTM A 325.

05010.2.2.6 OTHER ITEMS

Other structural and miscellaneous metal items shall be as indicated on the Plans or as specified elsewhere.

05010.3 CONSTRUCTION (FABRICATION) REQUIREMENTS

05010.3.1 GENERAL

All structural or foundry items shall be carefully fabricated to true dimensions without warp or twist. Welded closures shall be neatly made; and where weld material interferes with fit or is unsightly in appearance, it shall be ground off smooth.

05010.3.1.1 INSTALLATION - Each structural item shall be installed true to level, plumb, alignment, and grade with all parts bearing or fitting the structure or equipment for which it is intended accurately and securely. It shall not be permitted to cock out of alignment, re-drill, reshape, or force to fit any fabricated item. It is the Contractor's responsibility to place anchor bolts or other anchoring devices accurately and to make any surfaces, which bear against structural items smooth and true to level to preclude the necessity of any springing, re-drilling, or reshaping.

05010.3.1.2 SPECIAL ALIGNMENT - Pipe railings, posts, and structural items needing a special alignment to preserve straight, level, even, smooth lines shall be rigidly supported and braced and kept braced until concrete, grout, or dry pack cement mortar has hardened for a period of not less than 48 hours.

05010.3.1.3 FIT - The Contractor shall be responsible for the correct fitting of all metalwork in the field. The Contractor shall take all measurements necessary to properly fit its work in the field, and it shall be governed by and be responsible for these measurements and the proper working out of all details.

05010.3.1.4 WELDING – General welding procedures are as follows (see also Subsections below):

- The Contractor shall notify the Engineer at least 24 hours before starting shop or field welding.
- A welding inspector may check the materials, the equipment, and the qualifications of the welders.
- The inspector may use gamma ray, magnetic particle, dye penetrant, trepanning, or any other aid to visual inspection which it may deem necessary to be assured of the adequacy of the welding.
- The costs of any tests and all re-tests on defective welds shall be borne by the Contractor. Cost in connection with qualifying welders shall also be borne by the Contractor.
- The cost of tests on sound welds will be borne by the Owner.

- Welders doing unsatisfactory work shall be removed or may be required to pass qualification tests again.

05010.3.1.5 MISCELLANEOUS METALWORK - Where anchors, connections, or other details of miscellaneous metalwork are not definitely shown or specified, its material, size, form, attachment, and location shall conform to best practice.

05010.3.1.6 HAZARDOUS PROJECTIONS - Sharp or hazardous projections shall be rounded off and ground smooth.

05010.3.1.7 CHIPS AND DEBRIS - All chips and other debris lodged between contacting surfaces shall be removed before assembly.

05010.3.2 ALUMINUM

05010.3.2.1 STRUCTURAL ALUMINUM

The Contractor shall furnish and install all structural aluminum items in accordance with the Plans and as specified. It shall provide all supplementary parts necessary to complete each item even though such work is not definitely covered by the Plans and Specifications. Its size, form, attachment, and location shall be such as to conform to the best of current practice.

05010.3.2.2 LAYOUT ON ALUMINUM - Hole centers may be center punched and cutoff lines may be punched or scribed. Center punching and scribing shall not be used where such marks would remain visible on the surface of the fabricated material.

When critical dimensions exist, a temperature correction shall be applied in the layout as necessary. The coefficient of expansion shall be taken as 0.000013 per degree F.

05010.3.2.3 CUTTING AND DRILLING ALUMINUM – Aluminum may be cut and drilled as follows:

- Material 1/2 inch thick or less may be sheared, sawed, or cut with a router. Material more than 1/2 inch thick shall be sawed or routed.

- Cut edges shall be true, smooth, and free from excessive burrs or ragged breaks.

- Edges of plates carrying calculated stresses shall be planed to a depth of 1/4 inch. Sawn or routed edges will be acceptable when the finish is of equal quality to a planed edge.

- Re-entrant cuts shall be avoided wherever possible. If used, they shall be filleted by drilling prior to cutting.

- Rivet or bolt holes may be punched or drilled to finished size before assembly.

- The finished diameter of holes for unfinished bolts shall be not more than 1/16 inch larger than the nominal bolt diameter.

- All holes shall be cylindrical and perpendicular to the principal surface. Holes shall not be drifted in such a manner as to distort the metal.

- Flame cutting of aluminum alloys is not permitted.

05010.3.2.4 ALUMINUM FORMING AND ASSEMBLY - Structural aluminum material may not be heated except in forming operations where material may be heated to a temperature not exceeding 400 degrees F for a period not exceeding 30 minutes to facilitate bending. Such heating shall be done only when proper temperature controls and supervision are provided to insure that the limitations on temperature and time are carefully observed.

05010.3.2.5 WELDING ALUMINUM - This Specification shall apply to both field and shop welding operations. The general recommendations and regulations shown in the American Welding Society Specifications D1.1, "Structural Welding Code," apply to 6061-T6 structures. Detail requirements for welding aluminum alloy 6061-T6 are given as follows:

- Filler metal for welding shall be aluminum alloy welding rods conforming to the requirements of AWS A 5.10 and shall be AWS classification ER 4043, ER 5154, ER 5254, ER 5183, ER 5356, or ER 5556.

- The welding process and welding operators shall both meet a qualification tests. The method of qualification shall conform to the method described in the ASME Boiler and Pressure Vessel Code, Section IX, "Welding Qualifications," Part B. Aluminum alloy 6061-T6 shall be used for the qualification test plates. Operators shall be qualified on the basis on bend tests and a fillet weld soundness test.

- Dirt, grease, forming or machining lubricants, or any organic materials shall be removed from the areas to be welded by cleaning with a suitable solvent or by vapor degreasing. Additional operations to remove the oxide coating just prior to welding are required when the inert gas tungsten arc welding method is used. This may be done by etching or by scratch brushing. The oxide coating may not need to be removed if the welding is done with the automatic or semi-automatic inert gas shielded metal arc.
- Suitable edge preparation to assure 100 percent penetration in butt welds shall be used. Oxygen cutting shall not be used. Sawing, chipping, machining or shearing may be used.

- Any welding of aluminum shall be done using a nonconsumable tungsten electrode with filler metal in an inert gas atmosphere (TIG) or using a consumable filler metal electrode in an inert gas atmosphere (MIG). No welding process that requires the use of a welding flux shall be used unless prior approval has been obtained from the Engineer. Preheating for welding is permissible provided the temperature does not exceed 400° F for a total time of 30 minutes.

- Welding of any structure which is to be anodized shall be done using filler alloy rods that will not discolor when anodized. ER 5154, ER 5254, ER 5183, ER 5356, or ER 5556 filler alloy rods shall be used.

05010.3.2.6 PROTECTION OF ALUMINUM SURFACES - Aluminum surfaces to be placed in contact with wood, concrete, masonry, or dissimilar metals other than stainless steel shall be protected as specified in the appropriate sections of Division 9 – Finishes.

05010.3.2.7 BOLTING - Where aluminum comes in contact with steel it shall be bolted with stainless steel bolts and separated or isolated from the steel with neoprene gaskets or washers or as specified in Division 9.

05010.3.3 STEEL

05010.3.3.1 STRUCTURAL STEEL – The following shall apply:

- The Contractor shall furnish and install all structural steel items in accordance with the plans and as specified herein.

- The Contractor also shall provide all supplementary parts necessary to complete each item even though such work may not be specifically covered by the Plans and Specifications.

- Wherever applicable, all fabrication and erection of steel items shall conform to AISC "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings" except as the same may be modified by applicable building codes, the General Conditions, and these Specifications.

05010.3.3.2 WELDING OF STEEL – Both the general recommendations and regulations shown in the American Welding Society Specifications D1.1, "Structural Welding Code," as well as the detail requirements in those specifications apply to welding of steel structures. Welding of steel shall adhere to the following:

- All welding of steel under this section shall be done by welders who have a current AWS certificate for the type of welding to be done by the welder.

- All welding of structural steel type ASTM A 36 shall be done using mild steel covered Arc Welding Electrodes conforming to ASTM A 233, Series E70, or

shall be done using Electrodes and Fluxes for Submerged Arc Welding conforming to ASTM A 558, Classification F70-XXXXX, where XXXXX refers to any electrode referred to in ASTM A 558.

- Welding of stainless steels shall be done with electrodes and techniques as recommended in Welded Austenitic Chromium - Nickel Stainless Steels - Techniques and Properties as published by the International Nickel Company, Inc., New York, New York. All welds shall be full penetration welds, unless specified otherwise.

05010.3.3.3 PROTECTION OF STEELWORK - The Contractor shall paint steel and miscellaneous ferrous metal items as specified in the appropriate sections of Division 9-Finishes.

05010.3.4 DUCTWORK

05010.3.4.1 DESIGN AND FABRICATION - Ducts shall be fabricated of aluminum or galvanized steel sheets with gauges of sheet metal, joint types, reinforcing, bracing, supporting, fabricating, installing, and other requirements in accordance with Duct Manual and Sheet Metal Construction for Ventilating and Air Conditioning Systems of the Sheet Metal and Air Conditioning Contractors National Association, Inc. Ducts shall be designed for the appropriate pressure type as shown in the above mentioned Duct Manual. Details on the Plans in some cases call for sheet metal thicknesses greater than called for in the Duct manual. Sheet metal shall conform to whichever requirement calls for the greater thickness. Aluminum ducting shall be not less than 0.063 inches thick.

05010.3.4.2 HANGERS - Ducts shall be supported on both sides at all changes in direction and at not greater than eight foot intervals by suitable hangers as specified herein or as detailed on the Plans. For galvanized ducting, hangers for ducts 12-inch by 24-inch or smaller shall be galvanized sheet metal straps not lighter than 18-gauge by one inch secured to the structure by one 5/16-inch bolt and to the duct by not less than two No. 10 sheet metal screws or 3/16-inch stove bolts. Hangers for ducts larger than 12-inch by 24-inch shall be galvanized steel straps or rods not less than 0.13 square inches in net cross section, secured to the structure by a Grinnell Figure 152, Size 2, concrete insert, or approved equal, and to a duct pocket or reinforcing angle by two 1/4-inch stove bolts. For aluminum ducting, supports shall be equivalent to supports for galvanized ducting except that all fasteners, fittings, and shafting shall be stainless steel.

05010.3.4.3 FLEXIBLE CONNECTIONS - Where blowers or equipment containing blowers or other machine elements, which may cause vibration, are connected to ducts or housing, such connections shall be by means of flexible connections. These flexible connections shall be airtight at the pressures encountered and be flame proof and water proof. The flexible material shall be equivalent to 14 ounce canvas.

05010.4 METHOD OF MEASUREMENT

Not used.

05010.5 BASIS OF PAYMENT

Not used.

05050.1 DESCRIPTION

This section covers a generic list of miscellaneous metals specifications.

05050.1.1 RELATED WORK

Not used.

05050.1.2 SUBMITTALS

Not used.

05050.1.3 DEFINITIONS

Not used.

05050.2 MATERIALS

05050.2.1 LADDERS AND METAL STAIRS

All ladders shall be safety ladders conforming to OSHA standards. All ladders and stairways supplied to the project shall be of one manufacturer. All stair and ladder wells shall be adequately guarded, and all stairs shall have handrails as specified or shown on the Plans.

Ladders shall be secured to the supporting surface by bent plate chips providing not less than 7 inches between the supporting surface and center of rungs. If exit from the ladder is forward, over the top rung, side rails shall be extended not less than 3-feet-3 inches above, and returned to the landing. If exit from the ladder is to the side, the ladder shall extend not less than 5-feet 6-inches above the landing and be rigidly secured at the top.

05050.2.2 ALUMINUM LADDERS

Aluminum ladders shall be made of 6063-T5-aluminum alloy, of welding construction. Rungs shall be not less than 1-inch square bar with 1/8-inch grooves in the top and redivided edges. Side rails shall be no lighter than 3 inches by 3/8 inches. Ladders shall be of the size, shape, location, and details indicated on the Plans. Ladders greater than 20 feet in height shall have standard ladder cages designed in accordance with State and OSHA requirements. All aluminum surfaces, which will be in contact with concrete, shall be coated as specified in Division 9.

05050.2.3 ALUMINUM STAIRWAYS

Aluminum stairways shall be fabricated and installed as shown on the Plans. Stairway stringers shall be fabricated of aluminum alloy 6061-T6. Treads shall be

aluminum as specified below. Handrail shall be fabricated of aluminum pipe as specified under aluminum handrail.

Stair treads shall be aluminum of the sizes called for on the Plans, and shall be of the same type and make as called for under GATING. All fasteners shall be of Type 304 or 316 stainless steel.

Stair treads shall be furnished with cast abrasive type safety nosing.

05050.2.4 ARCHITECTURAL AND MISCELLANEOUS SHEET METAL

Sheet metal flashing and counterflashing shall be installed as indicated on the Plans. Galvanized steel or anodized aluminum flashing shall be used when indicated and specified on the Plans. Unless otherwise indicated flashing shall be 0.025-inches thick. The aluminum flashing shall receive a 215-R1 anodic finish after fabrication as indicated on the Plans. Exposed edges shall be folded back 1/2-inch to provide stiffness. Except as otherwise indicated and specified on the Plans, counterflash shall be provided over all base flashings.

Unless specifically noted, galvanized steel flashing shall be used in contact with structural steel and anodized aluminum flashing shall be used in contact with structural aluminum. This shall be done to protect against dissimilar metal action.

Surfaces to which sheet metal is to be applied shall be even, smooth, round, thoroughly clean and dry, and free from all defects that might affect the application. All cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades shall be performed under this section. All accessories or other items essential to the completeness of this sheet metal installation, though not specifically shown or specified, shall also be provided under this section. Nails, screws, and bolts shall be of the types best suited for the intended purpose and shall be of a composition that will not support galvanic action in the installation. Where sheet metal abuts into adjacent materials, the juncture shall be executed in a manner satisfactory to the Engineer.

Sheet metal items not covered elsewhere shall be as indicated on the Drawings and as required to provide a watertight installation. Formed sheet metal for metal covered work shall accurately reproduce the detail and design shown and profiles, bends, and intersections shall be sharp, even, and true.

05050.2.5 ALUMINUM SHEET METAL WORK

Except as otherwise specified or indicated on the Plans, sheet aluminum shall be alloy 5005-H14 conforming to the requirements of ASTM B 209 and shall be not less than 0.025 inch in thickness and extruded aluminum shall be 6063-T42.

05050.2.6 MISCELLANEOUS STRUCTURAL STEEL

Miscellaneous steel items not specified herein shall be as shown on the Plans or specified elsewhere and shall be fabricated and installed in accordance with the best practices of the trade.

05050.2.7 LINTELS

Lintels for masonry construction shall be structural steel beams or angles, fabricated as indicated on the Plans.

05050.2.8 SUBMERGED ASSEMBLY BOLTS

Assembly bolts for wood baffles, collectors, and other assemblies in areas where stainless steel anchor bolts would be required shall be stainless steel bolts Type 304 or 316.

05050.2.9 ANCHOR BOLTS AND INSERTS

Wherever feasible, anchor bolts shall be cast in place when concrete is placed.

All anchor bolts and concrete anchors embedded in concrete shall be accurately spaced with bolts truly normal to the surfaces from which they project. Type 304 or Type 316 stainless steel anchor bolts and nuts shall be used under these circumstances:

- Any time they are submerged in water.
- In the case of structures customarily containing water, placed in walls, ceilings, or overheads, even if above water level.
- In the dry side of water bearing walls.
- Where securing aluminum to steel or concrete.

Anchor bolts not required by above conditions to be of stainless steel, may be of carbon steel conforming to ASTM A 307 or ASTM A 36. Carbon steel anchor bolts in the following locations shall be hot-dip galvanized.

- Anchor bolts exposed to the weather.
- In electrical manholes or pull boxes.
- In tunnels, passageways, galleries, vaults, or rooms below grade or enclosed in part by water bearing walls.

In anchoring machinery bases subject to heavy vibration, two nuts shall be used, one serving as a locknut. In all cases where steel anchor bolts are used, a liberal coating of nonoxidizing wax shall be applied to the threads before screwing on nuts.

All bolts, when indicated for future use, shall be first coated thoroughly with nonoxidizing wax, followed by turning nuts down to the full depth of thread. Exposed thread shall then be neatly wrapped with a waterproof polyvinyl tape.

05050.2.10 INSTALLATION

Anchor bolts shall be embedded not less than 12 diameters. Where shown on the Plans, anchor bolts shall be set in metal sleeves having an inside diameter approximately 3 times the bolt diameter and not less than 12-bolt diameters in length. Sleeves shall be filled with grout when the machine or other equipment is grouted.

05050.2.11 CONCRETE ANCHORS

Concrete anchors, where indicated on the Plans or specified, shall mean drilled in place anchors with integral anchor bolts. Concrete anchors shall be Phillips "Wedge Anchors" with integral anchor bolts, or Expansion Products Company "Wej-It" concrete anchors with integral anchor bolts, or approved equal.

The material of each concrete anchor, including its integral anchor bolt, shall be the same material as would be required, under these Specifications, for anchor bolts in the same location that the concrete anchor is to be used.

Concrete anchors shall have the following minimum embedment lengths:

EMBEDMENT OF CONCRETE ANCHORS

Size	Embedment Length
3/8"	1-1/2"
½"	2-1/4"
5/8"	2-3/4"
¾"	3-1/4"

If Wej-It expansion anchors are used they shall have the following minimum embedment length:

WEJ-IT ANCHORS

Size	Embedment Length
¼"	1-1/2"
½"	5"
5/8"	5"
¾"	5"

Anchor bolts, of the same material and size as required for the specified concrete anchors, may be cast in the concrete in lieu of using concrete anchors. Embedment of bolts in concrete shall be not less than 12-bolt diameter plus a standard hook.

No cast iron, lead cinch, or slug-in anchors will be permitted for use.

05050.2.12 MISCELLANEOUS CAST IRON

All castings shall be tough, gray iron, free from cracks, holes, swells, and cold shuts, and be of workmanlike finish, and shall conform to the Standard Details and with the ASTM Specification Designation A 48, Class 40 B. The quality shall be such that a blow from a hammer will produce an indentation on a rectangular edge of the casting without flaking the metal. Before leaving the foundry, all castings shall be thoroughly cleaned and subjected to a hammer inspection, after which they shall receive a coating of coal-tar pitch varnish in such a manner as to form a firm, tenacious coating.

05050.2.13 MANHOLE FRAMES AND COVERS

Manhole frames and covers shall be made from a superior quality gray iron, conforming to the requirements of ASTM A 159, Class G3000, or ASTM A 48, Class 30-B. Frames and covers shall have horizontal and vertical bearing surfaces machined to fit neatly, and the cover shall bear firmly in the frame without rocking and shall be easily removable. Frames and covers shall be heavy-duty traffic type designed for H-20 loading and shall have a combined set weight of at least 265 pounds.

Frames shall have a clear inside opening of 24 inches diameter and shall be of the bottom flange type. Frame height shall be approximately 4½" and bottom flange outside diameter shall be approximately 32 inches.

Covers shall have a skid resistant grid pattern design as recommended ASTM publication STP326.

The elevations at which manhole frames and covers are to be set shall conform to the requirements set forth on the Plans, but in all cases shall be governed by the Engineer in the field. Where the cover is in existing pavement or in the traveled way of the existing road shoulder, it is to be placed flush with the existing surface. Where the structure is outside the limits of the traveled shoulder but not in the roadside ditch, it should be placed 1/10 foot or more above the existing ground surface. Where the manhole cover falls in the existing roadside ditch or right of way, it is to be placed approximately 1-1/2 feet above the existing ground surface or as directed by the Engineer. Manhole frames shall be set at the required grade and shall be securely attached to the top precast manhole shaft unit. After the frames are securely set in the place provided herein, covers shall be installed and all necessary cleaning and scraping of foreign materials from the frames and covers shall be accomplished to ensure a fine satisfactory fit. All costs of setting and securing manhole frame and cover sets in place as herein provided, including all necessary concrete work shall be considered as included in applicable contract unit prices and no additional allowance will be made therefor.

Cast lettering on manhole covers shall be as shown on the Plans. Shop drawings of all manhole rings and covers shall be submitted to the Engineer.

05050.2.14 CAST IRON PRESSURE MANHOLE FRAME AND COVER

The Contractor shall furnish and install, ready for use as indicated on the Plans and as specified herein, rectangular pressure manholes and covers. Each pressure manhole shall have a clear opening of 18" X 30". The pressure plate shall be flat on top and shall not be less than 1/2 inch thick steel and fastened with 316 stainless steel studs and stainless steel nuts. A 1/8-inch thick neoprene gasket shall be supplied between the frame and pressure plate. Lifting shall be provided with a watertight pickhole. The frame shall be a seal-type with flanges at the base and at the top.

05050.2.15 MISCELLANEOUS ALUMINUM

Structural and other metal items fabricated from aluminum, not covered separately herein shall be fabricated in accordance with the best practices of the trade and shall be field assembled by riveting or bolting with no welding or flame cutting permitted except as approved by the Engineer.

05050.2.16 ALUMINUM STAIR NOSING

Stair nosings shall be installed on all treads of all concrete stairs including the top tread of the upper slab. Stair nosings shall be aluminum abrasive cast nosings with aluminum oxide granules integrally cast into the metal forming a permanent nonslip long wearing surface. The nosings shall be Type 101 Stair Tread by Wooster Products, Inc., Spruce Street, Wooster, Ohio 44691, Type A stair treads by American Abrasive Metals Company, or approved equal. The treads shall have integrally cast anchors. Stair nosings shall be cast in fresh concrete and shall be flush with the tread and riser faces. Stair nosing shall be coated with zinc chromate primer in accordance with the provisions of Division 9. Screws shall be 304 or 316 stainless steel.

05050.2.17 MANHOLE STEPS

Manhole steps shall consist of 3/4-inch diameter stainless steel or polyethylene rungs. Rungs shall extend 7-inches from the face of the wall to which they are anchored and shall have a minimum clear width of 16-inches. Rungs shall be designed such that the foot cannot slide off the end. Distance between rungs shall be 12-inches. Rungs shall be hook anchored into walls a minimum of 6-inches.

05050.3 CONSTRUCTION REQUIREMENTS

Not used.

05050.4 METHOD OF MEASUREMENT

Not used.

05050.5 BASIS OF PAYMENT

Not used

08122.1 DESCRIPTION

The Contractor shall furnish and install embedded access hatches and associated fittings in designated structures in accordance with the Drawings and these Specifications.

08122.1.1 RELATED WORK

MAG Section 505 – Concrete Structure

08122.1.2 SUBMITTALS

08122.1.2.1 DESCRIPTIVE LITERATURE - Descriptive literature which identifies the manufacturer, model number, size and materials of fabrication for all equipment and materials furnished under this section shall be provided by the Drawings in accordance with Section 01300 of these Specifications.

08122.1.2.2 CERTIFICATION OF COMPLIANCE - Certification of compliance with the standards and Specifications contained herein shall be obtained from the manufacturer and provided by the Contractor at the time of delivery of these materials to the project site.

08122.1.3 DEFINITIONS

Not used

08122.2 MATERIALS

08122.2.1 QUALITY CONTROL

This specification is not intended to be exclusive or limit competition, but rather to set forth the minimum standards for quality and performance. The Owner reserves the right to reject substitutions if in his opinion, the proposed substitutions will not achieve comparable equipment installation and performance standards.

08122.2.2 HATCH

The embedded access hatch shall be as manufactured by the Bilco Company, or approved equal. The model number or type shall be shown on the Drawings, but as a minimum shall be equal to a Type J-AL or Type JD-AL, as applicable. Frame shall be ¼" extruded aluminum with built-in neoprene cushion and with strap anchors bolted to exterior. Door leaf shall be ¼" aluminum diamond plate reinforced with aluminum stiffeners as required. Stainless steel 316 hinges shall be bolted to underside along with compression spring operators enclosed telescopic tubes lift assistance. The door shall open to 90 degrees with automatic hold-open arm with release handle that automatically locks cover in the open position. A vinyl grip handle shall be provided to release the cover for closing. Doors shall be built to withstand a live load of 300 pounds per square foot and equipped with a snap lock and removable handle or be H-20 traffic rated where called for in the plans. Aluminum shall be mill finish, with bituminous coating to be applied to exterior of frame by manufacturer.

08122.2.3 HARDWARE

Hardware shall be type 316 stainless steel throughout. Installation shall be in accordance with manufacturer's instructions. Manufacturer shall guarantee against defects in material or workmanship for a period of five years.

08122.3 CONSTRUCTION REQUIREMENTS

The Contractor shall install all equipment and components under this section in accordance with the manufacturer's installation instructions, the Drawings and these Specifications. Where instructions are unavailable or unnecessary, the Contractor shall at all times use good workmanship practices, applicable building codes, and regulations. The Contractor shall supply and install all miscellaneous fittings required to provide a complete operating system or component, as applicable.

08122.4 METHOD OF MEASUREMENT

08122.4.1 NO MEASUREMENT

Unless a separate bid item for furnishing and installing the work outlined in this Section is provided in the Bid Schedule, this work shall not be measured for separate payment, but shall be considered incidental to other items in the Bid Schedule.

08122.4.2 SEPARATE MEASUREMENT

Where items installed under this section are listed separately in the Bid Schedule, the items shall be measured by counting the number of units installed and accepted.

08122.5 BASIS OF PAYMENT

Complete compensation for the accepted work outlined in this Section shall be included in other bid items when no separate bid item is provided in the Bid Schedule for this work.

When a separate bid item is provided in the Bid Schedule, complete compensation for this accepted work shall be included in the contract unit price on the Bid Schedule.

PAY ITEM	UNIT
Embedded Access Hatch (*Type*)	Each

09910.1 DESCRIPTION

The Contractor shall furnish all labor, materials and equipment necessary to paint all designated components of buildings, piping and equipment in accordance with these Specifications.

09910.1.1 RELATED WORK

Not used.

09910.1.2 SUBMITTALS

09910.1.2.1 DESCRIPTIVE LITERATURE - Descriptive literature identifying manufacturer, type, content, application recommendations, and color samples, shall be provided in accordance with Section 01300 of these Specifications.

09910.1.2.2 DATA FOR PAINT APPROVAL - Complete data on each type and kind of paint and primer shall be submitted to the Engineer for approval. Approval shall be received from the Engineer before the paint is delivered to the jobsite. This procedure must be followed whether or not the paint that the Contractor proposes to use is named in the Specifications. Approval data shall show where and for what uses each paint product is proposed. Information submitted on each proposed type and kind of paint shall include data to show that the paint meets the detailed requirements of these Specifications.

09910.1.2.3 SAMPLES - The Contractor shall prepare and submit sample colors for all items which require color selection by the Engineer. No color selection will be made until all samples of all paints have been submitted. After all samples of all paints have been submitted, the Engineer will prepare a color scheme using the submitted colors. Colors will not necessarily be standard colors with all suppliers. The manufacturer shall mix colors, to secure the desired color when it is not one of his standard colors.

09910.1.2.4 SAND BLAST PANELS - The Contractor, at the beginning of the Project, shall furnish one square foot steel panels sandblasted in accordance with the sandblasting specifications and coated with non-yellowing shellac or clear non-yellowing plastic coating. Panels shall be used as the standards for preparation of steel surfaces for the duration of the project.

09910.1.2.5 PAINT REMNANT - At the end of the project, the Contractor shall turn over to the Owner a gallon can of each type and color of paint, primer, thinner, or other coating used in the field painting. If the manufacturer packages the material concerned in gallon cans, then it shall be delivered in unopened labeled cans as it comes from the factory. If the manufacturer does not package the material in gallon cans, and in the case of special colors, the materials shall be delivered in new gallon containers, properly closed with typed labels indicating brand, type, color, etc. The manufacturers' literature describing the materials and giving directions for their use

shall be furnished in three bound copies. A typewritten inventory list shall be furnished at the time of delivery.

09910.1.3 DEFINITIONS

Submerged Surfaces - In general, items shall be treated as submerged if they are to be at any time under water or are in structures that normally contain water. Unless specified otherwise, anything below the tops of the walls of such structures shall be considered as submerged.

09910.2 MATERIALS

09910.2.1 QUALITY CONTROL

This Specification is not intended to be exclusive or limit competition, but rather to set forth the minimum standards for quality and performance. The Owner reserves the right to reject substitutions if in his opinion, the proposed substitutions will not achieve comparable equipment installation and performance standards.

09910.2.2 COLOR

The Engineer will make color selection from color samples provided by the Contractor.

09910.2.3 PAINT SELECTION

All paint and coating systems shall include high quality materials, resistant to temperatures up to 130°F, and sunlight exposure. Paints selected shall meet the manufacturer's recommendations and suitability standards for the specific application where it will be used.

09910.2.3.1 MINIMUM REQUIREMENTS - Minimum requirements for paint materials and their application shall be as shown in the tables below:

EXTERIOR PAINT APPLICATION TABLE

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
Wood Siding, Trim, Doors, and Fencing	1 2 1 2	A-100 Exterior Alkyd Wood Primer A-100 Exterior Latex Flat House & Trim by Sherwin Williams - OR - SUPRIME 8 Exterior Pro-Hide Plus Latex Satin House	2.3 1.3 1.3 1.3

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
	1 2	by Pratt & Lambert- OR - System 2H-4 Alkyd by Tnemec Tnemec Series 10-99W Undercoater 2H-Color Hi-Build Tnemec Gloss	2.5 2.5
Porous Masonry (Block)	2	Tnemec Series 180 WB TnemeCrete	4-8
Concrete Walls, Above Grade	1 2 2 2	Loxon Ext. Masonry Acrylic Primer A-100 Exterior Latex Satin House & Trim by Sherwin Williams -OR - Pro-Hide Plus Latex Satin House by Pratt & Lambert – OR – Series 1029 Acrylic Latex Low Sheen by Tnemec	3.1 1.3 1.3 2.5
Metal (Aluminum)	2 1 2 1 1 1	A-100 Exterior Latex Satin House & Trim by Sherwin Williams - OR - SUPRIME 3 Latex Metal Primer Pro-Hide Plus Latex Satin House by Pratt & Lambert – OR – DEFLEX 4020 Primer DEFLEX 4206 S/G Waterborne Acrylic Enamel by DeVoe Tnemec Series 115 Unibond	1.3 1.3 1.3 3 1.5 2-3
Metal, New Steel, (Mild Service)	1 2 1 2 1 1 2 1 1	Kem Kromik Universal Metal Primer Direct to Metal Enamel by Sherwin Williams - OR - SUPRIME 3 Latex Metal Primer Pro-Hide Plus Latex Satin House by Pratt & Lambert – OR – Devguard 4160 Primer followed by Devguard 4308 Alkyd Enamel or DEFLEX 4218 DTM Enamel by DeVoe Tnemec Series 115 Unibond Tnemec Series 1029 Enduratone	2.5 3.0 1.3 1.3 2 2 2 2-4 2-3
Metal, New Steel, (Severe Service)	1 1	Series 27 WB Typoxy by Tnemec 73-Color Endura-Shield	4 2
Metal, Galvanized Steel, (Mild	1 2	Galvite HS A-100 Exterior Latex Satin House	2.0 1.3

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
Service)		& Trim by Sherwin Williams -OR -	
	1	SUPRIME 2 Latex Metal Primer	1.3
	2	Pro-Hide Plus Latex Satin House by Pratt & Lambert – OR –	1.3
	1	Devguard 4020 Primer	3
	2	DEFLEX 4206 S/G Waterborne Acrylic Enamel by DeVoe	1.5
	1	Tnemec Series 115 Unibond	2-4
	1	Tnemec Series 1029 Enduratone	2-3
Metal, Galvanized Steel, (Severe Service)	1	Series 27 WB Typoxy by Tnemec	4
	1	Series 10 Primer by Tnemec	2
PVC Pipe		System 66-23 Epoxy Polyamide by Tnemec	
	1	66-Color Hi-Build Epoxoline	4

INTERIOR PAINT APPLICATION TABLE

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
Woodwork	1	ProMar 200 Alkyd Enamel	1.9
	2	Undercoater ProMar 200 Int Alkyd Semi-Gloss by Sherwin	1.7
	1	Williams-OR	1.5
	2	SUPRIME 11 Int Alkyd Wood Primer	1.5
Woodwork Continued	1	Pro-Hyde Plus Alkyd Satin by Pratt & Lambert – OR –	2.5
	2	Tnemec Series 10-99W Tnemec Primers Tnemec 2H-Color Hi-Build Tnemec Gloss	2-3
Drywall	1	ProMar 200 Latex Wall Primer	2.5
	2	ProMar 200 Int Alkyd Semi-Gloss by Sherwin Williams - OR -	1.8
	1	SUPRIME 1 100% Acrylic MP	1.1
	2	Primer	1.5
	2	Pro-Hyde Plus Latex Satin by Pratt & Lambert – OR – Tnemec Series 1029 Enduratone	2-3

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
Metal (Aluminum)	1	SUPRIME 9 Int/Ext Alkyd Metal Primer	1.1
	2	Pro-Hyde Plus Alkyd Satin by Pratt & Lambert – OR –	1.5
	1	DEFLEX 4020 Primer	3
	1	DEFLEX 4206 Semi-Gloss Waterborne Acrylic Enamel	1.5
	1	Tnemec Series 115 Unibond	2-4
	1	Tnemec Series 1029 Enduratone	2-3
Metal, New Steel, (Mild Service)	1	Kem Kromik Universal Metal Primer	2.5
	2	ProMar 200 Int Alkyd Semi-Gloss by Sherwin Williams - OR -	1.7
	1	SUPRIME 9 Int/Ext Alkyd Metal Primer Pro-Hyde Plus Alkyd Satin by Pratt & Lambert – OR –	1.1
	2	Devguard 4160 Primer followed by Devguard 4308 Alkyd Enamel or	1.5
	1	DEFLEX 4218 DTM Enamel by DeVoe	2
	1	Tnemec Series 115 Unibond	2.5
	2	Tnemec Series 1029 Enduratone	2
	1		2-4
	1		2-3
Metal, New Steel, (Severe Service)	1	Tnemec Series 66-1211 Epoxoline Primer	3-5
	1	Tnemec Series 66 Color Hi-Build Epoxoline	4-6
Metal, Galvanized Steel, (Mild Service)	1	Galvite Paint	2.0
	2	ProMar 200 Int Alkyd Semi-Gloss by Sherwin Williams - OR -	1.8
	1	SUPRIME 9 Int/Ext Alkyd Metal Primer Pro-Hyde Plus Alkyd Satin by Pratt & Lambert – OR –	1.1
	2	Devguard 4020 Primer	1.5
	1	DEFLEX 4206 S/G Waterborne Acrylic Enamel by DeVoe	3
	2	Tnemec Series 115 Unibond	1.5
	1	Tnemec Series 1029 Enduratone	2-4
	1		2-3
Metal, Galvanized Steel, (Severe Service)	1	Tnemec Series 66-1211 Epoxoline Primer	3-5
	1	Tnemec Series 66-Color Hi-Build Epoxoline	4-6

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
Ductile Iron (DI) Pipe and fittings	1 2 1 1 2 1 1	SUPRIME 9 Int/Ext Alkyd Metal Primer Pro-Hyde Plus Alkyd Satin by Pratt & Lambert – OR – Devguard 4160 Primer followed by Devguard 4308 Alkyd Enamel or DEFLEX 4218 DTM Enamel by DeVoe Tnemec Series 115 Unibond Tnemec Series 1029 Enduratone	1.1 1.5 2 2.5 2 2-4 2-3
PVC Pipe (Mild Service, Interior Only)	2	Tnemec Series 1029 Enduratone	2-3
PVC Pipe (Severe Service)	1	System 66-23 Epoxy Polyamide by Tnemec 66-Color Hi-Build Epoxoline	4
Concrete Walls and Ceilings (Mild Service)	1 2 1 2 1	ProMar 200 Latex Wall Primer ProMar 200 Int Alkyd Semi-Gloss by Sherwin Williams - OR - SUPRIME 4 Latex Wall Primer Pro-Hyde Plus Latex Satin by Pratt & Lambert Tnemec Series 1029 Enduratone	1.1 1.3 1.2 1.5 2-3
Concrete Walls and Ceilings (Severe Service)	2	Tnemec Series N69 Hi-Build Epoxoline II	4-6
Porous Masonry Walls (Mild Service)	 1 2 1 2	Pre-Prime 167 by Devoe ProMar 200 Latex Wall Primer ProMar 200 Int Alkyd Semi-Gloss by Sherwin Williams - OR - SUPRIME 4 Latex Wall Primer Pro-Hyde Plus Latex Satin by Pratt & Lambert	1.5 1.1 1.3 1.2 1.5
Porous Masonry Walls (Severe Service)	1 2	Tnemec Series 1254 Epoxoblock Tnemec Series N69 Hi-Build Epoxoline II	 75-100 sf/gallon 4-6
Concrete Floors (Mild Service)	1 1 2	Pre-Prime 167 by Devoe Concrete and Terrazzo Sealer (ANCO Cure and Hard by Intermountain Concrete Specialties. Industrial Enamel by Sherwin	1.5 None 2

Application Substrate	No. of Coats	Paint Materials and Manufacturer*	Coating Thickness (Mils Per Coat)
	2 2 2	Williams - OR - With STAND Alkyd Floor Enamel by Pratt & Lambert – OR – Devguard 4328 Alkyd Enamel by DeVoe Tnemec Series 205 TerraTread	1 2 3-5
Concrete Floors (Severe or Mild Service)	2	Tnemec Series 280 TnemeGloss	6-8

*Brand names of materials have been used to indicate the types and quantities of materials required. Approved equals will be accepted.

09910.2.3.2 PAINT FOR WASTEWATER SYSTEMS - All paint for concrete and metal surfaces in wastewater systems shall be especially adapted for such use.

- Fume Resistance. All paint for final coats shall be fume resistant, compounded with pigments suitable for exposure to sewage gases, especially to hydrogen sulfide and to carbon dioxide. Pigments shall be materials, which do not tend to darken, discolor, or fade due to the action of sewage gases. If a paint manufacturer proposes use of paint which is not designated "fume resistant" in its literature, it shall furnish full information concerning the pigments used in this paint.
- Interior coating for metal pipes shall be Novocoat SP-2000W by ErgonArmor or Series 431 Perma-Shield PL by Tnemec. Installation shall be per the manufacturer recommendation and shall include any required primers or under coatings.
- Buried exterior piping shall coated with a bituminous coat, 4 mils minimum dry film thickness

- Lead Paint. No lead paints shall be used.

09910.2.3.3 PAINT FOR POTABLE WATER SYSTEMS - All paint systems to be used in potable water service shall meet NSF requirements. See also Subsection 09910.2.3.4 below.

09910.2.3.4 PAINT FOR SUBMERGED SURFACES

- Coal Tar Epoxy. Coal tar epoxy shall meet and conform with Government Specification Mil P-23236 with further qualification that the coal tar epoxy

manufacturer and product must be listed on the current U.S. Navy Qualified Products List. Coal tar epoxy shall be subject to the Engineer's approval.

- Alternate Systems. Alternate coating systems for submerged service, such as Tnemec Series 141Epoxy Polyamide Epoxoline by Tnemec, Epoxy Bar Rust 233H, by DeVoe, or equal, may be required for some applications, or may be approved in lieu of coal tar by the Engineer, upon request. Some colors of Epoxy Polyamide Epoxoline, or equal may be acceptable for use in potable water systems, however the manufacturer must be consulted for verification of acceptability prior to use in potable water applications.

- Submerged DIP that come into contact with the potable water process must be painted with Tnemec Pota-Pox Plus Series N140 or approved equal. This includes all submerged DIP in the surface water tank, floc tank, treated water tank, FEQ tank, recovery clarifier, recovery clarifier lift station and any other process that has the ability to come into contact with the potable water process. The surfaces shall be prepped and painted according to manufacturer's recommendation. The DIP shall be coated according to manufacturer's recommendation with a minimum of 2 coats.

09910.2.3.5 HIGH TEMPERATURE SURFACE TO 400°F - Paint for high temperature surfaces shall be DeVoe Hi-Heat Aluminum HT-4, Glidden 592 Metallite Aluminum, or Sherwin-Williams Silver-Brite Heat resisting aluminum paint B59 S1, or approved equal.

09910.2.4 CLEANING MATERIALS

Cleaning materials shall be best quality solvents, chemicals or detergents, which are commercially prepared for preparing painted surfaces and delivered to the site in sealed containers bearing an identifying label and the manufacturer's name.

09910.2.5 STEEL HAND RAILING

Steel hand railing shall be painted according to the manufacturers recommendation according to the following application.

Surface Preparation:
SSPC SP3 Power Tool Cleaning

Prime Coat:
Tnemec Series 135 Chembuild (or approved equal); 1 coat; 3-4 mils DFT

Finish Coat:
Tnemec Series 1026 Enduratone (or approved equal); 1 coat; 2-3 mils DFT

09910.3 APPLICATION REQUIREMENTS

ALL paint and coating systems shall be applied in strict accordance with the manufacturer's published instructions for use.

09910.3.1 SURFACE PREPARATION

09910.3.1.1 CLEANING - All surfaces to be painted shall be clean and dry except that in some cases the paint manufacturer's directions may require wetting the surface before painting. Grease and oil shall be removed by wiping with mineral spirits or naphtha per Specification SP-1. Rust, scale, welding slag, and spatter shall be removed and the surface prepared by hand tool cleaning, power tool cleaning, or blast cleaning in accordance with the appropriate Specification SP-2 through SP-10.

09910.3.1.2 METAL SURFACES - Except as otherwise provided, all preparation of metal surfaces shall be in accordance with Specifications SP-1 through SP-10 of the Steel Structures Painting Council (SSPC). Sandblasting procedures shall be as follows:

- No surface, which is to be sandblasted, shall be given a coat of primer or paint in the shop or in the field before sandblasting.

- Unless otherwise specified, all iron or steel surfaces which are to be painted as submerged metal shall be dry sandblasted on the site in accordance with Specification SP-10, near white blast cleaning.

- Except as otherwise specified, all metal surfaces, which are to be painted as non-submerged metal, shall be commercial blast cleaned per Specification SP-6. This sandblasting shall be done not more than 12 hours ahead of the painting, subject to humidity and weather conditions between the time of sandblasting and painting operations. If any rusting of sandblasted surfaces occurs before painting, such rusting shall be removed by additional sandblasting.

- Threaded portions of valve and gate stems, machined surfaces intended for sliding contact, surfaces to be assembled against gaskets, surfaces of shafts for sprockets or to fit into bearings, machined surfaces of bronze trim on slide gates, and similar surfaces shall be masked off to protect them from the sandblasting of adjacent surfaces.

- Cadmium-plated or galvanized items shall not be sandblasted except that cadmium plated, zinc-plated, or sheradized fasteners used in assembly of equipment to be sandblasted shall be sandblasted in the same manner as the other metal.

- Surfaces which cannot be sandblasted, or cannot be sandblasted and then painted after the assembly of which they are a part has been completed and placed in final position, shall be sandblasted, or sandblasted and painted, before the items are put into final position. In some cases, while the painting could be done after the items concerned were in place, the limitation on time between

sandblasting and painting may make it necessary to paint the surfaces before installation of those items.

- Sand or other media residue from sandblasting operations shall be thoroughly removed, using any method necessary and consistent with the requirements of the painting system, including vacuum cleaners or other means.

09910.3.1.3 GALVANIZED SURFACES - Galvanized surfaces which are to be painted shall first be treated with Koppers No. 40 Metal Conditioner; Amercoat No. 59 as manufactured by Amercoat Corporation, Brea, California; Galvaprep No. 5 as manufactured by Amchem Products, Fremont, California; or approved equal.

09910.3.1.4 CONCRETE SURFACES - Concrete and masonry surfaces shall be free of dust, mortar droppings and spatter, fins, loose concrete particles, form release materials, oil, grease, and other deleterious materials. If required by the coating manufacturer, such surfaces shall be etched as specified below or brush off blast cleaned per ICRI CSP 3=6.

Concrete surfaces specified to be acid etched shall be etched with a 15 to 20 percent solution of muriatic or sulfamic acid until the surface has the texture of find sandpaper. The surface shall then be thoroughly scrubbed with clean water, rinsed, and allowed to dry.

09910.3.1.5 WOOD SURFACES - Wood shall be cleaned and dusted immediately prior to painting. Final dusting shall be accomplished using tack cloth. Shelves, drawers, benches, and associated woodwork shall be sanded before painting and lightly sanded between coats. Prior to application of each coat, the surfaces shall be again dusted with tack cloth to remove all dust.

09910.3.1.6 BITUMINOUS PAINTED SURFACES - Surfaces, which are to be painted with other than bituminous paint, and which have a bituminous coating (such as coal tar varnished pipe), shall be sealed with not less than 2 coats of Inertol Tar Stop; Sherwin-Williams Metalatex B42W100; Glidden Insulcap as manufactured by the Glidden Company; or approved equal. This seal coating shall be applied in sufficient quantity to permanently prevent bleeding of the bituminous coating.

09910.3.1.7 HIGH TEMPERATURE SURFACES - In general, high temperature paint shall be applied to exposed (un-insulated) steam line valves and traps, heat exchangers, and miscellaneous metal piping and equipment in piping and mechanical systems exposed to high temperatures. The Contractor shall paint these surfaces with two coats of high temperature paint as specified herein or as otherwise shown or directed. No painting shall be done on surfaces with a temperature in excess of 125 degrees F at the time of application. Immediately before application of the first coat of paint, the surface shall be sandblasted according to SSPC-SP-5 (Blast Cleaning to "white" metal). See also Subsection 09910.3.1.2 above.

09910.3.1.8 THINNING - No thinning of paint other than as directed by the manufacturer's published directions shall be done without the approval of the Engineer. No painting shall be done under conditions, which, in the opinion of the Engineer, will jeopardize the appearance of quality of the painting in any way.

09910.3.1.9 TINTING OF FIRST COAT - When two coats of the same material are specified, the first coat applied shall be tinted with aluminum powder, lampblack, or other suitable pigment to distinguish it from the top coat.

09910.3.1.10 BETWEEN-COATS TREATMENT - All painted surfaces shall be dusted between coats, and high gloss finish shall be lightly sanded and dusted between coats unless otherwise directed by the manufacturer.

09910.3.2 PAINT APPLICATION

09910.3.2.1 PAINTER QUALIFICATIONS - Contractor or subcontractor personnel applying the coating system shall have had past experience in application of the type or types of coatings and under similar conditions that it will be required to meet in this contract. The qualifications of personnel applying the coating system, whether Contractor or subcontractor shall be verified by the Contractor prior to allowing application to proceed. The Contractor shall not subcontract paint application to a subcontractor that is not qualified to apply the coating system.

09910.3.2.2 WEATHER CONDITONS - No painting shall be done under dusty conditions, during or immediately after a rain, during rainy weather, or when the temperature is less than 50°F.

09910.3.2.3 GENERAL REQUIREMENTS FOR APPLICATION OF PAINT – These requirements shall be as follows:

- All work shall be done in a workmanlike manner, leaving the finished surfaces free from drops, ridges, waves, holidays, laps, or brush marks.
- Where possible, prime coats shall be applied by brush and well worked into the surface, unless directed otherwise by the paint manufacturer.
- Other paints may be applied by brush, roller, trowel, or spray, unless manufacturer's recommendations or these Specifications require a particular method of application.
- Primer and intermediate coats of paint shall be un-scarred and completely integral at the time of application of each succeeding coat.
- Each coat shall be subject to the inspection and approval of the Engineer before the next succeeding coat is applied, and defective work of any kind shall be deemed sufficient cause for re-coating the entire surface involved.

- Where spray application is used, each coat of paint shall be applied to a thickness equivalent to a brush coat application at a coverage rate not greater than that specified by the manufacturer for a brush coat application. All spray painting shall be done with airless type spray units.

- The time interval between paint coats shall meet the recommendations of the paint manufacturer, and these Specifications. The Contractor shall not allow excessive time or exposure between coats, where such excessive time or exposure will impair the bond between the coats.

- The number of coats specified in these Specifications is the minimum to be applied. Suction spots between coats shall be touched up, and additional coats shall be provided if required to produce a finished surface with a solid, even color free from defects.

- The total thickness of the coating shall be as specified. Additional coats of paint shall be added if necessary to bring the total thickness up to not less than that specified. For control, the Contractor shall determine the dry film thickness of the coatings on metal surfaces with a correctly calibrated thickness meter. The Contractor also shall check for holidays with a low voltage holiday detector. The Engineer may use the Contractor's meter and detector for additional inspection and checking deemed necessary.

- Particular care shall be used to assure that the specified coverage is secured on the edges and corners of all surfaces. Additional brush coats shall be applied if necessary to ensure coverage of the edges and corners.

- Damaged paint or scratched painted surfaces shall be sanded smooth before repainting. Sanding and repainting shall be done to such a degree and in such a manner that all evidence of the scratches or damages is obscured.

09910.3.2.4 COAL TAR EPOXY – Application of coal tar epoxy shall be as follows:

- Where called for in the Painting Schedule, shown on the Drawings, or required in these Specifications, concrete and some other submerged surfaces shall be coated with not less than two coats of coal tar epoxy.

- Structures to be coated are as follows:

  a) Surface Water Flow Meter Vault
  b) Static Mixer Vault
  c) Reuse Flow Meter Vault
  d) Sewer Flow Meter Vault
  e) Main Lift Station Dry Pit
  f) 4" ARV Assembly Vault

- Only components from new, previously unopened containers shall be used to mix coal tar epoxy coatings. Coal tar epoxy shall be mixed and applied in accordance with the manufacturer's recommendations. All coating components shall be mixed with power mixers. The time during pouring or stirring will not be allowed as mixing time. The minimum mixing time as recommended by the manufacturer shall be met. Only unit quantities shall be mixed.

- Coal tar epoxy shall be applied to a total dry film thickness of not less than 16 mils.

- Some metal surfaces may require sandblasting prior to application of the coating system. See Subsection 09910.3.1.2 above.

- In some cases it may also be necessary to apply coatings to parts or subassembly surfaces before they are actually installed at their final Project or system location. All support brackets, stem guides, pipe clips, fasteners, etc. that are bolted to concrete shall be painted on all sides.

- Application of coal tar epoxy shall be performed only at the job site unless specific approval is granted for offsite application. Offsite application will not be allowed unless by an applicator with acceptable proven and documented experience in the application of coal tar epoxy systems.

- Each succeeding coat shall be applied over the previous coat as soon as possible in accordance with the manufacturer's instructions, without causing sagging. Succeeding coats shall not be delayed longer than allowed by the manufacturer's instructions. In no case shall the application of subsequent coats be made after the previous coat has set or oxidized. All coats, and the full thickness on all parts, shall be applied before the previous coat has cured. The Contractor shall check the film thickness after application, and before the coating has cured, to ensure that sufficient coating thickness has been applied. If additional coating is necessary, it shall be applied the same day. Checking and control of thickness at this stage shall be the Contractor's obligation and responsibility and not the Engineer's.

- If the surface coating has been applied for a longer period of time than the limits in the Table below, and if it is found that bituminous paint has not been applied to the specified thickness, the areas that are too thin shall be sandblasted to remove the surface film from the coating. These sandblasted areas shall then be washed and cleaned with the solvent recommended by the manufacturer and shall be re-coated within the time limits specified for coating over fresh bituminous paint. Washing or cleaning the surface of the paint with solvents or other solutions will not be a satisfactory substitute for the specified sandblasting if the painted surface is older than the time limits indicated in the table. This applies even if the paint manufacturer approves the solvent method as adequate for preparing the old surface.

TEMPERATURES AND COATING TIMES

Average Temperature	Maximum Time Between Coats
50 - 60° F	36 hours
60 - 70° F	24 hours
70 - 80° F	12 hours
80 - 120° F	4 hours

Coal tar epoxy shall not be applied when the ambient temperature is less than 50 degrees.

09910.3.2.5 EDGES AND CORNERS - The Contractor is hereby CAUTIONED that the edges and corners of members are difficult places upon which to build the required thickness of paint. The required thickness must be applied to all surfaces, including the corners and edges, by applying as many spray coats as necessary or by additional brush coats on the corners and edges, if necessary, in order to build up the required thickness.

09910.3.3 FINISH SCHEDULE

The Contractor shall finish all work as follows unless indicated otherwise on the Drawings or within these Specifications:

TABLE OF FINISH SCHEDULES

NO FINISH	FACTORY FINISH	SITE FINISH
Stainless Steel Surfaces	Heating Units	Interior Concrete Building Floors and Walls
Polished Aluminum Surfaces	Electric Control Panel Cabinets	Interior Building Walls & Ceiling
Name Plates	Cranes & Hoists	All Interior and Exterior Exposed Piping, Valves & Pipe Supports
Exterior Concrete	Gauges and Meters	Exposed Electrical Conduit & Junction Boxes
Exterior Masonry Surfaces	Instruments	Entry Doors and Frames
Exposed Plastic Pipe & Fittings	Light Fixtures and Cover Plates	Wood Moldings and Trim
Warning Labels	Electrical Wiring & Transformers	Other Exterior Surfaces Indicated on drawings
Operating Instructions	Ventilating Fans	Sludge Clarifier Equipment
Gratings	Dampers	GAC Units
Ladders	Air Conditioning Units	Bollards
Stairs	Metal Soffit & Fascia Covering	
Buried or Encased Pipe	Roofing and Siding	
	Roll-Up Overhead Doors	
	Motors, Pumps, Equipment	
	Chain Link Fencing	

09910.3.4 CLEANUP

Upon completion of painting, the Contractor shall remove all masking and protective covers and properly dispose of all rubbish, debris and unused paint materials. The Contractor shall remove and cleanup all paint overspray, drips, spatters and etc. from any and all surfaces where it does not belong.

09910.4 METHOD OF MEASUREMENT

09910.4.1 NO MEASUREMENT

Separate measurement for Painting will not be made when painting is included as part of an item, building or structure listed in the Bid Schedule.

09910.4.2 SEPARATE MEASUREMENT

Separate measurement for Painting will be made as a Lump Sum when painting is listed as a separate item in the Bid Schedule.

09910.5 BASIS OF PAYMENT

When Painting is included as part of the measurement of another item, structure or building listed in the Bid Schedule, separate payment will not be made.

When Painting is required for a specific item, the accepted quantity will be paid for at the contract unit price for:

PAY ITEM	**UNIT**
Paint *(Item Description)*	Lump Sum

10420.1 DESCRIPTION

The Contractor shall furnish and install steel safety and hand railings and their supporting frames and/or hardware in buildings or other structures at locations shown on the Drawings and as required by these Specifications.

10420.1.1 RELATED WORK

Not used.

10420.1.2 SUBMITTALS

10420.1.2.1 DESCRIPTIVE INFORMATION - The Contractor shall provide descriptive information which shows detailed dimensions of rails and posts, material composition, details of fittings or anchors required for fastening, finishing, manufacturer's name, loading bearing capacity and manufacturer's installation instructions in accordance with the requirements of Section 01300.

10420.1.2.2 CERTIFICATION OF COMPLIANCE - Certification of compliance to the standards and Specifications contained herein shall be obtained from the manufacturer and provided by the Contractor at the time of delivery of these materials to the project site.

10420.1.2.3 EVIDENCE OF STANDARDS - Evidence of these materials complying with applicable industrial safety standards shall be provided. In cases where a potential exists for the railing to serve public access, compliance with the Uniform Federal Accessibility Standards shall be required.

110420.1.3 DEFINITIONS

Not used.

10420.2 MATERIALS

10420.2.1 QUALITY CONTROL

This specification is not intended to be exclusive or limit competition, but rather to set forth the minimum standards for quality and performance. The Engineer reserves the right to reject substitutions if in his opinion, the proposed substitutions will not achieve comparable equipment installation and performance standards.

10420.2.2 FEDERAL SAFETY STANDARDS

The railings system shall comply with minimum Federal safety standards.

10420.2.3 HANDRAIL SYSTEMS

10420.2.3.1 MANUFACTURE - Steel pipe handrail systems shall be by R. B. Wagner, Inc., or approved equal. One manufacturer shall supply all railings of each specific type used on the project.

10420.2.3.2 COMPOSITION - The steel tubing handrail system shall be carbon steel, galvanized steel, or stainless steel, as required on the Drawings, and shall be round or square configuration as shown. Handrail components, including tubing, posts and support fittings, shall be specifically manufactured for handrail installation. Round tubing shall have a minimum outside diameter of 1.90-inches and the minimum wall thickness of handrail material shall be 0.145-inches. All posts shall be single unspliced lengths.

10420.2.3.3 TOE BOARDS - The handrail system shall include toe boards on all open sides of walkways or platforms where a person can pass beneath the walkway or platform, where there is moving machinery or where there is equipment with which falling material could create a hazard.

Toe boards shall be 4-inches nominal in vertical height from top edge to level of the floor or walkway. They shall be securely fastened in place with not more than 1/4-inch clearance above floor level.

10420.2.3.4 FINISH - Stainless steel and hot dipped galvanized handrail systems shall have no factory-applied coatings, and stainless-steel railings shall have a satin finish.

10420.2.3.5 HARDWARE - Mounting anchors and all fasteners shall be stainless steel, unless otherwise approved by the Engineer.

10420.2.4 GATE MATERIALS

Handrail system gate materials, quality, design and workmanship shall be similar to the railing, and shall be designed as part of the railing system. Hinges shall be installed so that each gate can swing 180 degrees from the closed position to the fully open position. Gates shall swing to the walkway side of the handrail only. Gate stops shall be installed on the stationary railing posts to prohibit gates from swinging the wrong direction. Latch assemblies shall be of a durable self-locking type. Construction and installation of each gate frame, hinges, gate stops and latch shall conform to OSHA minimum strength requirements. Gate closing springs shall be stainless steel.

10420.3 CONSTRUCTION REQUIREMENTS

The Contractor shall install handrails, as shown on the Drawings, in strict accordance with the manufacturer's installation instructions.

10420.3.1 WORKMANSHIP AND PROTECTION OF SYSTEM

The Contractor shall use all precautions necessary to protect the handrail system from damage until final acceptance.

10420.3.2 ASSEMBLY AND INSTALLATION

10420.3.2.1 HANDRAIL SYSTEMS – Procedure shall be as follows:

- All pipe cuts shall be square, clean, straight, and accurate. Welds shall be ground smooth and finished to provide an uninterrupted surface without burrs or nicks.
- Spans between posts and/or mounting brackets shall not exceed 6-feet. Joints shall be made through the use of standard flush weld techniques with uniform locking weld connectors.
- All screwed or bolted fasteners shall be drawn up tight so that the completed railing is rigid and free of movement at all attachments.

10420.3.2.2 GATES - Handrail gates shall be installed at handrail openings where shown on the Drawings. Each gate shall consist of a gate frame, hinges, gate stops, and a latch. Each gate in the closed position shall be in a vertical plane with the handrail.

10420.3.2.3 FINISH - Following installation, all carbon steel railings, posts and fittings shall be painted in accordance with Section 09910.2.5 of these Specifications. The color shall match the block wall and the surrounding area. Color shall be submitted to Engineer for approval.

10420.4 METHOD OF MEASUREMENT

10420.4.1 NO MEASUREMENT

Unless a separate bid item for furnishing and installing the work outlined in this Section is provided in the Bid Schedule, this work shall not be measured for separate payment, but shall be considered incidental to other items in the Bid Schedule.

10420.4.2 SEPARATE MEASUREMENT

Where items to be furnished and installed under this section are listed separately in the Bid Schedule, quantities shall be established by using a tape measure or other accurate measuring device to determine the total number of lineal feet of handrail system installed and accepted. This measurement shall include all gates, components, and fittings.

10420.5 BASIS OF PAYMENT

Complete compensation for the accepted work outlined in this Section shall be included in other bid items when no separate bid item is provided in the Bid Schedule for this work.

When a separate bid item is provided in the Bid Schedule, complete compensation for this accepted work shall be included in the contract unit price on the Bid Schedule.

PAY ITEM	UNIT
Steel Handrail System	Lineal Foot

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Sewage/Non-Potable Water
   1. Pump Stations
      i. Extent of packaged pump station work required by this Section is indicated on Drawings and Schedules and by requirements of this Section.
         a) Under this Section the Contractor shall furnish and install one (1) pre-packaged, pre–assembled pump station complete with submersible pumps, precast concrete pump chamber with integral valve vault structure, slide rail pump removal system, discharge piping with required supports and fittings, discharge check and plug valves, access hatches, internal wiring and other required appurtenances.
         b) The pre-packaged pump station shall be manufactured and pre-assembled off site to ensure product quality and consistency. The pre-package pump station manufacturer or their distributors shall provide sole-source responsibility to the owner through the warranty period.

1.2 RELATED SECTIONS

A. MAG Section 206 – Structure Excavation and Backfill
B. MAG Section 301 – Subgrade Preparation MAG Section
C. MAG Section 725 – Portland Cement Concrete
D. Section 01300 - Submittals
E. Division 26 – Electrical
F. Division 40 – Process Integration

1.3 REFERENCES

Where applicable, the latest editions of the following standards shall form a part of this specification to the extent referenced. The publications are referenced to in the text of this guide specification by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

Standard Specifications for Highway Bridges

AASHTO LRFD Bridge Design Specification

ACI INTERNATIONAL (ACI)

ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete

ACI 211.2	Standard Practice for Selecting Proportions for Structural Lightweight Concrete
ACI 304R	Guide for Measuring, Mixing, Transporting, and Placing Concrete
ACI 305R	Hot Weather Concreting
ACI 306R	Cold Weather Concreting
ACI 309R	Consolidation of Concrete
ACI 318	Building Code Requirements for Structural Concrete
ACI 350	Code Requirements for Environmental Engineering Concrete Structures and Commentary
ACI 517.2R	Accelerated Curing of Concrete at Atmospheric Pressure

AMERICAN NATIONAL STANDARDS INSTITUTE (ASTM)

ASTM A 36	Specification for Carbon Structural Steel
ASTM A 82	Specification for Steel Wire, Plain, for Concrete Reinforcement
ASTM A 615	Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM C 31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C 33	Specification for Concrete Aggregates
ASTM C 39	Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C 40	Test Method for Organic Impurities in Fine Aggregates for Concrete
ASTM C 70	Standard Test Method for Surface Moisture in Fine Aggregate
ASTM C 117	Standard Test Method for Materials Finer than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 123	Standard Test Method for Lightweight Particles in Aggregate
ASTM C 136	Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 138	Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C 150	Specifications for Portland Cement
ASTM C 172	Standard Practice for Sampling Freshly Mixed Concrete

ASTM C 192	Practice for Making and Curing Concrete Test Specimens in the Laboratory
ASTM C 231	Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C 260	Specification for Air-Entraining Admixtures for Concrete
ASTM C 494	Standard Specification for Chemical Admixtures for Concrete
ASTM C 566	Test Method for Total Evaporable Moisture content of Aggregate by Drying
ASTM C 595	Specification for Blended Hydraulic Cements
ASTM C 617	Standard Practice for Capping Cylindrical Concrete Specimens
ASTM C 618	Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
ASTM C 805	Test Method for Rebound Number of Hardened Concrete
ASTM C 857	Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
ASTM C 858	Specification for Underground Precast Concrete Utility Structures
ASTM C 890	Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
ASTM C 891	Practice for Installation of Underground Precast Concrete Utility Structures
ASTM C 913	Specification for Precast Concrete Water and Wastewater Structures

ASTM C 920	Specification for Elastomeric Joint Sealants
ASTM C 990	Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM C 1037	Practice for Inspection of Underground Precast Concrete Utility Structures
ASTM C 1064	Standard Test Method for Temperature of Freshly Mixed Concrete
ASTM C 1107	Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C 1231	Standard Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Concrete Cylinders
ASTM C 1240	Standard Specification for Use of Silica Fume for Use as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar, and Grout
ASTM C 1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C 1293	Standard Test Method for Determination of Length Change of Concrete due to Alkali-Silica Reaction
ASTM C 1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM C 1611	Standard Test Method for Slump Flow of Self-Consolidating Concrete

CONCRETE REINFORCING STEEL INSTITUTE (CRSI)

Manual of Standard Practice

Placing Reinforcing Bars

NATIONAL PRECAST CONCRETE ASSOCIATION (NPCA)

NPCA QC Manual	Quality Control Manual for Precast Concrete Plants

1.4 GENERAL REQUIREMENTS

Precast concrete units shall be designed and fabricated by an experienced and acceptable precast concrete manufacturer. The manufacturer shall have been regularly and continuously engaged in the manufacture of precast concrete units similar to that indicated in the project specifications or drawings for at least 10 years with annual sales of more than $40 million. In addition, the manufacturer shall employ a professional engineer registered in the state where the product is to be installed.

1.5 SUBMITTALS

Submittals shall be per Section 01300 and contain the following items unless specified otherwise herein.

A. Preconstruction Submittals
    1. Upon request by the customer, submit quality control procedures established by the precast manufacturer's Quality Control Manual

B. General
    1. Submit Four (4) copies of complete project submittals for the Engineer's review and Approval. The submittal shall be provided in and electronic pdf format with relevant bookmarks for easy navigation, complete with index and cover, clearly identifying the Project Title, Customer, Project Engineer and submittal date. The submittal shall be compiled in a logical and organized manner.
    2. Partial or incomplete submittals will not be reviewed, but instead will be returned as "Incomplete- Revise and Resubmit".
    3. Product Data: Submit manufacturer's specific technical product data, including installation and start-up instructions, furnished specialties and accessories, and pump characteristic performance curves with selection points clearly indicated. Provide structural calculations stamped by a Professional Engineer registered in the State the project is being installed.

C. Drawings
    1. Submit manufacturer's assembly-type shop drawings indicating dimensions, mechanical & electrical components, complete bill of materials, structural layout & reinforcing per calculations and structural weights. Structural reinforcing drawings shall be stamped by a Professional Engineer registered in the State the project is being installed.
    2. The drawings for precast concrete units shall be furnished by the precast concrete producer for approval. These drawings shall show the design loads and standards

have been met. Installation and construction information shall be included on shop drawings upon request. It is the responsibility of the project's engineer-of-record to verify that the design assumptions are suitable for the proposed application.

3. For custom made precast concrete units, in addition to the requirements in B.1, the drawing for submittal shall show locations and dimensions to all penetrations and special embed items. Product dimensions and thicknesses shall be shown, and the drawing shall be to a common architectural scale with the precast producer's information in the title block.

D. Precast Concrete Unit Data

1. Anchorage, Lifting Inserts and Devices
    i. For anchors, lifting inserts and other devices, the precast concrete producer shall provide product data sheets and proper installation instructions upon request.
2. Accessory Items
    i. For items including, but not limited to sealants, gaskets, pipe entry connectors, steps, racks, and other items installed before or after delivery, the precast concrete producer shall include proper installation instructions and relevant product data upon request.

E. Design Data

1. The precast concrete producer shall supply submittals showing design loading and material specifications for supplied products. At a minimum, the following shall be shown on the submittals:
    i. Live load used in design
    ii. Vertical and lateral earth loads used in design
    iii. Depth of soil fill on the structure
    iv. Water table depth used in calculations
2. Upon request, the precast concrete producer shall supply precast concrete unit design calculations and concrete mix design proportions and appropriate mix design test data. Structural design calculations shall be sealed by a licensed professional engineer in the state of this project.

F. Test Reports

1. Upon request, the precast concrete producer shall supply copies of material certifications and/or laboratory test reports, including mill tests and all other test data, for Portland cement, blended cement, pozzolans, ground granulated blast-furnace slag, silica fume, aggregate, admixtures, and curing compound proposed for use on this project
2. Upon request, the precast concrete producer shall submit copies of test reports showing that the mix has been successfully tested to produce concrete with the properties specified and will be suitable for the project conditions. Such tests may include compressive strength, plastic air content, temperature of freshly mixed concrete, and slump of freshly mixed concrete. Special tests for precast concrete items shall be clearly detailed in the specifications
3. Upon request, the precast concrete producer shall supply copies of in-plant QA/QC inspection reports.

1.6 DESIGN

All components of the pre-package submersible pump station with integral valve vault shall be

designed for all stresses that may occur during continuous operation, and for any additional stresses that may occur during fabrication or erection. Workmanship shall be high quality in all respects. All equipment shall be constructed of materials that will maintain their functional integrity during continuous handling, and in contact with the liquids and atmosphere, likely to be encountered in this application. The following items shall be accounted for in the precast unit design.

A. Precast Concrete Unit Design
   1. Design standard precast concrete units to withstand design load conditions in accordance with ACI 350. Precast structures will be in close proximity to CMU walls and must account for the transfer of forces. CMU walls may be acting as retaining walls. Design must also consider stresses induced during handling, shipping, and installation in order to avoid product cracking or other handling damage. Design loads for precast concrete units shall be indicated on the shop drawings, and designed by a licensed professional engineer.
   2. The structural design shall take into account discontinuities in the structure produced by openings.
   3. The Precast Pump Station with Integral Valve vault shall be designed to support its own weight as well as the minimum superimposed loads tabulated below. All additional equipment shall be accounted for in the design of the elements.
      i. Pump Station with Integral Valve Vault
         a) Top Slab
         b) Live Load & Impact Load – AASHTO LRFD HL-93
         c) Floor Slab (valve vault & base)
         d) Live Load – 200 psf
         e) Dead Loads – CMU walls are located in close proximity to the wet wells and must be taken into consideration. The Mystic Hills CMU wall also acts as a retaining wall. CMU design calculations will be provided for wet well design purposes.
         f) Exterior Walls
         g) All exterior walls below finished grade shall be designed for an equivalent fluid pressure of 90 psf caused by saturated earth pressure. The top of the pressure diagram is assumed to originate at finished grade. In addition to the soil pressure, a Live Load Traffic Surcharge shall be applied according to the AASHTO Specification.
   4. The structures shall be designed to prevent floatation without the benefit of skin friction and the weight of mechanical equipment when the ground water level is at finished ground surface. The factor of safety against uplift calculated as a ratio of the total resisting force (excluding skin friction and the weight of the equipment) to the total hydrostatic uplift force shall be at least 1.15. The net uplift force shall be transferred to the anti-buoyancy collar.

B. Joints and Sealants
   1. Joints and sealants between adjacent units shall be of the type and configuration indicated on the shop drawings meeting specified design and performance requirements.

C. Concrete Mix Design
   1. Concrete type
      i. For non machine cast products, the concrete shall be self-consolidating concrete which produces minimal bugholes and does not segregate.
   2. Concrete Proportions
      i. Selection of proportions for concrete shall be based on current self-

consolidating concrete mix design techniques. At a minimum, ACI 211.1 shall be used.

ii. Upon request the precast concrete producer shall submit a mix design for each strength and type of concrete that will be used. Submitted mix designs shall include the quantity, type, brand and applicable data sheets for all design constituents as well as documentation indicating conformance with applicable reference specifications.

iii. Concrete mix design shall meet the requirements of MAG Specification 725 - Portland Cement Concrete.

3. Durability and Performance Requirements

i. Concrete Compressive Strength

1. Precast concrete units shall have a 28-day compressive strength of 5000 psi for SCC.

ii. Water-Cementitious Ratio

1. Concrete that will be exposed to freezing and thawing shall contain air and shall have a water-cementitious ratio of 0.45 or less. Concrete which will not be exposed to freezing, but which is required to be leak resistant, shall have a water-cementitious ratio of 0.48 or less. For corrosion protection, reinforced concrete exposed to deicer salts, brackish water or seawater shall have a water-cementitious ratio of 0.40 or less.

iii. Air Content

1. The air content of concrete that will be exposed to freezing conditions shall be within the limits given below

Nominal Maximum Aggregate size (in)	Air Content %	
	Severe Exposure	Moderate Exposure
3/8	6.0 to 9.0	4.5 to 7.5
1/2	5.5 to 8.5	4.0 to 7.0
3/4	4.5 to 7.5	3.5 to 6.5
1	4.5 to 7.5	3.0 to 6.0
1-1/2	4.5 to 7.0	3.0 to 6.0
* For specified compressive strengths greater than 5000 psi, air content may be reduced 1%		

D. Pump Design Criteria

Pumps shall be submersible, non-clog, explosion-proof wastewater pumps suitable for pumping sewage.

Pumps shall be specially designed, constructed, and installed for the service intended and shall comply with the following minimum conditions:

Design Conditions	**Wet Well Pumps**

Location:	Mystic Hills
Use:	Sewer
Number Required:	2
Design Flow: gpm	610
Design TDH: ft.	202
Motor: hp	72
Max. Operating Speed: rpm	3560
Impeller Diameter: in	8 7/16
No. of Blades	2
Discharge Size: in.	4
Motor: Volts/Phase/Hertz	460/3/60

1.7 QUALITY ASSURANCE

The precast concrete producer shall demonstrate adherence to the standards set forth in the plant Quality Control Manual. The precast concrete producer shall meet the requirements written in subparagraph 1.7.A. The Precast Concrete Pump Station Manufacturer shall have a minimum of ten (10) years successful experience in the design and the assembly of factory-built, prefabricated, pre-assembled Pump Stations. In addition, the Manufacturer shall have made no less than ten (10) Pump Stations similar to the one on this project. Evidence shall be submitted to verify these requirements are met prior to being deemed an acceptable manufacturer.

A. Qualifications, Quality Control and Inspection

1. The precast producer shall maintain a permanent quality control department.
2. The precast concrete producer shall have a quality control program which is audited for compliance annually by persons outside that plant's employee structure.
3. Upon request, the precast concrete producer shall supply a copy of their quality control manual.

B. Quality Control

1. The precast concrete producer shall show that the following quality control tests are performed as required and in accordance with the ASTM International standards indicated
    i. Concrete Testing
        a) Slump: A slump test shall be performed at least once per day per mix design used. Slump tests shall be performed in accordance with ASTM C 1611 for self-consolidating concrete.
        b) Temperature: The temperature of fresh concrete shall be measured each time a slump, air content, or compressive strength tests are made. Temperature shall be measured in accordance with ASTM C 1064.
        c) Compressive Strength: At least four compressive strength specimens shall be made each day for each mix design unless otherwise specified. In accordance with ASTM C 31, C 39, C 192.
        d) Air Content: Tests for air content shall be performed if the mix

design specifies air entrainment. The air content will be measured in accordance with ASTM C 231. The Air Content shall be measured once per day per mix design.

e) Density (Unit Weight): Tests for Density (Unit Weight) shall be performed monthly for each mix design used at a minimum. Tests shall be in accordance with ASTM C 138

ii. Aggregate Testing

a) A full set of aggregate tests shall be performed on each aggregate at least annually by an independent testing agency or an in house test lab. These tests will include gradations (ASTM C136), Soundness (ASTM C 88), Organic Impurities (ASTM C 40), Sand Equivalent for fine aggregates only (ASTM D 2419)

b) Potential reactivity shall be performed once per each aggregate source, and when aggregate sources change (ASTM C 1260 or C 1293)

c) Monthly, at a minimum, gradations shall be performed per ASTM C 33.

d) Aggregate Moisture tests: Moisture tests on aggregates shall be performed in accordance with ASTM C 70 or ASTM C 566. Fine aggregate moisture content tests shall be performed at least once per day if there are no moisture meters, otherwise it shall be performed once per month. Alternatively, the speedy moisture test is acceptable (ASTM D 4944).

iii. Preplacement Check

a) All products shall be inspected for accuracy prior to placing concrete. Checks shall include, but not be limited to, form condition and cleanliness, form dimensions, joints, release agent, blockouts, inserts and locations, lifting devices, reinforcing steel size, spacing, clearances and proper placement.

b) Preplacement checks shall be documented and initialed by the inspector. A drawing with verifications of the above criteria can be used as documentation.

iv. Postplacement Check

a) All products shall be inspected for accuracy after the concrete forms have been removed. Checks shall include, but not be limited to, dimensional checks, finishing, insert locations, squareness, honeycombing, cracking, marking, coatings, racking, hole size and location. Postplacement checks may require a corrective action report.

b) Postplacement checks shall be documented and initialed by the inspector. A drawing with verifications of the above criteria can be used as documentation.

2. Copies of the test results and Inspections above shall be available upon request.

C. Wet Well Corrosion Protection Liner

1. Once hardened surface is achieved, a holiday tester shall be utilized to ensure a continuous pinhole-free lining.
2. Test results for the holiday test shall be submitted to the engineer for approval.

3. Any holes shall be repaired per the lining manufacturers recommendation.

D. Outside Inspection
   1. The customer or customer's agent (specifier) may place an inspector in the plant when the units covered by this specification are being manufactured. The precast concrete producer shall give notice of 3 days prior to the time the precast concrete units will be available for plant inspection

E. All equipment and materials furnished in the pump station shall be new and free of defects. All equipment shall be the manufacturer's latest and proven design.

F. All electrical materials, devices, and equipment shall be UL listed wherever applicable.

G. All equipment and installations shall meet the National Electric Code.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Handling
   1. Precast concrete units shall be handled and transported in a manner to minimize damage. Lifting devices or holes shall be consistent with industry standards. Lifting shall be accomplished with methods or devices intended for this purpose as indicated on the shop drawings. Upon request, the precast concrete producer shall provide documentation on acceptable handling methods for the product.

   2. Pumps shall be handled and transported per the manufacturers recommendation to prevent damage.

B. Storage
   1. Precast concrete units shall be stored in a manner that will minimize potential damage.

   2. Pumps shall be stored per the manufacturers recommendation to prevent damage.

C. Delivery
   1. Precast concrete units shall be delivered to the site in accordance with the delivery schedule. Upon delivery to the jobsite, all precast concrete units shall be inspected by the contractor for quality and final acceptance.

D. Final Acceptance
   1. Upon final acceptance, the contractor acknowledges and understands the appropriate methods for handling the accepted precast concrete unit(s). Upon acceptance by the contractor, the precast concrete manufacturer is not responsible for replacing damaged product resulting from improper handling practices on the job site. Damage due to improper handling at the job site will be repaired or replaced by the Contractor at no cost to the customer.

1.9 PLANT CONDITIONS

Any plant producing precast concrete units for this specification shall have a written, implemented, comprehensive safety and environmental program. Upon request, documentation shall be provided to show the safety program meets the following minimum requirements.

A. Safety Program Requirements

The safety program shall include the following written and documented parts as a minimum.

1. Housekeeping
2. Lock-Out Tag-Out
3. Machine Guarding
4. Risk Assessment
5. Personal Protective Equipment
6. Contractor and Visitor Safety
7. Cranes and Lifting Equipment Safety
8. Ergonomics and handling Safety
9. Fall Protection

B. Health and Safety Management System Requirements

The health and safety management system shall be used to manage the safety program and all measurable aspects.

C. Environmental Management System Requirements
The Environmental Management System shall encompass the following:
1. Air Pollution Control
2. Water and Wastewater Management

D. Recordable rate
1. The recordable rate shall be below the industry average. If the industry average is not readily available, assume a value of 6 recordable injuries per 200,000 hours worked as the industry average.

1.10 Single Source Responsibility

A. To ensure that all equipment required for the installation of the pre-package pump station is properly coordinated and will function as a unit in accordance with the intent of these specifications, the Contractor shall obtain all the equipment specified under this section, from a single supplier with whom the responsibility for the proper function of all equipment, regardless of manufacturer, as an integrated and coordinated system shall be vested. This requirement is to establish unit responsibility for all the equipment with the equipment supplier. The use of the word responsibility relating to the equipment supplier is in no way intended to relieve the Contractor's ultimate responsibility for equipment coordination, installation, operation, and guarantee.

B. Factory pre-assembly: During fabrication and before shipment, all equipment shall be fully factory installed to verify all proper clearances. All installed equipment, except for pumps and equipment unless crossing structural joints, shall remain in the precast structure during travel to the jobsite and final re-assembly.

C. The manufacturer shall furnish the services of an experienced service technician to check the installation, and provide to the Owner, a certificate indicating that the pre-packaged submersible

pump station has been installed in accordance with the manufacturer's recommendations.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. PRECAST WETWELL AND VALVE VAULT

1. Acceptable Manufacturer: Oldcastle Precast Inc.

2. Substitutions: Not permitted.

   a. Alternative systems based upon a built-in-place, field erected pump station utilizing separate precast structures, or cast-in-place concrete shall not be accepted.

B. WET WELL CORROSION PROTECTION LINER

1. Acceptable Manufacturer: Sauereisen

2. Substitutions: Not permitted.

C. LIFT STATION PUMPS

1. Acceptable Manufacturer: Flygt Pumps

2. Substitutions: Not permitted.

2.2 PRODUCTS

A. Precast Concrete Pump Station Sections with Valve Vault

1. The Pump Station with Integral Valve Vault shall be composed of precast reinforced concrete units, rectangular in shape with rounded corners. The precast structures shall be monolithically cast, and have minimum interior dimensions of 6' wide by 11' long with 3' radius corners (RC611). The precast base section will be supplied with an extended buoyancy collar to withstand upward buoyant forces with ground water at grade. Overall structure heights shall be as shown on the contract drawings, and range from 10'-10" to 22'-10", in product-standard 2', 3' & 4' increments.
2. Exterior Walls shall be a minimum of 6 inches thick, integral valve vault common wall and floor shall be a minimum or 4 inches thick, station floor and buoyancy footing shall be a minimum of 8 inches thick, and the roof slab with hatches shall be a minimum of 12 inches thick.
3. The Integral Valve Vault shall be located in the pump station structure as shown on the contract drawing, to conserve site space and to eliminate the possibility of differential settlement. Conventional means, utilizing two (2) separate structures for the pump station and the valve vault **will not be accepted as an equal**.

4. The Precast Structures shall be comprised of product-standard: base, riser sections, integral valve vault, optional vault riser shims as required, and station cover.
5. The Pump Station Manufacturer shall have a production facility in which all work associated with structural fabrication, mechanical/electrical pre-assembling and product final inspection of the pump station will be performed. The building shall keep the pump station components protected from the elements and kept at an ambient temperature of at least 45 degrees Fahrenheit. No concrete shall be batched and placed when the ambient temperature is below 50 degrees Fahrenheit.
6. All wall penetrations shall be formed utilizing hole-formers or cored drilled holes for manhole boots, and galvanized threaded couplings with waterstops for electrical connection.
7. All cast wall openings for ductile iron, PVC or galvanized steel pipe shall incorporate adjustable rubber manhole boots for a watertight seal.
8. All Precast components shall be fabricated on steel forms with machined rings to form accurate bell and spigot joint surfaces to ensure watertight joints.
9. The Horizontal joints between precast sections shall be sealed with a vulcanized butyl rubber joint material conforming to AASHTO M-198. The joint material shall be "Conseal CS-102" as manufactured by Concrete Sealants, or approved equal.
10. All surfaces of the precast structures shall be smooth, even, and free from roughness, irregularities and other defects. The surfaces shall be suitable for receiving exterior treatments as specified elsewhere herein.

B. Pump Removal Rail System
1. The pump station shall be supplied with a stainless steel guide rail pump removal system, to facilitate emergency and routine maintenance in removing and re-installing the submersible pumps from the top of the station. The guide rail system will include lower guide brackets incorporated in the pump base elbow, 316-stainless upper guide brackets, 316-stainless intermediate guide brackets as may be required per the pump manufacture, and 304stainless steel Sch40 guide rails of size and quantity as dictated by the select pump manufacturer and model.
2. Guide rail components shall be assembled and installed plumb to the pump station structure, and shall allow for pump removal and re-installation without interfering with the access hatch or frame. All assembly hardware shall be 316-stainless steel.

C. Hazardous Location Compliance
1. The wet well and the area within 2 feet of the wet well has been classified as a Class 1, Division 1, A Hazardous Location as defined by the National Electrical Code. All electric wiring and motors located within the subject area shall be in strict compliance with these standards. The shop drawings carry the manufacturer's certification that all equipment located in the subject area meets the requirements of NEC Class 1, Division 1 Criteria and the Underwriter's Laboratory (UL).

D. Pump Station Access Frame and Cover
1. Furnish and install (1) aluminum pump access hatch, 36" x 54" nominal interior dimension, flush with precast cover, 300psf load rating with 316-stainless steel hardware. Cover will be minimum ¼" diamond plate with stainless steel slam lock and weather plug, lift handle which sits flush with cover, recessed pad lock clip (pad lock by others), hold open arm to lock cover in 90-degree position, heavy duty stainless hinges. Frame to be angle style with continuous 1 ½" anchor flange and

full slab-height skirt to show no exposed concrete when hatch is open, exterior surfaces in contact with concrete to receive one coat bituminous paint.

2. Pump access hatch to be supplied with integral safety grating system. The safety grate shall be made of 6061-T6 aluminum and designed per the "Specifications for Aluminum Structures". The grating shall be designed to withstand 300psf loading. Each grate shall be supplied with a heavy duty, stainless steel pneu-spring for ease of operation when opening. Each grate shall be provided with a permanent hinging system; which will lock the grate in the 90-degree position once opened. Grate shall be coated with an OSHA type safety orange color, base coat is a thermosetting epoxy powder coat finish with a minimum thickness of 2-4 mils. The top coat is a mar-resistant, TGIC polyester powder coating with a minimum thickness of 2-4 mils. Each coat shall be baked at 350-375 degrees F until cured.
3. Access hatches to be manufactured by EJ, East Jordan, MI, or approved equal.

E. Valve Vault Access Frame and Cover

1. Furnish and install (1) aluminum valve vault access hatch, 30" x 36" nominal interior dimension single door, flush with precast cover, 300psf load rating with 316 stainless steel hardware. Cover will be minimum ¼" diamond plate with stainless steel slam lock and weather plug, lift handle which sits flush with cover, recessed pad lock clip (pad lock by others), hold open arm to lock cover in 90-degree position, heavy duty stainless hinges. Frame to be channel style with 1 ½" NPT drain port in the bottom of the channel, continuous 1 ½" anchor flange and full slab-height skirt to show no exposed concrete when hatch is open, exterior surfaces in contact with concrete to receive one coat bituminous paint. Hatch will be supplied with a heavy duty, stainless steel pneu-spring, for ease of operation when opening cover.
2. Valve Vault access hatch to be supplied with integral safety grating system. The safety grate shall be made of 6061-T6 aluminum and designed per the "Specifications for Aluminum Structures". The grating shall be designed to withstand 300psf loading. Each grate shall be supplied with a heavy duty, stainless steel pneu-spring for ease of operation when opening. Each grate shall be provided with a permanent hinging system; which will lock the grate in the 90-degree position once opened. Grate shall be coated with an OSHA type safety orange color, base coat is a thermosetting epoxy powder coat finish with a minimum thickness of 2-4 mils. The top coat is a mar-resistant, TGIC polyester powder coating with a minimum thickness of 2-4 mils. Each coat shall be baked at 350-375 degrees F until cured.
3. Access hatches to be manufactured by EJ, East Jordan, MI, or approved equal.

F. Polyvinyl Chloride (PVC) Piping and Fittings

1. All PVC pressure piping and fittings for water and wastewater treatment are to be Sch80. Unless stated otherwise in the drawings. Corrosion resistant pressure pipe, IPS sizes, for use at temperatures up to and including 140°F. Pressure rating (120 psi to 1230 psi) varies with schedule, pipe size, and temperature.
2. The material used in the manufacture of the pipe and fittings shall be domestically produced rigid polyvinyl chloride (PVC) compound, Type 1 Grade 1, with a Cell Classification of 12454 as defined in ASTM D1784, trade name designation H707 PVC. This compound shall be gray in color, and shall be approved by NSF International for use with potable and non-potable water (NSF Std 61). All sizes of PVC Schedule 80 pipe & fittings shall be manufactured in strict accordance to

the requirements of ASTM D1785 for physical dimensions and tolerances, and all performance test requirements of ASTM D1785.

G. Polyvinyl Chloride (PVC) Ball Valves (Standard 2" & 3" PVC)
   1. All ball valves shall be of the flanged model with one-piece capsule and shall open counterclockwise. The valves shall be rated for 250psi at 73 degrees F.
   2. The ball valve shall be of full-port design to minimize flow restriction to the lowest possible pressure drop. Full flange face gaskets having a 50to 70 durometer A hardness shall be used.
   3. Ball valve bodies shall be constructed of PVC, with Teflon seats and Viton seals.
   4. PVC ball valves shall be manufactured by Haward, Nibco Inc., or approved equal.

H. Polyvinyl Chloride (PVC) Check Valves (Standard 2" & 3" PVC)
   1. All check valves shall be of the flanged model with one-piece capsule. The valves shall be rated for 150psi at 73 degrees F.
   2. Free oscillation of ball in guide ribs facilitates full port flow with minimum of turbulence and chatter. Full flange face gaskets having a 50to 70 durometer A hardness shall be used.
   3. Check valve bodies and ball shall be constructed of PVC, with EPDM seals.
   4. PVC check valves shall be manufactured by Hayward, Nibco Inc., or approved equal.

I. Ductile Iron Pipe and Fittings
   1. All ductile iron pipe shall be designed in accordance with ANSI A21.50, and shall be manufactured in accordance with ANSI A21.51. Pipe for use with grooved end couplings shall have grooved ends in accordance with AWWA C606.
   2. Pipe thickness class shall be Class 53 for use with threaded flanges, unless specified otherwise on the product drawings.
   3. Flanged joints shall conform with ANSI A21.15, utilizing long-hub flanges which shall be screwed on tight by the foundry before they are faced and drilled.
   4. Fittings shall conform to the requirements or ANSI A21.10 and shall be of a pressure classification at least equal to that of the pipe with which they are used. Flanged fittings shall be faced and drilled in accordance with ANSI A21.10.
   5. All ductile iron piping and fittings shall Novocat SP-200W, by ErgonArmor, or Series 431 Perma-Shield PL, by Tnemec, on the inside and a bituminous seal coat on the outside, all in accordance with ANSI/AWWA A21.4/C104.

J. Flange Type Couplings
   1. Flange couplings shall be mounted on each pump base elbows to ensure proper pressure seal while providing a minimum of assembly flexibility. The flange couplings shall be fusion bond epoxy coated and supplied with 304-stainless assembly and mounting hardware for harsh & wet environments. The pipe gasket and O-ring seal shall be Nitrile (Buna N) NFS 61 Listed.
   2. To ensure correct fitting of pipe and couplings, all flange couplings shall be furnished by the pipe supplier and shall be of the pressure rating of at least that of the pipeline in which they are to be installed.
   3. The flange couplings shall be Smith-Blair Inc., model 912 or approved equal.

K. Grooved Couplings
   1. Grooved couplings shall be supplied where shown on the product drawings and shall conform to AWWA C606. The couplings are designed for use on radius cut grooved pipe with minimum wall thickness of ANSI/AWWA C151/A21.51, Class

53 DIP, or a transition coupling may be required for connection of grooved end IPS steel pipe to grooved end AWWA ductile iron pipe.

2. The housing coating shall be coal tar epoxy, the gasket shall be Nitrile (red color code), and bolting hardware of 304-stainless steel.
3. The grooved coupling shall be Victaulic style 31/307, or approved equal.

L. Pipe supports

1. Piping shall be supported in the valve vault by means of horizontal supports that attach to the sides of the valve vault. No portion of the pipe support shall rest on the floor of the valve vault. The pipe support shall be 304-stainless steel with 316-stainless steel hardware. Where piping enters and exits the vault structure; aluminum wall supports angles with 304-stainless U-bolts and 316-stainless expansion bolt wall-mounting hardware shall be utilized in (3) locations.
2. Piping shall be supported in the pump station by means of a common 304-stainless fabricated angle brace spanning the width of the station and mounted with wall brackets and 316-stainless hardware. Both vertical discharge pipes shall be supported from the brace by means of individual 316-stainless U-bolts and bolting hardware.
    i. (1) Common pipe support assembly at mid length shall be required when the vertical discharge pipe lengths exceed 10'-0".
    ii. (2) Common pipe support assemblies at equal spacing shall be required when the vertical discharge pipe lengths exceed 14'-0".

M. Wall/Lid Penetrations

1. Where wall penetrations are called for on the plans; mechanical piping shall utilize cast or cored openings with flexible manhole boots. Flexible rubber boots shall consist of EPDM polymer compounds meeting ASTM C923 material performance requirements. Expansion banding and strap shall be 304-stainless material and the connection between boot and structure shall utilize an expansion wedge system with 304-stainless wedge and hardware components.
2. Where penetrations through the concrete lid of the wet well are called out in the plans; mechanical seals shall be used. Mechanical seals shall be Link Seal by GPT and shall utilize 316-stainless assembly hardware
3. Electrical conduit penetrations will utilize galvanized electrical couplings assemblies with 2" wide minimum waterstop embedded in the structure at casting, or cored openings with mechanical rubber seals to fill the annular spacing between electrical conduit and precast wall structure. Mechanical seals shall be Link Seal by GPT and shall utilize 316-stainless assembly hardware. Mechanical seals shall be employed when pump control panel or exterior junction box option is factory mounted to the station.

N. Check Valves Outside L&W (Standard)

1. The check valve shall have a heavy-duty body of ASTM A126 Class B cast iron with integral flanges faced and drilled to ANSI B16.1 Class 125 for horizontal installation as listed in the schedule or shown on plans. Valve clapper shall swing completely clear of the waterway when valve is full open, permitting a full flow through the valve equal to the nominal pipe diameter. Check valves shall comply with AWWA Standard C-508 latest revision. The valve shall have a bolted and gasketed cover to allow for clapper access without removing the flanged valve from line.

2. Pressure ratings: Class 125 flanged valve body shall be rated for a shell pressure of 250 PSI.
3. The check valve shall be supplied with adjustable outside lever and weight.
4. Manufacturer-paint all interior & exterior ferrous surfaces with fusion bonded epoxy coating, AWWA C550 Manufacturer standard color only applies.
5. Manufactured valve shall be Matco-Norco, mod. 120WC or approved equal.

O. Plug Valve (Standard)

1. Plug valves shall be of the non-lubricated, quarter-turn, eccentric type with flanged ends and lever operated, in full conformance with the latest revision of the AWWA C517 Standard.
2. Valves sizes 3" to 6" shall have a minimum 175 PSI pressure rating. Plug Valves shall be round ported for reduced pumping costs and improved flow characteristics. The valves shall have the following minimum full open flow coefficients (Cv): 3"=569, 4"=982, 6"=1997.
3. Flange diameter, thickness, and drilling shall conform to ANSI B16.1 Class 125.
4. Valve shaft seals shall be of the self-adjusting U-cup design for reduced maintenance and replaceable without removing the cover from the valve.
5. Valves shall have bodies and covers of ductile iron per ASTM A536 for superior strength. Valve sizes 3" and larger shall have body seats of 95% welded nickel applied directly to the body and machined to a smooth finish. Sprayed, plated or removable seats are not acceptable. Valves shall have plugs made from ductile iron per ASTM A536 with a vulcanized synthetic rubber seat facing tested per ASTM D429 for all sizes.
6. Valves shall be provided with stainless steel thrust bearings on the upper and lower plug shaft to eliminate plug-to-body contact and ensure long lasting plug-to-seat alignment. Grit seals shall be provided on the upper and lower bearing journals to minimize the entrance of grit into the shaft seal and bearing areas.
7. Valves shall be coated internally and externally with 6-8 mils NSF approved two part epoxy paint for corrosion protection.
8. Valves shall be Golden Anderson Figure 517 "ECO-Centric" or approved equal.

P. Gaskets, Bolts, Nuts

1. For flange joints, gaskets shall be a minimum of 1/8" thick full faced gaskets. Gaskets shall be of composition suitable for exposure to fluids within the pipe. Gaskets shall meet AWWA C110, C111, and C115 performance standards.
2. Flange joints shall be bolt-assemble utilizing the full faced gasket. Bolting hardware, number & size, shall conform to the same ANSI standards as the flange. Bolts and nuts shall be 316-stainless steel, heavy hex Grade B conforming to ASTM A493/494.

Q. Station Vent

1. Valve Vault - A passive station vent shall be supplied using 4" DIP piping & fittings, and a #14 stainless steel insect screen. The vent will be factory assembled and mounted to the exterior of the station, where the venting will rise above the station, and turn downward (gooseneck), and end with insect screen minimum 12" above top of wet well.
2. Wet Well - A passive station vent shall be supplied using 4" DIP pipe with flange, and a top mounting carbon canister unit. The vent will be factory assembled and mounted to the exterior of the station, where the venting will rise above the station

12"- above top of wet well, and end with a top mounted carbon canister unit with rain shield. The canister housing shall be aluminum with 4" mounting flange, rain shield, with power coat finish. The replaceable canister shall contain a minimum of 12 pounds of activated carbon, and shall be safe for recyclable disposal.

i. The carbon canister assembly shall be Wager 1800 Vent Scrubber 4-1800FAPC Vertical Mounted with rain shield or approved equal.

R. Interior Pump Cable Support

1. The SJO jacketed pump power/control cables shall run un-cut from the submersible pumps to the pump control panel and not require any interior junction boxes. The weight of the pump cables shall be supported within the pump station via stainless strain relief (Kellums Grip), so that cable weight is not transferred to the associated conduit bushings.
2. Where submersible or ultrasonic type level control transducer device is used instead of, or in conjunction with, level control/emergency floats, the transduce cable shall have a dedicated conduit entrance to the station with dedicated conduit and cord bushing. All final transducer positioning and connection to pump control panel shall be completed on site by the site electrician.
3. Conduit seal fittings shall be supplied outside of the pump station and prior to the control panel on site by site electrician.

S. Wet Well Corrosion Protection Liner

1. The corrosion protection liner shall be Sewergard – Trowelable No. 210 by Sauereisen. Liner shall be factory applied and tested in a controlled environment per the manufacturer's recommendation.
2. Field Coring shall be coated with the corrosion protection liner as recommend by the manufacturer.
3. Any damage to the liner during installation or coring shall be repaired per the manufacturer's recommendation.

T. Lift Station Pumps

Requirements

Furnish and install two (2) submersible, non-clog, explosion-proof wastewater pump(s). Each pump shall be equipped with a 72 HP submersible electric motor, connected for operation on 460 volts, 3 phase, 60 hertz, with 50 feet of submersible cable (SUBCAB) suitable for submersible pump applications. The power cable shall be sized according to NEC and ICEA standards and also meet with P-MSHA Approval.

Pump Design Configuration

The pump shall be supplied with a mating cast iron four (4) inch discharge connection and be capable of delivering 610 GPM at 202 FT. TDH. The pump(s) shall be automatically and firmly connected to the discharge connection, guided by no less than two guide bars extending from the top of the station to the discharge connection.

There shall be no need for personnel to enter the wet-well. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact. Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable. No portion of the pump shall bear directly on the sump floor. Each pump shall be fitted with FLYGT Grip-Eye Lifting System. The working load of the lifting system shall be

50% greater than the pump unit weight.

Pump Construction

Major pump components shall be of grey cast iron, ASTM A-48, Class 35B, with smooth surfaces devoid of blow holes or other irregularities. The lifting handle shall be of stainless steel. All exposed nuts or bolts shall be of stainless steel construction. All metal surfaces coming into contact with the pump, other than stainless steel or brass, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with a polyester resin paint finish on the exterior of the pump.

Sealing design shall incorporate metal-to-metal contact between machined surfaces. Critical mating surfaces where watertight sealing is required shall be machined and fitted with Nitrile O-rings. Fittings will be the result of controlled compression of rubber O-rings in two planes and O-ring contact of four sides without the requirement of a specific torque limit.

Rectangular cross sectioned gaskets requiring specific torque limits to achieve compression shall not be considered as adequate or equal. No secondary sealing compounds, elliptical O-rings, grease or other devices shall be used.

Cooling System

Each unit shall be provided with an integral motor cooling system. A stainless steel motor cooling jacket shall encircle the stator housing, providing for dissipation of motor heat regardless of the type of pump installation. An impeller, integral to the cooling system and driven by the pump shaft, shall provide the necessary circulation of the cooling liquid through the jacket. The cooling liquid shall pass about the stator housing in the closed loop system in turbulent flow providing for superior heat transfer. The cooling system shall have one fill port and one drain port integral to the cooling jacket. The cooling system shall provide for continuous pump operation in liquid or ambient temperatures of up to 104°F (40°C). Operational restrictions at temperatures below 104°F are not acceptable. Fans, blowers or auxiliary cooling systems that are mounted external to the pump motor are not acceptable.

Cable Entry Seal

The cable entry seal design shall preclude specific torque requirements to insure a watertight and submersible seal. The cable entry shall consist of dual cylindrical elastomer grommets, flanked by washers, all having a close tolerance fit against the cable outside diameter and the entry inside diameter. The grommets shall be compressed by the cable entry unit, thus providing a strain relief function. The assembly shall provide ease of changing the cable when necessary using the same entry seal. The cable entry junction chamber and motor shall be sealed from each other, which shall isolate the stator housing from foreign material gaining access through the pump top. Epoxies, silicones, or other secondary sealing systems shall not be considered equal.

Motor

The pump motor shall be a NEMA B design, induction type with a squirrel cage rotor, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with

moisture resistant Class H insulation rated for 180°C (356°F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31. The stator shall be heat-shrink fitted into the cast iron stator housing. The use of multiple step dip and bake-type stator insulation process is not acceptable.

The use of pins, bolts, screws or other fastening devices used to locate or hold the stator and that penetrate the stator housing are not acceptable.

The motor shall be designed for continuous duty while handling pumped media of up to 104°F. The motor shall be capable of no less than 30 evenly spaced starts per hour. The rotor bars and short circuit rings shall be made of aluminum. Three thermal switches shall be embedded in the stator end coils, one per phase winding, to monitor the stator temperature. These thermal switches shall be used in conjunction with and supplemental to external motor overload protection and shall be connected to the motor control panel.

The junction chamber shall be sealed off from the stator housing and shall contain a terminal board for connection of power and pilot sensor cables using threaded compression type terminals. The use of wire nuts or crimp-type connectors is not acceptable. The motor and the pump shall be produced by the same manufacturer.

The motor service factor (combined effect of voltage, frequency and specific gravity) shall be 1.15. The motor shall have a voltage tolerance of +/- 10%. The motor shall be designed for continuous operation in up to a 40°C ambient and shall have a NEMA Class B maximum operating temperature rise of 80°C. A motor performance chart shall be provided upon request exhibiting curves for motor torque, current, power factor, input/output kW and efficiency. The chart shall also include data on motor starting and no-load characteristics.

Motor horsepower shall be sufficient so that the pump is non-overloading throughout its entire performance curve, from shut-off to run-out. The motor and cable shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 feet or greater.

Refer to Section 26_05_09 of the Electrical Specifications for additional requirements.

Bearings

The integral pump/motor shaft shall rotate on two bearings. The motor bearings shall be sealed and permanently grease lubricated with high temperature grease. The upper motor bearing shall be a two row angular contact ball bearing to handle radial loads. The lower bearing shall be a two row angular contact ball bearing to handle the thrust and radial forces. The minimum L10 bearing life shall be 50,000 hours at any usable portion of the pump curve.

Mechanical Seals

Each pump shall be provided with a positively driven dual, tandem mechanical shaft seal system

consisting of two seal sets, each having an independent spring. The lower primary seal, located between the pump and seal chamber, shall contain one stationary and one positively driven rotating corrosion and abrasion resistant tungsten-carbide ring. The upper secondary seal, located between the seal chamber and the seal inspection chamber shall be a leakage-free seal. The upper seal shall contain one stationary and one positively driven rotating corrosion and abrasion resistant tungsten-carbide seal ring. The rotating seal ring shall have small back-swept grooves laser inscribed upon its face to act as a pump as it rotates, returning any fluid that should enter the dry motor chamber back into the lubricant chamber. All seal rings shall be individual solid sintered rings. Each seal interface shall be held in place by its own spring system. The seals shall not depend upon direction of rotation for sealing.

Mounting of the lower seal on the impeller hub is not acceptable. Shaft seals without positively driven rotating members or conventional double mechanical seals containing either a common single or double spring acting between the upper and lower seal faces are not acceptable. The seal springs shall be isolated from the pumped media to prevent materials from packing around them, limiting their performance.

Each pump shall be provided with a lubricant chamber for the shaft sealing system. The lubricant chamber shall be designed to prevent overfilling and shall provide capacity for lubricant expansion. The seal lubricant chamber shall have one drain and one inspection plug that are accessible from the exterior of the motor unit. The seal system shall not rely upon the pumped media for lubrication.

The area about the exterior of the lower mechanical seal in the cast iron housing shall have cast in an integral concentric spiral groove. This groove shall protect the seals by causing abrasive particulate entering the seal cavity to be forced out away from the seal due to centrifugal action.

A separate seal leakage chamber shall be provided so that any leakage that may occur past the upper, secondary mechanical seal will be captured prior to entry into the motor stator housing. Such seal leakage shall not contaminate the motor lower bearing. The leakage chamber shall be equipped with a float type switch that will signal if the chamber should reach 50% capacity.

Pump Shaft

The pump and motor shaft shall be a single piece unit. The pump shaft is an extension of the motor shaft. Shafts using mechanical couplings shall not be acceptable. The shaft shall be stainless steel – ASTM A479 S43100-T. Shaft sleeves will not be acceptable.

Impeller

The impeller shall be of Hard-Iron™ (ASTM A-532 (Alloy III A) 25% chrome cast iron), dynamically balanced, semi-open, multi-vane, back swept, screw-shaped, non-clog design. The impeller leading edges shall be mechanically self-cleaned automatically upon each rotation as they pass across a spiral groove located on the volute suction.

The leading edges of the impeller shall be hardened to Rc 60 and shall be capable of handling

solids, fibrous materials, heavy sludge and other matter normally found in wastewater. The screw shape of the impeller inlet shall provide an inducing effect for the handling of up to 5% sludge and rag-laden wastewater. The impeller to volute clearance shall be readily adjustable by the means of a single trim screw. The impeller shall be locked to the shaft, held by an impeller bolt and shall be coated with alkyd resin primer.

Volute/Suction Cover

The pump volute shall be a single piece grey cast iron, ASTM A-48, Class 35B, non-concentric design with smooth passages of sufficient size to pass any solids that may enter the impeller. Minimum inlet and discharge size shall be as specified. The volute shall have a replaceable suction cover insert ring in which are cast spiral-shaped, sharp-edged groove(s). The spiral groove(s) shall provide trash release pathways and sharp edge(s) across which each impeller vane leading edge shall cross during rotation so to remain unobstructed. The insert ring shall be cast of Hard-Iron™ (ASTM A-532 (Alloy III A) 25% chrome cast iron) and provide effective sealing between the multi-vane semi-open impeller and the volute housing.

Protection

Each pump motor stator shall incorporate three thermal switches, one per stator phase winding and be connected in series, to monitor the temperature of the motor. Should the thermal switches open, the motor shall stop and activate an alarm. A float switch shall be installed in the seal leakage chamber and will activate if leakage into the chamber reaches 50% chamber capacity, signaling the need to schedule an inspection.

The thermal switches and float switch shall be connected to a Mini CAS control and status monitoring unit. The Mini CAS unit shall be designed to be mounted in the pump MCC. The Mini CAS unit shall be provided by the pump manufacturer to the MCC manufacturer.

2.3 MATERIALS

Except as otherwise specified, material shall conform to the following section.

A. Materials

Cement	ASTM C 150 (Type I, II, III, or V)
	ASTM C 595 (for Blended Cements)
Silica Fume	ASTM C 1240
Fly Ash and Pozzolans	ASTM C 618
Ground Granulated Blast-Furnace Slag	ASTM C 989

Water	ASTM C 1602 (the use of reclaimed/recycled water shall be permitted)
Aggregates	ASTM C 33 (and aggregate specifications)
Air Entraining Admixtures	ASTM C 260
Accelerating, Retarding, Water Reducing Admixtures	ASTM C 494
Corrosion Inhibitors	ASTM C 1582
Reinforcing Bars	ASTM A 615 or ASTM A 706
Plain, Welded Wire Reinforcement	ASTM A 185
Deformed, Welded Wire Reinforcement	ASTM A 497
Epoxy Coated Reinforcing Bars	ASTM A 775
Epoxy Coated Welded Wire Reinforcement	ASTM A 884
Hot-Dipped Galvanizing for Inserts	ASTM A 152
Rubber Gaskets for Circular Pipe	ASTM C 443
External Sealing Bands for Pipe	ASTM C 877
Preformed Flexible Joint Sealants for Concrete Pipe, Manholes, and Manufactured Box Sections	ASTM C 990
Elastomeric Joint Sealants	ASTM C 920
Pipe Entry Connectors	ASTM C 923, ASTM C 1478
Nonshrink Grout	ASTM C 1107

2.4 MANUFACTURE

Manufacture shall conform to the producer's acceptable quality control manual

A. Forms

1. Forms for manufacturing precast concrete units shall be of the type and design consistent with industry standards and practices. They should be capable of consistently providing uniform products and dimensions. Forms shall be constructed so that the forces and vibrations to which the forms will be subjected cause no damage to the precast concrete unit.
2. Forms shall be cleaned of concrete build-up after each use.
3. Form release agents shall be applied according to the manufacturer's recommendations and shall not be allowed to build up on the form casting surface.

B. Reinforcement

1. Cages of reinforcement shall be fabricated by tying the bars, wires or welded wire reinforcement. The tolerances for concrete cover shall be 3/8 in. or as specified in the design. Welding shall be allowed only for ASTM A 706 rebar.
2. Positive means shall be taken to assure that the reinforcement does not move significantly during the casting operations

C. Embedded Items

1. Embedded items shall be positioned at locations specified in the design documents. Inserts and other embeds shall be held rigidly in place so that they do not move significantly during casting operations.

D. Concrete

1. Concrete Mixing
   i. Mixing operations shall produce batch-to-batch uniformity of strength, consistency and appearance
   ii. Batching weight and volume measurement devices shall be annually calibrated by an independent testing laboratory or more frequently if batching irregularities or concrete inconsistencies are observed
2. Concrete placing
   i. Concrete shall be placed in a manner in which it flows and consolidates without segregation or air entrapment. The freefall of concrete shall be kept to a minimum.
   ii. Cold Weather Concreting
      1. Recommendations for cold weather concreting are given in detail in ACI 306 R. Adequate equipment shall be provided for heating concrete materials and protecting concrete during freezing or near-freezing temperatures. All concrete materials, reinforcement, and forms shall be free from frost. In cold weather, the temperature of the concrete at the time of placement shall not be below 45 degrees F. Concrete that freezes before it reaches a compressive strength of 500 psi shall be discarded.
   iii. Hot Weather Concreting
      1. Recommendations for hot weather concreting are given in detail in ACI 305 R. During hot weather excessive concrete temperatures and water evaporation shall be minimized. The temperature of concrete at the time of placing shall not exceed 95 degrees F.
3. Concrete Curing
   i. Curing operations shall commence immediately following the initial set of the concrete and completion of surface finishing.
   ii. Curing by moisture retention

1. Precast products shall be protected from drafts and wind to prevent plastic shrinkage cracking.
2. Moisture shall be prevented from excessively evaporating from exposed surfaces until adequate strength for stripping the precast concrete unit from the form is reached.

iii. Curing with Heat and Moisture
1. Concrete shall not be subjected to steam or hot air until after the concrete has attained its initial set. If hot air is used, precautions shall be taken to prevent moisture loss from the concrete. The temperature of the concrete shall not be permitted to exceed 150 degrees F. The temperature gain shall not exceed 40 degrees F per hour.

4. Surface Finish
i. The surface finish shall be as specified on the contract documents and/or approved shop drawings.

5. Stripping Precast Concrete Units from Forms
Precast concrete units shall not be removed from the forms until the concrete reaches the compressive strength for stripping required by design. Stripping strengths shall be routinely measured to ensure product has attained sufficient strength for safe handling.

6. Patching and Repair
i. Repairing Minor Defects
1. Defects that will not impair the functional use or expected life of the precast concrete unit may be repaired by any method that does not impair the product

ii. Repairing Honeycombed Areas
1. When honeycombed areas are to be repaired, all loose material shall be removed, and the areas cut back into essentially horizontal or vertical planes to a depth at which coarse aggregate particles break under chipping rather than being dislodged. Proprietary repair materials shall be used in accordance with the manufacturer's instructions. Otherwise, the area shall be saturated with water. Immediately prior to repair, the area should be damp, but free of excess water. A cement-sand grout or an approved bonding agent shall be applied to the chipped surfaces, followed immediately by consolidating an appropriate repair material into the cavity.

iii. Repairing Major Defects
1. Defects in precast concrete products which impair the functional use, or the expected life of products shall be evaluated by qualified personnel to determine if repairs are feasible and, if so, to establish the repair procedure.

7. Shipping Precast Concrete Units
i. Precast concrete units shall not be shipped until they have reached at least 70% of their specified 28-day design strength, unless damage will not result, impairing the performance of the product.

2.5 WARRANTY

A. The manufacturer of the lift station shall guarantee for one (1) year from the date of installation, or 15-months from the date of factory completion (whichever occurs first), that the structure and all equipment will be free from defects in design, material and workmanship.
B. Warranties and guarantees by the suppliers of various components in lieu of a single source

responsibility by the manufacturer will not be accepted. The manufacturer shall be solely responsible for the warranty of the station and all components.

C. In the event a component fails to perform as specified or is proved defective in service during the warranty period, the manufacturer shall provide a replacement part without cost to the Owner. The Contractor shall further provide, without cost to the Owner such labor as may be required to replace, repair or modify major components such as the station structure, pumps, pump motors sewage piping manifold, etc.
D. The pumps warranty shall be 5 year prorated as follows.
    1. 1 - 18 Months: 100% Replacement
    2. 19 - 39 Months: 50% Replacement
    3. 40 - 60 Months: 25% Replacement
E. Wet Well Corrosion Protection Liner Warranty shall be 25 years or longer.

PART 3 EXECUTION

3.1 SURVEY

F. The installation area shall be surveyed using the work print and a checklist to identify the work to be done and to determine that the plans are correct
G. All underground facilities and structures such as gas, water, sewer, power, telephone cable, and so forth shall be located and identified. Location markings shall be placed by the affected utilities before construction
H. The survey shall identify and obstacles such as overhead wires, building structures that will interfere with crane operations, work progress, or create a safety hazard.
I. The survey shall give consideration to the soil structure so that proper shoring, sloping, or both may be planned in advance of the excavation work

3.2 PLANNING

A. Permits required to do work in accordance with the detail plans shall be secured before starting the job. All permits or a record of the permits shall be retained on the job for immediate reference
B. All utilities and owners of surface and subsurface facilities and structures in the area shall be given advance notification of proposed excavation. Every effort shall be made to avoid damage to the facilities of others. If any damage occurs, the owner of the damaged facility shall be notified immediately.
C. Planning shall include the coordination of all responsible parties to ensure that arrangements for removal of excess and damaged material have been made.
D. Should it appear that a structure location will interfere with traffic, review the situation with the engineer and notify appropriate authorities.
E. Provide for access to call boxes, fire hydrants, etc.

3.3 SAFETY REQUIREMENTS

A. Safety requirements for construction shall be in accordance with all federal, state, and local regulations.

3.4 EXCAVATING

A. If unforeseen facilities or obstructions are encountered, stop excavation operations immediately. Expose the obstruction with wood handled digging tools and investigate them with caution. If there is any doubt as to the type of obstruction exposed, request positive identification from those suspected of owning the facility and then proceed as circumstances dictate.
B. Inspect excavations after every rainstorm or other hazard-increasing occurrence, and increase the protection against slides and cave-ins, if necessary
C. In dewatering excavations, make certain that the discharge is carried to a suitable runoff point. Also verify that the design accounts for the level of groundwater encountered.
D. Excavation size shall be large enough to allow access around the structure after it is installed.
E. All excavating shall be under the full guidelines for on-site OSHA regulations, and shall be under the supervision of an OSHA-certified safety coordinator.

3.5 SHORING

A. Shoring for construction shall be in accordance with all federal, state, and local regulations

3.6 INSTALLATION

A. General
Installation of the pump chamber sections and related equipment shall be done in accordance with written instructions supplied by the manufacturer. Installation oversight service (1-day) can be provided by the pump station manufacture (as may be required by the owner), when specifically stated as necessary site service. Additional days for factory technicians shall be paid for at the standard daily rate.

B. Assembly
1. The pump station shall be factory assembled and shipped to the job site as follows:
    i. Wet well precast base assembly with interior fillet and extended base. Pump base elbow & slide couplings will be factory mounted.
    ii. Precast concrete riser shims as required, shall include holes and factory installed rubber boots as required.
    iii. Integral valve pit assembly shall include factory installed: piping, valves, supports, gauges, bypass, hatch drain to pump station – as required. Valve pit assembly my incorporate riser sections of 2' & 4' as may be required.
    iv. Precast pump station top slab shall include aluminum access covers (300# or HS20 loading as required).
    v. Miscellaneous items provided, and field installed shall include: pumps, floats, vertical discharge piping, dresser couplings, leak seals, and pump guide rails.

C. Site Access
The general contractor shall be responsible for providing adequate access to the site to facilitate hauling, storage, and proper handling of the precast concrete units.

D. Subgrade Bedding Materials and compaction

The installation contractor shall be responsible for ensuring that the subgrade is compacted to 95% of ASTM D558 density. The subgrade shall be a minimum of 6" in depth. A granular material shall be used to create a level surface for placing the precast concrete unit.

E. Installation

Precast concrete units shall be installed: to the lines and grades shown on the contract documents or otherwise specified; be lifted by suitable lifting devices at points provided by the precast concrete producer; in accordance with applicable industry standards. Upon request, the precast concrete producer shall provide installation instructions

Field modifications to the product shall relieve the precast producer of liability and warranty regardless if such modifications result in the failure of the precast concrete unit.

F. Leak Resistance

Where leak resistance is a necessary performance characteristic of the precast concrete unit's end use, joint sealant, pipe-entry connectors and other penetrations shall be sealed according to manufacturer's requirements to ensure the integrity of the system.

G. Lift Station Pumps

The Lift Station pumps and equipment shall be installed as shown on the Drawings.

The pumps shall be accurately aligned as specified by the use of steel shims or other approved methods so no binding in any moving parts or distortion of any member occurs before equipment is finally secured in place. After completion of alignment, equipment shall be carefully secured in place by anchor bolts.

3.7 BACKFILLING AND RESTORATION

A. Do the backfilling as soon as possible after the structure has been placed.
B. Backfill material shall be granular and free from large stones, rocks, and pavement. Expansive soil material shall not be used as backfill around the structure.
C. Backfilling shall be achieved by lifts (layers) to the required compaction.
D. Follow up inspections for settlements are required. Should settlement occur, the contractor shall be responsible for all necessary repairs.

3.8 FIELD QUALITY CONTROL

A. Inspection
    1. Final field elevations and compaction properties shall be verified and documented.

3.9 SPARE PARTS

A. Spare parts shall include the following:
    - Upper and lower bearings
    - Upper and lower mechanical seals
    - o-ring kit

3.10 O&M MANUALS

A. Four (4) sets of Operation and Maintenance Manuals shall be furnished for the pump station along with a pdf digital copy. The digital copy shall be searchable with bookmarks for easy navigation. The manuals shall contain instructions that are comprehensive, and sufficiently detailed for the intended use.
B. The Operation and Maintenance Manuals shall be assembled in a permanent binder, complete with index and cover clearly identifying the pump station name. The manuals shall be compiled in a logical and organized manner.
C. The Manuals shall contain specific pump station instructions which will enable personnel to operate and maintain the pump station and all equipment associated with each individual system installed within the station.
D. Manuals that are a compilation of generalized manufacturer's literature that are not solely applicable to the particular pumping station will not be accepted.
E. The Manuals shall contain, but not be limited to:
F. Pump service and maintenance instructions to include the following:
    1. Instructions on operation of the pump and pump control in all intended modes of operations.
    2. Written instruction to enable an operator to properly operate and maintain the equipment supplied. Content of the instructions shall assume the operator is familiar with pumps, motors, piping and valves but that he has not previously operated and/or maintained the exact equipment supplied.
    3. Instruction for all adjustments which must be performed at initial start-up of pump equipment, adjustments required after the replacement of liquid level control system components, and adjustments as required in the course of preventative maintenance as specified by the manufacturer.
    4. Electrical schematic diagram of the pump and control package prepared in accordance with NMTBA and JIC Standards. Schematics shall illustrate, to the extent of authorized repair, pump motor branch, control and alarm system circuits, and interconnections among the circuits. Wire numbers shall be shown on the schematic. Schematic diagrams for individual components, not normally repairable by the station operator, need not be included and details for such parts shall not be substituted for an overall system schematic. Partial schematics, block diagrams, and simplified schematics shall not be provided in lieu of an overall system diagram.
    5. Operation and maintenance instructions shall be specific to the equipment supplied in accordance with these specifications. Instruction manuals applicable to many different configurations of pump stations and which require the operator to selectively read portions of the manual shall not be acceptable.
G. Duplex pump control panel programing and maintenance instruction and wiring diagrams, as detailed in the control panel specification section
H. All pump station equipment service and maintenance instructions for equipment supplied in the package pump station product.
I. AS-BUILT fabrication and assembly drawings.
J. Start-up & training reports
K. Product warranties

L. Product contact information and project reference information.

3.11 Leak Testing

The wet well shall be leak tested to ensure a water tight seal. The leak test shall be a negative air pressure test per ASTM C1244.

3.12 Start-Up and Testing

A. The contractor shall have a pump manufacturer rep onsite to aid in the start-up and testing of the system.

B. The start-up must be done in the presence of the City Inspector and Wastewater Operations personnel before the City will accept the installation.

C. The contractor shall make adjustments required to place system in proper operating condition. The equipment shall be field tested and calibrated to assure that the system operates in accordance with these Specifications and to the satisfaction of the Owner.

After completion of installation, the system shall be completely tested to ensure compliance with the operating requirements as specified and indicated on the Drawings.

The Contractor shall initially start-up and place all equipment installed into successful operation according to manufacturer's written instructions and as instructed by manufacture's field representative. Start-up must demonstrate and test the full functionality/range of all equipment. The Contractor shall provide all materials, labor, tools, equipment, chemicals, lubricants and expendables required to complete start-up.

No system or sub-system shall be started up for continuous operation unless all components of that system or subsystem, including instrumentation, have been tested and proven to be operable as intended by the Contract Documents.

3.13 Method of Measurement

Method and measurement shall be per Section 01019.3.

3.14 Basis of Payment

Basis of payment shall be lump sum per Section 01019.3.

END OF SECTION

15010.1 DESCRIPTION

15010.1.1 WORK INCLUDED

A. Basic requirements common to the work in general of Division 15 and other Divisions and Sections of the Specification where referenced.

B. Provide, unless specified otherwise, all labor, materials and equipment necessary for completely finished and operational mechanical systems described and specified under other Sections of this Division 15.

C. Provide all minor incidental items such as offsets, fittings, and accessories required as part of the work even though not specified or indicated.

D. Inspection: Inspect work preceding or interfacing with work of Division 15 and report any known or observed defects that affect the Work to the Construction Manager/General CONTRACTOR. Do not proceed with the work until defects are corrected.

E. Existing Utilities: Are indicated as accurately as possible on the Drawings. Close openings and repair damage in acceptable manner to utilities encountered. This CONTRACTOR shall be responsible for field surveying all aspects of existing conditions prior to bid date. Change orders will not be issued for a failure to review existing conditions which affect division 15000 work.

15010.1.2 RELATED WORK

Requirements: Provide Basic Requirements in accordance with the Contract Documents.

15010.1.3 UTILITIES, EXTENSIONS, CONNECTIONS AND FEES FOR WATER AND SEWER

A. Provide all building services extensions and connections to off-site and on-site utilities.

B. Sewer connection charges, typically based on fixture units, that in principle allow the right to obtain the sewer services from the utility will be arranged and paid for by the Division 15 CONTRACTOR.

C. Water system development fees, typically based on meter size, that in principle allow the right to obtain the water services from the utility will be arranged and paid for by the Site Utilities CONTRACTOR.

D. Sewer tap fees as they are known to the trade and are the charges for actual materials and labor for tapping, inspection and recording of the tap shall be arranged and paid for by the Site Utilities CONTRACTOR.

E. Water tap fees as they are known to the trade and are the charges for actual materials and labor for tapping, inspection and recording of the tap shall be arranged and paid for by the Site Utilities CONTRACTOR.

F. In the event that the serving utility company installs their own taps, service, meters, etc., all costs imposed by this action shall be paid for by the Division 15 CONTRACTOR. Extensions from termination points to connection with building services and systems will be the responsibility of the Division 15 CONTRACTOR.

G. Be responsible for all pads, vaults, manholes, manhole covers, meter enclosures, valves, services boxes, and the like, all in conformance with requirements of the serving utility company.

H. In the event that the water service to the building is a combination domestic and fire protection service, the responsibility of said "combination service" to the point of domestic connection shall be that of a licensed Fire Protection CONTRACTOR, including tap, valves, excavation, backfill, compaction and meters, if any. After point of domestic connection, responsibility for separate fire and domestic services is with appropriate trades including all labor and materials as herein before mentioned.

1. CONTRACTOR shall coordinate with other trades all interface piping and types of connections to be provided for interface.
2. Provide fire hydrant, auxiliary gate valve, tapping sleeve and valve or tee, service boxes, and anchor or swivel couplings, thrust blocks, deadmen, rods, and the like, all in conformance with the requirements of serving utility company.

15010.1.4 REFERENCES

General:

1. For products or workmanship specified by association, trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

2. The date of the standard is that in effect as the date of the Contract Documents, except when a specific date is specified.

3. When required by individual Specifications section, obtain copy of standard. Maintain copy at job site during work until substantial completion.

15010.1.5 DEFINITIONS

A. Specification Language Explanation: These Specifications are of abbreviated, simplified or streamlined type and include incomplete sentences. Omissions of words of phrases such as "the CONTRACTOR shall", "in conformity therewith", "shall be", "as noted on the drawings", "a", "the", are intentional. Supply when "NOTE" occurs on Drawings. Supply words "shall be" or "shall" by inference when colon is used with sentences or phrases. Supply words "on the Drawings" by inference when "as indicated" is used with sentences or phrases. Singular words will be interpreted as plural and plural words will be interpreted as singular where applicable and where full context of the Contract Documents so indicates.

B. Furnish: Except as otherwise defined in greater detail, term "furnish" is used to mean supply and deliver to project site, ready for unloading, unpacking, assembly, installation, etc., as applicable in each instance.

C. Install: Except as otherwise defined in greater detail, term "install" is used to describe operations at Project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations, as applicable in each instance.

D. Provide: Except as otherwise defined in greater detail, term "provide" means furnish and install, complete and ready for intended use, as applicable in each instance.

E. Indicated: The term "Indicated" is a cross-reference to graphics, notes or schedules on Drawings, to other paragraphs or schedules in the Specifications, and to similar means of recording requirements in contract documents. Where terms such as "shown", "noted", "scheduled", and "specified" are used in lieu of "indicated", it is for purpose of helping reader locate cross-reference, and no limitation of location is intended except as specifically noted.

F. General CONTRACTOR: The term "General CONTRACTOR" used in Division 15 and elsewhere in the Contract Documents means the party with whom the OWNER has executed the OWNER-CONTRACTOR Agreement.

G. Approved equal: Except as otherwise defined in greater detail, term "approved equal" means that any materials, equipment, work procedures and techniques shall be either addressed on the drawing, specifications or addendum by manufacturer or by detailed material description. When brand names are referenced it implies that only the manufacturers listed are approved. All approved material, equipment, work procedures, and

techniques will be noted in the specifications, drawings, or by addendum prior to bid date. Items not approved in this manner will not be considered.

15010.1.6 QUALITY ASSURANCE

A. Quality Control

1. Materials and apparatus required for the work to be new and of first-class quality; to be furnished, delivered, erected, connected and finished in every detail; and to be so selected and arranged so as to fit properly into the appropriate spaces. Where no specific kind or quality of material is given, a first-class standard article shall be furnished.

2. Furnish the services of an experienced superintendent, who will be constantly in charge of the installation of the work, together with all skilled workmen, fitters, metal workers, certified welders, plumbers, millwrights, sprinkler fitters, drain layers, helpers, and labor required to unload, transfer, erect, connect, adjust, start, operate and test for each system.

3. Unless otherwise specifically indicated, equipment and materials to be installed in accordance with the recommendations of the manufacturer. This includes the performance of tests as recommended by the manufacturer.

B. Proof of Performance

1. Division 15 CONTRACTOR shall provide proof of performance certification of all Mechanical Equipment and Systems to demonstrate that all Mechanical Equipment and Systems are operating to the intent of the design. This proof of performance shall include, but shall not be limited to, actual demonstration of all temperature/pressure control loops, operation of all heating/cooling equipment and other required tests upon request by the Engineer or OWNER. A signed certificate from the piping, sheetmetal, control, and balancing subcontractors stating that they have personally checked the operation of all equipment and control loops and that everything under their subcontract is operating as specified. These certificates shall be furnished to the 15000 CONTRACTOR for inclusion in the Operation and Maintenance Manual.

15010.1.7 REGULATORY REQUIREMENTS

A. Execute Work per Underwriters, Public Utility, Local and State Codes, Ordinances and applicable regulations. Obtain and pay for required permits, inspections, and certificates. Notify Architect of items not meeting said requirements.

B. Comply with editions of all applicable codes, ordinances and regulations in effect at the time of bid opening including but not necessarily limited to the following:

International Mechanical Code
International Plumbing Code
State Department of Health Requirements
Model Energy Code
National Fire Protection Association Standards
International Fire Code
International Building Code
National Electrical Code NFPA-70
State Boiler Code
Jurisdictional County Health Department
Jurisdictional City Wastewater Management Division or District
Jurisdictional City Water Department
Jurisdictional Water Conservation Standards

C. If discrepancies occur between the Contract Documents and any applicable codes, ordinances, acts, or standards, the most stringent requirements shall apply.

D. Where hourly fire ratings are indicated or required, provide components and assemblies meeting requirements of the UBC, and listed by Underwriters Laboratories, Inc.

15010.1.8 SUBMITTALS

A. CONTRACTORs are required to submit Mechanical Cost Breakdown to Engineer when submitting shop drawings. Shop drawings will not be accepted without a complete Mechanical Cost Breakdown. See last page of this Section for requested breakdown. If your standard compilation of bids is different than our requested breakdown, please send it in your format. We need the data to keep our cost estimating files up to date. Just fill-in blanks with a pencil, typing is not required.

B. Submit Samples, Shop Drawings and Product Data as required by various Sections of Division 15 in accordance with The General Conditions of the Contract. The CONTRACTOR agrees that these Submittals processed by the Engineer are not Change Orders; that the purpose of these Submittals by

the CONTRACTOR is to demonstrate to the Engineer that the CONTRACTOR understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install and by detailing the fabrication and installation methods he intends to use. CONTRACTOR further agrees that if deviations, discrepancies, or conflicts between these Submittals and the Contract Documents in the form of design drawings and specifications are discovered either prior to or after these Submittals are processed by the Engineer, the Design Drawings and Specifications shall control and shall be followed.

C. The submittals shall be submitted in a single package with all mechanical equipment for the project enclosed. The submittals shall be enclosed in a stiff back, 3-ring binder. All mechanical equipment shall be separated with tabbed index cards with an indexed legend provided in the front of the binder.

D. Test Reports: Submit certified test reports as required by various Sections of Division 15 showing compliance in accordance with General Conditions of the Contract. Signed copies shall be included in the Operation and Maintenance Manual.

E. Operating Instructions and Maintenance Data: Prepare and submit printed operating instructions and maintenance data in accordance with Operating and Maintenance Data paragraph in this Section.

15010.1.9 PRODUCT OPTIONS AND SUBSTITUTIONS

A. Substitutions and Prior Approvals: Substitutions and prior approvals will be acceptable only when the proposed substitute has been submitted to the Engineer and approved through an addendum or change order. Request for prior approval shall be submitted a minimum of 10 calendar days prior to bid.

B. Some materials and equipment are specified by manufacturer and catalog numbers. The manufacturer and catalog numbers are used to establish a degree of quality and style for such equipment and material.

C. NOTE: When alternate or substitute materials and equipment are used Division 15 CONTRACTOR shall be responsible for engineering/redesign costs, space requirements, configurations, performance, changes in bases, supports, structural members and openings in structure, electrical changes and other apparatus and trades that may be affected by their use. Notification of General CONTRACTOR and other affected subcontractors shall be the responsibility of the Division 15 CONTRACTOR.

15010.1.10 PROJECT RECORD DOCUMENTS

A. General: Comply with Division 1.

B. Job Site Documents: Maintain at the job site, one record copy of the following:

1. Drawings
2. Specifications
3. Addenda
4. Reviewed Shop Drawings
5. Field Test Records

Do not use record documents for construction purposes. Maintain documents in clean, dry legible condition, apart from documents used for construction.

C. Record Information: Label each document "Record Document". Mark information with red ink. Keep each record current. Do not permanently conceal any work until required information is recorded.

D. Record following information on Drawings:

1. Horizontal and vertical location of underground utilities to be dimensioned from column lines.

2. Dimensioned location of internal utilities and appurtenances concealed in construction.

3. Field changes of dimension and detail.

4. Changes by change order or field order.

5. Details not on original contract drawings.

6. Manufacturer, trade name, catalog number and supplier of each product and item of equipment actually installed shall be indicated on equipment schedules.

E. Record the following information on Specifications.

1. Changes by change order or field order.
2. Other matters not originally specified.

F. Shop Drawings: Maintain shop drawings as record documents recording changes made after review as specified for drawings above.

G. Submittal: At completion of project, deliver record documents to OWNER's representative and transmit a copy of signed receipt from OWNER to the Engineer.

15010.1.11 OPERATING AND MAINTENANCE DATA

A. Division 15 CONTRACTOR shall submit O&M manual in pdf format for review. Once approved, three (3) typed and bound copies of the final manual, 8-1/2" x 11" in size, shall be submitted to the OWNER. These approved copies will be returned to the CONTRACTOR and shall then be transmitted to the OWNER. A table of contents shall be provided which indicates all equipment in the O&M manuals. Additionally, a bookmarked PDF copy of all O&M manuals must be provided to the owner.

B. Organization of the manuals shall follow the recommendations in ASHRAE Guideline 4-1993.

C. The manual shall be enclosed in a stiff-back, three-ring binder and shall have:

1. Alphabetical list of all system components including the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year's operation.

2. Operating instructions for complete system, including emergency procedures for fire or failure of major equipment and procedures for normal starting/operating/ shutdown and long-term shutdown.

3. Maintenance instructions, including valves, valve tag and other identified equipment lists, proper lubricants and lubricating instructions for each piece of equipment and necessary cleaning/replacing/adjusting schedules.

4. All test reports and proof of performance certificates.

5. Manufacturer's data on each piece of equipment, including the following. Provide original printed material in each book, faxes and photocopies are NOT acceptable.

a. Installation instructions.
b. Drawings and specifications (final shop drawings).
c. Parts lists.
d. Complete "as-built" wiring and temperature control diagrams. (Shop drawings are not acceptable.)
e. Lubrication and other preventative maintenance data.
f. Equipment warranties.

D. In addition to the maintenance manual, and keyed to it, the equipment shall be identified and tagged as specified on drawings. Insert a copy of the Equipment List or Equipment Schedules in manual.

1. Identify all starters, disconnect switches, and manually operated controls, except integral equipment switches. Label with permanently applied, legible markers corresponding to operating instructions in the "Maintenance Manual".

2. Tag all manual operating valves per requirements in Section 15010.

3. Provide a typed tag list or schedule mounted under glass in the equipment room stating number, location, and function of each tagged item. Insert a copy of tag list in each "Maintenance Manual".

E. Division 15000 CONTRACTOR shall be responsible for scheduling instructional meetings for maintenance personnel on the proper operation and maintenance of all mechanical systems, using the maintenance manual as a guide. These meetings must be scheduled through the Architect, Construction Manager/General CONTRACTOR and far enough in advance so that all necessary personnel can be adequately notified.

15010.1.12 DELIVERY, STORAGE AND HANDLING

A. General: Deliver and store materials and equipment in manufacturer's unopened containers fully identified with manufacturer's name, trade name, type, class, grade, size and color.

B. Protection: Store materials and equipment off the ground and under cover, protected from damage. Maintain caution labels on hazardous materials.

C. Large Items: Make arrangements with other contractors on the job for introduction into the building of equipment too large to pass through finished openings.

D. Handling of Materials: Materials shall be handled, sorted and distributed using appropriate handling methods to protect all materials from damage. Dented, rusted, corroded or otherwise damaged materials shall be removed from the project site. Determination of materials deemed unusable or inappropriate for installation shall be made by the Architect/Engineer.

15010.1.13 PROJECT CONDITIONS

A. Accessibility:

1. Division 15 CONTRACTOR shall be responsible for the sufficiency of the size of shafts and chases and the adequate clearance in double partitions and hung ceilings for proper installation of his work. He shall cooperate with CONTRACTORs of other Divisions of the Work whose work is in the same space and shall advise the Construction Manager/General CONTRACTOR of his

requirements. Such spaces and clearances shall, however, be kept to the minimum size required.

2. Division 15 CONTRACTOR shall locate all equipment which must be serviced, operated, or maintained in fully accessible positions. Equipment shall include (but not be limited to) valves, shock absorbers, traps, cleanouts, motors, controllers, switchgear, filters, VAV boxes, control valves, balancing valves, and drain points. If required for better accessibility, furnish access doors for this purpose. Minor deviations from Drawings may be allowed to provide for better accessibility. Any changes shall be approved by the Architect/Construction Manager/General CONTRACTOR prior to making the change.
3. Division 15 CONTRACTOR shall provide the Construction Manager/General CONTRACTOR with the exact locations of access doors for each concealed valve, shock absorber control, damper, or other device requiring service. Locations of these doors shall be submitted in sufficient time to be installed in the normal course of work.

B. Fabrication: Before any ductwork is fabricated and before running and/or fabricating any lines of piping or ductwork, the CONTRACTOR shall assure himself that they can be run as contemplated in cooperation with CONTRACTORS of other Divisions of the Work and the physical constraints of the Structural and Architectural Work.

C. Freeze Protection: Do not run lines in outside walls, or locations where freezing may occur. Piping next to outside walls shall be in furred spaces with insulation between the piping and the outside wall. Insulation of piping shall not be considered freeze protection.

D. Scaffolding, Rigging and Hoisting: Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises of any equipment and apparatus furnished; remove same from premises when no longer required.

15010.1.14 COORDINATION

A. General: Coordinate and order the progress of mechanical work to conform to the progress of the work of the other trades. Complete the entire installation as soon as the condition of the building will permit.

B. Coordination with Electrical Work: Section 15010.

C. Utility Interruptions: Coordinate mechanical utility interruptions with the OWNER and the Utility Company. Plan work so that duration of the interruption is kept to a minimum.

D. Cutting and Patching: Section 15010.

E. Drawings and Specifications: The Mechanical Drawings indicate the general design and arrangement of lines, equipment, systems, etc. Information shown is diagrammatic in character and does not necessarily indicate every required offset, fitting, etc. Do not scale the Drawings for dimensions. Take dimensions, measurements, locations, levels, etc., from the Architectural Drawings and equipment to be furnished.

F. Each Division 15 subcontractor shall coordinate with other contractors to make certain that any of his equipment; piping or ductwork which is mounted on isolators or flexibly connected does not become "grounded" by another contractors work (e.g. walls, ceiling, etc.).

G. Discrepancies: Examine Drawings and Specifications for other parts of the work, and if any discrepancies occur between the plans for the work of this Division and the plans for the work of others, report such discrepancies to the Construction Manager/General CONTRACTOR and obtain written instructions for any changes necessary.

H. Order of Precedence: The precedence of mechanical construction documents are as follows:

1. Addenda and modifications to the Drawings and Specifications take precedence over the original Drawings and Specifications.

2. Should there be a conflict within the Specifications or within Drawings of the same scale, the more stringent or higher quality requirements shall apply.

3. In the Drawings, the precedence shall be Drawings of larger scale over those of smaller scale, figured dimensions over scaled dimensions and noted materials over graphic indications.

4. Should there be a conflict in dimensions or locations between Mechanical Drawings and Architectural Drawings, the Architectural Drawings shall have precedence.

15010.1.15 START-UP PROCEDURES

A. Before start-up, each piece of equipment comprising a part of the system shall be checked for proper lubrication, drive rotation, belt tension, proper control sequence, and any other condition which may cause damage to equipment or endanger personnel.

B. Insure that all control systems are fully operational in automatic mode. Individually test each control loop to make certain it is operating as intended and is communicating properly with other devices.

C. If systems are not to continue in use following the start-up procedures, steps should be taken to insure against accidental operation or operation by unauthorized personnel. Provide padlocks on disconnect switches where applicable.

D. Factory personnel shall be notified as appropriate to start systems requiring their services.

E. Notify Engineer at least 2 weeks prior to the scheduled start-up date of all major mechanical equipment and systems.

15010.1.16 SCHEDULE OF TESTING

A. Provide testing in accordance with the Division 15 and General Conditions of the Contract.

B. A schedule of testing shall be drawn up by the Division 15 CONTRACTOR in such a manner that it will show areas tested, test pressure, length of test, date, time and signature of testing personnel.

C. All testing must be performed in the presence of the Architect's/Construction Manager's/General CONTRACTOR's representative; his signature for verification of the test must appear on the schedule.

D. All testing must be performed in accord with the procedures set forth in Division 15 and other Sections of the Specifications where referenced. At completion of testing, the completed schedule shall then be submitted in triplicate to the Architect and a copy shall be forwarded to the 15000 CONTRACTOR for inclusion in Operation and Maintenance Manual.

E. Make all specified tests on piping, ductwork and related systems as specified in this specification.

F. Make sure operational and performance tests are made on seasonal equipment.

G. Complete all tests required by Code Authorities, such as smoke detection, life safety, fire protection and health codes.

H. After test runs have been completed and systems have been demonstrated to be satisfactory and ready for permanent operation, all permanent pipeline strainers and filters shall be cleaned, air filters cleaned or replaced, valve and

pump packings properly adjusted, belt tensions adjusted, drive guards secured in place, lubrication checked and replenished if required.

15010.1.17 CLEANING AND FINISHING

A. Provide cleaning in accordance with the General Conditions of the Contract and Division 1.

B. Cleaning shall include but not be limited to removing grease, dirt, dust, stains, labels, fingerprints and other foreign materials from sight-exposed piping, ductwork, equipment, fixtures and other such items installed under Division 15 of the work. If finishes have been damaged, refinish to original condition and leave everything in proper working order and of intended appearance.

15010.1.18 WARRANTIES

A. Warranty: Provide a written warranty to the OWNER covering the entire mechanical work to be free from defective materials, equipment and workmanship for a period of one year after Date of Acceptance.

B. During this period provide labor and materials as required to repair or replace defects. Provide certificates for such items of equipment which have warranties in excess of one year. Submit to the Construction Manager/General CONTRACTOR for delivery to the Architect. Include a copy of all warranties in the Operation and Maintenance Manual.

C. This warranty will be superseded by the terms of any specific equipment warranties or warranty modifications resulting from use of equipment for construction heat or ventilation.

D. All refrigeration compressors shall have a (4) four year extended warranty from the manufacturer of the equipment in addition to the standard one-year warranty.

15010.1.19 PROJECT CLOSEOUT

Project Observation Reports: At or near the completion of the construction phase of this project, the Engineer will generate one or more Project Observation Reports for the owner. These reports will list the items of construction observed by the Engineer which are not in compliance with the Contract Documents. The Mechanical CONTRACTOR and/or subcontractors shall certify completion of each listed item in writing and forward copies to the Architect, Engineer and General CONTRACTOR. The Engineer will not recommend the payment of retainage until this compliance certification has been received. Each item on the Project Observation Report shall have a signature/date in the margin of the report indicating completion of that item.

15010.1.20 CERTIFICATES AND KEYS

A. Certificates: Upon completion of the work, deliver to the Construction Manager/General CONTRACTOR one copy of Certificate of Final Inspection.

B. Keys: Upon completion of work, submit keys for mechanical equipment, panels, etc. to the Construction Manager/General CONTRACTOR.

15100 PIPING

15100.1 DESCRIPTION

This section covers piping materials for the project.

15100.1.1 REFERENCES

MAG Section 615 – Sanitary Sewer Line Construction
MAG Section 750 – Iron Water Pipe and Fittings
MAG Section 745 – PVC Sewer Pipe and Fittings
MAG Section 753 – Galvanized Pipe and Fittings
Section 01300 – Submittals

15100.1.2 SUBMITTALS

The Contractor shall submit for review complete information, showing all pipe, materials, fittings, gaskets, couplings, coatings, linings, supports, mechanical restraints, and configuration prior to the delivery of any components to the project. All information shall be provided in accordance with Section 01300 and written evidence of compliance from the manufacturer shall accompany each delivery of material.

15100.2 MATERIALS

15100.2.1 Ductile Iron Pipe (DIP) – DIP pipe and fittings shall be per MAG 750. Approved manufacturers are McWane Ductile, US Pipe, or American.

Interior and Exterior corrosion protection for pipes and fittings shall per Section 09910.2.3.2.

15100.2.2 Polyvinyl Chloride Pipe (PVC)

- PVC Schedule 80 Piping and Fittings - Piping shall meet the requirements of ASTM D1785 of the schedule and size shown on the Drawings. Fittings shall meet the requirements of ASTM D2467. Fittings and piping will be glued with appropriate adhesives.

- PVC C900 Piping – Piping shall meet the requirements of ANSI/AWWA Standard C900 (latest revision). The pressure class or the dimensional ratio and the size shall be as shown on the Drawings. Approved manufacturers are Diamond Plastics Corporation, North American Specialty Products, JM Eagle, of Vinyltech Corporation.

- Fittings for PVC C900 Piping – C900 lines shall have DIP fittings shown on the Drawings. Fittings per MAG 750.

- PVC SDR-35 – Gravity sewer piping shall be per MAG 745.

15100.2.3 Stainless Steel (SS) Pipe – SS pipe and fittings shall be 316L stainless steel per ASTM A312

Size	Description
1 inch and smaller	Schedule 80, seamless
>1 inch to 3 inch	Schedule 80, seamless
3 inch and larger	Schedule 40, welded or seamless

All welding procedures and qualifications of the welding procedures shall conform to Section IX of the ASME Boiler and Pressure Vessel Code. Al welders and welding operators shall be qualified under Section IX of the ASME Boiler and Pressure Vessel Code. Provide full penetration welds, free of cracks, overlap and cold laps.

SS Fittings - Fittings 3 inches and smaller shall be forged butt welded per ASTM A-182 or cast threaded and socket welded per ASTM A-351

15100.2.4 Galvanized Pipe and Fittings shall be per MAG 753.

15100.3 CONSTRUCTION REQUIREMENTS

Construction requirements shall be per MAG, these Specifications, and the Drawings.

15100.4 METHOD OF MEASUREMENT

The method of measurement shall be per Section 01019.3.

15100.5 BASIS OF PAYMENT

The basis of payment shall be per Section 01019.3.

15240 FORCE MAIN

15240.1 DESCRIPTION

This section is for the materials, construction, restraining, and testing of the force main.

15240.1.1 REFERENCES

MAG Section 601 – Trench Excavation, Backfilling, and Compaction
MAG Section 610 – Water Line Construction
MAG Section 611 – Water, Sewer, and Strom Drain Testing
MAG Section 615 – Sanitary Sewer Line Construction
MAG Section 750 – Iron Water Pipe and Fittings
Section 01300 – Submittals

15240.1.2 SUBMITTALS

Submittals shall be in accordance with Section 01300 and these Specifications.

15240.2 MATERIALS

15240.2.1 DIP - Piping and fittings shall be DIP per MAG 750.

15240.2.2 C900 – C900 pipe shall be per AWWA C900-07 and have a pressure rating of DR14.

15240.2.2 Joint Restraints – Joint restraints shall be mechanical restraints, no thrust blocks will be allowed. Approved manufacturers are Star Pipe Product, Tyler Union Tuf Grip, EBAA Iron Inc Megalug, Romac Industries RomaGrip, or Sigma Corporation PV-LOK. Appropriate model shall be selected for PVC and DIP as required. No other restrain systems will be allowed.

15240.2.3 All DI pipe, fittings, and valves shall have a polyethylene wrap per MAG 610.

15240.2.4 Interior Corrosion Protection – Interior corrosion protection for DI pipes, fittings, and valves shall be Novocoat SP-2000W by ErgonArmor or Series 431 Perma-Shield PL by Tnemec.

15240.2.4 1" Stainless Steel Ball Valve – The ball valve shall be ANSI Class 150 and can be full bored or reduced bored.

15240.2.5 Plug Valve – Plug valve shall be DeZurik 100% port eccentric plug valve with accessories as shown on the plans.

15240.3 CONSTRUCTION REQUIREMENTS

15240.3.1 Piping, valves, and fittings shall be installed per MAG 610.

15240.3.2 Joint restraints shall be used at all bends, elbows, tees, crosses, dead ends, stubs, taps, fire hydrants, and valve locations. Fittings shall be either flange or Mechanical Joints. Where required, mechanical restraints shall be installed.

15240.3.3 Polyethylene wrap shall be installed per MAG 610 for DIP.

15240.3.4 Interior corrosion protection for DIP shall be applied according to manufacturer recommendation.

15240.3.5 Trenching and Backfill shall be per MAG 601 and the Drawings. Cover shall be 36" unless stated otherwise in the Drawings.

15240.3.6 The plug valve shall be orientated as shown on the plans. The seat of the DeZurik valve shall be field adjusted by a DeZurik rep.

15240.4 TESTING

The force main shall be pressure tested per MAG 611 hydrostatic test.

15240.5 METHOD OF MEASUREMENT

The method of measurement shall be per Section 01019.3.

15240.6 BASIS OF PAYMENT

The basis of payment shall be per Section 01019.3.

CITY OF SEDONA

SEDONA, ARIZONA

MYSTIC HILLS LIFT STATION IMPROVEMENT PLANS

TECHNICAL SPECIFICATIONS
DIVISIONS 26 & 40

100% SUBMITTAL

January 2019

4600 EAST WASHINGTON STREET, SUITE 500 • PHOENIX, ARIZONA 85034 • P. 602.263.9500 • F. 602.265.1422

MYSTIC HILLS LIFT STATION IMPROVEMENT PLANS

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SECTION 26_05_00

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 as specified in Section 00700 - General Requirements.
   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. The General and Supplementary Conditions of the Contract Documents govern the Work.
      b. 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 Section 00700 - General Requirements for substitute item provisions.

F. Changes and change orders:
1. As specified in Section 00700 - General Requirements.

1.02 REFERENCES

A. Code compliance:
1. 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.
2. 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).
2) 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
k. National Institute of Standards and Technology (NIST).
l. Underwriters' Laboratories, Inc. (UL).

B. Compliance with laws and regulations:
1. As specified in Section 00700 - General Requirements.

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. Demolition:
    a. Where demolition is specified or indicated on the Drawings, disconnect all associated electrical equipment and render the equipment safe.
    b. Remove and dispose of all conduit, wire, electrical equipment, controls, etc. associated with the items and/or areas to be demolished as indicated on the Drawings unless otherwise indicated.
    c. Salvage electrical equipment as indicated on Drawings or indicated herein.
    d. For each piece of equipment to be removed, remove all ancillary components (e.g. instruments, solenoid valves, disconnect switches, etc.).
    e. Conduit:
        1) Where conduit removal, other than associated with equipment to be removed, is indicated on the Drawings:
            a) Remove exposed conduit to the point of encasement or burial.
            b) Cut conduit flush and plug or cap encased or buried conduit.
        2) Where conduits are to remain in place and removal is not indicated on the Drawings:
            a) Cap conduit open ends.
            b) Re-label empty conduits as spare.
    f. Remove all wire back to the source for all conduits to be removed or abandoned in place.
    g. Provide new nameplates for modified electrical distribution equipment, motor control centers etc. to identify equipment and circuits that are no longer used as spares.
6. 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.
7. 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.
8. Utility coordination: Coordinate with the electric utility as required by Section 26_05_03 - Utility Coordination.

B. Existing system:
    1. Mystic Lift Station:
        a. Demolish existing electrical equipment as indicated on the Drawings.
        b. Salvage existing generator and remote fuel tank to Sedona WTP.

C. New system:
    1. Mystic Lift Station:
        a. Coordinate the installation of new electric utility transformer and meter with the Electric Utility.
        b. Install new Motor Control Center and service entrance disconnect as indicated on Drawings.
        c. Install new Generator as indicated on Drawings.

d. Install new lighting and receptacles, and associated cable and conduit as indicated on Drawings.
e. Install cable and conduit associated with new Lift pumps.
f. Install new instruments and associated cable and conduit as indicated on the Drawings.
g. Bid Alternate: In addition to the above work,
    1) Install magnetic flow meter as indicated on drawings.
    2) Install cable associated with the magnetic flow meter, and generator apparent power.

1.05 SUBMITTALS

A. Furnish submittals as specified in 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 26_05_53 - 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.
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 01090 - Abbreviations & Reference Standards, 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.

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. Submittal organization:
1. First page:
    a. Specification section reference.
    b. Name and telephone number of individual who reviewed submittal before delivery to Engineer.
    c. Name and telephone number of individual who is primarily responsible for the development of the submittal.
    d. Place for Contractor's review stamp and comments.
2. Next pages:
    a. Provide confirmation of specification compliance:
        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.
    b. Include a response in writing to each of the Engineer's comments or questions for submittal packages which are re-submitted:
        1) In the order that the comments or questions were presented throughout the submittal.
        2) Referenced by index section and page number on which the comment appeared.
        3) Acceptable responses to Engineer's comments are either:
            a) Engineer's comment or change is accepted and appropriate changes are made.
            b) Explain why comment is not accepted or requested change is not made.
            c) Explain how requirement will be satisfied in lieu of comment or change requested by Engineer.
        4) Any re-submittal, which does not contain responses to the Engineer's previous comments shall be returned for Revision and Re-submittal.
        5) No further review by the Engineer will be performed until a response for previous comments has been received.
3. Remaining pages:
    a. Actual submittal data:
        1) Organize submittals in exactly the same order as the items are referenced, listed, and/or organized in the specification section.
        2) 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 intended to be used.

E. Submittal requirements:
   1. Furnish submittals that are fully indexed with a tabbed divider for every component.
   2. Sequentially number pages within the tabbed sections. Submittals and operation and maintenance manuals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.
   3. Edit all submittals and operation and maintenance manuals so that the submittal specifically applies to only the equipment furnished.
      a. 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.
   4. Submit copies of shop drawings, and product data:
      a. Show dimensions, construction details, wiring diagrams, controls, manufacturers, catalog numbers, and all other pertinent details.
   5. Where submittals are required, provide a separate submittal for each specification section. 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. (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.)
   6. Exceptions to Specifications and Drawings:
      a. Include a list of proposed exceptions to the Specifications and Drawings along with a detailed explanation of each.
      b. If there is insufficient explanation for the exception or deviation, the submittal will be returned requiring revision and re-submittal.
      c. Acceptance of any exception is at the sole discretion of the Engineer.
         1) Provide all items (materials, features, functions, performance, etc.) required by the Contract Documents that are not accepted as exceptions.
      d. Replace all items that do not meet the requirements of the Contract Documents, which were not previously accepted as exceptions, even if the submittals contained information indicating the failure to meet the requirements.
   7. Specific submittal requirements:
      a. Shop drawings:
         1) Required for materials and equipment listed in this and other sections.
         2) Furnish sufficient information to evaluate the suitability of the proposed material or equipment for the intended use, and for compliance with these Specifications.
         3) Shop drawings requirements:
            a) Front, side, and, rear elevations, and top and bottom views, showing all dimensions.
            b) Locations of conduit entrances and access plates.
            c) Component layout and identification.
            d) Schematic and wiring diagrams with wire numbers and terminal identification.

e) Connection diagrams, terminal diagrams, internal wiring diagrams, conductor size, etc.
f) Anchoring method and leveling criteria, including manufacturer's recommendations for the Project site seismic criteria.
g) Weight.
h) Finish.
i) Nameplates:
(1) As specified in Section 26_05_53 - Identification for Electrical Systems.
j) Temperature limitations, as applicable.

b. Product data:
1) Submitted for non-custom manufactured material listed in this and other sections and shown on shop drawings.
2) Include:
a) Catalog cuts.
b) Bulletins.
c) Brochures.
d) Quality photocopies of applicable pages from these documents.
e) Identify on the data sheets the Project name, applicable specification section, and paragraph.
f) Identify model number and options for the actual equipment being furnished.
g) Neatly cross out options that do not apply or equipment not intended to be supplied.

c. Detailed sequence of operation for all equipment or systems.

F. Operation and maintenance manuals:
1. Furnish the Engineer with a complete set of written operation and maintenance manuals 8 weeks before Functional Acceptance Testing.
2. Additional operation and maintenance manual requirements:
a. Completely index manuals with a tab for each section:
1) Each section containing applicable data for each piece of equipment, system, or topic covered.
2) Assemble manuals using the approved shop drawings, and include, the following types of data:
a) Complete set of 11-inch by 17-inch drawings of all equipment.
b) Complete set of control schematics.
c) Complete parts list for all equipment being provided.
d) Catalog data for all products or equipment furnished.

G. 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.

H. Record Documents:
1. Provide Record Documents of all Electrical Drawings.
2. Record Drawing requirements:
a. Update Record Drawings weekly.
b. Record Drawings must be fully updated as a condition of the monthly progress payments.

c. Submit Record Drawings upon completion of the Work for final review.
d. Clearly and neatly show all changes including the following:
1) All existing pipe, conduit, wire, instruments or other structures encountered or uncovered during construction.

3. Shop drawings:
a. Upon completion of the Work, update all shop drawings to indicate the final as-built configuration of the systems:
1) Provide as-built shop drawings for all electrical equipment on 11-inch by 17-inch paper.
a) Size all drawings to be readable and legible on 11-17 inch media.
2) Provide electronic copies of these documents on CD-ROM or DVD disks in PDF format.

4. Review and corrections:
a. Correct any record documents or other documents found to be incomplete, not accurate, of poor quality, or containing errors.
b. Promptly correct and re-submit record documents returned for correction.

I. Test reports:
1. Include the following:
a. A description of the test.
b. List of equipment used.
c. Name of the person conducting the test.
d. Date and time the test was conducted.
e. All raw data collected.
f. Calculated results.
g. Each report signed by the person responsible for the test.
2. Additional requirements for field acceptance test reports are specified in Sections 01200 - Contract Closeout and 26_08_50 - 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. Shipping precautions:
1. After completion of shop assembly and successful factory testing, pack all equipment in protective crates, and enclose in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture.
2. Place dehumidifiers, when required, inside the polyethylene coverings.
3. Skid-mount the equipment for final transport.
4. Provide lifting rings for moving without removing protective covering.
5. Display boxed weight on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.

B. 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.

C. Special instructions:
   1. Securely attach special instructions for proper field handling, storage, and installation to each piece of equipment before packaging and shipment.

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.
   3. Wind load resistance:
      a. Provide electrical equipment with construction and anchorage to supporting structures designed to resist site wind loads.
   4. Altitude, temperature and humidity:
      a. Provide all electrical components and equipment fully rated for continuous operation at this altitude, with no additional derating factors applied.
      b. 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 Division 1 and 2 specifications.
   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 materials 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. Provide specific materials as specified or indicated on the Drawings.
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. NEMA Type 6: Rated for submergence.
6. NEMA Type 6P: Rated for prolonged submergence.
7. NEMA Type 7: Intended for installation in locations where explosive or combustible gas or vapors may be present (Class I Division 1 or Class I Division 2) meeting the requirements outlined in Section 26_05_02 - Hazardous Classified Area Construction.

C. Plant area Electrical Work requirements:
1. Provide all Electrical Work in accordance with the following table, unless otherwise specifically indicated on the Drawings:

PLANT AREA	NEMA ENCLOSURE TYPE	EXPOSED CONDUIT TYPE	ENVIRONMENT W = WET D = DAMP C = CLEAN/DRY X = CORROSIVE H = HAZARDOUS	SUPPORT MATERIALS
Wet Well Interior	NEMA 7	PCS	W, X, H	316 SS
Wet Well Exterior 3 ft from wet well hatch and 1.5 ft above wet well hatch, and Metering vault	NEMA 4X SS	PCS	D, X, H	316 SS
Other areas except Generator and Motor Control Center	NEMA 4X SS	PCS	D, X	316 SS

2. Modify exposed conduit runs as specified in Section 26_05_33 - Conduits.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING

A. General:
1. As specified in Sections 01030 - Project Meetings and 01200 - Contract Closeout.
2. Testing requirements are specified in Sections 01200 - Contract Closeout, 26_08_50 - Field Electrical Acceptance Tests and other sections.
3. Work restrictions and other scheduling requirements are specified in Section 01400 MAG Section 105 and 106 - Quality Control.
4. Commissioning requirements as specified in Section 01200 - Contract Closeout.

B. Pre-submittal conference:
   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. Contractor, electrical subcontractor, all suppliers, and individual equipment manufacturers furnishing major pieces of equipment must attend.

C. Factory acceptance testing (FAT):
   1. Where FAT is required for equipment covered by these Specifications, notify the Engineer in writing when the equipment is completed and ready for factory inspection and testing:
      a. Indicate the desired dates for inspection and testing.
      b. Schedule the FAT after approval of the FAT procedures submittal:
         1) Submit a copy of the test procedures including all forms at least 21 days before any scheduled test date.
         2) Notify the Engineer of the scheduled tests a minimum of 15 days before the date of the test.

1.11 WARRANTY

A. Warrant the Electrical Work as specified in MAG Section 108:
   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 as specified in Section 00700 - General Requirements.

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. 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. Terminations:
    1. Provide and terminate all conductors required to interconnect power, controls, instruments, panels, and all other equipment.

G. Miscellaneous installation requirements:
    1. In case of interference between electrical equipment indicated on the Drawings and the other equipment, notify the Engineer as specified in Section 00700 - General Requirements.
    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.

H. Labeling:
    1. Provide all nameplates and labels as specified in Sections 26_05_53 - Identification for Electrical Systems and 26_05_74 - Electrical System Studies.

I. 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.
    2. All control panels, VCPs, LCPs, RTUs, PCMs, etc., 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 01200 - Contract Closeout.

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 01200 - Contract Closeout.

C. Owner training:
   1. As specified in Section 01200 - Contract Closeout and in this Section.

D. Source testing (FAT):
   1. Provide source testing and owner training on electrical equipment as defined in the table below:

Table1: 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)
26_32_14	Single Diesel Fueled Engine Generator	Non-Witnessed	6	4
26_29_05	Motor Starters	Non-Witnessed	8	8
26_24_20	Low Voltage Motor Control Centers	Non-Witnessed	8	8

3.08 FIELD QUALITY CONTROL

A. Inspection:
   1. Allow for inspection of electrical system installation as specified in Section 01400 - MAG Section 105 and 106 - 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.
   4. Inspection activities conducted during construction do not satisfy inspection or testing requirements specified in Section 26_08_50 - 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 26_08_50 - 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. Remove all foreign material and restore all damaged finishes to the satisfaction of the Engineer and Owner.

B. 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.

C. Clean and re-lamp all new and existing luminaries that were used in the areas affected by the construction, and return all used lamps to the Owner.

D. 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 26_05_02

HAZARDOUS CLASSIFIED AREA CONSTRUCTION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Executing and completing Work in hazardous and/or classified areas as defined by the NEC Articles 500 through 516, NFPA 820, and as indicated on the Drawings and specified in the Specifications.

1.02 REFERENCES

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Specific definitions:
   1. For the purposes of these Specifications, the terms "Hazardous" and "Classified" will be considered synonymous.

1.04 SYSTEM DESCRIPTION (NOT USED)

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26_05_00 - Common Work Results for Electrical.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Regulatory requirements:
   1. All wiring in hazardous and/or classified locations shall comply with all applicable articles of the NEC, in particular Articles 500 through 516.
   2. Except as modified in Articles 500 through 516, all other applicable rules contained in the NEC shall apply to electric equipment and wiring installed in hazardous and/or classified locations.
   3. All devices used in Class I Division 1 or Division 2 areas must have visible manufacturer installed nameplates specifically stating the Class, Division, and Group for which the device is approved.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. A list of hazardous areas is specified in Section 26_05_00 - Common Work Results for Electrical.

B. The following areas are classified Class I, Division 1:
   1. Interior of the wet well.

C. The following areas are classified Class I, Division 2:
   1. Area extending 3 feet beyond the hatch opening of the wet well.
   2. Area extending 1.5 feet above the hatch.

1.09 SEQUENCING

A. Conduit seals shall be filled during start-up and commissioning after verification of field wiring. Conduit seals shall be filled prior to the introduction of process or gas to the equipment/area.

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 (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

A. Conduit and sealing fittings:
   1. As specified in Section 26_05_33 - Conduits.

B. Conduit boxes and bodies:
   1. As specified in Section 26_05_34 - Boxes.

C. Wiring devices:
   1. As specified in Section 26_27_26 - Wiring Devices.

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 26_05_00 - Common Work Results for Electrical.

B. Conduit installation:
   1. As specified in Section 26_05_33 - Conduits.
   2. Wrench tighten all conduit joints to minimize sparking when fault current flows through the conduit system.
   3. Make all conduit connections so that there are a minimum of 5 threads fully engaged in the connection.
   4. Flexible conduit:
      a. Class I Division 1 hazardous areas:
         1) Approved and marked suitable for Class I Division 1.
         2) Listed for compatibility with the group type atmosphere where used.
      b. Class I Division 2 areas:
         1) Liquidtight metal conduit with approved fittings.
      c. Maximum length as specified in Section 26_05_33 - Conduits.

C. Sealing fittings:
   1. Provide an approved seal, no more than 12 inches from the enclosure, for all conduits entering an enclosure containing switches, circuit breakers, fuses, relays, resistors, or any other apparatus which may produce arcs, sparks, or high temperatures:
      a. Only explosion proof unions, couplings, elbows, capped elbows, and conduit bodies similar to "L", "T", and "X" may be installed between the sealing fitting and the enclosure.
   2. Provide entire assemblies approved for Class I locations for self-sealing or factory sealed assemblies where the equipment that may produce arcs, sparks, or high temperatures is located in a compartment separate from the compartment containing splices or taps, and an integral seal is provided where conductors pass from one compartment to the other:
      a. Seals are required in all conduit connections to the compartment containing splices and must be within 12 inches of the enclosure.
   3. Install a conduit seal within 12 inches of the boundary in each conduit run entering or leaving a classified location. No union, coupling, box, or fitting is allowed in the conduit between the sealing fitting and the point at which the conduit leaves the classified location.

4. For underground conduits entering or leaving a classified location or between Class I Division 1 and Division 2 locations:
    a. Provide a conduit seal at both points where the conduit emerges from the ground:
        1) Place the conduit seal within 18 inches of finished grade.
        2) No union, coupling, box, or fitting is allowed in the conduit system between the seal fitting and the point at which the conduit enters the ground.
5. Separate all conductors within the conduit system and seal using an approved packing dam installed to both hold the sealing compound and to maintain the separation between the wires:
    a. Remove the outer jacket of multi-conductor non-shielded cables in the area of the sealing fitting and separate each conductor from the cable and seal individually.
6. Install seals with drains in all electrical control stations, low points of conduit or any place where moisture may condense and accumulate.
7. Install the sealing compound with a minimum thickness of 5/8 inch or the trade size of the conduit, whichever is greater.

D. Boxes and fittings:
1. Class I Division 1 areas:
    a. Utilize threaded connections for all metallic boxes, fittings, and joints to the conduit system.
2. Class I Division 2 areas:
    a. Provide approved grounding bushings on conduits entering and exiting metallic boxes to bond the conduits together.

E. Outlet boxes and bodies:
1. Provide conduits bodies and boxes suitable for the conduit system as specified in Section 26_05_33 - Conduits.
2. Class I Division 2 areas:
    a. Boxes not containing arcing parts:
        1) Material and NEMA ratings as specified in Section 26_05_00 - Common Work Results for Electrical.
        2) Pressed metal boxes are not allowed.
    b. Provide heavy duty cast construction type conduit fittings and joints:
        1) Explosion proof rated fittings and joints are not necessary.
    c. Any enclosure containing arcing parts, etc. shall have all construction associated with the enclosure, conduit system, etc. conforming to Class I Division 1 construction.

F. Motor connections:
1. Conduit installation in Class I Division 1 and Class I Division 2 locations for motors that contain arcing parts, shall proceed as follows:
    a. First - Conduit.
    b. Second - Explosion proof flexible coupling.
    c. Third - Sealing fitting.
    d. Fourth - Explosion proof union.
    e. Fifth - Connection to the motor terminal box.
2. Wiring connections to motor leads shall be as specified in Section 26_05_21 - Low Voltage Wire Connections.
3. Bond the non-current-carrying metal parts of equipment, raceways and other enclosures as required by the NEC to ensure electrical continuity.

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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Obtain inspection and approval from the Engineer before and after each seal is poured.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION (NOT USED)

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_05_03

UTILITY COORDINATION

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Coordination with the utility companies to provide service.
   2. Contractor's responsibilities for connecting to utilities and providing utility service to the facilities.
   3. Descriptions of utility services required.

1.02 REFERENCES

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Utility contacts:
   1. Electric utility:
      a. Name: Jonathan Meyer.
      b. Utility: APS.
      c. Phone number: 928-646-8462, 928-592-2364.
      d. E-mail: Jonathan.Meyer@aps.com.

1.04 SYSTEM DESCRIPTION

A. Electrical service:
   1. Provide all Work and materials and bear all costs for providing temporary construction power and the permanent electrical service, including but not limited to:
      a. All Work and materials not provided by the electric utility.
      b. All permits and fees required by the electric utility.
   2. Provide electrical ducts, raceways, conductors and connections indicated on the Drawings, and all other Work and materials required for a complete electrical service, including but not limited to the following:
      a. Electrical service conduits and conductors from the point of electric utility connection to the service entrance equipment.
      b. Metering conduits from the instrument transformers to the meter.

B. General:
   1. Coordinate and obtain inspections and final installation approval from the serving utilities and other authorities having jurisdiction.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section26_05_00 - Common Work Results for Electrical.

B. Certification:
   1. Submit certification that the intended installation has been coordinated with the utility companies.
   2. Include a narrative description of the utility's requirements and points of connection, names and telephone numbers for contacts at the utilities.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Materials and equipment used in performance of Electrical Work shall be listed or labeled by UL, or other equivalent recognized independent testing laboratory, for the class of service intended.

1.07 DELIVERY, STORAGE, AND HANDLING (NOT USED)

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING

A. General:
   1. Before start of Site Work, make arrangements for electrical service as required.

B. Electrical systems:
   1. Before bidding, the electrical contractor shall contact the utilities to determine the Work and materials that will be required from the Contractor, and all fees and permits that will be required, so that all utility systems furnished by the Contractor will be included in the bid.
   2. Coordinate Work with Engineer to minimize downtime of existing operating equipment and electrical distribution systems and to preclude unsafe operation:
      a. Notify Owner 10 days before power interruptions.
      b. Coordinate downtime with Owner and local electric utility.
   3. Before commencing Work, coordinate electric service entrance requirements with local electric utility to ensure that the installation will be complete as specified in these Contract Documents:
      a. Ensure power transformer size, electrical characteristics, and location are consistent with the design and service voltage provided by the electric utility coordinated with other trades.
      b. Arrange for utility revenue meter.
      c. Coordinate installation of metering CTs and PTs furnished by the electric utility.
      d. Pay any charges required by the electric utility for connection and turn-on.

C. Before commencing Site Work, coordinate underground conduit installations with other Work to eliminate conflicts and avoid interferences with other underground systems.

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS (NOT USED)

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Furnish materials in accordance with the applicable requirements of the utilities and as specified in these Specifications.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. Furnish equipment in accordance with the applicable requirements of the utilities and as specified in these Specifications.

B. Refer to APS "Electric Service Requirements 2018" for additional utility requirements.

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 26_05_00 - Common Work Results for Electrical.

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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_05_09

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 26_05_00 - 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 - Vibration, Axial Position, and Bearing Temperature Monitoring 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. 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).

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 26_05_00 - 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 Section 26_05_00 - 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. Additional data for motors installed in classified areas:
      a. Temperature code.
      b. Hazardous area approval indicating Class, Division, and Group:
   6. Accessories data:
      a. Power factor correction capacitors:
         1) Size in KVAR, for all motors not connected to variable frequency drives.
   7. Mechanical data:
      a. Bearing design and bearing life calculations.

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. Calculations:
   1. Where site conditions specified in Section 26_05_00 - Common Work Results for Electrical exceed manufacturer's ratings, provide derating calculations for each motor.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - 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. Explosion-proof:
        1) Tapped drain holes with corrosion resistant plugs for frames 286 and smaller and automatic breather and drain devices for frames 324 and larger.
    d. 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.
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 installed in hazardous locations:
1. Class I, Division 1 or Class II, Division 1 areas:
    a. Enclosures:
        1) Explosion proof for 3-phase motors.
        2) UL listed in conformance with UL-674.
        3) UL approval with nameplate and serial number.

D. Motors installed in corrosive environments:
    1. Nameplate indicating conformance to IEEE 841.
    2. Stator double dipped in varnish and baked.
    3. Stator and rotor coated with corrosion resistant epoxy.
    4. Frame, brackets, fan guard and conduit box coated with minimum of 2 coats of epoxy paint.
    5. Withstand salt spray tests in accordance with ASTM B117.

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 26_05_00 - Common Work Results for Electrical.

B. Install motors in accordance with 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 01200 - Contract Closeout.

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 26_05_00 - 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 26_08_50 - Field Electrical Acceptance Tests.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26_05_00 - 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 26_05_18

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 26_05_00 - 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 Nonshielded 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.

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 Tests for Fire Resistive Cables.
   6. 2225 - Standard for Cables and Cable-Fittings for Use in Hazardous (Classified) Locations.

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - 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. 9XHHW: 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 Section 26_05_00 - 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 26_05_00 - 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 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - 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.

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 26_05_53 - Identification for Electrical Systems:
      a. Use integral color insulation for #2 AWG and smaller wire.
      b. Wrap colored tape around cable larger than #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 #12 AWG minimum for power conductors.
         3) Provide #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.
      b. 90-degree Celsius rating.

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. #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. #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.

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 26_05_53 - 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 26_05_00 - 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. Wires in intrinsically safe circuits shall be light blue.
   8. 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 #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 #1 AWG and smaller, install cables by hand.
   3. For cables larger than #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. Use smooth-rolling sheaves and rollers when pulling cable into cable tray to keep pulling tension and bending radius within manufacturer's recommendations.

G. Install and terminate all wire in accordance with manufacturer's recommendations.

H. 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.

I. 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.

J. Lighting circuits:
   1. Each circuit shall have a dedicated neutral.

K. 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 26_05_00 - 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.

L. Apply wire markers to all wires at each end after being installed in the conduit and before meg-ohm testing and termination.

M. 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 26_05_26 - Grounding and Bonding.

N. Submersible cable in wet wells:
1. Provide Kellem's grip or stainless steel wire mesh to support cable weight and avoid stress on insulation.

O. 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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Grounding:
   1. As specified in Section 26_05_26 - Grounding and Bonding.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_05_21

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 26_05_00 - 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 26_05_00 - 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 Section 26_05_00 - Common Work Results for Electrical.

B. Product data:
   1. Catalog cut sheets.
   2. Installation instructions.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. All materials shall be UL listed.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - 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 and 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 and 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 26_05_00 - 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 26_05_18 - 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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_05_26

GROUNDING AND BONDING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Grounding materials and requirements.

1.02 REFERENCES

A. As specified in Section 26_05_00 - 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. 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 26_05_00 - Common Work Results for Electrical.

1.04 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 26_08_50 - Field Electrical Acceptance Tests, shall be:
   1. 5 ohms or less for industrial systems.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26_05_00 - Common Work Results for Electrical.

B. Product data:
   1. Catalog cut sheets.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. All grounding components and materials shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Compression connectors: One of the following or equal:
   1. FCI Burndy.
   2. Thomas & Betts.

B. Ground rods: One of the following or equal:
   1. Erico.
   2. Harger.
   3. Conex.

C. Ground cable: One of the following or equal:
   1. Nehring.
   2. Harger.
   3. 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 EXISTING PRODUCTS (NOT USED)

2.03 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.
   2. Size is as indicated on the Drawings, but not less than required by the NEC.

C. 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.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Precast ground well boxes:
   1. Minimum 10 inch interior diameter.
   2. Traffic-rated cast iron cover.
   3. Permanent "GROUND" marking on cover.

2.08 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 26_05_00 - 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:

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. 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.

I. 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.

J. 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.

K. Shield grounding:
   1. Shielded instrumentation cable shall have its shield grounded at one end only unless shop drawings indicate otherwise:
      a. The grounding point shall be at the control panel or at the power source end of the signal carried by the cable.
   2. Terminate the shield drain wire on a dedicated terminal block.
   3. Use manufacturer's terminal block jumpers to interconnect ground terminals.
   4. Connection to the panel main ground bus shall be via a green No. 12 conductor to the main ground bus for the panel.

L. 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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_05_29

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 26_05_00 - 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 26_05_00 - 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 01090 - Abbreviations & Reference Standards.
   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 26_05_00 - 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 26_05_00 - 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 Section 26_05_00 - 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, wall supports for all equipment in excess of 200 pounds, and all freestanding supports:
a. 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 26_05_00 - Common Work Results for Electrical.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM STARTUP

A. As specified in Section 26_05_00 - 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. Thomas & Betts.
   2. Power-Strut.
   3. Unistrut.
   4. Cooper B-Line.
   5. Robroy.
   6. Aickinstrut.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS

A. Use materials appropriate for the area as specified in Section 26_05_00 - Common Work Results for Electrical.

B. Hot dip galvanized steel:
   1. Supports:
      a. In accordance with ASTM A123 or A153.
      b. Minimum zinc coating thickness of 2.5 mils.
   2. Hardware:
      a. Electro-galvanized.
      b. In accordance with ASTM A153.

C. Stainless steel:
   1. Supports:
      a. In accordance with ASTM A240.
      b. ANSI Type 316 material.
   2. Hardware:
      a. ANSI Type 316 material.

D. PVC coated galvanized steel:
    1. Supports:
        a. Hot dip galvanized steel as specified in this Section.
        b. PVC coating thickness of 10 to 20 mils.
    2. Hardware:
        a. 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 Division 5 specifications.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Paint and finish all supporting structures as specified in Section 09910 - Painting.

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 26_05_00 - Common Work Results for Electrical.

B. Mount all raceways, cabinets, boxes, fixtures, instruments, and devices on Contractor-fabricated racks unless otherwise indicated on the Drawings.
    1. Provide the necessary sway bracing to keep trapeze type structures from swaying under seismic events or wind loading.

C. Brace and anchor freestanding equipment supports using methods that provide structural support based on the seismic loads and wind loads:
    1. Lateral deflection at top of supports not to exceed support height divided by 240 unless otherwise approved by the Engineer.

D. Provide fabricated steel support pedestals for wall mounted panels that weigh more than 200 pounds:
   1. Fabricate pedestals out of welded angle, tube sections, or preformed channel.
   2. If the supported equipment is a panel or cabinet, match the supported equipment in physical appearance and dimensions.
   3. Provide auxiliary floor supports for transformers hung from stud walls and weighing more than 200 pounds.

E. Mount all equipment, cabinets, boxes, instruments, and devices in damp or wet locations on minimum of 7/8-inch preformed mounting channel.
   a. Mount channel vertically along the length of the device so that water or moisture may run freely behind the device.

F. Corrosion protection:
   1. Isolate dissimilar metals, except where required for electrical continuity.
      a. Use neoprene washers, 9-mil polyethylene tape, or gaskets for isolation.

G. Raceway:
   1. Furnish all racks and trapeze structures needed to support the raceway from the structure.
      a. Group raceway and position on racks to minimize crossovers.
      b. Provide the necessary bracing to keep trapeze type structures from swaying under loads from cable installation, seismic forces, or wind forces.

H. Anchoring methods:
   1. Solid concrete: Anchor bolts, anchor rods or post-installed anchors as specified in Division 5 specifications.
   2. Metal surfaces: Machine screws or bolts.
   3. Hollow masonry units: Post-installed anchors as specified in Division 5 specifications.

I. When supporting devices on metal or wood stud construction, bridge studs with preformed channel, and mount the devices to the channel.

J. 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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_05_33

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 26_05_00 - 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 and 80 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 26_05_00 - 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. NPT: National pipe thread.

1.04 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.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26_05_00 - 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.

E. Installation drawings: Installation drawings, including individual conduit numbers, routing, sizes, cable sizes, and circuit numbers for each conduit.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - 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.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - 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.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 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.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. PVC-coated rigid steel conduit:
   1. One of the following or equal:
      a. Robroy Ind.
      b. Ocal, Inc.
      c. Calbond.

B. Sealtight-liquidtight flexible conduit:
   1. One of the following or equal:
      a. Southwire.
      b. AFC Cable Systems.
      c. Electri-Flex Co.
      d. Anaconda.

C. Rigid nonmetallic PVC conduit:
    1. One of the following or equal:
        a. Carlon.
        b. Cantex.
        c. Triangle Conduit and Cable.

D. 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.

E. Joint compound:
    1. The following or equal:
        a. Thomas and Betts.

F. Conduit seals:
    1. One of the following or equal:
        a. Appleton.
        b. Crouse-Hinds.
        c. O-Z/Gedney.

G. Conduit hangers and supports:
    1. As specified in Section 26_05_29 - Hangers and Supports.

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. 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 longitudinal 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 moisturetight seal at every connection.

B. 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 inches.

C. 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.

D. Conduit bodies:
   1. Material consistent with conduit type:
      a. Malleable iron bodies and covers when used with Type GRC.
      b. PVC bodies and covers when used with Type PVC.
      c. 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 #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.

2.07 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. Sealing fittings:
   1. Construction:
      a. 40 percent wire fill capacity.
      b. PVC-coated when used in corrosive areas.
      c. Malleable ductile iron with steel conduit.
      d. Type EYDX where drains are required.
      e. Type EYSX where drains are not required.
      f. UL listed for use in Class I, Division 1, Groups A, B, C, D; Class I, Division 2, Groups A, B, C, D; and Class II, Divisions 1 and 2, Groups E, F, and G.
   2. Sealing compound:
      a. Fiber filler and cement as recommended by the sealing fitting manufacturer.
      b. Approved for the conditions and use.
         1) Not affected by surrounding atmosphere or liquids.
      c. Melting point shall be 200 degrees Fahrenheit minimum.

H. PVC fittings:
   1. Shall include the following:
      a. Couplings.
      b. Terminal adapters.
      c. Female adapters.
      d. Caps.
      e. Reducer bushings.
      f. Duct couplings.

g. End bells.
h. Expansion couplings.
i. Duct couplings: 5 degree.
j. C-Type pull fittings.
k. E-Type pull fittings.
l. LB-Type pull fittings.
m. LL-Type pull fittings.
n. LR-Type pull fittings.
o. T-Type pull fittings.
p. X-Type pull fittings.
q. Service entrance caps.

2. Materials:
   a. All devices shall be made of PVC, using the same materials as used for Type PVC conduit.
   b. All metal hardware shall be stainless steel.

I. Conduit markers:
   1. As specified in Section 26_05_53 - 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. As specified in Section 26_05_00 - 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 26_05_00 - 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.
   2) Perform any changes resulting in additional conduits, or extra work from such deviations.
   3) Incorporate any deviations on the Record Documents.

c. Owner reserves the right to deduct the amount of applicable reimbursement, equivalent to the cost of the engineering effort required to show those unauthorized changes on Record Drawings.

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. Conduits may be run in concrete members or slabs with permission of the Engineer or as indicated on the Drawings:
    a. Refer to the typical details for conduit spacing and size requirements.
10. 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.
11. Plug conduits brought into pull boxes, manholes, handholes, and other openings until used to prevent entrance of moisture.
12. Install conduits through wall and floor seals where indicated on the Drawings.
13. 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.
14. 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.
15. Install complete conduit systems before conductors are installed.
16. 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.
17. Underground conduits:
    a. Make underground conduit size transitions at handholes and manholes.
    b. 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 26_05_00 - Common Work Results for Electrical.

D. Hazardous areas:
    1. As specified in Section 26_05_00 - Common Work Results for Electrical for hazardous areas and specific Class and Division.
    2. As specified in Section 26_05_02 - Hazardous Classified Area Construction for hazardous area conduit installation requirements.

E. Conduit usage:
    1. Exposed conduits:
        a. Rigid conduit:
            1) Install the rigid conduit type for each location as specified in Section 26_05_00 - 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. Type PVC Schedule 40 and PVC-coated rigid metallic conduit as specified below:
      1) Use Type PCS in underground and embedded installation as follows:
         a) Stub-up and risers to grade floor or equipment from nonmetallic conduits.
         b) Entering and exiting underground or embedded conduit runs a minimum 12 inches above and below grade of finished floor.
         c) For any and all bends where the total deflection is greater than 45 degrees.
   b. Minimum size:
      1) 2-inch in duct banks unless otherwise indicated on the Drawings.
      2) 1-inch for in-slab conduits unless otherwise indicated on the Drawings.
3. PVC:
   a. Conduit terminations shall be via threaded adapters into threaded hubs on the junction boxes or conduit bodies.
   b. Conduit terminations into boxes without threaded hubs shall utilize a threaded adapter and a flat neoprene washer on the outside of the box.
      1) Use a locknut on the inside of the box to tighten the adapter to the box.

c. Route conduit to afford it the maximum physical protection.
    1) If necessary, cover conduit to afford additional protection when it cannot be shielded by the structure or machinery frames.
        a) Use Schedule 80 where exposed runs may be subject to physical damage.

F. 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.
        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.

G. 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.

H. Conduit supports:
   1. General:
      a. Provide appropriate hangers, supports, fasteners, and seismic restraints to suit applications:
         1) As specified in Section 26_05_29 - Hangers and Supports.
         2) Provide support materials consistent with the type of conduit being installed as specified in Section 26_05_00 - 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 conduit supports:
    a. Mount all conduits with hangers specifically designed for use with PVC to minimize the problems of bowing resulting from the expansion and contraction of conduits caused by varying temperatures:
        1) Hangers to be constructed of PVC incorporating serrated teeth to grip the conduit securely and yet allow for conduit movement due to thermal considerations:
        2) Manufacturers: The following or equal:
            a) Carlon: Models E978D, E, F, G, H, and J.
6. 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.

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. 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.
2. Replace any conduits installed that the Engineer determines do not meet the requirements of this Specification.
3. 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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_05_34

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 26_05_00 - 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 26_05_00 - 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 Section 26_05_00 - 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 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - 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. Cast device boxes:
      a. Appleton.
      b. Crouse - Hinds.
      c. OZ/Gedney.
   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. 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.

B. Class I Division 1 areas:
   1. Provide boxes designed and listed for Class I Division 1 locations and group type atmosphere in which they will be used:
      a. The approval ratings must be permanently marked on each item.

C. Class I, Division 2 areas:
    1. For boxes not containing arcing parts:
        a. As specified in Section 26_05_00 - Common Work Results for Electrical.
        b. Pressed metal boxes are not allowed.
    2. For boxes containing arching parts provide:
        a. Boxes designed and listed for Class I Division 1 locations and group type atmosphere in which they will be used:
            1) The approval ratings must be permanently marked on each item.
    3. Cast iron box and cover.
    4. Precision machined flame path between box and cover with neoprene O-ring.
    5. Cast-in-place mounting feet for horizontal or vertical mounting.
    6. For applications requiring hinged cover, provide flexible hinge mounting either left or right side.
    7. External flange.
    8. Provisions for mounting pan.
    9. Ground lug.

D. Stainless steel enclosures:
    1. NEMA Type 4X:
        a. Boxes in locations subject to flooding or temporary submersion:
            1) NEMA Type 6.
    2. Fabricated from 14-gauge Type 316 stainless steel.
    3. All seams continuously welded.
    4. Door:
        a. Rolled lip around 3 sides.
        b. Attached to enclosure by means of a continuous stainless steel hinge and pin.
    5. Neoprene door gasket to provide a watertight seal:
        a. Attached with an adhesive.
        b. Retained by a retaining strip.
    6. Fabricate all external removable hardware for clamping the door to the enclosure body from heavy gauge stainless steel:
        a. With a hasp and staple for padlocking.
    7. Provide large enclosures with door and body stiffeners for extra rigidity.
    8. No holes or knockouts.
    9. Finish:
        a. Brushed.
    10. Stainless steel external mounting brackets when surface mounted.

E. Cast iron junction boxes:
    1. NEMA Type 4.
    2. Recessed cover boxes.
    3. Suitable for use outdoors where subject to rain, dripping, or splashing water.
    4. Designed for flush mounting in walls or floors:
        a. Can be surface mounted using mounting lugs.
    5. Construction:
        a. Cast iron box.
        b. Covers:
            1) Checkered plate covers suitable for foot traffic.
            2) When used in areas subject to vehicular traffic, design to support an AASHTO Standard Specifications for Highway Bridges, H-20 vehicle loading.

c. Hot dip galvanized.
d. Neoprene gasket.
e. Stainless steel screw covers.

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.

D. Floor stand kit when shown:
1. Fabricated from 12-gauge steel.
2. Bottom plate 11-gauge.
3. Heights:
a. 18 inches.

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 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

2. Provide outlet box materials to match the conduit system:
    a. 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 26_05_00 - 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.

F. Hazardous locations:
1. All metallic boxes, fittings, and joints shall utilize threaded connections to the conduit system.
2. All threaded connections shall be wrench tightened so that at least 5 threads are fully engaged.
3. Conduits entering and exiting metallic boxes in Class I Division 2 areas shall utilize approved grounding bushings to bond the conduits together.
4. Provide the following types of conduit bodies and boxes:
    a. Malleable iron bodies and boxes with GRC or IMC conduit systems.
    b. PVC coated conduit bodies and boxes with PCS conduit systems.

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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_05_53

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 26_05_00 - Common Work Results for Electrical.

B. Occupational Safety and Health Administration (OSHA).

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

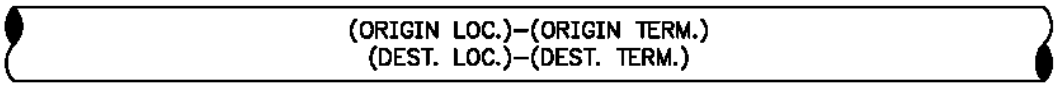
1.04 SYSTEM DESCRIPTION

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 26_05_33 - 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.

OR



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**: 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

4. **Case 2**: 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

5. **Case 3**: 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

6. 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 Section 26_05_00 - 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 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - 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. Non-metallic, one of the following or equal:
      a. Almetek: Mini Tags.
      b. Lapp Group: Maxi System.
   2. Stainless steel, one of the following or equal:
      a. Panduit: Pan Steel.

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. Non-metallic:
      a. UV resistant holder and letters.
      b. Black letters on yellow background.
      c. Minimum letter height: 1/2-inch.
      d. Adhesive labels are not acceptable.
   2. Stainless steel:
      a. Type 304 or 316.
      b. 3/16-inch character height.

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 26_05_00 - 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, or NEMA Type 7 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 non-metallic conduit markers with nylon cable ties:
    a. Provide ultraviolet resistant cable ties for conduit markers exposed to direct sunlight.
6. Attach stainless steel tags with stainless steel cable ties.
7. Mark conduits before construction review by Engineer for punch list purposes.
8. Label intrinsically safe conduits in accordance with the requirements of the NEC.

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 01200 - Contract Closeout.

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 26_05_74

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 26_05_00 - Common Work Results for Electrical.

B. Institute of Electrical and Electronics Engineers (IEEE):
   1. 1584 - IEEE Guide for Performing Arc Flash Hazard Calculations.

C. National Fire Protection Association (NFPA).

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.04 SYSTEM DESCRIPTION

A. General study requirements:
   1. Scope:
      a. The study shall be performed in an Electrical system study software noted herein. The software model of the Electrical system study shall be provided to the Owner at the end of the project.
      b. The short-circuit fault analysis, protective device coordination, and arc-flash hazard studies shall include all 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.

c. 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.

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 and generator 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) 6 copies of the project one-line diagrams for the initial meeting.
         3) 6 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 Section 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.
    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. At least 3 of the copies shall be in color.
            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 26_05_00 - 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 an independent firm.

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 and no equal:
   1. Operation Technology, Inc., ETAP.

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. Arc-flash protection boundary.
    d. Shock hazard boundary:
        1) The Contractor may provide separate labels for indication of the shock hazard boundary.
    e. Description of the combined level of personnel protective equipment.
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 26_05_00 - 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 accessible auxiliary or conductor compartment.
        c. Each accessible rear or side vertical section.
        d. Each motor control center vertical section.
        e. Each panelboard covered by the study.
        f. 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 subfed 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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - 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 26_06_01

CONDUIT SCHEDULE

PART 1 GENERAL

1.01 SUMMARY

A. Conduit requirements:
   1. As defined in Section 26_05_00 and Section 26_05_33.

B. Cable requirements and definitions:
   1. As defined in Section 26_05_00 and Section 26_05_18.
   2. 2/CS#16: 2 conductor, 16 gauge, twisted shielded pair.
   3. MFR: Manufacturer or vendor furnished cable.
   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

MYSTIC HILLS LIFT STATION IMPROVEMENTS

MYSTIC HILLS LS

ENGINEER	**SAI**
REVISION	**0**
DATE	1/31/19

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
C-051	E-6	1"	10	#14	XHHW-2	1	#14	XHHW-2	FR: GEN-0101 TO: MCC-0101 10 #14 >> GEN-0101 CONTROL	
C-052	E-6	1"	6	#14	XHHW-2	1	#14	XHHW-2	FR: GEN-0101 TO: MCC-0101 CONTROL PANEL SECTION 6 #14 >> GEN-0101 CONTROL	
C-110	E-6	1"	12	#14	XHHW-2	1	#14	XHHW-2	FR: JUNCTION BOX TO: MCC-0101 6 #14 >> PMP-0101 CONTROL 6 #14 >> PMP-0102 CONTROL	
C-120	E-6	2"	10	#14	XHHW-2	1	#14	XHHW-2	FR: LEVEL FLOATS - 0101 TO: MCC-0101 CONTROL PANEL SECTION 2 #14 >> LSLL-0101 CONTROL 2 #14 >> LSL-0101 CONTROL 2 #14 >> LSH1-0101 CONTROL 2 #14 >> LSH2-0101 CONTROL 2 #14 >> LSHH-0101 CONTROL	
L-011	E-6	1"	2	#12	XHHW-2	1	#12	XHHW-2	FR: FE-0101 TO: FIT-0101 CONTROL PANEL SECTIONS 2 #12 >> FE-0101 POWER	
L-051	E-6	1"	2 2	#8 #10	XHHW-2 XHHW-2	1	#10	XHHW-2	FR: GEN-0101 TO: LP-0101 2 #8 >> GEN JACK WATER HEATER POWER 2 #10 >> GEN BATTERY CHARGER	
P-001	E-6	4"	6	250	XHHW-2	1	#2	XHHW-2	FR: UTILITY METER PANEL TO: UTILITY TRASNFORMER 3 250 >> UTILITY METER PANEL POWER 3 250 >> UTILITY METER PANEL NEUTRAL	
P-011	E-6	2"	4	#2/0	XHHW-2	1	#2	XHHW-2	FR: SERVICE ENTRANCE DISCONNECT TO: UTILITY METER PANEL 3 #2/0 >> SERVICE ENTRANCE DISC POWER 1 #2/0 >> SERVICE ENTRANCE DISC NEUTRAL	
P-012	E-6	2"	4	#2/0	XHHW-2	1	#2	XHHW-2	FR: SERVICE ENTRANCE DISCONNECT TO: UTILITY METER PANEL 3 #2/0 >> SERVICE ENTRANCE DISC POWER 1 #2/0 >> SERVICE ENTRANCE DISC NEUTRAL	
P-021	E-6	2"	3	#2/0	XHHW-2	1	#2	XHHW-2	FR: MCC-0101 TO: SERVICE ENTRANCE DISCONNECT 3 #2/0 >> MCC-0101 POWER	
P-022	E-6	2"	3	#2/0	XHHW-2	1	#4	XHHW-2	FR: MCC-0101 TO: SERVICE ENTRANCE DISCONNECT 3 #2/0 >> MCC-0101 POWER	
P-051	E-6	2"	3	#2/0	XHHW-2	1	#4	XHHW-2	FR: GEN-0101 TO: MCC-0101 3 #2/0 >> GEN-0101 POWER	
P-052	E-6	2"	3	#2/0	XHHW-2	1	#4	XHHW-2	FR: GEN-0101 TO: MCC-0101 3 #2/0 >> GEN-0101 POWER	
P-081	E-6	2"	3	#3/0	XHHW-2	1	#6	XHHW-2	FR: EX PORTABLE GEN CONNECTION TO: MCC-0101 3 #3/0 >> EX PORTABLE GEN POWER	
P-101	E-6	2"	1	MFR	CABLE	1	#8	XHHW-2	FR: PMP-0101 TO: JUNCTION BOX 1 MFR >> PMP-0101 POWER	
P-105	E-6	1.5"	3	#2	XHHW-2	1	#8	XHHW-2	FR: JUNCTION BOX TO: MCC-0101 3 #2 >> PMP-0101 POWER	
P-111	E-6	2"	1	MFR	CABLE	1	#8	XHHW-2	FR: PMP-0102 TO: JUNCTION BOX 1 MFR >> PMP-0102 POWER	
P-115	E-6	1.5"	3	#2	XHHW-2	1	#8	XHHW-2	FR: JUNCTION BOX TO: MCC-0101 3 #2 >> PMP-0102 POWER	
S-001	E-6	1"	1	MFR	CABLE	1	#14	XHHW-2	FR: LT-0101 TO: LI-0101 CONTROL PANEL SECTION 1 MFR >> LT-0101 SIGNAL	

CONDUIT SCHEDULE

MYSTIC HILLS LIFT STATION IMPROVEMENTS

MYSTIC HILLS LS

ENGINEER	**SAI**
REVISION	**0**
DATE	1/31/19

CONDUIT			CONDUCTORS			GROUND				
NUMBER	**DWG**	**SIZE**	**#**	**SIZE**	**TYPE**	**#**	**SIZE**	**TYPE**	**DESCRIPTION**	**CONNECTING SEGMENTS**
S-011	E-6	1"	1	MFR	CABLE	1	#14	XHHW-2	FR: FE-0101 TO: FIT-0101 CONTROL PANEL SECTIONS 1 MFR >> FE-0101 SIGNAL	
S-051	E-6	1"	1	2/CS-#16		1	#14	XHHW-2	FR: GEN-0101 TO: CONTROL PANEL SECTION 1 2/CS-#16 >> GEN-0101 APPRANT POWER SIGNAL	
X-001	E-6	4"	1	PULL	ROPE		#4		FR: UTILITY METER PANEL TO: UTILITY TRASNFORMER 1 PULL >> SPARE	

END OF CONDUIT SCHEDULE

END OF SECTION

SECTION 26_08_50

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 26_05_00 - Common Work Results for Electrical.

B. American National Standards Institute (ANSI).

C. ASTM International (ASTM):
   1. D877 - Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
   2. D923 - Standard Practices for Sampling Electrical Insulating Liquids.
   3. D924 - Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
   4. D971 - Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method.
   5. D974 - Standard Test Method for Acid and Base Number by Color-Indicator Titration.
   6. D1298 - Standard Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
   7. D1500 - Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).
   8. D1524 - Standard Test Method for Visual Examination of Used Electrical Insulating Oils of Petroleum Origin in the Field.
   9. D1816 - Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using VDE Electrodes.
   10. D2285 - Standard Test Method for Interfacial Tension of Electrical Insulating Oils of Petroleum Origin Against Water by the Drop Weight Method.
   11. D3612 - Standard Test Method for Analysis of Gases Dissolved in Electrical Insulating Oil by Gas Chromatography.

D. 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.

E. Insulated Cable Engineer's Association (ICEA).

F. InterNational Electrical Testing Association (NETA):
1. ATS- Standard for Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.

G. International Electrotechnical Commission (IEC).

H. Manufacturer's testing recommendations and instruction manuals.

I. National Fire Protection Association (NFPA):
1. 70 - National Electrical Code (NEC).
2. 110 - Standard for Emergency and Standby Power Systems.

J. National Institute of Standards and Technology (NIST).

K. Specification sections for the electrical equipment being tested.

L. Shop drawings.

1.03 DEFINITIONS

A. As specified in Sections 01200 - Contract Closeout and 26_05_00 - 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 Section 26_05_00 - Common Work Results for Electrical.

B. Manufacturers' testing procedures:
   1. Submit manufacturers' recommended testing procedures and acceptable test results for review by the Engineer prior to beginning testing.

C. 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.

D. 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.

E. 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.

F. 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 26_05_00 - 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 26_05_00 - 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 26_05_00 - 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.

C. Engine generator tests:
    1. The following individuals must be present and remain at the site during the entire field testing of the engine generator:
        a. Manufacturer's field engineer for the voltage regulator.
        b. Manufacturer's field engineer for the governor and governor controller.
        c. Manufacturer's field engineer for the switchgear.
        d. Load bank operator.
        e. Electrical contractor.

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 01200 - Contract Closeout.

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 Contractor.
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) Perform turns ratio tests at all tap positions.
5) 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. Low voltage molded case case circuit breakers:
a. Visual and mechanical inspection:
1) Compare equipment nameplate data with the Contract Documents.
2) Inspect physical and mechanical condition.
3) Inspect anchorage and alignment.
4) Verify the unit is clean.
5) Operate the circuit breaker to ensure smooth operation.
6) 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.
7) Perform adjustments for final protective device settings in accordance with the coordination study.

b. Electrical tests:
1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
2) Perform insulation-resistance tests for 1 minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed and across each open pole:
a) Apply voltage in accordance with manufacturer's published data.
b) Refer to NETA ATS tables in the absence of manufacturer's published data.
3) Perform a contact/pole-resistance test.

4) Determine long-time pickup and delay by primary current injection.
5) Determine short-time pickup and delay by primary current injection.
6) Determine ground-fault pickup and delay by primary current injection.
7) Determine instantaneous pickup value by primary current injection.
8) Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data.
9) Verify correct operation of any auxiliary features such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free, anti-pump function and trip unit battery condition:
   a) Reset all trip logs and indicators.
10) Verify operation of charging mechanism.

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 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.
   4) Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data:
      a) If manufacturer's data is not available, investigate any values which deviate from adjacent poles or similar breakers by more than 50 percent of the lowest value.
   5) Long-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band including adjustment factors:
      a) If manufacturer's curves are not available, trip times shall not exceed the value shown in NETA ATS tables.
   6) Short-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
   7) Ground fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
   8) Instantaneous pickup values shall be as specified and within manufacturer's published tolerances:
      a) Refer to NETA ATS tables in the absence of manufacturer's published data.
   9) Pickup values and trip characteristics shall be within manufacturer's published tolerances.
   10) Breaker open, close, trip, trip-free, anti-pump, and auxiliary features shall function as designed.
   11) The charging mechanism shall operate in accordance with manufacturer's published data.

6. Instrument transformers - current transformers:
    a. Visual and mechanical inspection:
        1) Compare equipment nameplate data with the Contract Documents.
        2) Inspect physical and mechanical condition.
        3) Verify correct connection of transformers with system requirements.
        4) Verify that adequate clearances exist between primary and secondary circuit wiring.
        5) Verify the unit is clean.
        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 calibrated torque wrench method:
                (1) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
        7) Verify that all required grounding and shorting connections provide contact.
        8) Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
    b. Electrical tests:
        1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
        2) Perform insulation-resistance test of each current transformer and its secondary wiring with respect to ground at 1,000 VDC for 1 minute:
            a) For solid state devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.
        3) Perform a polarity test of each current transformer in accordance with IEEE C57.13.1.
        4) Perform a ratio verification test using the voltage or current method in accordance with IEEE C57.13.1.
        5) Perform an excitation test on current transformers used for relaying applications in with accordance with IEEE C57.13.1.
        6) Measure current circuit burdens at transformer terminals in accordance with IEEE C57.13.1.
        7) When applicable perform insulation-resistance tests on the primary winding with the secondary grounded:
            a) Test voltages shall be in accordance with NETA ATS tables.
        8) Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturer's published data.
        9) Verify that current transformer secondary circuits are grounded and have only 1 grounding point in accordance with IEEE C57.13.3:
            a) That grounding point should be located as specified by the Engineer in the Contract Documents.
    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 of instrument transformers shall be in accordance with manufacturer's published data:
    a) Refer to NETA ATS tables in the absence of manufacturer's published data.
4) Polarity results shall agree with transformer markings.
5) Ratio errors shall be in accordance with IEEE C57.13.
6) Excitation results for current transformers shall match the curve supplied by the manufacturer or be in accordance with IEEE C57.13.1.
7) Measured burdens shall be compared to instrument transformer ratings.
8) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the primary winding is considered to have passed the test.
9) Power-factor or dissipation-factor values shall be compared to manufacturer's published data:
    a) In the absence manufacturer's published data, use the test equipment manufacturer's published data.
10) Test results shall indicate that the circuits have only 1 grounding point.

7. Instrument transformers - voltage transformers:
    a. Visual and mechanical inspection:
        1) Compare equipment nameplate data with the Contract Documents.
        2) Inspect physical and mechanical condition.
        3) Verify correct connection of transformers with system requirements.
        4) Verify that adequate clearances exist between primary and secondary circuit wiring.
        5) Verify the unit is clean.
        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 calibrated torque wrench method:
                (1) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
        7) Verify that all required grounding and connections provide contact.
        8) Verify correct primary and secondary fuse sizes for voltage transformers.
        9) Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
        10) Perform as-left tests.
    b. Electrical tests - voltage transformers:
        1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
        2) Perform insulation-resistance tests winding-to-winding and winding-to-ground:
            a) Test voltage shall be applied for 1 minute in accordance with NETA ATS requirements.
            b) For solid state devices that cannot tolerate the applied voltage, follow the manufacturer's recommendation.
        3) Perform a polarity test on each voltage transformer to verify the polarity marks on H_1- X_1 relationship as applicable.

4) Perform a turns ratio test on all tap positions.
5) Measure voltage circuit burdens at transformer terminals.
6) Perform a dielectric withstand test on the primary windings with the secondary windings grounded:
    a) The dielectric voltage shall be in accordance with NETA ATS tables.
    b) Apply the test voltage for 1 minute.
7) Perform power-factor or dissipation-factor tests in accordance with test equipment manufacturers published data.
8) Verify that voltage transformer secondary circuits are grounded and have only 1 grounding point in accordance with IEEE C57.13.3:
    a) That grounding point should be located as specified by the Engineer in the Contract Documents.

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 of instrument transformers shall be in accordance with manufacturer's published data:
    a) Refer to NETA ATS tables in the absence of manufacturer's published data.
4) Polarity results shall agree with transformer markings.
5) Ratio errors shall be in accordance with IEEE C57.13.
6) Measured burdens shall be compared to instrument transformer ratings.
7) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the primary winding is considered to have passed the test.
8) Power-factor or dissipation-factor values shall be compared to manufacturer's published data:
    a) In the absence manufacturer's published data, use the test equipment manufacturer's published data.
9) Test results shall indicate that the circuits have only 1 grounding point.

8. Metering devices, microprocessor based:
a. Visual and mechanical inspection:
1) Compare equipment nameplate data with the Contract Documents.
2) Inspect meters and cases for physical damage.
3) Clean front panel.
4) Verify tightness of electrical connections.
5) Record the following:
    a) Model number.
    b) Serial number.
    c) Firmware revision.
    d) Software revision.
    e) Rated control voltage.
6) Verify operation of display and indicating devices.

7) Record passwords.
8) Verify the unit is grounded in accordance with the manufacturer's instructions.
9) Set all required parameters including instrument transformer ratios, system type, frequency, power demand methods/intervals, and communications requirements.

b. Electrical tests:
1) Apply voltage or current as appropriate to each analog input and verify correct measurement and indication.
2) Confirm correct operation and setting of each auxiliary input/output feature including mechanical relay, digital and analog.
3) After initial system energization, confirm measurements and indications are consistent with loads present.

c. Test values:
1) Nameplate data shall match the Contract Documents.
2) Tightness of electrical connections shall ensure a low resistance connection.
3) Display and indicating devices shall operate per manufacturer's published data.
4) Measurement and indication of applied voltages and currents shall be within the manufacturer's published tolerances for accuracy.
5) All auxiliary input/output features shall operate per settings and manufacturer's published data.
6) Measure and indications shall be consistent with energized system loads.

9. 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 26_05_26 - Grounding and Bonding.
5) Investigate point-to-point resistance values that exceed 0.5 ohm.

10. 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.
        10) Perform vibration test while machine is running under load.

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.

11. Motor starters, low voltage:
    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) Verify the unit is clean.
        5) Inspect contactors:
            a) Verify mechanical operation.
            b) Verify contact gap, wipe, alignment, and pressure is in accordance with manufacturer's published data.
        6) Motor-running protection:
            a) Verify overload element rating/motor protection settings are correct for its application.
            b) If motor running protection is provided by fuses, verify correct fuse rating.
        7) 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.
        8) Lubrication requirements:
            a) Verify appropriate lubrication on moving current-carrying parts.
            b) Verify appropriate lubrication on moving and sliding surfaces.
    b. Electrical tests:
        1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
        2) Perform insulation-resistance tests for 1 minute on each pole, phase-to-phase and phase to ground with the starter closed, and across each open pole for 1 minute:
            a) Test voltage shall be in accordance with manufacturer's published data.
            b) Refer to NETA ATS tables in the absence of manufacturer's published data.
        3) Test motor protection devices in accordance with manufacturer's published data.
        4) Test circuit breakers as specified in this Section.
        5) Perform operational tests by initiating control devices.
    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 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.
4) Motor protection parameters shall be in accordance with manufacturer's published data.
5) Circuit breaker test results shall as specified in this Section.
6) Control devices shall perform in accordance with system design requirements.

12. 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 an 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.

13. Surge arresters, 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 clearances.
      4) Verify the arresters are clean.
      5) 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.
      6) Verify that the ground lead on each device is individually attached to a ground bus or ground electrode.
      7) Verify that stroke counter is correctly mounted and electrically connected, if applicable.
      8) Record stroke counter reading.
   b. Electrical tests:
      1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
      2) Perform an insulation-resistance test on each arrester, phase terminal- to- ground:
         a) Apply voltage in accordance with manufacturers published data.
         b) Refer to NETA ATS tables in the absence of manufacturer's published data.
      3) Test grounding connection 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 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.
    4) Resistance between the arrester ground terminal and the ground system shall be less than 0.5 ohm.

14. Single Engine generator:
    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.
    b. Electrical and mechanical tests:
        1) Perform insulation-resistance tests in accordance with IEEE 43:
            a) Machines larger than 150 kilowatts: Test duration shall be 10 minutes. Calculate polarization index.
            b) Machines 150 kilowatts and less: Test duration shall be 1 minute. Calculate the dielectric-absorption rate.
        2) Test protective relay devices as specified in this Section.
        3) Verify phase rotation, phasing, and synchronized operation as required by the application.
        4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
        5) Conduct performance test in accordance with NFPA 110.
        6) Verify correct functioning of governor and regulator.
        7) Load bank testing:
            a) Provide a resistive load bank to test the operation of the engine generator.
            b) Load bank shall be capable of loading the engine generator to its full nameplate kilowatt rating at unity power factor.
            c) Load steps shall simulate the plant load steps used in sizing the engine generator.
            d) Test run at full nameplate kilowatt rating for a minimum of 4 hours:
                (1) Record at 10 minute intervals:
                    (a) Voltage.
                    (b) Frequency.
                    (c) Current.
                    (d) Power factor.
                    (e) Engine oil pressure.
                    (f) Engine oil temperature.
                    (g) Air inlet temperature.

(h) Radiator discharge temperature.
(i) Engine coolant temperature.
(j) Vibration levels at each main bearing cap.

c. Test values:
1) Anchorage, alignment, and grounding should be in accordance with manufacturer's published data and system design.
2) The dielectric absorption ratio or polarization index shall be compared to previously obtained results and should not be less than 1.0. The recommended minimum insulation ($IR_{1\ min}$) test results in megohms shall be corrected to 40 degrees Celsius and read as follows:
a) $IR_{1\ min}$ equals kilovolt + 1 for most windings made before 1970, all field windings, and others not described below.
(1) Kilovolt is the rated machine terminal-to-terminal voltage in rms kilovolt.
b) $IR_{1\ min}$ equals 100 megohms for most dc armature and ac windings built after 1970 (form-wound coils).
c) $IR_{1\ min}$ equals 5 megohms for most machines and random-wound stator coils and form-wound coils rated below 1 kilovolt.
(1) Dielectric withstand voltage and surge comparison tests shall not be performed on machines having lower values than those indicated above.
3) The polarization index value shall not be less than 2.0.
4) The dielectric absorption ratio shall be greater than 1.0.
5) Protective relay device test results shall be as specified in this Section.
6) Phase rotation, phasing, and synchronizing shall be in accordance with system design requirements.
7) Low oil pressure, over temperature, over speed, and other protection features shall operate in accordance with manufacturer's published data and system design requirements.
8) Vibration levels shall be in accordance with manufacturer's published data and shall be compared to baseline data.
9) Performance tests shall conform to manufacturer's published data and NFPA 110.
10) Governor and voltage regulator shall operate in accordance with manufacturer's published data and system design requirements:
a) Steady state voltage regulation shall be within 0.5 percent of set point.
b) The output voltage of the generator shall not fall below 10 percent of the power system nominal rating for more than 5 seconds.
c) The output voltage of the generators shall not exceed the power system nominal rating at any time.
d) Steady state frequency regulation shall be within 59.5 hertz to 60.5 hertz.
e) Frequency variations shall not exceed 2 hertz from 60 hertz for more than 2 seconds.

15. Automatic transfer switches:
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.
5) Lubrication requirements:
    a) Verify appropriate lubrication on moving current-carrying parts.
    b) Verify appropriate lubrication on moving and sliding surfaces.
6) Verify that manual transfer warnings are attached and visible.
7) Verify tightness of all control connections.
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 calibrated torque wrench:
        (1) Refer to manufacturer's instructions for proper foot-pound levels or NETA ATS tables.
9) Perform manual transfer operation.
10) Verify positive mechanical interlocking between normal and alternate sources.

b. Electrical tests:
1) Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
2) Perform insulation-resistance tests on all control wiring with respect to ground. Applied potential shall be 500 VDC for 300-volt rated cable and 1,000 VDC for 600-volt rated cable. Apply the test voltage for 1 minute:
    a) For units with solid-state components or for control devices that cannot tolerate the applied voltage, follow manufacturer's recommendation.
3) Perform a contact/pole-resistance test.
4) Verify settings and operation of control devices.
5) Calibrate and set all relays and timers as specified in this Section.
6) Verify phase rotation, phasing, and synchronized operation as required by the application.
7) Perform automatic transfer tests:
    a) Simulate loss of normal power.
    b) Return to normal power.
    c) Simulate loss of emergency power.
    d) Simulate all forms of single-phase conditions.
8) Verify correct operation and timing of the following functions:
    a) Normal source voltage-sensing and frequency-sensing relays.
    b) Engine start sequence.
    c) Time delay upon transfer.
    d) Alternate source voltage-sensing and frequency-sensing relays.
    e) Automatic transfer operation.
    f) Interlocks and limit switch function.
    g) Time delay and retransfer upon normal power restoration.
    h) Engine cool down and shutdown feature.

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:
3) Refer to NETA ATS tables in the absence of manufacturer's published data.
4) Insulation resistance values of transfer switches shall be in accordance with manufacturer's published data:
    a) Refer to NETA ATS tables in the absence of manufacturer's published data.
    b) Values of insulation resistance less than this table or manufacturer's recommendations shall be investigated.
5) Insulation-resistance values of control wiring shall not be less than 2 megohms.
6) Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data:
    a) If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
7) Control devices shall operate in accordance with manufacturer's published data.
8) Relay test results shall be as specified in this Section.
9) Phase rotation, phasing, and synchronization shall be as specified in the system design specifications.
10) Operation and timing shall be in accordance with manufacturer's and system design requirements.

3.08 FIELD QUALITY CONTROL (NOT USED)

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_09_13

ELECTRICAL POWER MONITORING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Power meters.

1.02 REFERENCES

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. American National Standard Institute (ANSI):
   1. C12.20 - Electricity Meters - 0.2 and 0.5 Accuracy Classes.

C. Institute of Electrical and Electronics Engineers (IEEE):
   1. C57.13.6 - Standard for High Accuracy Instrument Transformers.

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Specific definitions:
   1. FS - Full Scale.
   2. RDG - Of Reading.
   3. SSM - Solid State Multifunction Power Meter.
   4. THD - Total Harmonic Distortion.

1.04 SYSTEM DESCRIPTION (NOT USED)

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26_05_00 - Common Work Results for Electrical.

B. Product data:
   1. Power meter data including but not limited to:
      a. Power requirements.
      b. Communications protocols.
      c. Input/outputs.
      d. Dimensions.
      e. Measurement functions.
      f. Front panel controls.
      g. Display characteristics.

C. Operation and maintenance manuals:
   1. Descriptive and technical bulletins and sales aids edited to reflect only the equipment to be provided and covering each of the components in the system.
   2. A maintenance section including all instruction leaflets and technical data necessary to setup, change setup and maintain the power meters.
   3. Original licensed copies of all software and software manuals.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Same manufacturer as Motor Control Center.

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. Power meters:
   1. Power meter type 2 (SSM2) device which shall include at a minimum:
      a. Individual phase currents, plus or minus 0.3 percent FS.
      b. Phase-to-phase and phase-to-neutral voltages, plus or minus 3 percent FS.
      c. Watts, VARs, VA, plus or minus 6 percent FS.
      d. Watt-hours 0.6 percent FS; VAR-hours 0.6 percent FS; VA-hours 0.6 percent FS.
      e. PF apparent 1 percent FS; PF displacement 1 percent FS.
      f. Frequency 0.17 percent FS.
      g. THD:
         1) Voltage - 31st harmonic.
         2) Current - 31st harmonic.
      h. Demand:
         1) Ampere, plus or minus 0.3 percent FS.
         2) Watt, VAR, VA, plus or minus 0.6 percent FS.
      i. Minimum and maximum values:
         1) Volts (L-L), volts (L-N), current (L), watts, VARs, VA.
         2) PF (apparent and displacement).
         3) Frequency.
         4) THD-amps, THD-volts.
         5) Demand:
            a) Ampere, watt, VAR, VA.
      j. Trend analysis:
         1) 2 selectable parameters.
      k. Other features:
         1) 3 form C relays, rated 10 amps.
      l. Kilowatt hour pulse initiator.
      m. Synch-input kilowatt utility.
      n. Graphic LCD with LED backlight:
         1) Seven lines, 147 characters.

2.07 ACCESSORIES

A. Current transformers:
   1. Ring type current transformers:
      a. Suitable for service within low or medium voltage equipment as indicated on the Drawings.
      b. Designed to have a mechanical and thermal rating to withstand short-circuit current, stresses, and heating effects equal to the rating of the equipment of the application.
   2. Current ratio: As indicated on the Drawings, for use as a guideline:
      a. It is the manufacturer's responsibility to size the current transformers to ensure that they will not saturate under the maximum available fault current at the installed location based upon the fault current study as specified in Section 26_05_74 - Electrical System Studies.
   3. Rated in accordance with IEEE C57.13.6 with accuracy of the current transformers suitable for relay accuracy class and rated for 200 percent burden for the required connected devices.
   4. Identify polarity with standard marking or symbols.

5. Capable of carrying rated primary current continuously without damage.
6. Install secondary wiring from current transformers in a suitable wiring trough, or conduit to proper short-circuiting type terminal blocks for connection to relays, instruments, and other devices.

B. Potential transformers:
1. Indoor dry type, single-phase, 60 hertz, with a minimum thermal capacity of not less than 400 volt-amperes at 55 Celsius rise above 40 Celsius ambient.
2. Accuracy classification determined in accordance with IEEE C57.13.6, suitable for relay accuracy class, and 200 percent burden, for the required connected devices, with the secondary voltage 120 volts.
3. Insulation levels as required for the equipment system voltage but not less than:
   a. 600 VAC, 10 kV BIL for 480 VAC systems.
   b. 5.6 KV, 60 kV BIL for 2300 and 4160 VAC systems.
   c. 15.5 KV, 110 kV BIL for 12.47 kV and 13.2 kV systems.
4. Identify polarity with standard markings or symbols.
5. Connect transformer secondary to potential buses as required.
6. Protect medium voltage potential transformers on the primary side with medium voltage current-limiting fuses.
7. Protect low voltage potential transformers on the primary side and secondary side with current-limiting fuses.
8. Mount medium voltage potential transformers in a separate compartment on a drawout device which, when in the FULLY WITHDRAWN position, disconnects both primary and secondary terminals of the transformer and grounds the primary potential fuses.

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 26_05_00 - Common Work Results for Electrical.

B. Install power meters in the electrical equipment as 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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 26_05_00 - Common Work Results for Electrical

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_22_14

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 26_05_00 - 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. C57.96 - 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 26_05_00 - 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 26_05_00 - 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 Section 26_05_00 - 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 26_05_00 - 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 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Same manufacturer as Motor Control Center.

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. 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. 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 26_05_00 - 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 liquidtight 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 3-1/2-inch 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 01200 - Contract Closeout.

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 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_24_16

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 26_05_00 - Common Work Results for Electrical.

B. Underwriter's Laboratories, Inc. (UL):
   1. 67 - Standard for Panelboards.

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - 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 Section 26_05_00 - 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 26_28_01 - 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 26_05_00 - 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 26_05_00 - 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 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Same manufacturer as Motor Control Center.

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 26_05_00 - 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. Interior design such that replacement of circuit breakers does not require disturbing adjacent units or removal of the main bus connectors.
   10. NEMA Type 1 interior panelboard, unless otherwise indicated.

B. Bus:
   1. General:
      a. Tin-plated copper.
   2. Phase bus:
      a. Full size and height without reduction.
      b. Sized in accordance with UL standards to limit temperature rise on any current carrying part to a maximum of 50 degrees Celsius:
         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. 200 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 26_28_01 - 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. Surge protective devices:
   1. Furnish panelboards with surge protective devices as indicated on the Drawings.
   2. As specified in Section 26_43_14 - Surge Protective Devices.

B. Nameplates:
   1. As specified in Section 26_05_53 - Identification for Electrical Systems.
   2. Install on outside of door.
   3. Indicating:
      a. Panel designation.
      b. Voltage.
      c. Number of phases and configuration.

C. 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.

D. 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 26_05_00 - 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, flush or MCC 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. In all NEMA Type 4 and NEMA Type 4X locations, mount panelboards on 7/8-inch deep stainless steel preformed channel, with channel running vertically from top to bottom of panelboard:
      a. Use only stainless steel mounting hardware.
   6. 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 01200 - Contract Closeout.

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 26_05_00 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.11 PROTECTION

A. As specified in Section 26_05_00 - 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 26_24_20

LOW VOLTAGE MOTOR CONTROL CENTERS

PART 1GENERAL

1.01 SUMMARY

A. Section includes:
   1. Low voltage motor control centers.

1.02 REFERENCES

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. National Electrical Manufacturer's Association (NEMA):
   1. ICS 18-2001 - Motor Control Centers.

C. Underwriters Laboratories (UL):
   1. 845 - Motor Control Centers.

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.04 SYSTEM DESCRIPTION

A. Factory assembled, factory wired and factory tested motor control centers:
   1. Motor control centers and major components to be products of a single manufacturer.

B. The Motor Control Center shall have service entrance rated Auto Transfer Switch.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26_05_00 - Common Work Results for Electrical.

B. Product data:
   1. Manufacturer of motor control center.
   2. Manufacturer of motor control center parts.
   3. Nameplate schedule.
   4. Bill of material.
   5. Enclosure:
      a. NEMA rating.
      b. Finish color.
   6. Ratings:
      a. Voltage.
      b. Phase.

c. Current:
    1) Horizontal bus ampacity.
    2) Vertical bus ampacity.
    3) Ground bus ampacity.
d. Short circuit withstand rating.
e. Protective device interrupting rating.

7. List of recommended spare parts.
8. Catalog cut sheets:
    a. Submit complete manufacturer's catalog information:
        1) Clearly indicate the features of the equipment including any options necessary to meet the required functionality.
9. Furnish component submittals as specified in the appropriate Section.
10. For equipment installed in structures designated as seismic design category C, D, E, or F submit the following as specified in Section 26_05_00 - 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. Layout drawings:
    a. Provide fully dimensioned and to scale layout drawings which include:
        1) Dimensions:
            a) Overall length.
            b) Overall width.
            c) Overall height.
            d) Overall weight and weight of individual shipping splits.
2. Interfaces to other equipment.
3. Shipping splits.
4. Allowable top and bottom conduit windows.
5. Complete component and unit layout drawings.
6. Indicate lug sizes, type, and manufacturer based on the cable size specified in the Contract Documents and as indicated on the Drawings.
7. Elementary schematics:
    a. Provide one custom schematic diagram for each compartment:
        1) Include all remote devices.
        2) Show wire numbers on the schematics:
            a) Provide wire numbering as specified in Section 26_05_53 - Identification for Electrical Systems.
8. External connection diagram showing the wiring to the external controls and devices associated with the motor control center.
9. One-line diagrams:
    a. Provide complete one-line diagrams for each motor control center, including but not limited to: protective devices, starters, drives, metering, and other equipment.
    b. Indicate electrical ratings of the equipment shown on the one-line diagrams.

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 26_05_00 - 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. Provide complete operating and maintenance instructions presenting full details for care and maintenance of all types of equipment furnished and/or installed under this Section. Include the following:
    a. Electrical ratings:
        1) Phase.
        2) Wire.
        3) Voltage.
        4) Ampacity.
        5) Bus bracing and protective device interrupting ratings.
    b. Manufacturer's operating and maintenance instructions for the motor control center and all component parts, including:
        1) Starters.
        2) Overload relays and heater elements.
        3) Variable frequency drives.
        4) Protective devices including, but not limited to, fuses, circuit breakers and protective relays.
        5) Pilot devices.
    c. Complete renewal parts list.

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. Record Documents:
1. Elementary schematics:
    a. Furnish as-built elementary schematics indicating final:
        1) Wire numbers.
        2) Interfaces with other equipment.
    b. Provide one custom schematic diagram for each compartment:
        1) Include all remote devices.
        2) Show wire numbers on the schematics.
    c. Layout drawings: Provide complete dimensioned component and unit layout drawings.
2. The Record Documents shall reflect all modifications made during the submittal review process and during construction.

I. Calculations:
   1. Detailed calculations or details of the actual physical testing performed on the motor control center to prove the motor control center is suitable for the seismic requirements at the Project Site.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. All portions of the motor control center, vertical bays, and components shall be UL listed and labeled.
   1. Where indicated as service entrance equipment, the motor control center shall be UL labeled and listed "Suitable for Service Entrance".

1.07 DELIVERY, STORAGE AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Ship the motor control center and associated equipment to the job site on a dedicated air ride vehicle that will allow the Contractor to utilize onsite off-loading equipment.

C. Furnish temporary equipment heaters within the motor control center to prevent condensation from forming.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING

A. Conduct the initial fault current study as specified in Section 26_05_74 - Electrical System Studies and submit results for Engineer's review.

B. After successful review of the initial fault current study, as specified in Section 26_05_74 - Electrical System Studies, submit complete equipment submittal.

C. Conduct factory acceptance test.

D. Submit Manufacturer's Certificate of Installation and Functionality Compliance.

E. Ship equipment to the Project Site after successful completion of factory acceptance test.

F. Assemble equipment in the field.

G. Conduct field acceptance test and submit results for Engineer's review.

H. Submit manufacturer's certification that the equipment has been properly installed and is fully functional for Engineer's review.

I. Conduct Owner's training sessions.

J. Commissioning and process start-up as specified in Section 01200 - Contract Closeout.

1.10 SCHEDULING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - 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. Allen-Bradley.
   2. Eaton.
   3. General Electric.
   4. Schneider Electric.

2.02 EXISTING PRODUCTS

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. General:
   1. Furnish motor control centers as specified in the Contract Documents and indicated on the Drawings.
   2. Arrange the equipped sections to form continuous motor control center lineups as indicated on the Drawings:
      a. Identify any deviations from the Drawings in writing and submit for approval.
   3. Provide wire markers at each end of every wire as specified in Section 26_05_53 - Identification for Electrical Systems.
   4. Provide complete and functional motor control centers.
   5. Provide devices or accessories not specified in this Section but necessary for the proper installation and operation of the equipment.

B. Design and construct motor control center to operate at the voltage level and configuration indicated on the Drawings.

C. Bus system:
    1. Material:
        a. Tin-plated copper.
        b. Short-circuit rating:
            1) As indicated on the Drawings.
        c. Bus bar supports:
            1) High impact strength, non-tracking glass-polyester material that is impervious to moisture and gases.
    2. Horizontal power bus:
        a. Current-carrying capacity as indicated on the Drawings.
        b. Mounting:
            1) Mount horizontal bus bars edgewise, one above the other, and fully isolated from all wireways and units.
        c. Temperature rise:
            1) In accordance with UL 845.
            2) De-rate the temperature rating of the bus for the specified conditions of ambient temperature and altitude as specified in Section 26_05_00 - Common Work Results for Electrical.
    3. Vertical power bus:
        a. Current-carrying capacity of not less than 600 amps.
        b. Mounting:
            1) Enclose the vertical bus in a polyester-glass cover with small openings to permit unit stabs to mate with the bus:
                a) Provide a shutter mechanism to cover the stab openings when plug-in units are removed.
            2) Provide top and bottom bus covers for insulation and isolation of the ends of the bus.
        c. Isolated from the unit compartments by a full height barrier.
    4. Ground bus:
        a. Horizontal ground bus:
            1) Current-carrying capacity:
                a) 300 amps when the horizontal bus is 2,000 amps or less.
                b) 600 amps when the horizontal bus is greater than 2,000 amps.
            2) Mounting:
                a) Full-width, firmly secured to each vertical section structure:
                    (1) Located in the top or bottom wireway.
                b) Pre-drilled and furnished with lugs for connection to equipment ground wires:
                    (1) Furnish a minimum of 10 lugs per vertical section of MCC.
        b. Vertical ground bus.
            1) Mounting:
                a) Furnish in each vertical section.
                b) Bolted to the horizontal ground bus.
                c) Install parallel to the vertical power bus.
                d) Mount vertical ground bus such that plug-in units engage the ground bus before any connection to the power bus is made. Upon removal of plug-in units, ground stabs are disconnected from the ground bus after the power stabs have been disconnected.
    5. Bus splice bars:
        a. Provided to join the bus at the splits.
        b. Connected to each horizontal bus bar with a minimum of two bolts.

c. Employ conical or spring washers at connections, designed to maintain constant pressure against the splice joint.
d. Same ampacity rating as the horizontal bus.

6. Provide bus system configured for back-to-back MCCs, where required.

D. Enclosures:
1. Each motor control center shall consist of 1 or more vertical sections bolted together:
a. Freestanding.
b. Totally enclosed.
c. Dead-front assembly.
d. Designed for modification and/or addition of future vertical sections.
e. Form each vertical section of heavy gauge steel.
f. Designed for back-to-back arrangement installation, where required and/or as indicated on the Drawings.
2. Enclosure rating:
a. Outdoor:
1) NEMA Type 3R non-walk-in with separate interior enclosure:
a) Interior enclosure:
(1) NEMA Type 1 gasketed.
3. Standard section dimensions:
a. Nominal height: 90 inches.
b. Nominal depth: 20 inches.
c. Vertical section width as indicated on the Drawings.
4. Wireways:
a. Provide each vertical section with a horizontal wireway at the top and bottom of the section:
1) Arranged to provide a full-width metal enclosed wiring trough across the entire motor control center assembly.
b. Provide each vertical section with a full-height vertical wireway.
c. Completely isolated from the vertical and horizontal bus bars.
d. Provide a removable, hinged door.
5. Shipping splits:
a. No more than 3 vertical sections and not more than 60 inches in width.
b. Solid bussing between vertical sections in a shipping split is not acceptable.
6. Lifting angles:
a. Furnish each vertical section and/or shipping split with a removable lifting angle mounted to the top of the enclosure:
1) Extending the entire width of the shipping split.
7. Mounting channels:
a. Mount each vertical section and/or shipping split on an external 1.5-inch by 3-inch mounting channel.

E. Units:
1. A plug-in unit consists of:
a. Unit assembly.
b. Unit support pan.
c. Unit door assembly.
2. Completely enclosed and isolated from adjacent units, buses, and wireways, except for conductor entries into the unit, by a metal enclosure.
3. Constructed so that any fault will be contained in the unit compartment.

4. Supported and guided by a removable unit support pan:
    a. Re-arrangement of units and the removal of a unit so that a new and possibly larger unit can be added without the removal of an in-service unit to gain access to the unit support pan.
5. Held in place by screws or other positive locking means after insertion.
6. Provide a test position with the unit supported in the structure but disengaged from the bus.
7. Integral plug-in ground stab.
8. Stabs:
    a. Free floating.
    b. Self-aligning.
    c. Backed by spring steel clips to ensure high pressure contacts.
    d. Electrolytically tin-plated copper.
9. Handle:
    a. Provide a flange mounted handle mechanism to operate each disconnect switch or circuit breaker.
    b. Door mounted operators or operator handles are not acceptable.
    c. Engaged with the disconnect device at all times as an integral part of the unit independent of the door position.
    d. Lockable in the "OFF" position with up to 3 padlocks.
    e. Mechanically interlocked so that the door cannot be opened with the handle in the "ON" position.
        1) Provide a means for qualified personnel to defeat this interlock.
    f. Interlocked so the unit cannot be inserted or withdrawn with the handle in the "ON" position.
    g. Lockable in the "ON" position:
        1) This shall not prevent the circuit breaker from operating and opening the contacts in the event of a fault condition.
    h. Color-coded to indicate position.
    i. Located so the center of the grip when it is in its highest position is not more than 6 feet 7 inches above the finished floor, including the height of the housekeeping pad and mounting channels.
10. Where indicated on the Drawings, provide units for spaces and future equipment:
    a. Equip these units to accept a future plug-in unit without modification to the vertical sections.

2.06 COMPONENTS

A. Provide components contained within the motor control center as specified in:
1. Section 26_05_53 - Identification for Electrical Systems.
2. Section 26_05_18 - 600-Volt or Less Wires and Cables.
3. Section 26_05_21 - Low Voltage Wire Connections.
4. Section 26_09_13 - Electrical Power Monitoring.
5. Section 26_22_14 - Dry-Type Transformers.
6. Section 26_43_14 - Surge Protective Devices.
7. Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.
8. Section 26_29_05 - Motor Starters.
9. Section 26_24_16 - Panelboards.
10. Section 26_36_24 - Transfer Switches.

2.07 ACCESSORIES

A. Wiring:
   1. Wire the motor control center in accordance with the following NEMA Class and Type as defined by NEMA ICS 18-2001:
      a. NEMA Class II-S:
         1) Furnish wiring diagrams for individual units consisting of drawings that identify electrical devices, electrical connections, and indicate terminal numbering designations.
         2) Furnish individual unit diagrams with each unit and include inter-wiring between units, i.e. electrical interlocking, etc., as specifically specified in the Contract Documents.
         3) Provide custom drawings with unique terminal numbering designations in lieu of standard manufacturer drawings.
      b. NEMA Type B wiring:
         1) Control wiring:
            a) Type B-T pull-apart terminal blocks.
         2) Power wiring:
            a) Type B-T for Size 1 starters.
            b) Type B-T or B-D for Size 2 and 3 starters.
            c) Type B for Size 4 and larger starters and feeder units.

B. Lugs and terminals:
   1. For all external connections of No. 6 AWG wire or larger:
      a. UL listed for copper or aluminum conductors.
   2. Compression type, requiring a hydraulic press and die for installation.
   3. Provide 20 percent spare control block terminals.

C. Nameplates:
   1. Provide nameplates as specified in Section 26_05_53 - Identification for Electrical Systems:
      a. Identifying the motor control center designation as indicated on the Drawings.
   2. Identifying each vertical section:
      a. Mounted and centered on the top horizontal wireway of the vertical section.
   3. Furnish individual nameplates for each unit indicated on the Drawings:
      a. 1 nameplate to identify the unit designation.
      b. 1 nameplate to identify the load served.
      c. Furnish space units with blank nameplates.
   4. Manufacturer's labels:
      a. Furnish each vertical section with a label identifying:
         1) Serial number.
         2) Bus rating.
         3) Vertical section reference number.
         4) Date of manufacture.
         5) Catalog number of section.

D. Overcurrent protection device - 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.
3. Provide circuit breakers as specified in Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.

E. Selection and ratings of protective devices:
1. Interrupting ratings: Not less than the system maximum available fault current at the point of application.
2. Voltage rating: Not less than the voltage of the application.
3. Select current rating and trip characteristics to be suitable for:
   a. Maximum normal operating current.
   b. Inrush characteristics.
   c. Coordination of the protective devices to each other and to the source breaker feeding the panel.

F. Provide a separate protective device for each powered electrical device:
1. An individual circuit breaker for each 120-VAC instrument installed within its respective control panel and clearly identified for function.
2. An individual fuse for each PLC discrete output. Provide with individual blown fuse indication external of the I/O card:
   a. Size external fuse to open before any I/O-card-mounted fuses.
   b. Individual discrete inputs shall use a 0.5-ampere fuse.
3. Control loops can use individual 5-ampere fuse for the loop.
4. Install protective devices on the back mounting panel and identify by a service nameplate in accordance with the wiring diagrams.

G. Fuses for 4 to 20 milliamperes signals:
1. Provide durable, readily visible label for each fuse, clearly indicating the correct type, size, and ratings of replacement fuse:
   a. Label shall not cover or interfere with equipment manufacturer's instructions.
2. An individual 1/2-ampere fuse for each 4 to 20 milliamperes analog loop powered from the control panel.
3. Provide fuses rated for the voltage and available short-circuit current at which they are applied.
4. Manufacturers: One of the following or equal:
   a. Ferraz Shawmut.
   b. Littelfuse.
   c. Bussmann.

H. Fuse holders:
1. Modular type:
   a. DIN rail mounting on 35-millimeter rail.
   b. Touch-safe design: All connection terminals to be protected against accidental touch.
   c. Incorporates blown-fuse indicator.
   d. Plug-in style fuse terminals and fuse plugs are not acceptable.
2. Provide nameplate identifying each fuse:
   a. As specified in Section 26_05_53 - Identification for Electrical Systems.
3. Manufacturers: One of the following or equal:
   a. Phoenix Contact, UT4-HESI Series.
   b. Allen-Bradley, 1492-FB Series B.

I. Control circuit breakers:
   1. DIN rail mounting on 35-millimeter rail.
   2. Manual OPEN-CLOSE toggle switch.
   3. Rated for 250 VAC.
   4. Interrupting rating: 10 kiloampere (kA) or available fault current at the line terminal, whichever is higher.
   5. Current ratings: As required for the application.
   6. Provide nameplate identifying each circuit breaker:
      a. As specified in Section 26_05_53 - Identification for Electrical Systems.
   7. Manufacturers: One of the following or equal:
      a. Phoenix Contact, TMC Series.
      b. ABB.
      c. Allen-Bradley.
      d. Square D.

J. Electronic circuit protectors:
   1. Used where equipment is equipped with a NEC Class 2 power supplies requiring 100 watts to 8 amps.
   2. DIN rail mounting on 35-millimeter rail.
   3. Rated for 24 VDC.
   4. 4 channels to feed 4 independent power feeds to separate devices.
   5. Output current ratings: As required for the application.
   6. LED input status indication.
   7. LED failure status of each channel indication.
   8. Fail contacts.
   9. Provide nameplate identifying each circuit breaker:
      a. As specified in Section 26_05_53 - Identification for Electrical Systems.
   10. Manufacturers: One of the following or equal:
      a. Rockwell Automation 1692-TD014.
      b. Puls PISA11 series.

K. 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.

L. 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. 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.
5. 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.

M. 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 continuous (minimum).
        3) 7,200 volt-amperes make.
        4) 720 volt-amperes 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. Alternating Relay:
    a. Manufacturer: One of the following or equal:
        1) Allen Bradley 700-HTA Alternating relay- 700-HTA-3-A12-7.
        2) Control voltage 120VAC.
        3) Power - 4 VA.
        4) Duty cycle - Continuous.
        5) Contact ratings
            a) 3-30 amps, 1/3 hp @ 120 VAC.
            b) 1-15 amps, 1/2 hp @ 240 VAC.
            c) 10A @ 30VDC.

N. Intrinsic safety barriers:
    1. Transformer isolated barrier:
        a. Containing a transformer to provide complete:
            1) Isolation between the safe and hazardous areas for loop-powered devices.
            2) 3-way isolation between the safe area, hazardous area, and power supply powered devices.
        b. Resistor for current limitation.
        c. Fuses for short-circuit protection.
        d. Provide barriers with pluggable connectors that are coded for easy replacement.
        e. Transmission error shall be less than or equal to 0.1 percent of full-scale.
        f. DIN rail mounting on 35-millimeter rail.
        g. Approvals:
            1) FM.
            2) UL 913.
    2. Types:
        a. Switch isolators:
            1) Designed and approved for use with discrete inputs.
            2) Supply power: 20 to 30 VDC.
            3) Output to track input.
            4) LED in the cover to indicate the status of the input.
            5) Selector switch to change the logic of the input.
            6) Input: Dry contact.
            7) Output: SPDT relay.
        b. Transmitter and converters for use with 4- to 20-milliampere signals without Hart® communications capability:
            1) Designed and approved for use with 4- to 20-milliampere analog signals.
            2) Designed for powering 2- and/or 3-wire transmitters in hazardous locations and repeating and/or generating the current to the safe area.
            3) Supply voltage: 20 to 30 VDC.
        c. Transmitter and converters for use with 4- to 20-milliampere signals with Hart® communications capability:
            1) Designed and approved for use with 4- to 20-milliampere analog signals.
            2) Designed for powering 2- and/or 3-wire transmitters in hazardous locations and repeating and/or generating the current to the safe area.
            3) Transfer digital signals from the hazardous area to the safe area.
            4) Complete bi-directional communication between a smart transmitter located in the field and the suitable equipment located in the safe area.
            5) Supply voltage: 20 to 30 VDC.
    3. Manufacturers: One of the following or equal:
        a. Phoenix Contact, MACX Series.

O. Pepperl + Fuchs.Terminal blocks:
    1. DIN rail mounting on 35-millimeter rail.
    2. Suitable for specified AWG wire.
    3. Rated for 15 amperes at 600 volts.
    4. Screw terminal type.

5. 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.
6. Finger-safe protection for all terminals for conductors.
7. Construction: Polyamide insulation material capable of withstanding temperature extremes from - 40 to 105 degrees Celsius.
8. Terminals: Plainly identified to correspond with markings on the diagrams:
    a. Permanent machine-printed terminal identification.
9. Disconnect-type field signal conductor terminals with socket/screw for testing.
10. Identify terminals suitable for use with more than 1 conductor.
11. Position:
    a. So that the internal and external wiring does not cross.
    b. To provide unobstructed access to the terminals and their conductors.
12. Provide minimum 25-percent spare terminals.
13. Manufacturers: One of the following or equal:
    a. Phoenix Contact, UT4 Series.
    b. Allen-Bradley, 1492 Series.

P. Panel meters:
1. Manufacturers: One of the following or equal:
    a. Yokogawa UM33A series - UM33A-0-3-0-1-1-/LP.
    b. No. of analog inputs (4-20mA) - 1.
    c. No. of analog outputs (4-20mA) - 1 (Retransmission).
    d. No of digital inputs - 2.
    e. No. of digital outputs - 5 and programmable.
        1) Low Low level alarm set point - 1.75-ft.
        2) Low level setpoint - 2-ft.
        3) High level 1 setpoint - 5-ft.
        4) High level 2 setpoint - 5.5-ft.
        5) High High level alarm setpoint - 5.75-ft.
    f. Power Supply - 100-240 VAC, 24AC/DC.
    g. Power Consumption - 15VA @ 120VAC.
    h. 24 VDC loop power supply is required.

Q. 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.

R. 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.

S. Surge protection devices:
    1. 120-volt control power for panels:
        a. Panels without a UPS:
            1) Provide surge protection device (SPD) for panel power entrances:
                a) Nominal 120-VAC with a nominal clamping voltage of 200 volts.
                b) Non-faulting and non-interrupting design.
                c) A response time of not more than 5 nanoseconds.
            2) Control panel power system level protection, non-UPS powered:
                a) Designed to withstand a maximum 10-kA test current of an 8/20 µs waveform according to IEEE C62.41.1 Category C Area.
                b) For panels receiving power at 120 VAC, provide surge protection at secondary of main circuit breaker.
                c) Provide both normal mode noise protection (line to neutral) and common mode (neutral to ground) surge protection.
                d) DIN rail mounting.
                e) Attach wiring to the SPD by means of a screw-type cable-clamping terminal block:
                    (1) Gastight connections.
                    (2) The terminal block: Fabricated of non-ferrous, non-corrosive materials.
                f) Visual status indication of MOV status on the input and output circuits.
                g) Dry contact rated for at least 250 VAC, 1 Amp for remote status indication.
                h) Meeting the following requirements:
                    (1) Response time: Less than or equal to 100 ns.
                    (2) Attenuation: Greater than or equal to -40 dB at 100 kilovolt-hertz as determined by a standard 50-ohm insertion test.
                    (3) Safety approvals:
                        (a) UL 1283 (EMI/RFI Filter).
                        (b) UL 1449 2nd Edition.
                i) Manufacturers: One of the following or equal:
                    (1) Phoenix Contact, Type SFP Filter.
                    (2) Schneider Electric:
                        (a) ASCO, Model 277 (formerly Islatrol IE Series) Surge Protection Device.

T. Lighting:
    1. Provide 1 luminaire for each section, on the interior of the panel, spaced evenly a long 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.

U. Receptacles:
    1. Provide 1 duplex receptacle located every 4 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.

V. Grounding:
   1. Provide the following:
      a. Grounding strap between enclosure doors and the enclosure.
      b. Equipment grounding conductor terminals.
      c. Provide equipment ground bus with lugs for connection of all equipment grounding wires.
      d. Bond multi-section panels together with an equipment grounding conductor or an equivalent grounding bus.
   2. Identify equipment grounding conductor terminals with the word “GROUND,” the letters “GND,” the letter “G,” or the color green.
   3. Signal (24 VDC) grounding: Terminate each drain wire of a signal (shielded) cable to a unique grounding terminal block, or common ground bus at the end of the cable as shown on the Loop Drawings.
   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. 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.
   10. Bond together all remote and local control panels, processor racks, and conductive enclosures of power supplies and connect to the equipment-grounding circuit to provide a common ground reference.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES

A. Finish metal surfaces and structural parts with phosphatizing, or equal, treatment before painting.

B. Finish interior surfaces including bus support angles, control unit back plates, and top and bottom barrier plates with baked white enamel.

C. Finish exterior of enclosure with manufacturer's standard gray.

D. Finish NEMA Type 3R exterior cabinets with ultraviolet resistant enamel paint that is UL recognized for outdoor use.

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 26_05_00 - 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 necessary to completely install the motor control center for the line, load, and control connections.
   2. Assemble and install the motor control center in the locations and with the layouts as indicated on the Drawings.
   3. Make bus splice connections.
   4. Perform work in accordance with manufacturer's instruction and shop drawings.
   5. Furnish all components, and equipment necessary to complete the installation.
   6. Replace hardware, lost or damaged during installation or handling, in order to provide a complete installation.
   7. Install the MCC on a 3-1/2-inch raised concrete housekeeping pad:
      a. Provide structural leveling channels in accordance with the manufacturer's recommendations to provide proper alignment of the units.
         1) Remove the manufacturer's supplied mounting channels as required by the manufacturer's installation instructions.
      b. Weld and/or bolt the motor control center frame to leveling channels.

D. Provide openings in the top or bottom of the motor control center for conduit only.
   1. No additional openings will be accepted:
      a. Miscut holes will require that the entire vertical section or removable panel be replaced.
      b. No hole closers or patches will be accepted.

E. Bundle circuits together and terminate in each unit:
   1. Tie with nylon wire ties as specified in Section 26_05_18 - 600-Volt or Less Wires and Cables.
   2. Label all wires at each end with wire markers as specified in Section 26_05_53 - Identification for Electrical Systems as shown on the approved elementary schematics.

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 01200 - Contract Closeout.

B. Source testing (Factory Acceptance Tests):
   1. Owner and Engineer will witness the factory acceptance test as specified in Section 26_05_00 - Common Work Results for Electrical.
   2. Test the complete motor control center at the manufacturer's establishment. Completely assemble, wire and test the motor control center:
      a. Detailed inspections before and after assembly to ensure correctness of design and workmanship.
      b. Provide groups of wires leaving the shipping-assembled equipment with terminal blocks with suitable numbering strips.

3.08 PROVIDE MANUFACTURER'S CERTIFICATE OF INSTALLATION AND FUNCTIONALITY COMPLIANCE. FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Provide the services of a manufacturer's representative to:
   1. Inspect, verify, and certify that the motor control center installation meets the manufacturer's requirements.

3.09 ADJUSTING

A. Make all adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

3.10 CLEANING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_27_26

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 26_05_00 - 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. 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 26_05_00 - 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 Section 26_05_00 - 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 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - 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.

C. Plates:
    1. General location:
        a. One of the following or equal:
            1) Pass and Seymour.
            2) Cooper Wiring Devices.
    2. In-use covers:
        a. One of the following or equal:
            1) TayMac.
            2) Cooper Wiring Devices.
            3) Pass and Seymour.
            4) Thomas and 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) Ivory in finished areas.
            2) Brown in all other areas.
    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.

C. Plates:
1. General location:
    a. Type 302 or 304 stainless steel.
    b. Brushed satin finish.
    c. Minimum thickness: 0.032 inch.
    d. Rectangular or square shape.
    e. Engraving:
        1) Engrave each switch plate with the following:
            a) Area served.
            b) Panelboard and Circuit.
        2) Engrave each receptacle plate with the following:
            a) Panelboard and Circuit.
        3) Treat engraving to improve visibility.
        4) Characters shall be block letter pantograph engraved with a minimum character height of 1/8 inch.
    f. Coordinate the number of gangs, number, and type of openings with the specific location.
2. Outdoor and wet areas requiring NEMA Type 4 or NEMA Type 4X enclosures:
    a. General:
        1) UL listed for wet locations.
        2) Gasketed.
        3) Die cast metal:
            a) Match material to box material.
    b. Switches:
        1) Lever operated:
            a) Provide toggle switch.
    c. Receptacles:
        1) Weather proof in-use cover:
            a) Die cast metal construction with electrostatic powder coating for corrosion resistance.
            b) Gasketed.
            c) Lockable.
            d) UL listed and in accordance with NEC.
3. 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 26_05_00 - 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.

C. 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 26_05_00 - Common Work Results for Electrical, or in accordance with the NEC.
   2. Mount weatherproof receptacles horizontally:
      a. Neutral slot up.

D. 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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_28_01

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 26_05_00 - 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 26_05_00 - 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 Section 26_05_00 - 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 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - 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.

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 26_05_74 - 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. Provide ground fault trip devices as indicated on the Drawings.

E. 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

A. Key interlocks:
   1. Provide key operated interlocks to ensure safe switching procedures 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

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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_29_05

MOTOR STARTERS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Motor starters and contactors.

1.02 REFERENCES

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. International Electrotechnical Commission (IEC):
   1. 60 947-4 - Low-Voltage Switchgear and Control Gear.
   2. 801-1 - Electromagnetic Compatibility for Industrial-Process Measurement and Control Equipment - Part 1: General Information.

C. National Electrical Manufacturer's Association (NEMA):
   1. ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 V.

D. Underwriters Laboratories (UL):
   1. 508 - Standard for Industrial Control Equipment.
   2. 508A - Standard for Industrial Control Panels.

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Specific definitions and abbreviations:
   1. RVSS: Reduced voltage solid state.
   2. Overload relay class: A classification of an overload relay time current characteristic by means of a number which designates the maximum time in seconds at which it will operate when carrying a current equal to 600 percent of its current rating.

1.04 SYSTEM DESCRIPTION

A. General requirements:
   1. Starters for motor control centers, individual enclosed starters, or control panels.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26_05_00 - Common Work Results for Electrical:
   1. Submit motor starter data with equipment submittal.

B. Product data:
    1. Manufacturer.
    2. Catalog cut sheets.
    3. Technical information.
    4. Complete nameplate schedule.
    5. Complete bill of material.
    6. List of recommended spare parts.
    7. Confirmation that the overload relay class for each starter meets the requirements of the equipment and motor supplier.
    8. Electrical ratings:
        a. Phase.
        b. Wire.
        c. Voltage.
        d. Ampacity.
        e. Horsepower.
    9. Furnish circuit breaker submittals as specified in Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.

C. Shop drawings:
    1. Elementary and schematic diagrams:
        a. Provide 1 diagram for every starter and contactor.
        b. Indicate wire numbers for all control wires on the diagrams:
            1) Wire numbering as specified in Section 26_05_53 - Identification for Electrical Systems.
        c. Indicate interfaces with other equipment on the drawings.

D. Operation and maintenance manuals:
    1. Submit complete operating and maintenance instructions presenting full details for care and maintenance of equipment furnished or installed under this Section. Including but not limited to:
        a. Electrical ratings:
            1) Phase.
            2) Wire.
            3) Voltage.
            4) Ampacity.
        b. Complete bill of material.
        c. Manufacturer's operating and maintenance instructions starter and/or contactor component parts, including:
            1) Protective devices (fuses, breakers, overload relays, heater elements, etc.).
            2) Pilot devices.
        d. Complete renewal parts list.
        e. As-built drawings:
            1) Furnish as-built drawings for each starter and contactor indicating final:
                a) Wire numbers.
                b) Interfaces with other equipment.
            2) 11-inch by 17-inch format.

E. Certifications:
   1. Provide manufacturer's certification that the reduced voltage solid state starter will reliably control the acceleration and deceleration of the driven load at the installed conditions:
      a. Failure of the manufacturer to provide said certification will be interpreted to mean that the manufacturer has agreed that the reduced voltage solid state starter is matched to the driven load at the installed conditions and will function without fault.
      b. If the reduced voltage solid-state starter fails to perform as desired, replace or modify the reduced voltage solid-state starter in order to achieve the desired operational conditions, as directed by the Engineer.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Regulatory requirements:
   1. All starters and components shall be UL listed and labeled:
      a. UL 508 - Industrial Control Equipment.
      b. UL 508A - Industrial Control Panels.
   2. NEMA ICS 2 - Industrial Control and System Controllers; Contactors and Overload Relays Rated: 600 Volts.
   3. Combination starters shall be UL listed and labeled.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING

A. Reduced voltage solid state starters:
   1. Submit certification that the RVSS will reliably accelerate and decelerate the driven load at the installed conditions as part of the equipment submittal.
   2. RVSS start-up and testing by manufacturer after connection to equipment.
   3. RVSS training by manufacturer after start-up and testing, and before plant commissioning.

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. RVSS:
1. Provide the services of the manufacturer's technical representative for start-up, adjustment, and troubleshooting, a minimum of 2 hours per starter at the Owner's facility.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE

A. Spare parts:
1. Provide the following spare parts, suitably packaged and labeled with the corresponding equipment number:
a. 1 spare fuse of each size and type per starter.
b. 1 of each type of circuit board used in the RVSS starters, including but not limited to:
1) Control board.
2) Power board.
3) Bridge rectifier.
4) Inverter module.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:
1. NEMA starters and contactors:
a. Same manufacturer as Motor Control Center.
2. Reduced voltage solid state starters:
a. Same manufacturer as Motor Control Center.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. General:
1. Provide combination type starters with motor circuit protector or thermal-magnetic circuit breaker and control power transformer with ratings as indicated on the Drawings.
2. NEMA size, design, and rated:
a. NEMA Size 1 minimum.
3. Coordinate motor circuit protector, thermal magnetic circuit breaker, or fusible disconnect, and overload trip ratings with nameplate horsepower and current ratings of the installed motor:
a. If motors provided are different in horsepower rating than those specified or indicated on the Drawings, provide starters coordinated to the actual motors furnished.
4. Provide starters NEMA Size 2 and larger with arc quenchers on load breaking contacts.
5. Mount extended overload reset buttons to be accessible for operation without opening starter enclosure door.

B. RVSS:
   1. Manufactured and tested in accordance with the applicable requirements of IEEE, UL, and NEMA, including the following:
      a. Dielectric withstand per UL 508.
      b. Noise and RF immunity per NEMA ICS-2-230.
   2. Furnish with a motor circuit protector or thermal magnetic circuit breaker as indicated on the Drawings.
   3. Provide protection against internal faults and high SCR temperature during operation of the motor including starting, running (except when bypassed), and stopping modes.
   4. Capable of continuously delivering full rated current of the motor plus the motor service factor in ambient temperatures from 0 degree Celsius to 40 degrees Celsius at the installed altitude.
   5. Provide a magnetically operated bypass contactor in parallel with the solid state starter:
      a. The bypass contactor to energize when the motor has reached full speed:
         1) The electronic overload protection circuits must be fully functional with the bypass contactor closed.
   6. RVSS control module requirements:
      a. Microcomputer based, and contains the required circuitry to drive the power semiconductors in the power section of the starter.
      b. Integrally mounted on the power section and requires no additional panel space or wiring.
      c. Mounted for easy wiring, testing, service, and replacement.
      d. Provide 3-phase current sensing.
      e. Quick disconnect plug-in connectors for current transformer inputs, line and load voltage inputs, and SCR gate firing output circuits.
      f. Operates on power supplied from a control power transformer.
      g. Phase insensitive or with phase rotation protection.
      h. Control modes:
         1) Soft start with adjustable linear ramp time and a "kick start" or "boost" feature to provide a short time (typically 0.1 second) application of approximately full voltage.
         2) Soft start with adjustable linear ramp time, with a current limit:
            a) The current limit shall be adjustable over the range of 2 to 4 times normal full load current.
         3) Across the line starting.
         4) Reverse voltage ramp (line voltage to zero voltage):
            a) Adjustable from 2 to 30 seconds to provide smooth stop.
            b) Automatic shutdown at end of voltage ramp.
      i. Protective functions:
         1) Single phase protection.
         2) Under voltage protection.
         3) Short circuit electronic trip overcurrent protection. Time not to exceed 3 cycles.
         4) Inverse time running overcurrent protection.
         5) Auxiliary trip circuitry.
         6) Gate firing circuit lockout protection on trip.
         7) Jam and stall detection.
         8) Fault relay lockout protection.
         9) 100 percent to 130 percent full load running current trip adjustment.
         10) 100 percent to 450 percent of starting current limit adjustment.

11) Dwell time at current limit with ramp continuation after acceleration.
12) Individual light emitting diodes (LEDs) for trip and phase loss.
13) Minimum and maximum initial starting voltage adjustments.
14) Initial torque adjustment.

7. RVSS power section requirements:
   a. 3 sets of back-to-back phase controlled power semiconductors:
      1) Minimum repetitive peak inverse voltage of 1,500 volts at 480 VAC.
      2) Resistor/capacitor snubber networks to prevent false firing of the SCRs.
      3) Equipped with individual heat sink assemblies.
      4) Provide high-speed fuses for protection of the SCR stacks against short circuit conditions.
   b. Provide metal oxide varistors for surge protection on the line and load side power terminal connections:
      1) Rated for a minimum of 120 joules.
   c. Capable of supplying the following current levels:
      1) 600 percent of full load current for a minimum of 10 seconds.
      2) 450 percent of full load for a minimum of 30 seconds.
   d. Furnish ground lugs, one for incoming and one for outgoing ground connections.
   e. Furnish pressure type terminals for top or bottom entry power terminations.
8. Remote indicators:
   a. Provide Form C dry contacts for remote indication of:
      1) Internal fault error.
      2) Undervoltage.
      3) Overvoltage.
      4) Phase reversal.
      5) Phase loss.
      6) Overload.
      7) Frequency out of range.
      8) Excessive starts per hour.
      9) Drive electronics over temperature.
      10) Stall.
      11) Jam.
      12) System failure.
      13) Starter failure.
      14) Run status.
      15) Full speed.
9. Metering:
   a. 3-phase motor current.
   b. Power in kW.
   c. Power factor.
   d. 3-phase voltage.
   e. Power usage in kWh.
10. Phase re-balance:
   a. Continuously monitor the incoming 3-phase line voltage balance and adjust the output voltage to automatically balance the 3-phase currents supplied to the motor.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

A. Molded case circuit breakers:
   1. Circuit breaker type and ratings as indicated on the Drawings.
   2. Provide as specified in Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.

B. Contactors:
   1. NEMA size as indicated on the Drawings.
   2. Electrically held:
      a. For lighting loads designed to withstand the initial inrush currents of ballast and lamp loads.
   3. Factory adjusted and chatter free.
   4. Auxiliary contacts:
      a. Contact ratings as per NEMA A 600 rating:
         1) Auxiliary contacts rated 10 amps at 600 volts.
      b. Provide all contacts indicated on the Drawings, and any additional contacts required for proper operation.
      c. Provide at least 1 normally open and 1 normally closed spare auxiliary contact.
   5. Constructed in accordance with the following standards:
      a. UL 508.
      b. IEC 947-4:
         1) Type 1 coordination when protected by a circuit breaker.
         2) Type 2 coordination when protected by a suitable UL listed fuse.
      c. IEC 801-1 parts 2 through 6.

C. Overloads:
   1. Solid state electronic:
      a. Selectable Class 10, 20, 30 protection.
      b. Ambient insensitive:
         1) Operating temperature: -20 to 70 degrees Celsius.
      c. Thermal memory.
      d. Protective functions:
         1) Motor overcurrent.
         2) Phase unbalance (adjustable.)
         3) Phase loss.
         4) Ground fault protection.
      e. Self-powered.
      f. Provide current transformers for metering of motor current.
      g. Visible trip indicator.
      h. Push-to-trip test.
      i. Isolated normally open alarm contact.
      j. Normally closed trip contact.
      k. Manual reset.

D. Control power transformer:
   1. Furnish integral control power transformer capacity to power:
      a. All motor controls; Motor and starter accessories indicated on the Drawings or specified.

2. Primary and secondary fusing as indicated on the Drawings:
    a. Fusing sized by the manufacturer for the rating of the transformer furnished.
3. Control power transformer secondary voltage:
    a. As indicated on the Drawings.

2.07 ACCESSORIES

A. Lugs and terminals:
    1. For all external connections of No. 6 AWG and larger.
    2. UL listed for either copper or aluminum conductors.

B. Surge protective devices:
    1. Furnish surge protection devices across the coil of each starter, contactor, and relay.

C. Pilot devices:
    1. Provide pilot lights, switches, elapsed time meters, and other devices as specified or as indicated on the Drawings.

D. Nameplates and wire markers:
    1. As specified in Section 26_05_53 - Identification for Electrical Systems.

E. Conformal coating:
    1. Provide conformal coating material applied to electronic circuitry and printed circuit boards to act as 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 (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. RVSS starters:
    1. The manufacturer of the respective RVSS starter shall supply certified test results to confirm that the controller has been tested to substantiate designs according to applicable ANSI and NEMA standards.
    2. The tests shall verify not only the performance of the unit and integrated assembly, but also the suitability of the enclosure venting, rigidity, and bus bracing. In addition, the unit shall be factory tested in accordance with ANSI standards.
    3. The RVSS starter manufacturer shall test for noise immunity on both input and output power connections and provide test results to the Engineer. Noise testing shall be performed in accordance with NEMA ICS 2-230.40.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 26_05_00 - 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. Starters in motor control centers:
   1. Install as specified in Section 26_24_20 - Low Voltage Motor Control Centers.

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 01200 - Contract Closeout.

B. Factory testing:
   1. Owner and Engineer will witness the factory acceptance test as specified in Section 26_05_00 - Common Work Results for Electrical.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.09 ADJUSTING

A. Make all adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

B. Set all overloads and motor circuit protectors based on the nameplate values of the installed motor.

3.10 CLEANING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_32_14

SINGLE DIESEL FUELED ENGINE GENERATOR

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Packaged automatic "standby" diesel engine generator systems.

1.02 REFERENCES

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. ASTM International (ASTM):
   1. A106 - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.

C. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1,000 Volts Maximum).
   2. MG-1 - Motor and Generators.

D. National Fire Protection Association (NFPA):
   1. 30 - Flammable and Combustible Liquids Code.
   2. 37 - Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.
   3. 110 - Standard for Emergency and Standby Power Systems.
   4. 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

E. Underwriters Laboratories (UL):
   1. 142 - Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids.
   2. 2200 - Standard for Stationary Engine Generator Assemblies.

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. NEMA:
   1. Type 4X enclosure in accordance with NEMA 250.

C. Specific definitions:
   1. Standby rated duty: Continuous operation for the duration of any power outage of a utility power source.

1.04 SYSTEM DESCRIPTION

A. Provide a complete automatic diesel engine driven generator system, with all necessary components and accessories to make a complete and operating standby power supply.
   1. Coordinate the generator control system with the transfer equipment specified in the Electrical Specifications and as indicated on the Drawings.

B. Provide such minor details of electrical, plumbing, or mechanical work not specified or indicated on the Drawings, which are necessary for the successful operation of the diesel engine-driven generator required by these Specifications.

C. A new generator shall be installed at Mystic Lift Station as indicated on the Drawings.

D. The existing generator at 60kW Mystic Lift Station shall be relocated to Chapel Lift Station.

E. Description of operation:
   1. As specified in Section 26_36_24 - Transfer Switches.

F. Step sequence:
   1. Mystic Lift Station generator, GEN-0101:
      a. Step 1:
         1) 30 kVA Transformer load and PANEL-0101.
      b. Step 2:
         1) Lift Pump 1, PMP-0101.
      c. Step 3:
         1) Lift Pump 2, PMP-0102.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26_05_00 - Common Work Results for Electrical.

B. Product data:
   1. General:
      a. Manufacturer of:
         1) Engine.
         2) Generator.
         3) Governor.
         4) Voltage regulator.
         5) Generator control panel.
         6) Radiator.
         7) Battery charger.
         8) Batteries.
         9) Silencer.
      b. Wet weight of engine generator system:
         1) List weight of fuel separately.
      c. Dimensions of engine generator system:
         1) Length.
         2) Width.
         3) Height.

d. Type and grade of fuel recommended.
e. Fuel oil consumption at:
    1) 50 percent load.
    2) 75 percent load.
    3) 100 percent load.
f. Type and grade lubricating oil recommended.
g. Amount of lubricating oil required per oil change.
h. Normal lubricating oil consumption.
i. Recommended lubricating oil change periods:
    1) By hours run.
    2) By time.
j. Heat rejection by engine generator to the room area.
k. Time interval from start-up contact closure until full load capabilities are available.

2. Engine:
    a. Number of cylinders, bore, stroke, and piston speed.
    b. Displacement in cubic inches.
    c. Compression ratio.
    d. Engine RPM at 60 hertz.
    e. Combustion air required.
    f. Cooling air required.
    g. Size of exhaust outlet.
    h. Gauges.
    i. Jacket water heater:
        1) Rating.
        2) Voltage and phase requirements.
3. Emissions:
    a. Certification of EPA compliance.
    b. Other exhaust emissions as required by the local air quality management district issuing the permit for the engine generator system.
    c. Reported at rated speed and load as measured by SAE J177 and J215 or ISO 8178 recommended practices.
4. Generator (alternator):
    a. Rated output:
        1) kW standby.
        2) Power factor.
        3) Voltage.
        4) Current.
    b. Number of poles.
    c. Number of leads and wires per lead.
    d. Pitch.
    e. Stator and field ratings including temperature rise at full and overload conditions.
    f. Insulation system:
        1) Insulation class.
        2) Stator rise.
        3) Rotor rise.
        4) Heat dissipated (kW).
        5) Air flow (m^3/min).
    g. Impedances (per unit and ohms):
        1) Synchronous reactance: Direct axis (X_d).
        2) Synchronous reactance: Quadrature axis (X_q).

3) Transient reactance: Saturated (X'_d).
4) Subtransient reactance: Direct axis (X''_d).
5) Subtransient reactance: Quadrature axis (X''_q).
6) Negative sequence reactance (X_2).
7) Zero sequence reactance (X_0).

h. Time constants:
1) Open circuit transient: Direct axis.
2) Short circuit transient: Direct axis.
3) Open circuit subtransient: Direct axis.
4) Short circuit Subtransient: Direct axis.
5) Open circuit subtransient: Quadrature axis.
6) Short circuit Subtransient: Quadrature axis.
7) Exciter time constant.
8) Armature short circuit.

i. Short circuit ratio.
j. Stator resistance.
k. Field resistance.
l. I^2t or K (heating time constant).
m. Voltage and frequency variation and duration with the step application and removal of 25 percent, 50 percent, 75 percent, and 100 percent of resistive load maximum.
n. Generator efficiency at:
1) 25 percent load.
2) 50 percent load.
3) 75 percent load.
4) 100 percent load.

o. Generator output characteristic curves:
1) Open circuit.
2) Short circuit.
3) Zero power factor.
4) Air gap.

p. Reactive capability curve.
q. Certified published engine horsepower curves showing manufacturer's engine rating for generator set standby and prime power application.
r. Decrement curve.
s. Thermal damage curve.

5. Governor.
6. Voltage regulator.
7. Generator control panel:
a. Dimensions:
1) Length.
2) Width.
3) Height.
4) Weight.

b. Power requirements.
c. Controls.
d. NEMA enclosure rating.

8. Space and ambient temperature requirements.
9. Battery system:
a. Battery charger:
1) Dimensions:
a) Length.

b) Width.
c) Height.
d) Weight.
2) Input power requirements.
b. Batteries:
1) Number.
2) Dimensions:
a) Length.
b) Width.
c) Height.
d) Weight.
3) Amount of electrolyte.
4) Enclosure or rack.
10. Silencer:
a. Grade.
b. Dimensions:
1) Length.
2) Width.
3) Height.
4) Weight.
11. Free field mechanical noise level at 23 feet. Provide overall decibels (dBA) rating referenced at 20 µPa.
12. Exhaust sound level in dBA at 5 feet from discharge end of silencer.
13. Recommended spare parts and special tools lists, specifying quantity of each item.
14. Weatherproof acoustical housing:
a. Dimensions:
1) Length.
2) Width.
3) Height.
4) Weight.
b. Materials.
c. Acoustic rating.
d. Door locations and access requirements.
e. Finish.

C. Shop drawings:
1. Provide detailed dimensional and to-scale layout drawings including:
a. A single drawing incorporating all equipment furnished:
1) Submittals that consist solely of individual drawings for each component and require that these sheets be compiled by the Engineer, in order to view the entire piece of equipment, are not acceptable.
b. Conduit stub-out locations.
2. Detailed electrical wiring diagrams of the engine and generator including:
a. Engine interconnection terminal box.
b. Generator interconnection terminal box.
c. Fuel system.
d. All interfaces between the engine driven generator skid and the transfer equipment.

e. All wire numbers and terminal block identifications:
    1) Wire numbers are to correspond to the wire number on the equipment.
    2) All wires are to be numbered.
f. Complete interior and exterior control panel layout:
    1) Scaled.
    2) With device descriptions.
    3) With nameplates.

3. Piping connection and instrumentation diagrams.
4. Mounting and installation drawings:
    a. Detailing mounting requirements for the Project Site seismic requirements as specified in Section 26_05_00 - Common Work Results for Electrical.
    b. Prepared and sealed by a registered structural professional engineer in the state where the Project is being constructed.

D. Operation and maintenance manuals:
1. Submit operating instructions and a maintenance manual presenting full details for care and maintenance of equipment of every nature furnished and/or installed under this Section.
2. Operating manual:
    a. The manual must detail the operational functions of all normally used controls that have been placed on the front of the control equipment.
    b. Standard operational manuals normally furnished by the manufacturer.
3. Maintenance manual:
    a. Printed and bound instructions covering all details pertaining to care and maintenance of all equipment as well as data identifying all parts.
    b. These manuals must include but are not limited to the following:
        1) Electrical controls:
            a) Adjustment and test instructions covering the steps involved in the initial test, adjustment, and start-up procedures.
            b) Detailed control instructions, which outline the purpose and operation of every control device used in normal operation.
            c) Description of the sequence of operation that outlines the steps the controls follow during normal power failure and normal power return conditions.
            d) All schematic, wiring, and external diagrams. Also, internal device wiring and schematic diagrams for all sub-assemblies used in the equipment:
                (1) Drawing to be furnished in a reduced 11-inch by 17-inch format and shall be fully legible at that drawing size.
        2) Engine and generator:
            a) Repair parts manuals normally furnished by the manufacturer.
                (1) Detailing all parts and sub-assemblies, which are available as repair parts.
        3) Shop maintenance manuals:
            a) Provide 1 shop manual on-site that is equivalent to the manual used by factory-authorized shop repair personnel.
            b) Manuals for the following equipment:
                (1) Engine.
                (2) Radiator.
                (3) Generator.
                (4) Engine generator control panel.

c. Material safety data sheets:
    1) Complete MSDS forms for all substances.
    2) Located in O&M manual.
    3) Include separate manual labeled MSDS with additional copies of all MSDS forms.
4. Warranty Data.
5. Maintenance Contract information (if applicable).

E. Test reports:
1. Furnish complete test reports as specified in this Section.

F. Certificates:
1. Certification of the emissions performance of the generator set engine by the engine manufacturer.
2. Certification that a torsional analysis between the engine and generator has been completed.
3. Seismic certification, as required.
4. Certification letter from the Generator manufacturer that the generator(s) has been inspected and installed in accordance with the manufacturer's requirements.
5. Upon completion of installation, manufacturer must issue a certification of compliance with the Contract Documents.

G. Calculations:
1. Complete loading calculations to support the recommended size of the engine-generator based upon actual facility loads and specified maximum allowable voltage drop.
2. Supply documentation identifying the maximum static pressure acceptable for the radiator fan. It is the manufacturer's responsibility to then provide calculations as part of the layout drawings, to ensure that the transition ductwork at the discharge of the radiator does not exceed the maximum static pressure acceptable for the radiator fan.
3. Submit exhaust system silencer noise attenuation curves.
4. Structural support system, mounting, and seismic calculations to be signed and stamped by a licensed structural professional engineer, registered in the state where the Project is located:
    a. Vibration isolator selection calculations.
    b. Vibration isolator anchoring calculations.
    c. Exhaust silencer structural support calculations on indoor applications.
5. Submit factory certification of the radiator ambient capability.
6. Submit exhaust system pressure loss calculations:
    a. Include piping, fittings, silencer, and rain cap in loss calculations on indoor applications.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Manufacturer qualifications:
1. The manufacturer of the engine, generator, and all major items of auxiliary equipment must be in current production of such equipment.

2. A factory authorized parts and service facility located within 100 miles of the Project Site.
3. Manufacturer is responsible for furnishing, testing, installation supervising, testing, and guaranteeing the system.

C. Regulatory requirements:
1. In accordance with NFPA-110 Type 10 (ten second) transfer requirements.
2. Fuel tanks:
   a. UL listed.
   b. Primary and secondary tanks shall be tested under pressure per the manufacturer's recommendation to check for leaks.
   c. Comply with the following, if applicable:
      1) NFPA 30 - Flammable and Combustible Liquids.
      2) NFPA 37 - Standard for Installation and Use of Stationary Combustible and Gas Turbines.
      3) NFPA 110 - Standard for Emergency and Standby Power Systems.
3. Regulations of the Fire Prevention Bureau of the fire department having jurisdiction.
4. Fire Code as specified in Section 01090 Abbreviations & Reference Standards.
5. Other applicable state and local codes.
6. EPA approved.
7. Requirements of local Air Quality Management District or Air Pollution Control District.
8. Comply with the Specifications that may be in excess of, and not contrary to, the regulations.

D. The generator set(s) shall be manufactured to the applicable specifications on file with UL and labeled with the UL 2200 mark.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Furnish the generator skid with removable lifting and jacking angles, eye bolts, etc., attached to the structural base to facilitate unloading and move-in operations.

C. Provisions on skid for the use of "Multiton" type rollers for moving the generator skid into position and then removal of the "Multiton" rollers and then for setting the engine generator skid in place.

D. Provide the services of a manufacturer's authorized representative to:
1. Be present at the jobsite when the engine-driven generator arrives:
   a. Act as an advisor in assisting the Contractor regarding the unloading and move-in operations.
2. Coordinate the delivery of the shipment with the Contractor.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING

A. Complete factory prototype and factory production tests in accordance with NFPA 110 before equipment is shipped.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE

A. Furnish the following spare parts:
   1. 3 sets of lube oil filters, fuel filters, and gaskets.
   2. 2 sets of air filters.
   3. 2 spare lamps of each different lamp type.
   4. 2 fuses (for each control circuit).
   5. 1 set of crankcase breather filters, when used.

B. Special tools: Furnish a set of specialty tools necessary for routine maintenance of the equipment.
   1. Special tools are those that only the manufacturer provides, for special purposes, or to reach otherwise inaccessible parts.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. The following list of manufacturers is a general guideline and makes no statement as to the capability of the manufacturer to meet the Specification requirements. The burden of proof of conformance with these Specifications lies with the Contractor and manufacturer. The Contractor must make special written application to use other than these named manufacturers:
   1. Engine generators:
      a. One of the following, no equal:
         1) Caterpillar.
   2. Governor:
      a. One of the following or equal:
         1) Woodward.
         2) Isochronous electronic by engine manufacturer.
   3. Engine starting battery:
      a. One of the following or equal:
         1) Auto Start.
         2) East Penn - Deka.
         3) Hawker.

4. Base mounted fuel tank:
    a. One of the following or equal:
        1) Pryco.
        2) Tramont.
        3) Engine-generator manufacturer's equivalent.

B. Exhaust system:
1. One of the following or equal:
    a. Silencer:
        1) GTE Ind.
        2) Harco Manufacturing.
        3) Silex Innovations.
    b. Corrugated, flexible engine connector:
        1) DME.
        2) GTE Ind.
        3) Engine-generator manufacturer's equivalent.
    c. Expansion joint:
        1) DME, Inc.
        2) GTE Ind.
    d. Exhaust pipe insulation:
        1) As specified in Section 40_05_06.55 - Piping Insulation.
    e. Expansion joint insulation:
        1) Pittsburgh-Corning/JPS Composite Materials Corp., Temp-Mat.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. Characteristics of assembled unit:
1. The engine-driven generator consists of a diesel engine directly coupled to an electric generator providing electric power.
2. The engine shall start, attain full speed, voltage, and assume full load within a maximum of 10 seconds, with jacket water at 85 degrees Fahrenheit.
3. Furnish the engine-driven generator on a steel sub-base to support engine, generator, and accessories as a unit:
    a. Base: Welded construction.
    b. Engine direct connected through a flexible coupling to a single bearing generator.
    c. System free of injurious torsional and bending vibrations within a speed range from 10 percent below to 10 percent above synchronous speed.
    d. Engine-driven generator balanced such that the peak-to-peak amplitude of vibration velocity in any direction does not exceed the engine or generator manufacturer's published limits.
    e. If shims are required under the feet of the generator for alignment purposes, use 1-piece laminated shim stock that covers at least 90 percent of the foot.
    f. Provide a complete assembled engine-driven generator skid requiring only field electrical and mechanical connections.

4. Connections to engine-driven generator skid:
    a. Flexible connections are required on all connections to the engine generator.
    b. These connections include but are not limited to:
        1) Exhaust.
        2) Fuel lines.
        3) Radiator discharge air ductwork.
    c. The length of all flexible connections to exceed the flexible connector manufacturer's minimum length recommendations for the diameter used and for the misalignment as measured after installation.

B. Generator system performance requirements:
1. Power output rating:
    a. Minimum kilowatts and voltage as indicated on the Drawings.
    b. 0.8 power factor.
    c. 3-phase, 4-wire, 60 hertz.
    d. In accordance with NEMA MG-1 temperature rise limits.
2. It is the manufacturer's responsibility to properly size the engine generator based upon site conditions and actual loads:
    a. Allowable voltage drop: 10 percent.
    b. The Drawings and Specifications indicate a minimum size that the Engineer has determined based upon non-certified information.
    c. No increase in Contract amount will be considered if the equipment size needs to be increased to meet the load requirements after bids have been submitted.
    d. Provide all changes to the electrical system as required as a result of manufacturers sizing including but not limited to:
        1) Conduit.
        2) Wire: Provide Nehr-McGrath calculations to verify appropriate cable sizing in accordance with NEC when additional wire is required.
        3) Circuit breakers.
        4) Transfer equipment.
3. Regulatory requirements:
    a. Specifically designed to meet the discharge of gaseous pollutants to the atmosphere as required by the EPA statute and local agency issuing the permit for the engine generator system.

2.06 COMPONENTS

A. Engine generator base:
1. Support system:
    a. Bolt the engine-driven generator to steel pads that are an integral part of structural support base.
    b. Vibration isolators shall be provided with the engine-driven generator and be installed between the engine generator and structural support base or between the base and the floor:
        1) As recommended by the isolator manufacturer.
        2) Located for equal load distribution and deflection per isolator.
        3) Designed for the load and seismic conditions as identified for the site.

B. Engine:
   1. Full compression ignition, 4-cycle, turbocharged, and aftercooled meeting the required emissions rating.
   2. The rated net horsepower of the engine with all accessories, including radiator fan, must not be less than that required to produce the minimum specified generator capacity at site altitude and maximum ambient temperature.
   3. Equipped and designed as follows:
      a. Spin-on type replaceable lube oil filters.
      b. Spin-on type replaceable fuel filters.
      c. Heat treated forged steel crankshaft:
         1) Dynamically balanced.
      d. Forged steel connecting rods.
      e. Crankshaft driven gear type lubricating pump.
      f. Electric fuel shut-off valve.
      g. Engine air cleaner: Dry type replaceable filter.
      h. 12- or 24-VDC positive engagement solenoid shift-starting motor:
         1) The starting equipment must include the necessary devices to prevent an overcrank and lockout if the starter pinion fails to engage the flywheel ring gear on the initial crank attempt.
         2) This starter disconnect shall electronically sense the speed of the flywheel and when the flywheel setpoint speed has been reached, the electronic control signals the starter disconnect to disengage.
      i. Oil level dip stick and oil drain pipe with valve and pipe plug:
         1) Oil drainpipe and valve are to extend 3 inches beyond edge of engine base.
      j. Engines requiring glow plugs are not acceptable.
      k. Crankcase breather filter for engines not equipped with EPA Tier certified engine's crankcase emissions control equipment:
         1) Provide crankcase ventilation system with coalescing filter/trap for blowby:
            a) Coalescing filter to be replaceable.
         2) If engine manufacturer recommends an open crankcase breather system, route outlet of breather filter to outside at 3 inches above grade and away from engine components:
            a) Provide on breather outlet Nelson "EcoVent" or equal, sized to match engine breather flow.
         3) If engine manufacturer recommends a closed crankcase breather system, provide integral crankcase pressure regulator with an automatic internal filter bypass and bypass indicator:
            a) Racor Model CCV 4500 or equal.
      l. Equipped with fuel heater mounted on the fuel filters:
         1) Thermostatically controlled.

C. Governor:
   1. Isochronous type to maintain engine speed:
      a. Within 0.5 percent for steady state conditions.
      b. Within 5 percent for a no load to full load step with recovery to within 2 seconds of step load application.
      c. Suitable for use on diesel engines.
      d. Electronic governor control of fuel.
      e. Suitable for automatic, unattended starts.

f. Speed sensing failure circuit to signal actuator to close if speed pick-up signal is lost.
g. With speed pick-up sensor.
h. With capabilities of local speed settings.
i. Adjustable acceleration rate control from 0 to 8 seconds.
j. Personnel guards over all exposed moving parts.
k. Equipped with a continuous duty shutdown system for normal remote stopping.

D. Engine jacket water heater:
1. Provide an in-line thermostat that disconnects power when coolant temperature exceeds the manufacturer's suggested setpoint.
2. Contacts from an oil pressure switch or control panel contacts disconnect the heater power when the engine is running.
3. Provided with shutoff valves and unions to allow heater replacement without draining the cooling system.
4. Make all water heater connections with high temperature silicon type hoses and constant torque hose clamps.
5. Size heater such that the engine block temperature is maintained at 85 degrees Fahrenheit at the specified minimum ambient temperature.
6. Connect water heater and thermostat to the engine to minimize heated water circulation through the radiator circuit.
7. Power supply:
a. Water heaters smaller than 3,000 watts shall be 120 volts, 1-phase.

E. Alternator (generator):
1. Brushless synchronous alternator.
2. Re-connectable 12 lead if available.
3. Self-ventilated.
4. Full amortisseur windings.
5. 2/3 pitch windings, skewed for smooth voltage waveform.
6. With permanent magnet generator pilot exciter.
7. Drip-proof enclosure.
8. Protected against corrosion.
9. Single bearing design.
a. Alternators over 2,000 kW may be 2 bearing design.
10. Insulation:
a. Insulated for continuous operation at 40 degrees Celsius ambient temperature.
b. Class H (125 degrees Celsius rise by resistance) for low voltage generators.
c. Vacuum impregnated with epoxy varnish to be fungus resistant per MIL I-24092.
d. Multiple dipped and baked with a non-hygroscopic varnish with a final dip of epoxy.
11. Terminate alternator power leads using compression lugs on an insulator and bus bar system within the alternator junction box:
a. These terminations must not require any taping to complete the connection.

b. Provide a ground terminal inside the junction box to terminate the ground cables between the alternator to the automatic transfer equipment ground bus:
1) Minimum size of the equipment-grounding conductor: 12-1/2 percent of the size of the phase conductors.

12. 120 VAC integral alternator winding heaters.
13. Maximum balanced telephone interference factor not to exceed 50.
14. Designed to supply power to the non-linear loads as specified and as indicated on the Drawings:

F. Alternator digital voltage regulator:
1. Located in the engine control panel.
2. Performance requirements:
a. Maintain the steady state voltage within 1 percent:
1) From 40 degrees Fahrenheit to 120 degrees Fahrenheit.
2) From no load to full load conditions.
3. Constant volts per hertz characteristics with under frequency roll-off for better transient response.
4. Static type.
5. Sized to match the power requirements of the exciter circuit and power from the permanent magnet generator pilot exciter.
6. Include manual control to adjust voltage drop, voltage level, and voltage gain.
7. With 3-phase sensing.
8. Sealed from the environment and isolated from the load to prevent tracking when connected to SCR loads.
9. Include loss of sensing shutdown to protect the generator against uncontrolled voltage output when the sensing circuit to the regulator is opened.
10. Shut down regulator when the sensing circuit to the regulator does not have continuity.
11. Include over-excitation shutdown to protect the generator against thermal damage caused by prolonged field forcing.

G. Exhaust system:
1. General:
a. Provide a complete exhaust system following as indicated on the Drawings and as specified.
b. Back pressure:
1) Provide components such that the maximum back-pressure in the exhaust system including piping and silencer is less than the maximum allowable back-pressure published by the engine manufacturer, measured at the exhaust manifold header:
a) Reduce back-pressure when recommended by the engine manufacturer.
c. Provide each exhaust manifold header with a plugged, tapped connection for the attachment of a test manometer.
2. Exhaust silencer:
a. Heavy-duty industrial type fabricated of welded steel with ported tubes and snubbing chambers, and a rating meeting the specified sound attenuation.
b. Mounting: As indicated on the Drawings.
c. End connections: Steel flanges with Class 150-pound drilling pattern.

d. Shell:
    1) Sufficiently heavy and reinforced to eliminate excessive vibration, stress, or deflection and to support all operating loads with the silencer at elevated temperatures and insulated as specified.
    2) Loads include insulation weight and connecting piping.
e. Drain: Provide threaded, plugged condensate drain.
f. Sound attenuation: Attain the following minimum sound attenuation at the listed octave band center frequencies with the engine at full load:
g. Supports: Provide shell lug supports suitable for supporting and mounting the silencer as indicated on the Drawings; support design to account for elevated temperatures under insulated shell.
h. Pressure drop not to exceed manufacturer's recommendation at maximum engine rating.

H. Radiator and cooling system:
1. Unit mounted:
    a. Furnish a skid mounted closed type radiator system for the engine driven generator:
    b. Sized and selected by engine manufacturer to cool the engine and turbo charge aftercooler under ambient conditions.
    c. Provide all necessary coolant specifically suitable for the location and conditions of service throughout the year:
    d. Ship both the engine and the radiator with the coolant installed.

I. Generator control panel:
1. Microprocessor-based control system that is designed to provide automatic starting, monitoring, protection and control functions for the generator set.
2. Mounted on the generator set:
    a. Provide vibration isolation:
        1) Prototype tested to verify the durability of all components in the system under the vibration conditions encountered.
3. Control system features and functions:
    a. Control switches:
        1) Mode selector switch:
            a) Provide a rotary switch or control panel keypads with status indicators.
            b) The mode select switch initiates the following control modes:
                (1) RUN or Manual position:
                    (a) Generator set starts, and accelerates to rated speed and voltage.
                (2) OFF or STOP position:
                    (a) Generator set immediately stops, bypassing all time delays.
                (3) AUTO position:
                    (a) Generator set accepts a signal from a remote device to start and accelerate to rated speed and voltage.
        2) EMERGENCY STOP switch:
            a) Red "mushroom-head" pushbutton.
            b) Activating the emergency stop switch causes the engine to immediately stop, and be locked out from automatic restarting.

3) RESET switch:
    a) Clears all faults and allow restarting the engine generator after it has shut down for any fault condition.
4) PANEL LAMP switch or automatic display panel illumination.

b. AC output metering: Provide the control system with metering including the following features and functions:
1) Provide digital metering:
    a) 1.0 percent accuracy.
2) Voltmeter:
    a) RMS voltage.
    b) Line-to-line.
    c) Line-to-neutral.
3) Ammeter:
    a) RMS current.
4) Frequency.
5) Power Factor.
6) Kilowatts (kW):
    a) kW-hours.
    b) Output kW.
7) Kilovars (kVars):
    a) kVar-hours.
    b) Output kVar.

c. Generator alarm and status display:
1) Provide high-intensity LED alarm and status indication lamps. Functions indicated include:
    a) Red alarm-indicating lamps.
    b) Red common shutdown lamp.
    c) Green lamp to indicate the engine generator is running at rated frequency and voltage based on actual sensed voltage and frequency on the output terminals of the generator set.
    d) Flashing red lamp to indicate that the control is not in automatic state.
    e) Amber common warning indication lamp.
2) Display the following alarm and shutdown conditions on an alphanumeric digital display panel:
    a) Low oil pressure (alarm).
    b) Low oil pressure (shutdown).
    c) Oil pressure sender failure (alarm or indication).
    d) Low coolant temperature (alarm).
    e) High coolant temperature (alarm).
    f) High coolant temperature (shutdown).
    g) High oil temperature (warning).
    h) Engine temperature sender failure (alarm or indication).
    i) Low coolant level (alarm or shutdown - selectable).
    j) Fail to crank (shutdown).
    k) Fail to start/overcrank (shutdown).
    l) Overspeed (shutdown).
    m) Low DC battery voltage (alarm).
    n) High DC battery voltage (alarm).
    o) Low fuel-day tank (alarm).
    p) High AC voltage (shutdown).
    q) Low AC voltage (shutdown).

r) Under frequency (programmable for alarm or shutdown).
s) Overcurrent (programmed for warning or shutdown).
t) Short circuit - circuit breaker function (trip).
u) Ground fault (alarm).
v) Emergency stop (shutdown).

d. Engine status monitoring:
1) Display the following status conditions on an alphanumeric digital display panel:
a) Engine oil pressure (pounds per square inch or kilopascal).
b) Engine coolant temperature (degrees Fahrenheit or Celsius).
c) Engine speed (revolutions per minute).
d) Number of start attempts.
e) Battery voltage (DC volts).

e. Data logging and display provision:
1) Log the last 10 warning or shutdown indications on the engine generator.
2) Monitor the total load on the generator:
a) Maintain data logs of total operating hours at specific load levels ranging from 0 to 110 percent of rated load, in 10 percent increments.
b) Display total hours of operation at less than 30 percent load and total hours of operation at more than 90 percent of rated load.
3) The control system to log:
a) Total number of operating hours.
b) Total kW hours.
c) Total control operational hours.

f. Engine control functions:
1) Provide a cycle cranking system, which allows for user selected crank time, rest time, and number of cycles:
a) Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.
2) Provide an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this Specification, including adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting.
3) Provide time delay start (adjustable 0 to 300 seconds) and time delay stop (adjustable 0 to 600 seconds) functions.

g. Battery monitoring system:
1) Initiate alarms when the DC control and starting voltage is outside the manufacturers tolerances.
2) Disable the low voltage limit during engine cranking (starter engaged).
3) Monitor DC voltage as load is applied to the battery, to detect impending battery failure or deteriorated battery condition.

h. Remote control interface:
1) Provide a minimum of 4 programmable output relays:
a) Configurable for any alarm, shutdown, or status condition.
2) Provide a minimum of 4 programmable inputs:
a) Label as indicated on the Drawings.
b) Labels shall match other control labels.

J. Battery system:
    1. Installed on the engine-driven generator skid.
    2. Provide extra flexible minimum 4/0 welding cable to make the connection between the battery and the engine:
        a. Proper compression lugs and tooling must be used to terminate these cables.
    3. Provide a 12- or 24-volt lead acid recombination no maintenance engine start battery system:
        a. The battery shall have sufficient capacity, at the minimum and maximum temperature specified, to provide the specified cranking periods.
        b. Provide battery capacity in order to supply power to the following:
            1) DC lighting.
    4. Charger:
        a. Sized to provide sufficient power to both fully charge a drained battery.
        b. Location: On the engine skid.
        c. DC ammeter and DC voltmeter.
        d. On-Off switch.
        e. Solid-state device with adjustable float voltage control.
        f. Constant voltage design with current limit.
        g. With an equalize switch which will allow the battery to be overcharged for maintenance purposes or an automatic charging cycle that has an equalize period.
        h. Designed to meet the charge, float, and equalize requirement of the battery furnished.
        i. Overload and short circuit protection.

2.07 ACCESSORIES

A. Fuel system:
    1. Base mounted fuel tank:
        a. Unit mounted base tank with the capacity to hold 12 hours of fuel with the engine generator set operating at full load.
        b. UL 142 listed tank with secondary containment rupture basin.
        c. Construction:
            1) Reinforced steel channel system.
            2) Minimum thickness of 7-gauge for channels.
            3) Minimum 12-gauge for tank construction.
        d. Provide tank baffle to separate hot fuel return from cooler supply fuel.
        e. Connections:
            1) 1.25-inch minimum vents:
                a) Pipe vent outside any room or enclosure containing the generator set, using Schedule 40 black steel pipe.
            2) 2-inch minimum fill connection.
            3) 2-inch minimum main fuel storage level gauge.
            4) 1.25-inch minimum low fuel level alarm with level switch connected to control panel.
            5) 0.5-inch minimum fuel supply with dip tube.
            6) 0.5-inch minimum fuel return with dip tube.
        f. Rupture basin level switch and alarm.
        g. Finish:
            1) Interior: Treated to inhibit corrosion until fuel is added.
            2) Exterior: Epoxy coating with urethane top coat.

h. Ancillary equipment:
    1) Provide the following base tank accessories as required by NFPA 30 for project application:
        a) Low fuel level float switch, set at 50 percent.
        b) High fuel level / overfill prevention, audible alarm, set at 90 percent.
        c) Overfill prevention valve on tank fill port, set at 95 percent.
        d) Fill port drop tube to within 6 inches of the bottom of the tank.
        e) Spill containment bucket or basin around fill port.
        f) Interstitial monitoring float switch (leak detection).
        g) Normal vents, extended 13 feet above grade, flame arrester caps.
        h) Emergency vents, on tank and containment basin.
        i) Provisions for connection of grounding conductor.
        j) Tank calibration chart in inches to gallons.
i. Warning signage:
    1) No Smoking.
    2) Flammable Liquids.
    3) Diesel Fuel.
    4) NFPA 704 Placards.

B. Weatherproof acoustical housing:
    1. Provide engine enclosure to protect engine, generator, starting system, batteries, and other specified accessories from weather exposure.
    2. Meet seismic and wind requirements at the Project Site.
    3. Construction:
        a. Minimum 14 gauge steel panel thickness.
        b. All panels and members hot dip galvanized after fabrication.
        c. Enclosure removable to allow for maintenance.
        d. Fitted with lockable latches.
        e. Stainless steel latches and hinges.
    4. Noise reduction:
        a. Provide acoustical insulation and acoustical enclosure ventilation louvers and fan discharge silencers as necessary to achieve a measured sound pressure level of 75 dBA when measured at 23 feet from the enclosure.
        b. Protect acoustical insulation with perforated metal covers and plastic bagging to prevent damage from abrasion or weather elements.
        c. Provide an exhaust silencer matched to the enclosure to reduce the overall noise emissions level of the engine/generator assembly to the levels required above.

C. Wiring:
    1. All external wiring connections to and from the engine and alternator shall be made via 2 engine mounted junction boxes:
        a. One box shall be used for all control and DC power connections.
        b. The other box shall be used for the alternator output connections:
            1) The alternator output breaker may be used for these connections.
    2. Enclose wiring in an NEC approved and recognized conduit system selected and sized by the engine generator manufacturer:
        a. Suitable for the temperatures, vibrations, and conditions on the engine-driven generator skid.

3. Control wiring shall terminate on terminal blocks in the control junction box:
    a. All connections shall be made to terminal blocks:
        1) 600 volt rated.
        2) Wires terminated on box with compression type ring type lugs, installed with proper tooling.
        3) Terminal blocks shall be numbered.
        4) All wiring in terminal box both internal and field connections shall be routed in plastic wire duct.
4. Terminate alternator output connection wires using solderless compression type lugs when connecting to bus bar:
    a. Lug manufacturer's termination methods and tools must be used.
5. Splices are not allowed:
    a. All connections are to be made at the terminal blocks in the control junction boxes.

D. Miscellaneous engine generator skid items:
1. Provide the following items:
    a. Sectionalized drip pans.
    b. Rain shields for exhaust lines.
    c. Roof jacks.

E. Generator output circuit breaker:
1. Engine generator skid mounted and line side connected to alternator.
2. Manually resettable.
3. Line current sensing.
4. Inverse time versus current response.
5. Sized and coordinated to protect the generator from damage from overload and/or short circuit:
    a. Coordinated with downstream devices:
        1) As specified in Section 26_05_74 - Electrical System Studies.
6. Breakers shall be as specified in Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.
7. Provide breakers with proper number of lugs to match cables 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 26_05_00 - Common Work Results for Electrical.

B. General:
   1. Install the equipment as indicated on the Drawings.
   2. Perform all Work in accordance with manufacturer's instructions and shop drawings.
   3. Before start-up, furnish written certification that the entire installation and all connections, both mechanical and electrical, have been inspected and are proper and consistent with the Drawings and Specifications.

C. Installation shall be by personnel experienced and regularly engaged in field installation of power generation systems:
   1. Make all field mechanical and electrical connections.

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 01200 - Contract Closeout.

B. Design prototype tests as follows:
   1. Use design prototypes similar to the equipment specified in this Section for testing, and not the actual equipment for the Project.
   2. Minimum testing requirements:
      a. In accordance with NFPA.
      b. Maximum power in kW.
      c. Maximum starting kilovolt-ampere at 35 percent instantaneous voltage dip.
      d. Alternator temperature rise:
         1) By embedded thermocouple.
         2) By resistance method.
         3) In accordance with NEMA MG1-22.40 and 16.40.
      e. Governor speed regulation under steady state and transient conditions.
      f. Fuel consumption at 25 percent, 50 percent, 75 percent, and 100 percent load.
      g. Harmonic analysis, voltage wave form deviation, and telephone influence factor.
      h. Cooling airflow.
      i. Torsional analysis testing to verify that the generator set is free of harmful torsional stresses.
      j. Endurance testing.
      k. A certified copy of the test results will be furnished to the Owner.

C. Test each engine generator under varying loads with all machine safety guards and exhaust system in place.

D. Test the complete engine generator system at full load and rated power factor with a reactive load bank in the manufacturer's factory:
   1. Tests shall include:
      a. Radiator.
      b. Engine control panel.
      c. Single-step load pickup.
      d. Transient and steady-state governing.
      e. Safety shutdown device testing.
      f. Rated power.
      g. Maximum power.
   2. During the tests, re-circulate the radiator cooling air through the radiator as necessary to test the system under the maximum ambient conditions specified in this Section.
   3. Run the unit for 2 hours with the following recordings made hourly:
      a. Frequency.
      b. Voltage.
      c. Amperage.
      d. Kilowatts.
      e. Room temperature measured at the generator end of the unit.
      f. Radiator air inlet temperature.
      g. Coolant temperature.
      h. Oil pressure.
   4. Record the following items:
      a. Time required for the engine/generator to start and reach rated voltage and frequency in seconds.
      b. Maximum block load capabilities of the unit.
      c. Point at which overtemperature shutdown occurs.
      d. Point at which overspeed shutdown occurs.
      e. Point at which low oil pressure shutdown occurs.
      f. Point at which overcrank shutdown occurs.
      g. Low water temperature alarm.
      h. Low fuel level alarm.
      i. Fuel leak alarm.
      j. Overvoltage alarm and shutdown.
      k. Undervoltage alarm and shutdown.
      l. Under frequency alarm and shutdown.
      m. Low battery voltage alarm.
   5. Furnish a certified copy of the test results to the Owner:
      a. Record any minor adjustments made during the test.
      b. If major changes, as determined by the Engineer, are made, the 2-hour test must be repeated.

E. Owner training:
   1. As specified in Sections 01200 - Contract Closeout and 26_05_00 - Common Work Results for Electrical.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Provide the services of a manufacturer's representative for the following:
   1. Before start-up, furnish written certification that the entire installation and all connections, both mechanical and electrical, have been inspected and are proper and consistent with all Drawings and Specifications.
   2. Furnish the services of factory-certified technicians during the start-up and adjustment period to make sure all items furnished are in proper operating condition:
      a. Engine technician must be completely knowledgeable in the operation, maintenance, and start-up of the mechanical system.
      b. Electrical technician must be completely knowledgeable in the operation, maintenance, and start-up of the electrical system.
      c. These technicians to instruct the Owner's personnel regarding the operation and maintenance of all items supplied:
         1) Supply written handouts during the training period, and these handouts should be suitable for future reference after the training period is completed.
      d. Furnish a written report after the start-up:
         1) Report must state that the installation is complete and satisfactory.
         2) List the items requiring additional attention.

C. Manufacturer to perform installation check, start-up, and load test.

D. Certify that fuel, lubricating oil, and antifreeze conform to the manufacturer's recommendations under the environmental conditions present.

E. Check accessories that normally function while the equipment is in standby mode for proper operation, before cranking the engine:
   1. These accessories include but are not limited to:
      a. Jacket water heaters.
      b. Fuel heaters, when used.
      c. Battery charger.
      d. Generator strip heaters, when used.

F. Start-up under manual mode:
   1. Check for the following items:
      a. Exhaust leaks.
      b. External path for exhaust gases.
      c. Cooling airflow.
      d. Movement during starting and stopping.
      e. Vibration during running.
      f. Normal and emergency line-to-line voltage and phase rotation.

G. Perform field acceptance tests as specified in Section 26_08_50 - Field Electrical Acceptance Tests

3.09 ADJUSTING

A. Make adjustments as necessary and recommended by the manufacturer, Engineer, or testing firm.

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_36_24

TRANSFER SWITCHES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Transfer switches.

1.02 REFERENCES

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Underwriters Laboratories (UL):
   1. UL 1008 Transfer Switch Equipment.

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Specific definitions:
   1. ATS: Automatic transfer switch.
   2. MTS: Manually initiated, electrically operated transfer switch.

1.04 SYSTEM DESCRIPTION

A. Provide transfer switches capable of transferring load circuits from utility power to standby power and back.

B. ATS sequence of operation:
   1. When the voltage of any normal source phase drops below 80 percent and after an adjustable time delay (0 to 6 seconds minimum), the transfer switch shall start the standby generator.
   2. When standby voltage reaches 90 percent of nominal, and frequency is within 2 hertz of nominal, following an adjustable time delay (0 to 10 seconds), the switch shall transfer to standby power.
   3. When normal power has been restored to 90 percent of nominal on all phases, following an adjustable time delay (0 to 30 minutes), the switch shall retransfer to normal power.
      a. If the standby source fails during this time delay, the switch shall automatically retransfer to normal power.
      b. The switch shall have an adjustable delay transition timer (0 to 5 minutes) for the load disconnect position.
         1) An alarm shall be initiated if the switch fails to retransfer in a pre-set period of time.
   4. Following an adjustable generator cool-down timer (0 to 60 minutes), the switch shall stop the generator.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26_05_00 - Common Work Results for Electrical.

B. Product data:
   1. Manufacturer of transfer switch.
   2. Manufacturer of all component parts of the ATS.
   3. Dimensions:
      a. Width.
      b. Length.
      c. Height.
      d. Weight.
   4. Bill of material.
   5. Description of operation.
   6. Ratings:
      a. Voltage.
      b. Phase.
      c. Current.
      d. Number of poles.
   7. Overcurrent devices:
      a. As specified in Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.
   8. List of recommended spare parts.
   9. For equipment installed in structures designated as Seismic Design Category C, D, E, or F, submit the following as specified in Section 26_05_00 - 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. Layout drawings:
      a. Furnish full-dimension and to-scale equipment layout drawings which include:
         1) Plan, front, and side views.
         2) Sub-panels.
         3) Interior panels.
         4) Top and bottom conduit windows.
   2. Complete electrical wiring diagrams:
      a. Point-to-point connections.
      b. Indicate wire numbers.
   3. Complete interface and connection diagrams.

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 26_05_00 - 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. Operating instructions:
    a. Printed and framed instruction chart suitable for wall hanging.
    b. Detail the operational functions of all transfer switch controls.
2. Maintenance manual:
    a. Furnish maintenance manuals with instructions covering maintenance of all equipment and data identifying all parts.
    b. Furnish all information needed to maintain the transfer switch including, but not limited to, the following:
        1) Instructions for testing, adjustment, and start-up.
        2) Detailed control instructions that outline the purpose and operation of every control device used in normal operation.
        3) Description of the sequence of operation that outlines the steps that follow normal power failure, transfer to standby power, return to normal power, and fault conditions.
        4) Schematics and wiring:
            a) Furnished in a reduced 11-inch-by-17-inch fully legible format.
        5) Report listing the installed setting of all adjustable parameters for the automatic transfer system.

F. Test forms and reports:
1. Submit complete factory acceptance test procedures and all forms used during the test.
2. Manufacturer to furnish certified report after the factory tests.
3. Manufacturer to furnish written report after start-up:
    a. Report must state that the installation is complete and satisfactory, or list items requiring additional attention and a proposal for the corrective actions.
    b. If the items require attention after the initial start-up, a final report is required stating that the installation is complete and satisfactory.

G. Calculations:
1. Detailed calculations or details of the actual physical testing performed on the transfer switch to prove the transfer switch is suitable for the seismic requirements at the Project Site.

H. Warranty.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Transfer switches shall be UL listed and labeled.
   1. Where indicated on the Drawings the transfer switch shall be UL labeled and listed "Suitable for Service Entrance."

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Transfer switch: One of the following, no equal:
   1. ASCO.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

A. General:
   1. Capable of switching all classes of load.
   2. Rated for continuous duty when installed in a non-ventilated enclosure.
   3. Provide circuit breakers or contactors rated for continuous duty.
   4. Minimum transfer time for delayed transition ATS: 1 second.

5. Capable of transferring successfully in either direction with 70 percent of rated voltage applied to the terminals.
6. Provide automatic transfer switches with provisions for manual operation under no load.

B. Electrical ratings:
   1. Voltage, configuration, and amp ratings as indicated on the Drawings.
   2. Withstand and close into fault ratings in accordance with UL 1008.

C. Contacts:
   1. Mechanically held.
   2. Mechanically interlocked to prevent normal and standby sources from being closed at the same time.
   3. Silver alloy construction.
   4. Neutral contact, when indicated on the Drawings:
      a. Same ratings as the phase contacts.
      b. Break last and make first operation.

D. Controls:
   1. ATS shall have 3-phase over-voltage, under-voltage, over-frequency, and under-frequency on both normal and standby sources.
   2. Control panel:
      a. Microprocessor based.
      b. 4-line, 20-character LCD display. Displayed data shall include:
         1) Normal and standby source parameters.
         2) Diagnostic information.
         3) Switch and timer status.
      c. Keypad for making all ATS settings and operating parameters.
         1) All settings shall be password protected.
      d. LED display of the following:
         1) Normal source available.
         2) Connected to normal source.
         3) Standby source available.
         4) Connected to standby source.
      e. Provisions for testing ATS operation by simulating a normal source failure.
      f. Generator exerciser:
         1) Programmable to start the generator on a daily, weekly, monthly, or yearly basis for an adjustable period of time.
         2) Load or no load selectable.
            a) When load is selected, ATS will transfer to the generator for the duration of the exercise period. Re-transfer back and cool down the generator.
            b) When no load is selected, the ATS will run the generator for the duration of the exercise period and then stop the generator.
   3. Status and control contacts:
      a. Generator start/stop contact:
         1) Single-pole, double-throw.
         2) Rated for 5 amps at 30 VDC.
      b. Status contacts:
         1) Single-pole, double-throw.
         2) Rated for 10 amps at 250 VAC.

3) Provide contacts for the following:
   a) Normal source available.
   b) Normal source failure.
   c) Connected to normal source.
   d) Standby source available.
   e) Standby source failure.
   f) Connected to standby source.

E. Enclosure:
   1. Open type for mounting in electrical equipment as indicated on the Drawings.

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

A. Overcurrent device:
   1. As specified in Section 26_28_01 - Low Voltage Molded Case Circuit Breakers.

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 26_05_00 - 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.

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 01200 - Contract Closeout.

B. Factory testing:
   1. Complete factory test to verify proper operation of all timers, settings, and operation.
   2. In accordance with UL-1008.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_43_14

SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. High-energy surge protective devices.

1.02 REFERENCES

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

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. C62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
   3. C62.45 - Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.
   4. C62.62- Standard Test Specifications for Surge Protective Devices (SPDs) for Use on the Load Side of the Service Equipment in Low Voltage (1000 V and less) AC Power Circuits.

C. National Electrical Manufacturers Association (NEMA):
   1. 250 - Enclosures for Electrical Equipment (1000 V Maximum).

D. Underwriters Laboratory:
   1. 1449, 4th Edition, Standard for Surge Protective Devices.

1.03 DEFINITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. NEMA:
   1. Type 1 enclosure in accordance with NEMA 250.
   2. Type 4 enclosure in accordance with NEMA 250.
   3. Type 4X enclosure in accordance with NEMA 250.
   4. Type 12 enclosure in accordance with NEMA 250.

C. Specific definitions:
   1. SPD: Surge protective device.
   2. SAD: Silicon avalanche diode.
   3. MOV: Metal oxide varistor.
   4. MCOV: Maximum continuous operating voltage.
   5. I_n: Nominal discharge current.
   6. VPR: Voltage protection rating.
   7. SCCR: Short circuit current rating.

1.04 SYSTEM DESCRIPTION

A. Surge protective devices as an integral component of the electrical equipment or externally mounted as indicated on the Drawings.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26_05_00 - Common Work Results for Electrical.

B. Product data:
   1. Furnish complete product data confirming detailed compliance or exception statements to all provisions of this Section.
   2. Manufacturer's catalog cut sheets indicating:
      a. Manufacturer and model numbers.
      b. Ratings of each SPD including but not limited to:
         1) Short circuit current rating.
         2) Nominal discharge current.
         3) Maximum continuous operating voltage.
         4) Voltage protection rating.
         5) System voltage.
         6) System frequency.
         7) Surge current capacity.
   3. Submit independent test data from a nationally recognized testing laboratory verifying the following:
      a. Overcurrent protection.
      b. UL 1449.

C. Shop drawings:
   1. Provide electrical and mechanical drawings by the manufacturer that detail:
      a. Unit dimensions.
      b. Weights.
      c. Components.
      d. Field connection locations.
      e. Mounting provisions.
      f. Connection details.
      g. Wiring diagram.

D. Operation and maintenance manuals:
   1. Provide the manufacturer's manual with installation, start-up, spare parts lists, and operating instructions for the specified system.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Provide SPD units that are designed, manufactured, tested and installed in compliance with the following codes and standards:
   1. Institute of Electrical and Electronics Engineers (IEEE C62.41.1, C62.41.2, C62.45, C62.62).
   2. Federal Information Processing Standards Publication 94 (FIBS PUB 94).
   3. National Electrical Manufacturer Association.
   4. National Fire Protection Association (NFPA 20, 75 and 780).

5. National Electric Code (NFPA 70).
6. Underwriters Laboratories (UL 1449 4th Edition and UL 1283).
7. International Electrotechnical Commission (IEC 801).

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING

A. Coordinate with and provide SPD equipment to the electrical equipment manufacturer before final assembly and factory testing.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Extended warranty:
   1. Furnish a manufacturer's full 5-year parts and labor warranty from date of shipment against any part failure when installed in compliance with manufacturer's written instructions, UL listing requirements, and any applicable national, state, or local electrical codes.
   2. Warranty shall include:
      a. Direct, factory trained employees must be available within 48 hours for assessment of the problem.
      b. A 24-hour toll-free 800-number for warranty support.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Same manufacturer as Motor Control Center.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS

A. Provide Type 1 or Type 2 SPD units as required for the locations indicated on the Drawings.

B. Electrical requirements:
   1. SPD ratings are to be consistent with the nominal system operating voltage, phase, and configuration as indicated on the Drawings.
   2. MCOV:
      a. For the SPD and all components in the suppression path (including all MOVs, SADs, and selenium cells): Greater than 115 percent of the nominal system operating voltage.
   3. Operating frequency:
      a. 47 to 63 hertz.
   4. SCCR:
      a. 65 kAIC minimum, but not less than the equipment it is connected to as indicated on the Drawings.
      b. The SCCR shall be marked on the SPD in accordance with UL 1449 and the NEC.
   5. Nominal discharge current I_n:
      a. 20 kA.
   6. Maximum VPR:

Modes	240/120	208Y/120	480Y/277
L-N, L-G, N-G	900	900	1,500
L-L	1,200	1,200	2000

   7. Peak surge current:
      a. Service entrance locations:
         1) 240 kA per phase minimum.
         2) 120 kA per mode minimum.
      b. Branch locations:
         1) 120 kA per phase, minimum.
         2) 60 kA per mode minimum.

C. Protection modes:
   1. Provide SPD protection modes as follows:
      a. Line to Neutral (L-N) where applicable.
      b. Line to Ground (L-G).
      c. Neutral to Ground (N-G), where applicable.

D. Environmental requirements:
   1. Storage temperature:
      a. -40 degrees to +50 degrees Celsius.
   2. Operating temperature:
      a. -0 degrees to +60 Celsius.
   3. Relative humidity:
      a. 5 percent to 95 percent.
   4. Audible noise:
      a. Less than 45 dBa at 5 feet (1.5 m).
   5. Operating altitude:
      a. Zero to 12,000 feet above sea level.

E. Provide surge protective devices that are suitable for application in IEEE C62.41.1, C62.41.2 Category A, B, and C3 environments, as tested to IEEE C62.45.

2.05 EQUIPMENT (NOT USED)

2.06 COMPONENTS

A. Enclosure:
   1. Located in electrical equipment as indicated on the Drawings.

B. Internal connections:
   1. Provide low impedance copper plates for intra-unit connections:
      a. Attach surge modules using bolted connections to the plates for low impedance connections.
   2. Size all connections, conductors, and terminals for the specified surge current capacity.

C. Surge diversion modules:
   1. MOV:
      a. Where multiple MOVs are used in parallel, utilize computer matched MOVs to within 1 volt variance and tested for manufacturer's defects.

D. Overcurrent protection:
   1. Individually fuse all components, including suppression, filtering, and monitoring components:
      a. Rated to allow maximum specified nominal discharge current capacity.
      b. Overcurrent protection that limits specified surge currents is not acceptable.

E. Connections:
   1. Provide terminals to accommodate wire sizes up to #2 AWG.

2.07 ACCESSORIES

A. Unit status indicators:
   1. Provide red and green solid-state indicators, with printed labels, on the front cover to redundantly indicate on-line unit status:
      a. The absence of the green light and the presence of the red light indicate that surge protection is reduced and service is needed to restore full operation.
      b. Indicates the status of protection on each mode or phase.

B. Dry contacts for remote monitoring:
   1. Electrically isolated Form C dry contacts (1 A/125 VAC) for remote monitoring of system integrity, and indication of under voltage, phase and/or power loss.

C. Provide an audible alarm which activates under any fault condition.
   1. Provide an alarm On/Off switch to silence the alarm.
   2. A visible LED will confirm whether alarm is On or Disabled.
   3. Locate both switches and the audible alarm on the unit's front cover.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL

A. Permanently affix surge rating to the SPD.

B. Perform manufacturer's standard factory test:
   1. Perform testing in accordance with UL 1449.

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

B. Follow the manufacturer's recommended installation practices and comply with all applicable codes.

C. Special techniques:
   1. Do not subject SPD to insulation resistance testing.

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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_08_50 - Field Electrical Acceptance Tests.

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES (NOT USED)

END OF SECTION

SECTION 26_50_10

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 26_05_00 - 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 26_05_00 - 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 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.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 26_05_00 - 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) Dimensioned drawings:
    a) Effective projected area rating for pole mounted luminaires.
12) Weight.
13) 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.
14) 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 26_05_00 - 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.

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:

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.

1.06 QUALITY ASSURANCE

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.07 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.08 PROJECT OR SITE CONDITIONS

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.09 SEQUENCING (NOT USED)

1.10 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.

1.11 WARRANTY

A. As specified in Section 26_05_00 - 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.

1.12 SYSTEM START-UP

A. As specified in Section 26_05_00 - Common Work Results for Electrical.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 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. 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 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 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.

B. 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.

2.06 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 26_05_00 - 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.

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 01200 - Contract Closeout.

3.08 FIELD QUALITY CONTROL

A. As specified in Section 26_05_00 - 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 26_05_00 - 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 26_05_00 - Common Work Results for Electrical.

3.12 SCHEDULES

A. Refer to the Luminaire Schedule in the Drawings.

END OF SECTION

SECTION 40_61_00

COMMON WORK RESULTS FOR PROCESS CONTROL AND INSTRUMENTATION SYSTEMS

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 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. Submit all such changes and additions to the Engineer for acceptance as specified in Document 00_72_00 - General Conditions.
   4. Review the complete set of Drawings and Specifications in order to ensure that 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. The Owner is not responsible for any additional costs due to the failure of the Contractor to notify all subcontractors and suppliers of the Instrumentation and Control 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. Section 00700 - General Requirements.
      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 Section 00700 General Requirements.

F. Changes and change orders:
    1. As specified in Division 1 specifications.

1.02 REFERENCES

A. Code compliance:
    1. 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 Section 00700 General Requirements.

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 24VDC 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 24VDC signal, a digital bus communications signal, or both.
   8. System supplier - As specified in ICSC Qualifications in the Quality Assurance article of this Section.

C. NEMA:
   1. Type 1 enclosure in accordance with NEMA 250.
   2. Type 3R enclosure in accordance with NEMA 250.
   3. Type 4X enclosure in accordance with NEMA 250.

4. Type 6 enclosure in accordance with NEMA 250.
5. Type 6P 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. 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.
28. SPDT: Single-pole, double-throw.
29. SPST: Single-pole, single-throw.
30. UPS: Uninterruptible power supply.

1.04 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 bench calibration and verify calibration after installation.
      g. Perform testing as indicated in Section 40_80_01 - Commissioning for Instrumentation and Controls.
      h. Prepare operation and maintenance manuals.
      i. Conduct training classes.
      j. Integrate the PCS with instrumentation and control devices provided under other sections.

k. 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.
l. Resolve signal, power, or functional incompatibilities between the PCS and interfacing devices.
m. 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 will provide the configuration and programming for SCADA/HMI and all PLCs with the exception of the vendor-furnished PLCs.
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. 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.
7. Defective Work:
    a. As specified in Section 00700 General Requirements.

B. Existing system:
1. Enusre the existing OMNI system XR50 is salvaged to the Owner for re-use as part of Base Bid.

C. New system:
1. There is no PLC in this project or any automatic controls. There is a control system called OMNI system which is used for monitoring. The OMNI system will transmit the information via cellular transmission. The cellular transmission is not part of Contractor's scope of work. Contractor scope of work is to wire the cables to OMNI system.
2. There are two types of OMNI system – XR 50 capable of monitoring up to 10 DIs and Crystalball capable up to 12 DIs, 4 AIs and 4 AOs.
3. Base Bid:
    a. Reinstall the existing OMNI XR50 in base bid.
    b. Provide and install new instruments as indicated on the Drawings.
4. Bid Alternate: In addition to the above work,
    a. Provide and install a OMNI Crystalball, in lieu of XR50.
    b. Install magnetic flowmeter, and the flow meter indicator in control panel section.

1.05 SUBMITTALS

A. Furnish submittals as specified in 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 26_05_53 - 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 organization:
   1. First page:
      a. Specification section reference.
      b. Name and telephone number of individual who reviewed submittal before delivery to Engineer.
      c. Name and telephone number of individual who is primarily responsible for the development of the submittal.
      d. Comments.
      e. Contractor's review certification statement and signature.
   2. Next pages:
      a. Provide confirmation of specification compliance:
         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.
      b. Include a response in writing to each of the Engineer's comments or questions for submittal packages which are re-submitted:
         1) In the order that the comments or questions were presented throughout the submittal.
         2) Referenced by index section and page number on which the comment appeared.
         3) Acceptable responses to Engineer's comments are either:
            a) Engineer's comment or change is accepted and appropriate changes are made.
            b) Explain why comment is not accepted or requested change is not made.
            c) Explain how requirement will be satisfied in lieu of comment or change requested by Engineer.
         4) Any re-submittal, which does not contain responses to the Engineer's previous comments shall be returned for Revision and Re-submittal.
         5) No further review by the Engineer will be performed until a response for previous comments has been received.

3. Remaining pages:
    a. Actual submittal data:
        1) Organize submittals in exactly the same order as the items are referenced, listed, and/or organized in the specification section.
        2) 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 intended to be used.

D. Submittal requirements:
1. Furnish submittals that are fully indexed with a tabbed divider for every component.
2. Sequentially number pages within the tabbed sections. Submittals and operation and maintenance manuals that are not fully indexed and tabbed with sequentially numbered pages, or are otherwise unacceptable, will be returned without review.
3. Furnish submittals in the following general order, each in a separate bound set:
    a. Schedule of Values.
    b. Product Data.
    c. After Engineer acceptance of the Product Data, submit the Project Shop Drawing submittals.
    d. Loop Description Submittal.
    e. The Process Control Hardware and Software Submittal including, control system software, programming, and screens.
    f. Testing, Calibration and Process Start-Up procedures.
    g. Operation and Maintenance Data.
    h. Training Submittals.
    i. Record Documents.
4. Edit all submittals and operation and maintenance manuals so that the submittal specifically applies to only the equipment furnished.
    a. 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.
5. Submit copies of shop drawings, and product data:
    a. Show dimensions, construction details, wiring diagrams, controls, manufacturers, catalog numbers, and all other pertinent details.
6. Where submittals are required, provide a separate submittal for each specification section. 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. (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.)
7. Exceptions to Specifications and Drawings:
    a. Include a list of proposed exceptions to the Specifications and Drawings along with a detailed explanation of each.
    b. If there is insufficient explanation for the exception or deviation, the submittal will be returned requiring revision and re-submittal.

c. Acceptance of any exception is at the sole discretion of the Engineer.
    1) Provide all items (materials, features, functions, performance, etc.) required by the Contract Documents that are not accepted as exceptions.
d. Replace all items that do not meet the requirements of the Contract Documents, which were not previously accepted as exceptions, even if the submittals contained information indicating the failure to meet the requirements.

E. 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.

F. 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 26_05_53 - 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 26_05_53 - 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 26_05_53 - 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. Submit preliminary sets of these manuals to the Engineer for review of format and content:
        1) Engineer will return 1 set with comments.
        2) Revise and/or amend as required and submit the requisite number of copies to the Engineer 15 days before Functional Testing of the systems.
    b. Incorporate changes that occur during process start-up and submit as part of the final manuals.
    c. Provide comprehensive information on all systems and components to enable operation, service, maintenance, and repair.
    d. Include Record Documents and the accepted shop drawing submittals, modified for conditions encountered in the field during the work.
    e. Include signed results from Functional Testing and Process Operational Period.
    f. Provide installation, connection, operating, calibration, setpoints (e.g., pressure, pump control, time delays, etc.), adjustment, test, troubleshooting, maintenance, and overhaul instructions in complete detail.
    g. Provide exploded or other detailed views of all instruments, assemblies, and accessory components together with complete parts lists and ordering instructions.
    h. Spare parts list:
        1) Include a priced list of recommended spare parts for all the equipment furnished under this Contract:
            a) Include recommended quantities sufficient to maintain the furnished system for a period of 5 years.
        2) Annotate the list to indicate which items, if any and quantity are furnished as part of this Contract.
    i. Provide the name, address, and phone number of manufacturer and manufacturer's local service representative of these parts.
    j. Additional operation and maintenance manual requirements:
        1) Completely index manuals with a tab for each section:
            a) Each section containing applicable data for each piece of equipment, system, or topic covered.
            b) Assemble manuals using the accepted shop drawings, and include, the following types of data:
                (1) Complete set of 11-inch by 17-inch drawings of equipment.
                (2) Complete set of 11-inch by 17-inch drawings of the control system.
                (3) Complete set of control schematics.
                (4) Complete parts list for all equipment being provided.
                (5) Catalog data for all products or equipment furnished.
    k. 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.
    l. 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.

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.
      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. Installation recommendations:
    a. Submit the manufacturer's printed recommendations for installation of instrumentation equipment.
10. 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 01200 - Contract Closeout.
    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.

11. Project Record documents:
    a. Furnish as specified in Section 01200 - Contract Closeout.
    b. Record Drawing requirements:
        1) Provide Project Record Drawing of all Instrumentation Drawings.
        2) Update Record Drawings weekly.
        3) Record Drawings must be fully updated as a condition of the monthly progress payments.
        4) Clearly and neatly show all changes including the following:
            a) All existing pipe, conduit, wire, instruments or other structures encountered or uncovered during construction.
    c. Shop drawings:
        1) General:
            a) Coordinate all aspects of the Work so that a complete, instrumentation, computer, and control system for the facility is supported by accurate shop and record drawings:
                (1) Clearly show every wire, circuit, and terminal provided under this contract on one or more submitted wiring diagrams.
            b) Show all interfaces between any of the following: instruments, vendor control panels, motor control centers, motor starters, variable speed drives, control valves, flow meters, chemical feeders, and other equipment related to the PCS.
            c) Generate all drawings developed for this project utilizing AutoCAD by Auto Desk Version 2012 or later:
                (1) Furnish on CD-ROM disks containing the following for each drawing:
                    (a) Original CAD files in DWG format.
                    (b) PDF version.
                (2) Provide hard copies on 11-inch by 17-inch plain bond paper.

d) Upon completion of the Work, update all shop drawings to indicate the final as-built configuration of the systems:
(1) Should an error be found in a shop drawing during installation or process start-up of equipment, note the correction, including any field changes found necessary, on the drawing and submit the corrections in the Record Documents.
(2) Update, check, and revise all wiring drawings and other submitted drawings and documents to show final installed conditions.
(3) Provide as-built shop drawings for all instrumentation equipment on 11-inch by 17-inch using plain bond paper.
(4) Provide electronic copies of these documents on CD-ROM disks in AutoCAD DWG 2010 format or later and PDF format. Size all drawings to be readable and legible on 11-inch by 17-inch media.
e) Submittal Documents:
(1) Provide an interim submittal of Record Documents after the PCS system Functional Testing.
(2) Submit final Record Documents before Substantial Completion.
f) Review and Corrections:
(1) Correct any Record Documents or other documents found to be incomplete, not accurate, of poor quality, or containing errors.
(2) Promptly correct and re-submit Record Documents returned for correction.

2) Furnish written information prepared specifically for this Project using Microsoft Word and PDF formats and printed on 8.5-inch by 11-inch plain bond paper:
a) Provide electronic copies of these documents on CD-ROM disks.

d. Review and corrections:
1) Correct any record documents or other documents found to be incomplete, not accurate, of poor quality, or containing errors.
2) Promptly correct and re-submit record documents returned for correction.

12. 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.

13. 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.

14. 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.
15. 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.

16. 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.
17. 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.
18. 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.
19. Test reports:
    a. Include the following:
        1) A description of the test.
        2) List of equipment used.
        3) Name of the person conducting the test.
        4) Date and time the test was conducted.
        5) All raw data collected.
        6) Calculated results.
        7) Each report signed by the person responsible for the test.

1.06 QUALITY ASSURANCE

A. Manufacture instruments at facilities certified to the quality standards of ISO 9001.

B. 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. Store all equipment and materials delivered to the job site in a location that will not interfere with the construction or the Owner's operations.

B. Shipping precautions:
   1. After completion of shop assembly, successful Source Test, pack all equipment, cabinets, panels, and consoles in protective crates and enclose in heavy-duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture.
   2. Place dehumidifiers when required, inside the polyethylene coverings.
   3. Skid-mount the equipment for final transport.
   4. Provide lifting rings for moving without removing protective covering.
   5. Display boxed weight on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.

C. Special instructions:
   1. Securely attach special instructions for proper field handling, storage, and installation to each piece of equipment before packaging and shipment.

D. 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.

E. 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.

1.08 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. Altitude, temperature and humidity:
      a. Provide all equipment and instrumentation fully rated for continuous operation at this altitude, temperature and humidity conditions with no additional derating factors applied.
      b. 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.
   3. Area classifications:
      a. Furnish enclosures that match the area classifications as specified in Section 26_05_00 - Common Work Results for Electrical.
   4. Site security:
      a. Abide by all security and safety rules concerning the Work on the Site.

1.09 SEQUENCING

A. General:
   1. As specified in Sections 01030 - Project Meetings and 01200 - Contract Closeout.
   2. Testing requirements are specified in Sections 01200 - Contract Closeout, 40_80_01 - Testing, Calibration, and Commissioning and other sections.
   3. Work restrictions and other scheduling requirements are specified in Section 01400 - MAG Section 105 and MAG Section 106 - Quality Control.
   4. Commissioning requirements as specified in Section 01200 - Contract Closeout.

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.

C. General Field Start-Up and testing procedures:
   1. As specified in Section 01200 - Contract Closeout.

D. Installation testing:
   1. As specified in Section 01200 - Contract Closeout.
   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.

E. Training:
   1. As specified in Section 01200 - Contract Closeout.

F. 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.

G. 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.

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. Provide additional warranty as specified in the individual Instrumentation and Control Specifications that extends beyond the Correction Period, as specified in Section 00700 - General Requirements.

1.12 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.

1.13 OWNER'S INSTRUCTIONS (NOT USED)

1.14 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 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 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.

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT (NOT USED)

2.06 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. Analog signals within enclosures may be 1 to 5 VDC.
      d. Electrically or optically isolate all analog signals from other signals.
      e. Furnish regulated analog signals that are not affected by changes in supply voltage or load resistance within the unit's rating.
      f. Maintain the total 4 to 20 milliamperes loop impedance to 10 percent below the published value at the loop operating voltage.
      g. Where necessary, reduce loop impedance by providing current-to-current (I/I) isolation amplifiers for signal re-transmission.
   2. Discrete input signals:
      a. As indicated in the controller hardware specification.
   3. 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.
   4. 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. Provide control panels with a signal ground bus, isolated from the power ground bus:
    a. Provide multiple panels in one location with a common point for signal ground bus connection to ground.
2. Ground single-point ground shields and measurement loops at the source panel external terminals, unless otherwise noted, by bonding to the control panel signal ground bus.
3. Provide isolating amplifiers within control panels for field equipment possessing a grounded input or output, except when the panel circuit is galvanically isolated.

2.07 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, 120VAC).
    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.

2.08 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 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.

PART 3 EXECUTION

3.01 EXAMINATION

A. The Contractor is encouraged to visit the site and examine the premises completely before bidding. It is the Contractor'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 exposed to direct sunlight.
   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 26_05_00 - 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. Use proper tool.
      b. Make bends for parallel lines symmetrical.
      c. 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. Conduit, cables, and field wiring:
   1. Provide all PCS equipment cables, and process LAN communication networks under the Instrumentation and Control Specifications.
   2. Provide terminations and wire identification as specified in the Electrical Specifications.
   3. Protect all wiring from sharp edges and corners.
   4. Provide all conduits, fittings, boxes, etc. in accordance with all the requirements of the Electrical Specifications.

G. 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.

H. Instrument tagging:
   1. As specified in Section 26_05_53 - 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 26_05_00 - 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 1/16 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.

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 01200 - Contract Closeout.

B. Owner training:
   1. Demonstration requirements are specified in Section 40_80_01 - Testing, Calibration, and Commissioning.
   2. General:
      a. Provide system maintenance and operator training courses for all the instrumentation and control systems furnished.
      b. Provide system maintenance and operator training courses for all the instrumentation and control equipment and systems furnished, as described below.
         1) All training described below shall be provided by the Contractor.
         2) The Programmer is not responsible for the training described in this Section.
         3) The Programmer will provide training on software provided by the Programmer.
      c. Conduct all training at the Project Site unless another location is accepted by the Engineer and Owner:
         1) Include instruction on the use of all maintenance equipment and special tools provided under the Contract.
      d. Tailor training classes to the specific needs of the class participants:
         1) Develop separate courses for operators, maintenance staff, and supervisors:
            a) The specific categories and number of personnel in each category are identified below.
         2) Furnish training courses that are a combination of classroom and hands-on training:
            a) To the greatest extent possible, utilize components from the Owner's PCS system.
            b) Limit classes that include extensive hands-on activities to a maximum of 5 students per class.
         3) Present the minimum number of sessions, specified in Table 1, for each course in order to satisfy class size restrictions and limitations scheduling Owner staff.
         4) Furnish additional sessions if required to accommodate the total number of personnel identified for each course.
      e. Temporarily install a test PLC and 2 user workstations in the training area for PCIS system training classes conducted on-site:
         1) Configure the workstations as full-function operator stations during the training classes.
         2) Connect these components with a LAN in order to fully simulate system operation.
      f. Schedule individual training classes:
         1) Coordinate with the Owner at least 3 weeks before the start of the class:
         2) Schedule training classes Monday - Friday between 7:30 a.m. and 3:30 p.m.
         3) Each individual daily training session, travel time excluded:
            a) Minimum duration of 4 hours.
            b) Maximum duration of 7 hours.
            c) Breaks scheduled at least every 90 minutes and 1 hour for lunch.

4) Complete training for maintenance personnel 90 days before Process Operational Period.
5) Complete operator training classes before process start-up of the control system software, or any part of it:
a) As specified in the Sequencing article of this Section.
6) Schedule follow-up training classes after the PCS start-up on a schedule determined by the Owner.

g. Instructor qualifications:
1) Highly qualified training instructors for technical training with demonstrated expertise in not only control system functionality but also professional training techniques:
a) Instructor qualifications are subject to the approval of the Engineer.
2) Furnish training instructors thoroughly familiar with the PCIS system, who are members of the implementation team.
3) One of the individuals conducting the PCIS training course must be the same individual responsible for the majority of the programming that was performed for the instrumentation and control system.

3. Training manuals and materials:
a. Furnish training manuals and other materials for training courses.
b. Manuals are to be professionally written to present the course material in a format that is easy to comprehend.
c. The manuals are to serve as teaching aids during presentation of the training classes.
d. Manuals are to serve as reference material after the training has been completed.

Table 1

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
Follow-Up Training	8	5	5
Instrument Training	8	3	1

4. Training course requirements:
a. System overview training:
1) Furnish training courses that give the Owner's supervisory level personnel an overview of all elements of the PCIS system that focus on the overall functional aspect of elements of the control system and provide an understanding of the interaction of the various components.
2) Furnish a training course that gives the Owner's supervisory level personnel an overview of the new Contractor-provided elements of the PCIS system. Focus on the overall functional aspects of each new elements of the control system, particularly the mechanical system vendor-provided control packages.

b. Operator training:
1) Furnish training courses that instruct system operators in the efficient operation of all aspects of the PCIS that include not only the general operation of the control system but also the operation of specific system features.

c. 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.
d. 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.

5. 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.

3.08 FIELD QUALITY CONTROL

A. Inspection:
1. Provide any assistance necessary to support inspection activities.
2. 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.

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. Additional general requirements are specified in Section 01200 - Contract Closeout.

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. Vacuum clean all control panels and enclosures before process start-up and again after final completion of the project.

B. Clean all panel surfaces.

C. Return to new condition any scratches and/or defects.

D. Wipe all instrument faces and enclosures clean.

E. 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.

F. 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 40_71_15

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 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SUBMITTALS

A. Furnish submittals as specified in Section 40_61_00 - 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 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.08 WARRANTY

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.09 MAINTENANCE

A. As specified in Section 40_61_00 - 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 L400.

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.
        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 6P 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) As noted in the instrument data sheets.
        2) For all instruments with 4 to 20 mA HART or digital bus protocol, provide a Device Type Manager (DTM) certification by FDT group.
    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.

D. Electronic tester for calibration verification and diagnostics.
   1. Transmitter shall have continuous internal meter verification method comparing current meter system values to base line value.
   2. Should variance in readings be determined exceeding a preset limit the transmitter will provide an alarm condition via a configurable discrete output.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 40_61_00 - 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 40_61_00 - 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 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 40_61_00 - 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 40_61_00 - 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

A/E:	Carollo Engineers	MAGNETIC FLOWMETERS				INSTRUMENT DATA SHEETS		
						Spec. No.		Rev.
Contractor:		No	By	Date	Revision	40_71_15		
Project:	Mystic Hills Lift Station Improvements					Contract		Date
Customer:	City of Sedona							
Plant:						Req.		P.O.
Location:								
BOM No.:						By	Chk	App
File:								

	1	Instrument Tag No.				FE/FIT-0101					
	2	Service									
	3	P&ID				N-8					
	4	C	Line Size / Schedule			6"					
	5	O	Line Material			Class 350DIP					
	6	N	Connection Type/ Pressure Rating			Flange					
	7	N	Connection Materials			Carbon Steel					
	8		Tube Size								
E	9		Tube Material			DIP					
L	10		Liner Material								
E	11	M	Electrode Type			Mfg Standard					
M	12	E	Electrode Material								
E	13	T	Meter Casing								
N	14	E	Power Spply	Phase							
T	15	R	Grounding Type & Matl.								
	16		Enclosure Class			NEMA 6P					
	17		Other								
	18		Fluid			WsateWater					
	19	F	Max Flow			750 gpm					
	20	L	Min Velocity			4.5 fps					
	21	U	Min Flow	Norm Flow		400 gpm	445 gpm				
	22	I	Min Temp	Max Temp		50 F	70 F				
	23	D	Min Press	Max Press		70 feet	80 feet				
	24		Vacuum Possibility								
	25		Conductivity								
T	26	Function									
R	27	Mounting				Remote					
A	28	Enclosure Class				NEMA 4X					
N	29	Length Signal Cable									
S	30	Type Span Adjustment									
M	31	Power Supply				120 VAC, 1P					
I	32	Transmitter Output				4-20 mA HART					
		Relay Outputs				Form C					
T	33	Accuracy				0.25%					
T	34	Calibrated Range									
E	35	Empty Pipe Detection									
R	36	Bi-Directional Flow									
	37	Display Scale Size	Range								
	38	Alarm Contact No.	Form								
	39	Manufacturer									
	40	Element (Meter) Model No.									
	41	Transmitter (Inst.) Model No.									

Notes:

SECTION 40_72_76

LEVEL MEASUREMENT: SWITCHES

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Ball float level switch.

B. Provide all instruments identified in the Contract Documents.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.03 DEFINITIONS

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SUBMITTALS

A. Furnish submittals as specified in Section 40_61_00 - 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 40_61_00 - 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 instrument 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 40_61_00 - 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 40_61_00 - 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. Ball float level switch:
      a. E+H, Liquifloat T FTS20.
      b. Evoqua Water Technologies, 9G-EF.
      c. ITT Flygt, Model ENM-10.
      d. Anchor Scientific Inc., Ecofloat/Solofloat.

2.02 MANUFACTURED UNITS

B. Ball float level switch:
   1. General:
      a. Free hanging, encapsulated body with a switch to determine position of float.
   2. Element:
      a. Mechanical switch encapsulated in waterproof floating ball of nominal diameter, supported by flexible PVC cable and jacket or heavy neoprene.
      b. The length of the PVC cable shall be, at a minimum, equal to sump depth plus 5 feet.
      c. Float: Provide Type 316 stainless steel or polypropylene, maximum 3 inches in diameter.
      d. An operating temperature rating: -30 degrees Fahrenheit to +150 degrees Fahrenheit.
      e. Mercury switches are not acceptable.
      f. Lead wires: Mounted in flexible waterproof PVC cable from switch to junction box terminals without splices.

3. Switch:
    a. Single pole double throw contacts rated 10 amps resistive at 120 VAC.
    b. Provide the number of floats per level system as indicated on the Drawings.
    c. Suspend ball float and adjust for level setpoint as required.
4. Components:
    a. Floats shall include Type 316 stainless steel clamp and brackets and 1/4-inch cable to allow testing of the float without entering the basin or wet well.
    b. Provide strain relief at both ends of the float cable.
    c. Float anchors:
        1) Furnish 15-pound PVC coated anchor kit with 10 feet of Type 316 stainless steel chain.
        2) Provide stainless steel shackles and float clamps.
        3) Manufacturers: The following or equal:
            a) Conery Mfg. Inc.

2.03 ACCESSORIES

A. Provide sunshades for outdoor installation.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 40_61_00 - 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. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.05 ADJUSTING

A. As specified in Section 40_80_01 - Testing, Calibration, and Commissioning.

3.06 CLEANING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.08 PROTECTION

A. As specified in Section 40_61_00 - 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, as specified in the Specifications or both.

END OF SECTION

A/E:	Carollo Engineers	LEVEL SWITCHES				Spec. No.	Rev.
Contractor:		No	By	Date	Revision	40_72_76	
Project:	Mystic Hills Lift Station Improvements					Contract	Date
Customer:	City of Sedona						
Plant:						Req.	P.O.
Location:							
BOM No.:						By / Chk. / App.	
File:							

	1	**Type**	Conductance:	Capacitance:	Tuning Fork:	Ball Float: **X**	Displacement:
	2	**Setting**	Field Set:	Factory Set: **X**			
G	3	**Dead Band**	Fixed: **X**	Adj:	Other:		
E	4	**Material**					
N	5	**Dimensions**	Field Set:				
E	6	**Mounting**	Flange:	Threaded:	Other: Suspended		
R	7	**Operating Pressure /Temperature**					
A	8	**Connection**	MFR STD: **X**	Other:			
L	9	**Manufacturer**					
	10	**Other**					
	11	**Other**					
S	12	**Type**	Mechanical: **X**	Reed:	Other:		
W	13	**Quantity**	Single: **X**	Dual:	Other:		
I	14	**Form**	SPST:	SPDT: **X**	DPDT:	Other:	
T	15	**Rating:** **Amps** **Volts** **Hertz**					
C	16	**Load**	Inductive:		Non-Inductive: **X**		
H	17	**Other**					
	18	**Other**					

Rev.	Tag Number	Model No.	Setpoint	P&ID	Service	Notes
	LSLL-0101		1.75 - FT	N-9		
	LSL-0101		2 - FT	N-9		
	LSH1-0101		5- FT	N-9		
	LSH2-0101		5.5 - FT	N-9		
	LSHH-0101		5.75 - FT	N-9		

Notes: Refer to Section 40_72_76 for additional level switch requirements.

SECTION 40_73_13

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 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SUBMITTALS

A. Furnish submittals as specified in Section 40_61_00 - 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 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.08 WARRANTY

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.09 MAINTENANCE

A. As specified in Section 40_61_00 - 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 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 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. Hermetically sealed.
   h. Connection and mounting:
      1) Direct mounted and suitable for outdoor installation.
      2) 1/2-inch NPT.
      3) Connection material: Stainless steel.
   i. 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 diaphragm seals as specified in the Contract Documents and in Section 40_73_63 - Pressure/Vacuum Measurement: Diaphragm Seal:
   1. Diaphragm seal and pressure gauge shall be assembled by manufacturer and shipped as an assembly.

C. Provide means for gauge isolation as specified in Section 40_73_64 - 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.

D. 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 40_61_00 - 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 40_61_00 - 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 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.08 PROTECTION

A. As specified in Section 40_61_00 - 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

A/E:	**Carollo Engineers**		**PRESSURE GAUGES**								
								Spec. No.		**Rev.**	
Contractor:			**No**	**By**	**Date**	**Revision**		40_73_13			
Project:	Mystic Hills Lift Station Improvements							**Contract**		**Date**	
Customer:	City of Sedona										
Plant:								**Req.**		**P.O.**	
Location:											
BOM No.:								**By**	**Chk**	**App**	
File:											

1	**Type**	Direct Rdg.: √		Receiver:		Other:
2	**Mounting**	Surface: Local: √				Flush:
3	**Dial**	Diameter: 4.5"			Color:	
4	**Case**	**Cast Iron:**	**Aluminum:**	**Phenolic:** √	**Polished SS**	**Other:**
5	**Ring**	Screwed:	Hinged:	Slip:	Std:	Other:
6	**Blowout Protection**	None:	Disc:	Front:	Other:	Mfr. Std.
7	**Lens**	Glass: √			Plastic:	
8	**Options**	Siphon: N/A			Material:	
9	**Other**	Snubber:				
10	**Other**	Pressure Limit Valve: N/A				
11	**Other**	Movement Damping: N/A				
12	**Nominal Accuracy Required**					
13	**Pressure Element**	Bourdon®: √		Bellows:		Other:
14	**Element Material**	Bronze:	Steel:		Type SS: 316 √	Other:
15	**Socket Material**	Bronze:	Steel:		SS: 316	Other:
16	**Connection**	¼ in.:	½ in.: √		Bottom:	Other:
17	**Movement**	Dampened:	Standard: √		Other:	
18	**Diaphragm Seal**	Mfr.:		Wetted Part Mat'l:		Type:
19	**Other**	Other Mat'l:		Fill Fluid:		Model:
20	**Manufacturer**					
21	**Model No.**					

Rev	Tag Number	Range	P&ID	Service	Notes
	PI-0101	**0-160 PSIG**	**N-9**		

Notes:
Refer to Section 40_73_64 - Pressure/Vacuum Measurement: Instrument Valves for additional instrument valve requirements.

SECTION 40_73_63

PRESSURE/VACUUM MEASUREMENT: DIAPHRAGM SEALS

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Diaphragm seals.

B. Provide all seals identified in the Contract Documents.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.03 DEFINITIONS

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SUBMITTALS

A. Furnish submittals as specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Additional requirements:
   1. Product data:
      a. Manufacturer's installation instructions.
      b. Seal type.
      c. Body materials.
      d. Diaphragm material.
      e. Fill fluid type.
      f. Seal size.
      g. Options.
      h. Process connection.

1.05 QUALITY ASSURANCE

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Examine the complete set of Contract Documents and verify the compatibility 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 manufacturer's recommendations or specifications.

1.06 DELIVERY, STORAGE, AND HANDLING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.08 WARRANTY

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.09 MAINTENANCE

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Provide spare annular seal for every size indicated in the project.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Diaphragm seals:
   1. For chemical applications, liquids containing solids, and liquids with pulsating flow having pressures greater than or equal to 15 pounds per square inch gauge: One of the following or equal:
      a. Ashcroft:
         1) Flushing connection: Type 201.
      b. Mansfield and Green:
         1) Flushing connection: Type SG.
      c. Wika.

2.02 MANUFACTURED UNITS

A. Diaphragm seals:
   1. General:
      a. Diaphragm seal and pressure instrument shall be assembled by pressure instrument manufacturer and shipped as an assembly.
   2. Requirements:
      a. Seal type:
         1) Metallic diaphragm: Welded to upper housing.
         2) Elastomer diaphragm: Bonded to upper housing.
      b. Process connection: 1 inch NPT.
      c. Instrument connection: 1/2 inch NPT.
      d. Material Construction: Type 316 Stainless Steel.

e. Provide 1/4-inch flushing connection in diaphragm lower housing or provide flushing ring.
f. Flush port plug: Same material of construction as diaphragm lower housing.
g. Provide fill/bleed connection.
h. Mounting: As indicated in the Contract Documents.
i. Provide Type 316 stainless steel armored capillary for all remote installations.
j. Nuts and bolts: Type 316 stainless steel.
    1) Sewage, sludge, liquids containing solids, and liquids with pulsating flow having pressures greater than 15 pounds per square inch:
        a) Diaphragm: Type 316 stainless steel.
        b) Lower housing: Type 316 stainless steel.
        c) Upper housing: Manufacturer's standard.
        d) Fill fluid: Silicon oil.

2.03 ACCESSORIES(NOT USED)

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation System.

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.

C. Do not use Teflon thread seal tape on pressure instruments with silicon oil fill fluid.

3.04 FIELD QUALITY CONTROL

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.05 ADJUSTING (NOT USED)

3.06 CLEANING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.08 PROTECTION

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.09 SCHEDULES (NOT USED)

END OF SECTION

SECTION 40_73_64

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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.03 DEFINITIONS

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SUBMITTALS

A. Furnish submittals as specified in Section 40_61_00 - 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 40_61_00 - 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 40_61_00 - 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 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.09 MAINTENANCE

A. As specified in Section 40_61_00 - 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. Gauge valve:
   1. One of the following or equal:
      a. Anderson Greenwood.
      b. Hex Valve.

2.02 MANUFACTURED UNITS

A. 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.

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 40_61_00 - 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 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.05 ADJUSTING

A. As specified in Section 40_80_01 - Commissioning for Instrumentation and Controls.

3.06 CLEANING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.09 SCHEDULES (NOT USED)

END OF SECTION

SECTION 40_73_65

PRESSURE MEASUREMENT: SUBMERSIBLE

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:
   1. Submersible pressure transmitters.

B. Provide all instruments identified in the Contract Documents.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.03 DEFINITIONS

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SUBMITTALS

A. Furnish submittals as specified in Section 40_61_00 - 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 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.07 PROJECT OR SITE CONDITIONS

A. Project environmental conditions as specified in Section 40_61_00 - 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 40_61_00 - 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. Submersible level measurement with 2-wire integral transmitter:
   1. One of the following, and no equal:
      a. Endress+Hauser, Waterpilot FMX21 with 1.65-inch outer diameter probe.
      b. Measurement Specialties, KPSI 700 Series.

2.02 MANUFACTURED UNITS

A. Submersible level measurement with 2-wire integral transmitter:
   1. General:
      a. Pressure is measured through a diaphragm-type measuring cell and converted to linear pressure measurement.
      b. Each submersible pressure transmitter system shall include:
         1) Signal cable, including pressure compensation tube.
         2) Transducer probe with integral transmitter.
         3) Transmitter cable termination box.
   2. Performance requirements:
      a. Accuracy:
         1) 0.3 percent of range.
      b. Repeatability:
         1) 0.25 percent of full scale.
      c. Rangeability:
         1) 3:1.
      d. Range:
         1) As indicated on the contract documents.

3. Element:
    a. Sensor housing shall be Type 316L stainless steel or titanium with ceramic, teflon-coated, or titanium diaphragm.
    b. Protective cap shall be manufacturer's recommended material, chemically resistant to process fluid.
    c. Slip resistant extension cable with pressure compensation tube with Teflon filter.
    d. Enclosure for probe and transmitter assembly shall be NEMA Type 6P.
4. Transmitter:
    a. Power supply:
        1) 24 VDC: 2 wire loop powered.
        2) Power consumption: 18 VA maximum.
    b. Outputs:
        1) Isolated 4 to 20 milliamperes DC.
    c. Without display.
    d. Ambient operating temperature limits of -10 to 70 degrees Celsius (-14 to 158 degrees Fahrenheit).
    e. Transmitter shall be integral to probe housing.
5. Transmitter cable termination box:
    a. NEMA Type 4X.
    b. Equipped with filter or desiccant chamber to eliminate moisture from the pressure compensation tube.
    c. Termination for signal wires and pressure compensation tube.

2.03 ACCESSORIES

A. Type 316L stainless steel mounting clamp with Type 304 stainless steel mounting screws.

B. Provide guide tube for stillwell mounting.

C. Provide additional Type 316L stainless steel weight to prevent movement.

D. Provide additional anchor to prevent movement.

E. Provide cable clamp and strain relief.

F. Provide computer cable adapter with Windows® software.

G. Provide remote display with backlight or loop indicator with backlight as indicated on the Drawings.

H. Provide sunshade for outdoor installations.

I. Provide integral surge protection.

2.04 SOURCE QUALITY CONTROL

A. As specified in Section 40_61_00 - 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 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.05 ADJUSTING

A. As specified in Section 40_80_01 - Testing, Calibration, and Commissioning.

3.06 CLEANING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.07 DEMONSTRATION AND TRAINING

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

3.08 PROTECTION

A. As specified in Section 40_61_00 - 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

A/E:	Carollo Engineers	SUBMERSIBLE PRESSURE INSTRUMENTS					
						Spec. No.	Rev.
Contractor:		No	By	Date	Revision	40_73_65	
Project:	Mystic Hills Lift Station Improvements					Contract	Date
Customer:	City of Sedona						
Plant:						Req.	P.O.
Location:							
BOM No.:						By	Chk App
File:							

	1	**Instrument Tag Number**	PE/LT/LIT-0101		
G	2	**Service**			
E	3	**P&ID**	N-9		
N	4	**Fluid Type**	Waste Water		
	5	**Fluid Specific Gravity**			
	6	**Type**	Submersible		
P	7	**Measuring Cell Material**	Diaphragm		
R	8	**Probe Body Material**			
O	9	**Op. Temp. Range**	40-80 deg F		
B	10	**Op. Pressure Range**	0- 20 ft		
E	11	**Other**			
	12	**Other**			
C	13	**Style**	Mfg. Std		
A	14	**Signal Cable Length**	As Required		
B	15	**Other**			
L	16	**Other**			
E	17	**Other**			
	18	**Type**			
T	19	**Operating Mode**	Continuous		
R	20	**Enclosure**			
A	21	**Mounting**			
N	22	**Temperature Range**			
S	23	**Measurement Range**			
M	24	**Power Supply**	24 VDC		
I	25	**Accuracy**	0.3 % of range		
T	26	**Display**			
T	27	**Output**	4-20 mA		
E	28	**Calibration**			
R	29	**Status Relay**			
	30	**Manufacturer**			
	31	**Model No.**			
	32	**Elect. Entry**			
	33	**Other**			
O	33				
P	34				
T	35				
S	36				

Notes:

SECTION 40_80_01

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.

1.02 REFERENCES

A. As specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Electronics Industries Alliance (EIA).

1.03 DEFINITIONS

A. As specified in Sections 01200 - Contract Closeout and 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

1.04 SYSTEM DESCRIPTION

A. Contractor to initiate, coordinate, supervise, schedule and conduct testing for all Contractor-furnished work and Owner-furnished programming:
   1. Contractor to Conduct testing for all Contractor-furnished work as indicated in this Section.
   2. For all Owner-furnished programming, conduct testing by coordinating with the Owner as indicated in this Section.

1.05 SUBMITTALS

A. Furnish submittals as specified in Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. General:
   1. Reference additional detailed test submittal scheduling and prerequisite requirements as specified in the Sequencing article of Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

C. 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.

D. Test forms:
   1. Provide test and calibration forms and checklists for each of the following:
      a. Calibration.
      b. Loop validation tests.
      c. Installation tests.
      d. Functional tests.
      e. Instrumentation Fine-Tuning.
   2. 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.
   3. 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.
   4. Some sample test forms are included at the end of this Section. These test forms show the minimum required test form content. They are not complete, and have not been customized for this Project. The Contractor is to develop and submit test forms customized for the Project and meeting all of the specified test and submittal requirements.

E. 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.

F. 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 40_61_00 - 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 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.

B. Installation supervision:
   1. Provide as specified in Section 40_61_00 - 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. Owner training:
   1. Demonstration requirements are specified in this Section.

B. Installation testing:
   1. General:
      a. The Owner reserves the right to test any specified function, whether or not explicitly stated in the test submittals.
      b. Failure testing:
         1) In addition to demonstrating correct operation of all specified features, demonstrate how the system reacts and recovers from abnormal conditions including, but not limited to:
            a) Equipment failure.
            b) Operator error.
            c) Communications sub-system error.
            d) Power failure.
            e) Process equipment failure.
            f) High system loading conditions.
      c. Conduct testing Monday through Friday during normal working hours for no more than 8 hours per day.
         1) Testing at other times requires approval of the Engineer.
   2. Sequencing:
      a. See additional requirements specified in the Sequencing article of Section 40_61_00 - Common Work Results for Process Control and Instrumentation Systems.
   3. Calibration:
      a. After installation but before starting other tests, calibrate and adjust all instruments, devices, valves, and systems, in conformance with the component manufacturer's instructions and as specified in these Contract Documents.
      b. Components having adjustable features are to be set carefully for the specific conditions and applications of this installation. Test and verify that components and/or systems are within the specified limits of accuracy.
      c. Replace either individually or within a system, defective elements that cannot achieve proper calibration or accuracy.
      d. Calibration points:
         1) 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.
      e. Field verify calibration of instruments that have been factory-calibrated to determine whether any of the calibrations are in need of adjustment.
      f. 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.
      g. Complete instrument calibration sheets for every field instrument and analyzer.
      h. Calibration tags:
         1) Attach a calibration and testing tag to each instrument, piece of equipment, or system.
         2) Sign the tag when calibration is complete.

4. LAN cable post-testing:
    a. After installing the cable and connectors, test all cables using the LAN certification to confirm the installation meets the requirements of the specification.
    b. 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.
        1) After installing connectors:
        2) 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.
        3) Submit a signed test report presenting the results of the cable testing.
        4) Repair or replace any portions of the system not meeting ANSI/TIA/EIA standards for installation. Repaired sections shall be retested.
    c. Submit 3 copies of all final documentation (including traces), using the approved test form, to the Engineer upon successful completion of the testing.
5. Ultrasonic and radar check out:
    a. Check response under all operating conditions.
    b. Track all responses through trend charts in the SCADA system by working with the Owner.
    c. Provide Echo Transmission and signal quality on all level transmitters including guided and unguided units.
    d. Provide printout of the actual transmission and all parameters.
6. Perform Loop check/validation tests by coordinating with the Owner.
    a. Check all 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 SCADA system. Issue commands from the SCADA system and verify proper responses of field devices. Use actual process inputs wherever available.
    b. Provide "end-to-end" tests as specified below. Invite the Owner for all necessary testing procedures.
        1) Test SCADA system inputs from field device to SCADA system operator workstations.
        2) Test SCADA system outputs from SCADA operator workstations to field devices and equipment.
        3) Observe and record responses at all intermediate devices.
        4) Work with the Owner, test and record operator commands and signal readouts to each operator device where there is more than one operator interface point.
        5) For each signal, perform separate tests for SCADA computer screens, local operator interface (LOI) screens, and local control panels.
    c. Retest any loop following any necessary corrections.
    d. 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.

e. Apply continuously variable up and down analog inputs to verify the proper operation and setting of discrete devices (signal trips, etc.).
f. Apply provisional settings on controllers and alarm setpoints.
g. Record all analog loop test data on test forms.
h. Exercise each field device requiring an analog command signal, through the SCADA system. Vary, during the validation process, the output from the PLC SCADA system and measure the end device position, speed, etc. to confirm the proper operation of the device for the supplied analog signal. Manually set the output from the 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.
i. Exercise each field device providing a discrete input to the SCADA system in the field to 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.
j. Test each device accepting a discrete output signal from the SCADA. Perform the appropriate operator action at the SCADA operator stations (including LOIs, if present) and confirm the proper operation of the field device. Invite the Owner for all necessary test procedures:
    1) Stroke valves through outputs from the SCADA system, and confirm proper directional operation. Confirm travel limits and any feedback signals to the SCADA system.
    2) Exercise motors starters from the SCADA system and verify proper operation through direct field observation.
    3) Exercise solenoids and other field devices from the SCADA system and verify proper operation through direct field observation.
k. Include in the test forms:
    1) Analog input devices:
        a) Calibration range.
        b) Calibration data: Input, output, and error at each test value.
        c) Analog input associated PLC register address.
        d) Value in PLC register at each test point.
        e) Value displayed at each operator interface station (local operator interface displays and SCADA workstations).
    2) Analog output devices:
        a) Calibration range.
        b) Test value at each test point.
        c) Analog output associated PLC register address.
        d) Control variable value at field device at each test point.
        e) Physical device response at each test point:
            (1) Response to be actual valve position, or motor speed, etc.
    3) Discrete instrument input devices:
        a) Switch setting, contact action, and dead band.
        b) Valve position switches:
            (1) Response in the PLC as the valve is stroked from the PLC.
            (2) Field observed actual valve position, and valve indicator position as the valve is stroked from the PLC.

c) Operator interface switches (control stations and other pilot devices) and associated response.
d) Starter and drive auxiliary device contact response.
e) Response of all other discrete inputs to the PLC.

4) Discrete output devices:
a) Observed response of field device to the discrete output from the PLC.
b) Observe the proper operation of Open, Close, Start, Stop, On, Off, etc.
c) Test equipment used and associated serial numbers.

7. 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, and manufacturer's representative 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. Perform loop tuning as mentioned below. Invite the Owner for all necessary testing procedures:
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 01200 - Contract Closeout.
        (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. Perform Instrumentation Fine-Tuning by coordinating with the Owner:
    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. General:
        a. 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.
        b. The complete PLC control and SCADA system must run continuously for the duration of the performance test.
        c. Test and use the entire process control system under standard operating conditions.

d. Exercise all system functions.
e. Log failure, any system interruption and accompanying component, subsystem, or program failure including time of occurrence, duration of each failure, failure classification, and cause:
    1) 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.
        a) Response time to the Project Site: 24 hours or less, for a major failure.
f. 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.

3. 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.
4. 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

	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 ☐ TRANSMITTER ☐ CONTROLLER ☐ INDICATOR

☐ 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 _____

SECTION 40_96_15

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 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

Engineers...Working Wonders With Water™

PLC I/O Listing for OMNI-0101

Drawing	Function	Loop	I/O	Location	Description	(E/F)
M_11115A10N-9.DWG	F	0101	AI	OMNI-0101		
M_11115A10N-9.DWG	L	0101	AI	OMNI-0101		
M_11115A10N-10.DWG	MCC	0101	AI	OMNI-0101	APPARENT POWER	
OMNI-0101 Total AI Points = 3						
M_11115A10N-9.DWG	AUX1	0101	DI	OMNI-0101	RVSS FAIL	
M_11115A10N-9.DWG	AUX2	0101	DI	OMNI-0101	PUMP FAIL	
M_11115A10N-10.DWG	GAUX1	0101	DI	OMNI-0101	GENERATOR RUNNING	
M_11115A10N-10.DWG	GAUX2	0101	DI	OMNI-0101	GENERATOR FAIL	
M_11115A10N-9.DWG	LSHH	0101	DI	OMNI-0101		
M_11115A10N-9.DWG	LSLL	0101	DI	OMNI-0101		
M_11115A10N-9.DWG	AUX1	0102	DI	OMNI-0101	RVSS FAIL	
M_11115A10N-9.DWG	AUX2	0102	DI	OMNI-0101	PUMP FAIL	
OMNI-0101 Total DI Points = 8						

BYPASS PUMPING REPORT

City of Sedona
Sedona Wastewater Collection System Improvements

BYPASS PUMPING REPORT

FINAL | January 2019

carollo

City of Sedona
Sedona Wastewater Collection System Improvements

BYPASS PUMPING REPORT

FINAL | January 2019

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Chapter 1

CHAPEL LS BYPASS BASIS OF DESIGN

1.1 Existing Conditions

The Chapel Lift Station (LS) is located in the Indian Cliffs development within a 20-foot wide public utility easement (PUE) between Parcels 45 and 55. This location is approximately between the Talia Court cul-de-sac and AZ Highway 179. Figure 1.1 shows the general location of the Chapel LS. The LS receives wastewater via an 8-inch diameter gravity sewer that is aligned in Talia Court and enters the LS on the southeast side as well as a force main from the Back of Beyond LS located south of the Chapel LS. The Back of Beyond LS force main alignment routes north along AZ Highway 179 and is believed to connect to the existing gravity sewer that flows to the Chapel LS. It is expected that this force main will be potholed and investigated during construction to verify how the flows are conveyed to the Chapel LS.

On the gravity system, the first upstream manhole (MH #1) is located just inside the pavement of the Talia Court cul-de-sac and in between the driveways of Parcel 45 and Parcel 55. The PUE is landscaped with decomposed granite, landscape cobbles, trees and shrubs. A decorative wooden fence is located along the southeast side of the LS. On the northwest side of the LS is a concrete bridge across a drainage easement channel and a gravel access road to AZ Highway 179. The LS is contained within a combination split block wall and wood picket fencing.

Figure 1.2 shows a partial view of the gravity sewer system that delivers wastewater to the LS. Of note, all parcels with the exception of Parcel 55 tie into the sewer system upstream of MH #1. Parcel 55 lateral ties into the 8-inch diameter sewer line between MH #1 and the LS. Upstream of MH #1 is a manhole located in the intersection of Indian Cliffs Road and Talia Court (MH #2). To the southwest of MH #2, the gravity sewer system terminates at a cleanout. To the north east of MH #2 the gravity sewer system collects wastewater flows from Parcels 30, 130 and 140 and flows from the next upstream manhole (MH #3). For the purposes of this report, this limited description of the gravity sewer system is sufficient.

Figure 1.1 Chapel Lift Station

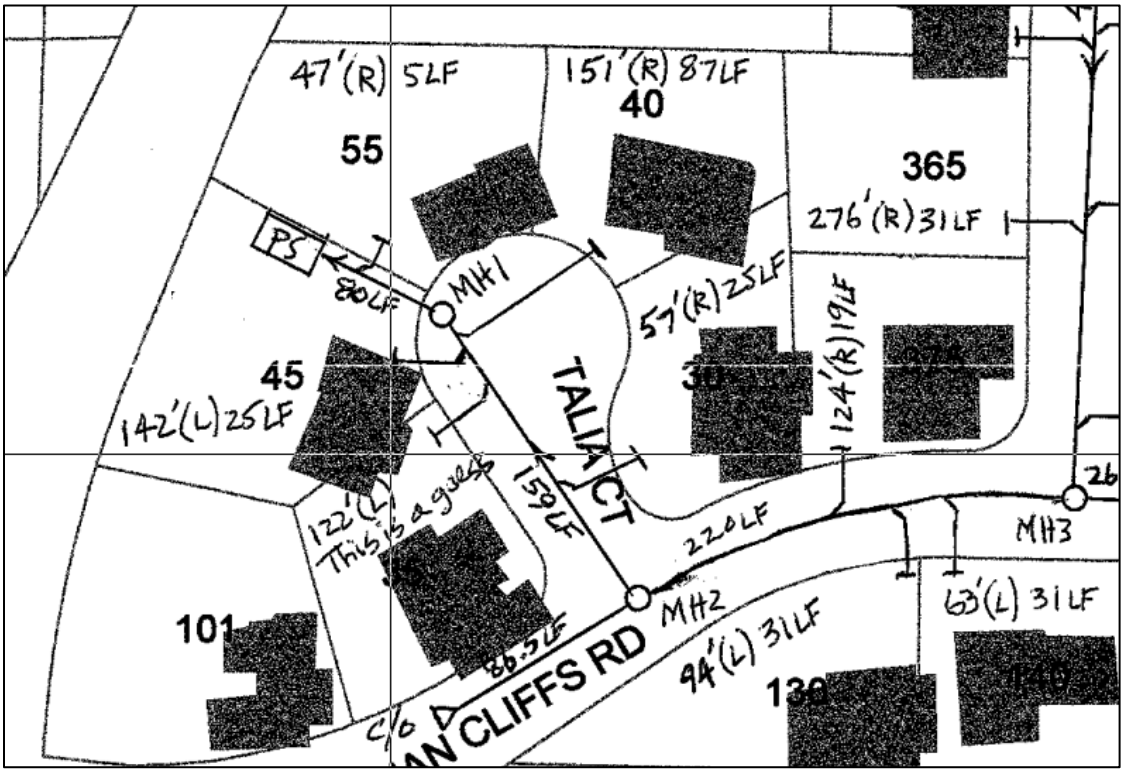


Figure 1.2 Partial View of Gravity System at the Chapel Lift Station

1.2 Design Flows

The design flows into the Chapel LS have been provided by Sunrise Engineering and are summarized in Table 1.1. These flows were utilized in the design of the temporary bypass pumping system. These flows are also included within the Specification Section 02553 included in Appendix A.

Table 1.1 Design Flows

Flow Rates	
Minimum Daily Flow	57 gpm
Average Daily Flow	85 gpm
Maximum Daily Flow (dry conditions)	153 gpm
Maximum Daily Flow (wet conditions)	392 gpm

1.3 Temporary Bypass System Storage

The temporary bypass plan for the Chapel LS is to be designed, installed, operated and maintained by the contractor. However, Carollo has prepared a temporary bypass plan to be utilized during the replacement of the Chapel LS design development. The plan consists of utilizing some storage within the existing gravity sewer infrastructure, a temporary trailer mounted pumping system, suction and discharge piping, and valve controls. The sewer system is to be plugged using an 8-inch diameter inflatable plug at the outlet of MH #1 creating a controlled backup of wastewater within MH #1 to a depth of no more than 4 feet. It is assumed that there are no basements in the immediate area of the storage that would be detrimentally affected by controlled backup into the laterals. Preliminary check of the homes in the area on the Internet indicate no basements.

Based on the elevations provided on existing drawings, the depth of MH #1 is approximately 9.4 feet. The depth MH #2 is approximately 7.8 feet and the depth of MH #3 is approximately 5.3 feet. Due to the elevation change between the manholes, the depth of wastewater varies in the other manholes when MH #1 is backed up to a depth of 4 feet. At this depth in MH #1, MH #2 has a depth of approximately 2.75 feet and MH #3 is at an elevation such that the invert is above the water level meaning no impact on this manhole. Storage therefore is determined based on the volume stored in MH #1 and MH #2 as well as within the 8-inch diameter sewer pipe between manholes. Table 1.2 summarizes the calculated volumes of this temporary storage system. Calculations are included in Appendix B.

Table 1.2 Temporary Bypass Storage

Bypass Storage Volumes	
MH #1	376 gallons
MH #2	259 gallons
Pipe between MH#1, MH#2, MH #3 and Clean Out	1088 gallons
Total Storage	1722 gallons

Utilizing this volume of controlled storage, fill times were calculated based on the design flows summarized in Table 1.1. Flow times ranged from 4 minutes to 30 minutes depending on flow conditions. A pumping flow rate of 450 gpm was chosen based on the time to empty the storage

during the different flow conditions. The time to empty the storage ranged between 4.5 and 30 minutes at this flow rate. This combination of fill and empty times creates a total fill/empty range of 17 to 35 minutes and is ideal at the chosen flow rate to minimize the pump cycles per hour to less than 4.

1.4 Temporary Bypass Pump Selection

The temporary bypass pumping at the Chapel LS is unique in that the bypass discharge is not being conveyed back into a gravity sewer system. Instead, the temporary bypass pumps discharge will connect directly to the existing 6-inch force main. Therefore, a higher discharge TDH is required for the temporary bypass pumps. The existing TDH needed for the new LS design was provided by Sunrise Engineering. This TDH was utilized in the selection of the temporary bypass pumps. For the Chapel LS, the TDH was given as 75 feet of head. Additional head loss was calculated for the temporary bypass pump discharge piping under the various flow scenarios and was added to the given TDH. Total head calculations are summarized in Table 1.3 and calculations are included in Appendix B.

Table 1.3 Total Head Calculations

Total Dynamic Head	
Minimum Daily Flow	75 feet TDH
Average Daily Flow	75 feet TDH
Maximum Daily Flow (dry conditions)	76 feet TDH
Maximum Daily Flow (wet conditions)	82 feet TDH
Design Flow Rate (450 gpm)	84 feet TDH

The information calculated for TDH and chosen flow rate were given to Baker Corporation who has significant experience in the temporary bypass pumping of wastewater. Baker Corporation provided a pump that would meet these requirements. For the Chapel LS, a 90 gallon diesel engine driven centrifugal pump with a mechanical priming system and a maximum flow rate of 925 gpm (minimum flow rate of 60 gpm) and a maximum head of 122 feet at design flow (minimum head of 68 feet at design flow) was chosen. The pump is trailer mounted with a sound attenuation enclosure. Pump cut sheets are included in Appendix C.

1.5 Temporary Bypass Pumping System Setup

The temporary bypass pumping system for the Chapel LS is shown on Figure 1.3. The following narrative describes the details of the various components of the system.

1.5.1 Existing Flow Management

The Chapel LS is fed by both gravity flows from the southeast as well as a force main discharge from the south. The gravity flows will be prevented from entering the LS via an inflatable 8-inch diameter plug inside the discharge pipe of MH #1. It is believed that the incoming force main connects to the existing gravity sewer that flows to the Chapel LS. It is expected that this force main will be potholed and investigated during construction to verify how the flows are conveyed to the Chapel LS. If the force main ties directly into the Chapel LS wet well or into the gravity line between the wet well and MH #1, the force main will be intercepted and routed above ground in a temporary pipeline which will discharge into MH #1. In addition to these flows, there is a sewer lateral from Parcel 55 that connects to the 8-inch diameter sewer line between MH #1 and the

LS. This flow from a single home will be intercepted by installing a temporary 55 gallon plastic sump (barrel) into the ground at the connection point to the 8-inch sewer line. A small "trash" pump operated by the contractor on a float system will be installed in the sump and a 2-inch diameter discharge line will be routed to MH #1. The sump will be sealed for odor control.

1.5.2 Pump Setup

One pump is capable of pumping the various ranges of flow rates including the design flow rate utilizing system storage. However, two identical pumps will be provided to ensure a 1+1 backup system. Both pumps will be positioned adjacent to each other on the AC pavement at the edge of the Talia Court cul-de-sac and adjacent to the PUE between Parcels 45 and 55. Both pumps will have a common suction and discharge manifold with valves such that either pump can be run by isolating the other pump. A single 6-inch diameter suction pipe will be inserted into MH #1 to the elevation of 6 inches from the invert of the manhole. The suction manifold will contain isolation valves. The 6-inch diameter discharge manifold will contain isolation valves and a check valve on the common discharge line which will route to a connection point with the existing 6-inch diameter force main northwest of the Chapel LS. Air release valves will be installed at the high point prior to the connection with the force main.

The pumps will be placed on top of plastic for spill containment and will be surrounded with 20 foot temporary fence panels that are lined with nylon fabric to visually hide the pumping system from the exterior as well as sound curtains (see Section 1.5.4). Traffic barricades will be installed around the fencing.

A float system for each pump will be installed within MH #1 to control the operation of both pumps. The float system will be set to turn the duty pump on once the volume in MH #1 reaches the 4 foot mark. A second float will be installed 6 inches above the invert to shut the pump off. The second pump will be operated only as a backup to the first pump and will have its own set of floats for operation. Switching between pumps will be done manually as needed by the attendant/operator. The contractor will be responsible through the attendant/operator to monitor the flows and pump to adjust the pump speed and to make the switch between duty and backup pump if there is a pump failure.

1.5.3 Pipe Setup

The piping for all temporary bypass pumping will be fused HDPE material ranging in diameter from 2 inches to 6 inches. It is expected that the pressures in the pumping systems will be no greater than about 40 psi and normally will be around 56 psi. A DR of 17 provides a pressure rating of 125 psi which was used in the head loss calculations. The existing material of the force mains coming into and out of the Chapel LS are unknown but no significant increase in pumping pressure is being added to the existing system. While DR 17 pipe provides a pressure rating of greater than two times the pumping system pressure, it is selected for its durability in handling for bypass pumping.

It is expected that all temporary bypass piping will be laid on the surface of the existing ground within the PUE between Parcels 45 and 55. Piping can be aligned to not interfere with existing landscaping and utilities. A small portion of the manifolds at both the suction and discharge location will be on the pavement of Talia Court cul-de-sac but will be within the fenced area of the two bypass pumps and will sit upon plastic sheeting under the entire system.

The suction manifold will consist of a single 6-inch diameter pipe extending vertically from 6 inches above the invert of MH #1 to grade outside the manhole rim. The suction will then turn horizontally and tee into two 6-inch diameter pipes, each with isolation gate vales and to the respective temporary bypass pumps suction connection. The discharge manifold will consist of two 6-inch diameter pipes from each of the temporary bypass pumps discharge connection, each with isolation gates valves, which will join at a tee and become a single 6-inch diameter pipe with a single check valve. The single pipeline will route through the PUE around the northeast side of the Chapel LS and connect directly to the existing LS discharge force main near the stormwater channel bridge. It is envisioned that this connection will be done with a tee providing a second connection point for the finished LS discharge piping such that the LS can be commissioned while the temporary bypass system is still connected and able to be utilized.

There will be at least one additional temporary HDPE pipeline within the PUE and routing above ground. This HDPE pipeline will be a 2-inch diameter line from the Parcel 55 temporary lateral tie-in sump pump discharge. This line will route within the PUE to MH #1 and then turn vertically down into MH #1 with a drop extension to 4-5 feet below the rim where it will discharge. If potholing during construction determines that the Back of Beyond FM does tie directly into the Chapel LS, a second temporary HDPE pipeline will be connected to the existing incoming force main to the southwest of the Chapel LS near the stormwater channel bridge. The pipeline will route along the southerly edge of the PUE and then turn vertically down into MH #1 with a drop extension to 4-5 feet below the rim where it will discharge.

1.5.4 Sound and Odor Control

Due to the immediate proximity of the temporary bypass system to residential homes, sound and odor control are required. The selected pumps are furnished with sound attenuation enclosures which are rated at 67 dBA at 23 feet away. The City of Sedona sound ordinance requires that the maximum permissible sound level limits be at or below 60 dBA from 7:00 AM to 10:00 PM and at or below 50 dBA from 10:00 PM to 7:00 AM as measured at any location at or within the property line of the receptor property. Sound curtains will be required in addition to the enclosures to meet this requirement. Odor control will be mainly at the location of MH #1 and the temporary sump for collection of wastewater from Parcel 55. Heavy plastic will be required over the open manhole lid and around the various suction/discharge piping. Taped seals will be required to trap all odors below the plastic. If venting is required, the vent shall be provided that is mechanically closed when not in use.

1.5.5 System Monitoring

The contractor will be required to provide an attendant/operator to monitor the temporary bypass system at all times, 24 hours per day. This attendant will be required to know how to operate the system and will make regular and routine inspections of the pumping system and the odor control. An inspection log will be kept and maintained. The attendant will be furnished with emergency contact information of the Owner, Contractor and Engineer.

Figure 1.3 Chapel Lift Station Layout

Chapter 2

MYSTIC HILLS LS BYPASS BASIS OF DESIGN

2.1 Existing Conditions

The Mystic Hills Lift Station (LS) is located in the Mystic Hills development at the end of Mallard Drive and adjacent to a wash leading to Oak Creek. The LS is located within a dedicated parcel owned by the Mystic Hills HOA and to the west of Parcels 89 and 90. Figure 2.1 shows the general location of the Mystic Hills LS. The LS receives wastewater via two 8-inch diameter gravity sewers that combine at a manhole to the south of the LS. A single 8-inch sewer line connects this manhole to the LS. The first incoming sewer line approaches from the southwest and passes through a manhole before reaching the manhole where it combines with the second sewer whereas the second incoming sewer line is aligned in Mallard Drive then turns north to combine with the first sewer at the manhole south of the LS.

The first upstream manhole (MH #1) where the two 8-inch diameter sewers combine is located south of the LS, adjacent to a rise in grade and to the west of the dirt/grave access lane. MH #1 extends out of the ground with an exposed cone, frame and cover for about 4-5 vertical feet. Power lines are located above MH #1 and to the east of the LS. The LS parcel is not landscaped and surrounding land is native vegetation. The area around the LS has been cleared away and a dirt and gravel access lane approaches the LS from the south and passes along the east side where it terminates. There is a cleared gravel area to the south of the LS as well. The LS is contained within a combination split block wall and wood picket fencing and gate.

Figure 2.2 shows a partial view of the gravity sewer system that delivers wastewater to the LS. Upstream of MH #1 are two sewer pipelines. The west pipeline comes from MH #5 which is located to the west at the top of the rise in grade. The south pipeline alignment is within the dirt/gravel access lane running north between MH #2 and MH #1. Upstream of MH #2, the pipeline alignment is in Mallard Drive and runs west between MH #3 and MH #2. All wastewater flows are collected upstream of MH #1. For the purposes of this report, this limited description of the gravity sewer system is sufficient.

Figure 2.1 Mystic Hills Lift Station

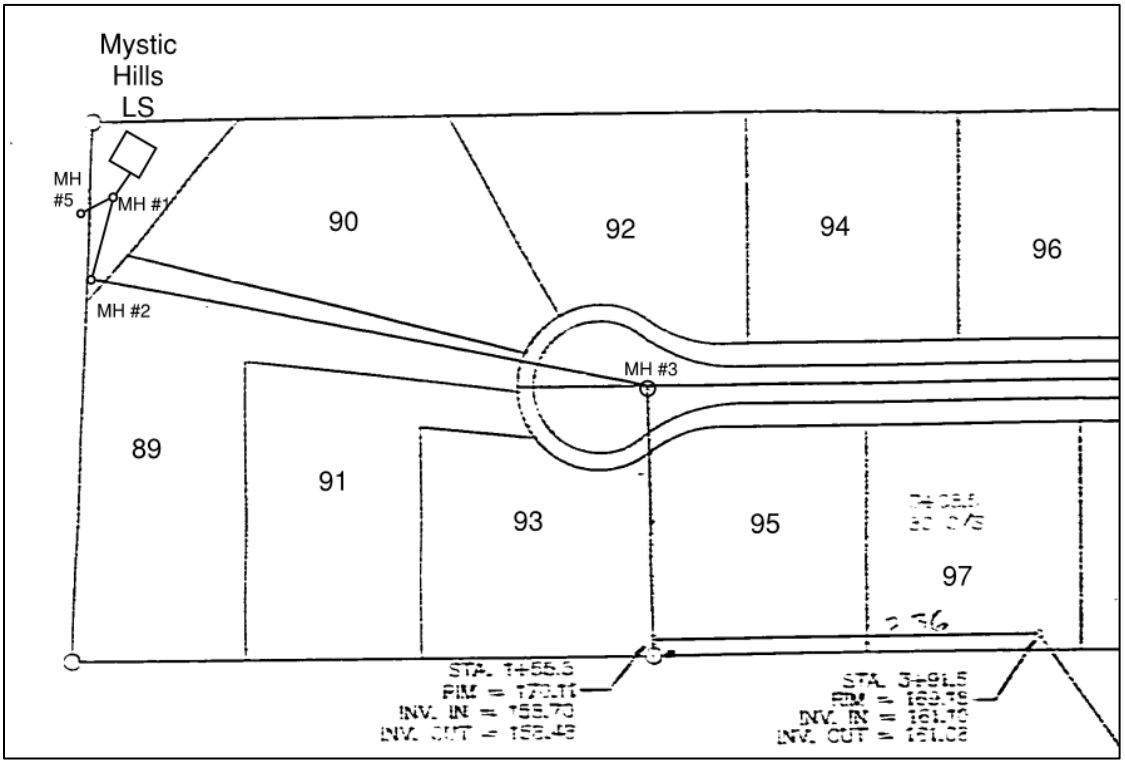


Figure 2.2 Partial View of Gravity System at the Mystic Hills Lift Station

2.2 Design Flows

The design flows into the Mystic Hills LS have been provided by Sunrise Engineering and are summarized in Table 2.1. These flows were utilized in the design of the temporary bypass pumping system. These flows are also included within the Specification Section 02553 included in Appendix A.

Table 2.1 Design Flows

Flow Rates	
Minimum Daily Flow	20 gpm
Average Daily Flow	115 gpm
Maximum Daily Flow (dry conditions)	207 gpm
Maximum Daily Flow (wet conditions)	553 gpm

2.3 Temporary Bypass System Storage

The temporary bypass plan for the Mystic Hills LS is to be designed, installed, operated and maintained by the contractor. However, Carollo has prepared a temporary bypass plan to be utilized during the replacement of the Mystic Hills LS design development. The plan consists of utilizing some storage within the existing gravity sewer infrastructure, a temporary trailer mounted pumping system, suction and discharge piping, and valve controls. The sewer system is to be plugged using an 8-inch diameter inflatable plug at the outlet of MH #1 creating a controlled backup of wastewater within MH #1 to a depth of no more than 4 feet. It is assumed that there are no basements in the immediate area of the storage that would be detrimentally affected by controlled backup into the laterals. Preliminary check of the homes in the area on the Internet indicate no basements.

Based on the elevations provided from existing drawings, the depth of MH #1 is approximately 10.95 feet. The depth MH #2 is approximately 7.3 feet and the depth of MH #5 is approximately 5.7 feet. Due to the elevation change between the manholes, the depth of wastewater varies in the other manholes when MH #1 is backed up to a depth of 4 feet. At this depth in MH #1, MH #2 has a depth of approximately 3.10 feet and MH #3 and MH #5 are at an elevation such that the inverts are above the water level meaning no impact on these manholes. Storage therefore is determined based on the volume stored in MH #1 and MH #2 as well as within the 8-inch diameter sewer pipe between manholes. Table 2.2 summarizes the calculated volumes of this temporary storage system. Calculations are included in Appendix B.

Table 2.2 Temporary Bypass Storage

Bypass Storage Volumes	
MH #1	376 gallons
MH #2	291 gallons
Pipe Between MH #1, MH #2, MH #3 and MH #5	809 gallons
Total Storage	1476 gallons

Utilizing this volume of controlled storage, fill times were calculated based on the design flows summarized in Table 2.1. Flow times ranged from 3 minutes to 74 minutes depending on flow conditions. A pumping flow rate of 600 gpm was chosen based on the time to empty the storage

during the different flow conditions. The time to empty the storage ranged between 2.5 and 30 minutes at this flow rate. This combination of fill and empty times creates a total fill/empty range of 11 to 76 minutes and is ideal at the chosen flow rate to minimize the pump cycles per hour to less than 6.

2.4 Temporary Bypass Pump Selection

The temporary bypass pumping at the Mystic Hills LS is unique in that the bypass discharge is not being conveyed back into a gravity sewer system. Instead, the temporary bypass pumps discharge will connect directly to the existing 6-inch force main. Therefore, a higher discharge TDH is required for the temporary bypass pumps. The existing TDH needed for the new LS design was provided by Sunrise Engineering. This TDH was utilized in the selection of the temporary bypass pumps. For the Mystic Hills LS, the TDH was given as 202 feet of head. Additional head loss was calculated for the temporary bypass pump discharge piping under the various flow scenarios and was added to the given TDH. Total head calculations are summarized in Table 2.3 and calculations are included in Appendix B.

Table 2.3 Total Head Calculations

Total Dynamic Head	
Minimum Daily Flow	202 feet TDH
Average Daily Flow	203 feet TDH
Maximum Daily Flow (dry conditions)	204 feet TDH
Maximum Daily Flow (wet conditions)	214 feet TDH
Design Flow Rate (600 gpm)	216 feet TDH

The information calculated for TDH and chosen flow rate were given to Baker Corporation who has significant experience in the temporary bypass pumping of wastewater. Baker Corporation provided a pump that would meet these requirements. For the Mystic Hills LS, a 120 gallon diesel engine driven centrifugal pump with a mechanical priming system and a maximum flow rate of 1,500 gpm (minimum flow rate of 260 gpm) and a maximum head of 285 feet at design flow (minimum head of 95 feet at design flow) was chosen. The pump is trailer mounted without a sound attenuation enclosure which is not available for this size of pump. Pump cut sheets are included in Appendix C.

2.5 Temporary Bypass Pumping System Setup

The temporary bypass pumping system for the Mystic Hills LS is shown on Figure 2.3. The following narrative describes the details of the various components of the system.

2.5.1 Existing Flow Management

The Mystic Hills LS is fed by gravity flows from the south. The gravity flows will be prevented from entering the LS via an inflatable 8-inch diameter plug inside the discharge pipe of MH #1.

2.5.2 Pump Setup

One pump is capable of pumping the various ranges of flow rates including the design flow rate utilizing system storage. However, two identical pumps will be provided to ensure a 1+1 backup system. Both pumps will be positioned adjacent to each other at the end of the dirt/gravel lane as well as west of Parcel 90 and the stormwater channel. Both pumps will have a common

suction and discharge manifold with valves such that either pump can be run by isolating the other pump. A single 6-inch diameter suction pipe will be inserted into MH #1 to the elevation of 6 inches from the invert of the manhole. The suction manifold will contain isolation valves. The 6-inch diameter discharge manifold will contain isolation valves and a check valve on the common discharge line which will route to a connection point with the existing 6-inch diameter force main south of the Mystic Hills LS. Air release valves will be installed at the high point prior to the connection with the force main.

The pumps will be placed on top of plastic for spill containment and will be surrounded with 20 foot temporary fence panels that are lined with nylon fabric to visually hide the pumping system from the exterior as well as sound curtains (see Section 2.5.4). Traffic barricades will be installed around the fencing.

A float system for each pump will be installed within MH #1 to control the operation of both pumps. The float system will be set to turn the duty pump on once the volume in MH #1 reaches the 4 foot mark. A second float will be installed 6 inches above the invert to shut the pump off. The second pump will be operated only as a backup to the first pump and will have its own set of floats for operation. Switching between pumps will be done manually as needed by the attendant/operator. The contractor will be responsible through the attendant/operator to monitor the flows and pump to adjust the pump speed and to make the switch between duty and backup pump if there is a pump failure.

2.5.3 Pipe Setup

The piping for all temporary bypass pumping will be fused 6-inch diameter HDPE pipe. It is expected that the pressures in the pumping systems will be no greater than about 94 psi. A DR of 11 provides a pressure rating of 200 psi which was used in the head loss calculations to provide a pipe pressure rating two times the pump pressure. The existing material of the force main out of the Mystic Hills LS is unknown but no significant increase in pumping pressure is being added to the existing system.

It is expected that all temporary bypass piping will be laid on the surface of the existing ground along the east edge of the dirt lane. Short sections of the suction and discharge temporary piping will need to be buried across the lane between the east edge of the lane and MH #1 to provide access to the LS. The manifolds at both the suction and discharge location will be within the fenced area of the two bypass pumps and will sit upon plastic sheeting under the entire system.

The suction manifold will consist of a single 6-inch diameter pipe extending vertically from 6 inches above the invert of MH #1 to the manhole rim. The suction will then turn vertically back down to grade and run under grade across the lane. The suction line will then run above grade to the north where the pumps will be located and tee into two 6-inch diameter pipes, each with isolation gate vales and to the respective temporary bypass pumps suction connection. The discharge manifold will consist of two 6-inch diameter pipes from each of the temporary bypass pumps discharge connection, each with isolation gates valves, which will join at a tee and become a single 6-inch diameter pipe with a single check valve. The single pipeline will route above ground along the east edge of the lane to south of the Mystic Hills LS and route below grade for a short distance across the lane and connect directly to the existing LS discharge force main near MH #1. It is envisioned that this connection will be done with a tee providing a second connection point for the finished LS discharge piping such that the LS can be commissioned

while the temporary bypass system is still connected and able to be utilized. Traffic plating over an open trench for the below grade piping will likely be utilized.

2.5.4 Sound and Odor Control

Due to the immediate proximity of the temporary bypass system to residential homes, sound and odor control are required. The City of Sedona sound ordinance requires that the maximum permissible sound level limits be at or below 60 dBA from 7:00 AM to 10:00 PM and at or below 50 dBA from 10:00 PM to 7:00 AM as measured at any location at or within the property line of the receptor property. The selected pumps are not available with sound attenuation enclosures. Therefore, sound control curtains will be required around the temporary bypass pumps to lower the noise of operating the system to within allowable levels. Odor control will be mainly at the location of MH #1. Heavy plastic will be required over the open manhole lid and around the suction piping. Taped seals will be required to trap all odors below the plastic. If venting is required, the vent shall be provided that is mechanically closed when not in use.

2.5.5 System Monitoring

The contractor will be required to provide an attendant/operator to monitor the temporary bypass system at all times, 24 hours per day. This attendant will be required to know how to operate the system and will make regular and routine inspections of the pumping system and the odor control. An inspection log will be kept and maintained. The attendant will be furnished with emergency contact information of the Owner, Contractor and Engineer.

2.6 Mystic Hills Alternative to Bypass Pumping

Mystic Hills LS improvements include a completely independent new wet well built adjacent to the existing wet well. The existing pumps will be replaced with new pumps and, once the new wet well is in operation, the existing wet well will be demolished along with the associated equipment. Since there will be a new wet well constructed independently of the existing wet well, an alternative approach may be taken to forgo bypass pumping of the Mystic Hills LS. This alternative approach would utilize the existing wet well and pumps throughout the construction of the new wet well and associated equipment. The existing electrical panel for the existing pumps could be relocated to the northwest side of the lift station site in a temporary arrangement to supply power to the existing pumps allowing the existing equipment pad for the existing electrical panel and generator to be replaced to accommodate the new electrical control panel and new generator. This would require temporary cables and conduits between the existing control panel and the existing wet well, as well as a temporary connection to the utility. For generator power, the existing generator could also be relocated or a portable generator could be utilized.

Upon completion of the new wet well and associated pumps, a strategic operational plan would be implemented (this would be titled a Maintenance of Plant Operations or MOPO which is a step-by-step outline of events planned out to execute a tie-in or interruption of operating systems) where the new wet well could be connected to the incoming gravity sewer line from Manhole #1. At the same time, the connection to the existing wet well would be removed.

As described above, the MOPO would outline the steps needed and the timing of each step to accomplish this tie-in. The new wet well would need to be fully operational and all but the final connecting fitting installed. The MOPO would be prepared to take place during a low flow time of day to minimize the flows coming to the Mystic Hills LS. An inflatable plug would be installed

inside Manhole #1 in the same manner as would be done for bypass pumping to prevent flows from leaving Manhole #1 to the wet well.

The low flow that would still occur in the system would back up within Manhole #1 and upstream collection system as described above in the bypass pumping scenario only for a much shorter time period. It is expected that if done during a low flow scenario, the cut-in work on the gravity line could be accomplished if all components were staged and proper backup procedures in place in about a half-day timeframe (4 hours). Once the cut-in of the connection fitting to the new wet well is complete, the plug would be removed and flow would enter the new wet well where it would be pumped into the force main.

A similar connection of the new wet well to the existing force main would need to be completed under a MOPO scenario as well and could be done at the same time as the connection to the gravity sewer. Two independent crews could be positioned to do the work during the 4 hour shutdown. Pressure testing of new piping of the new lift station would need to be coordinated and completed by the contractor prior to the tie-in and planning between the contractor, engineer and the City will be essential to a successful switch-over.

The benefit of this alternative to bypass pumping is the cost savings of implementing a bypass pumping system. While it would be an added challenge to work around the existing lift station while it stayed in operation and then planning a detailed MOPO strategy to make the switch from existing to new wet wells, the benefit of not installing a bypass pumping system not only provides potential cost savings, it also reduces spill risks and would be more amenable to nearby residences to not have the noisy bypass pumps running near their homes.

As an extra level of protection for this alternative during the cut-in period when the plug is installed in Manhole #1 and flows are backing up in the collection system upstream of the manhole, septic pumper trucks could be staged as a backup nearby Manhole #1 and if the volume in the manhole became higher than the 4 foot elevation as described in the bypass pumping scenario, the pumper trucks could pump out volume and haul it to a downstream location for discharge (vault and haul). It is unlikely that this will need to be done if coordinated during low flow times but would serve as added insurance so that the stored volume does not exceed the expected storage limits.

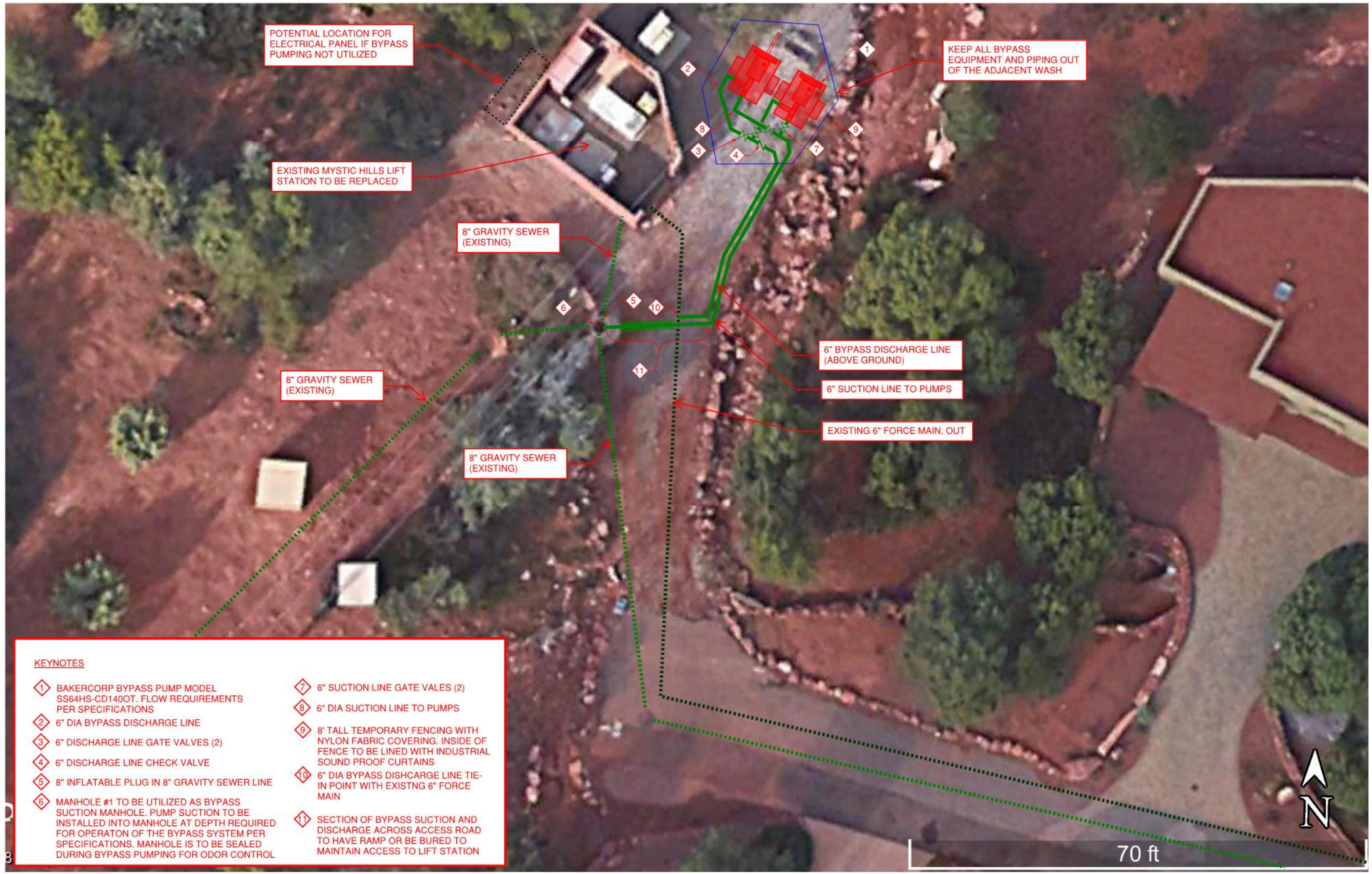


Figure 2.3 Mystic Hills Lift Station Layout

Appendix A

SPECIFICATION SECTION 02553 – TEMPORARY BYPASS PUMPING

SECTION 02553

TEMPORARY BYPASS PUMPING

PART 1 GENERAL

1.01 SUMMARY

A. Section includes: Requirements for temporary bypass pumping of wastewater flows at the Chapel and Mystic Hills lift stations to complete the Work.

B. Related sections:
   1. The Contract Documents are complementary; what is called for by one is as binding as if called for by all.
   2. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.

1.02 REFERENCES

A. National Fire Protection Association (NFPA):
   1. 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

1.03 GENERAL REQUIREMENTS

A. Provide all necessary labor, tools, materials, and supervision to provide temporary bypass pumping and flow control in accordance with the requirements of this Section.

B. Operate and maintain bypass pumping facilities including, but not limited to, pumps, piping, valves, controls, and monitoring until the involved portion(s) of the Work have been completed to the satisfaction of the Owner/Engineer.

C. Bypassing wastewater in a way that assures that no wastewater is allowed to leak outside of the bypass system or lift station facilities. If leakage does occur, pay all fines and reimburse the Owner for all costs associated with the cleanup of the leakage, as wells as costs associated with legal actions.

D. Accept responsibility for any release of wastewater and for penalties associated with bypass pumping activities, including commissioning, operating, and decommissioning of bypass pumping facilities.

E. Coordinate the placement of the bypass piping and pumping equipment with the Owner.

F. The means and methods of accomplishing and maintaining the temporary bypass pumping and associated facilities shall be the sole responsibility of the Contractor.

G. Except as otherwise specified or authorized in writing, no interruption of wastewater flow shall be permitted throughout the duration of the project. Contractor is responsible for all wastewater overflows during construction of this work and bypass operations.

H. Take precautions to prevent any potential spillage of wastewater from entering the stormwater system.

I. Temporary bypass pumping operation:
   1. Limited to the months, times, or seasons indicated, unless approved in writing by the Engineer.
   2. Continuous operation for 24 hours per day and 7 days per week is anticipated during the period of Work.

J. Continuously monitor temporary bypass pumping.

K. Provide qualified operators continuously during operation of the bypass systems.

1.04 SUBMITTALS

A. Prepare and submit a project-specific wastewater bypass pumping plan with completed wastewater bypass pumping checklist.
   1. Be advised that the bypass plan must provide accessibility for Owner operations and vehicular traffic in accordance with Owner requirements.

B. Wastewater bypass pumping plan: Include the following at a minimum:
   1. Capacities and sizes of pumps, standby equipment, and power requirements, if applicable.
   2. Design calculations of the system and selected equipment, including flow, TDH with static head including all friction and minor losses, pump curves showing operating range of flow and TDH at minimum, average, and peak flow.
   3. Standby power generator size and location for electrically-driven bypass pumps (if used).
   4. Downstream discharge plan.
   5. Pipe thrust and restraint types, sizes, and locations.
   6. Temporary pipe supports and anchoring required.
   7. Plans for access to bypass pumping locations.
   8. Schedule that shows duration of temporary bypass pumping including milestones for installation, maintenance, and removal of equipment and accessories.
   9. Means and methods of installing, operating, monitoring, and maintaining the temporary bypass pumping.
   10. Plan indicating bypass pumping line locations.
      a. Include details showing methods used to protect and identify the bypass pumping lines through the length of the bypass route.
   11. Detailed plans of a backup system.
   12. Address access for operators and vehicular traffic.
   13. Mechanical plan showing equipment, valves, pipe sizes and locations, pipe materials, dimensions, vehicle access (where applicable), pedestrian access (where applicable).
   14. Schematic drawings and written description of the control system and its' operating sequence.

15. Proposed type and location of collection system plugs.
16. Catalog cut sheets for pumping equipment, pipe and fittings, valves.
17. Emergency response plan.
18. Staffing plan.
19. Spill prevention and cleanup plan.
20. Noise control system.
21. Health and safety plan.
22. Surge or water hammer calculations and attenuation means.
23. Maintenance history of pumps.
24. Operating permits from jurisdictional air quality agency for each engine.

1.05 QUALITY ASSURANCE

A. Contractor's qualifications:
   1. Minimum 5 years' experience in performing substantially similar temporary bypass operations.
   2. Submit evidence of satisfactory operation of temporary bypass facilities similar to those specified in at least 5 separate projects in accordance with the specifications, including references.

B. Fulfillment of the specified experience requirements shall be a condition of acceptance.

PART 2 PRODUCTS

2.01 CAPACITY

A. Pumps, piping and accessories: Of adequate capacity and size to handle the range of wastewater flows from minimum flow to peak flow.

B. Piping, fittings, and all accessories shall withstand 2.0 times the maximum pressure including surge.

C. Maintain on site sufficient equipment and materials to ensure continuous and successful operation of the bypass system.
   1. Have standby pump(s) on site to provide 100 percent redundancy of the bypass system design Peak Flow.
      a. The redundant pump(s) shall be plumbed, fueled, and ready for operation at all times.
   2. Provide sufficient bypass lines to provide 100 percent redundancy of the bypass system design Peak Flow.
      a. The bypass lines and separate redundant lines shall be connected via a combined header that enables the shutdown and isolation of each individual line should a leak or rupture occurs.
   3. Maintain on site a sufficient number of valves, tees, elbows, connections, tools, pipe plugs, piping, and other parts or system hardware to ensure immediate repair or modification of any part of the bypass system as necessary.

2.02 BYPASS PUMPS

A. Provide a minimum of 2 pumps: 1 duty and 1 standby.

B. Pump capacity: Sufficient to pump the anticipated peak hour flow with the largest pump out of service.

C. Pumps: Packaged units with a skid base or trailer.

D. Pumps: Fully automatic, self-priming, close-coupled centrifugal units that do not require use of foot valves or vacuum pumps for priming.

E. Pumps shall use oil-lubricated mechanical seal.

F. Pump materials: As follows:
   1. Volute: Cast iron.
   2. Impeller: Cast iron.
   3. Pump shaft: Type 431 stainless steel.
   4. Mechanical seal faces: Silicon carbide.

G. Pumps shall be capable of passing 3-inch diameter solids, rags, rocks, hair, and other debris encountered in municipal wastewater.

H. Pump driver: Diesel engine or 480-V electric engine and include the following:
   1. Minimum 48-hour capacity diesel fuel tank as defined by fuel consumption during peak pumping rate.
   2. Fuel gauge with red warning light when tank approaches empty.

I. Pumps shall be capable of dry operation for up to 12 hours to accommodate large fluctuations in flow.

J. Maximum pump speed: Not exceeding 2,200 revolutions per minute.

K. The system shall include the following features:
   1. START/STOP operation.
   2. Variable flow based on water level in suction structure.
   3. Instrumentation and controls for operation and monitoring for each pump.

L. Electrical equipment, instrumentation, and accessories: Suitable for Class 1 Division 2 service as defined by NFPA 820.

M. Comply with applicable air quality regulations.

N. Utilize low noise level pumps as size permits manufactured by BakerCorp or Goodwin Quiet Pumps. Due to bypass into existing force mains, sound attenuated pumps may not be available for high head conditions. In this case, sound curtains are to be utilized for noise control.

2.03 BYPASS PIPING

A. Use HDPE piping for the temporary bypass pumping system.

B. Piping integrity: 0 leakage.

1. Include spill containment vessels or 'spillguards' as needed.

C. Provide sewage type air release valve at high point in piping and containment spills from valves.

D. Provide temporary ramps constructed over pipelines 6 inches in diameter or less to allow access to driveways.
   1. Bury pipelines larger than 6 inches in diameter crossing driveways, a minimum of 6 inches below the existing ground or pavement surface and backfilled with temporary asphalt concrete.
   2. No driveway access shall be blocked without the written authorization of the Owner.

2.04 PIPE PLUGS IN EXISTING PIPE

A. Pipe diameters 24 inches and smaller: Mechanical plugs with EPDM gaskets.

B. Pipe diameters larger than 24 inches: Inflatable bag stoppers with 2 or more pieces. Provide 2 plugs in series.

2.05 NOISE CONTROL

A. Pumping equipment: Equipped with devices or enclosures for noise attenuation including but not limited to mufflers and/or acceptable noise panels or enclosures. Due to the high head requirements for bypass of flow into existing force mains, pumps may not be available with noise attenuation. In that case, sound curtains shall be provided around the pumps to meet the noise level requirements of this Specification.

B. The noise level: The City of Sedona sound ordinance requires that the maximum permissible sound level limits be at or below 60 dBa from 7:00 AM to 10:00 PM and at or below 50 dBA from 10:00 PM to 7:00 AM as measured at any location at or within the property line of the receptor property.

2.06 ODOR CONTROL

A. The Contractor shall employ methods and procedures that mitigate the generation and discharge of objectionable odors to the surface environment at all times.

B. Seal all open manholes with plastic or similar material around suction piping that is adequately taped or tied to maintain an odor barrier.

C. All odor control methods shall be routinely inspected for maintaining of installation integrity.

PART 3 EXECUTION

3.01 GENERAL

A. Notify the Owner a minimum of seven (7) days prior to the Work and notify the Engineer at least 48 hours prior to bypassing or diverting flow in any of the pipelines or laterals.

B. Place pumps, generators, and other equipment on a plastic tarp to protect against spills of petroleum products used by the equipment.

C. Before taking process or pipeline out of service, verify that bypass system is fully operational and acceptable to Engineer. Testing of bypass system over a weekend period prior to taking pipeline out of service shall be performed.

3.02 PROTECTION

A. Be responsible for all bypass flows.
   1. Inspect the entire bypass pumping and piping system for leaks or spills at a frequency of not less than 4 times per day. This inspection is independent of the monitoring performed by the attendant as described below.
   2. Do not shutdown the temporary bypass system between shifts, on holidays or weekends, or during work stoppages without written permission from the Engineer.

B. Provide trained and qualified attendants 24 hours per day 7 days per week until the bypassing is no longer required. The attendants shall:
   1. Be capable of performing pump and piping maintenance required.
   2. Be capable of monitoring flows/levels in suction manhole and any upstream manholes to verify system operations.
      a. Monitoring of the operating pump and flow levels in the suction manhole shall be done frequently and at a frequency of not less than hourly.
      b. Records shall be kept in a log book of time and levels within the suction manhole and any relative comments.
   3. Have cellular phones for communication with the Contractor and the Owner in the event of emergencies.

C. No bypassing to the ground surface, receiving waters, storm drains, or bypassing which results in soil or groundwater contamination or any potential health hazards shall be permitted.
   1. In the event of any wastewater spill, be responsible for the prompt cleanup and disinfecting of the spill as called for in the wastewater bypass pumping plan.
   2. Compensate the Owner for the cost of any fines levied as the result of a spill or unauthorized discharge.

D. Implement measures to prevent interference between Owner operations and the bypass pumping equipment, pipelines and wastewater.

E. Take precautions to protect all bypass lines from damage.
   1. Clearly identify above ground portions of the bypass lines by flashers, fencing, or other means to warn of their presence.

3.03 FIELD QUALITY CONTROL

A. Hydrostatic pressure test:
   1. Prior to operation, test each section of discharge piping with maximum pressure equal to 2.0 times the maximum operating pressure.
   2. Conduct test for a duration of 2 hours.
   3. Test using non-potable water.
   4. The line in service after test if the pressure has been maintained and there are no observable leaks.

5. Notify Engineer at least 48 hours prior to testing.

B. Inspection:
   1. Inspect temporary bypass piping system at a minimum of four times per day.
   2. An attendant/operator shall be present to monitor the operation of the bypass pumps at all times 24 hours per day.
   3. Inspection log: Keep at each pumping location.

3.04 CLEAN-UP

A. The temporary bypass pumping system: Flush, clean and drain prior to dismantling.

B. Dispose of flushing water in approved manner.

C. Disturbed areas: Upon completion of bypass pumping operation, clean disturbed areas, restoring to original condition, including pavement and landscape restoration, at least equal to that which existed prior to start of Work.

3.05 SYSTEM CONDITIONS

A. Refer to Table below.

Bypass		Route		Flows (gpm)				
No.	**Description**	**From**	**To**	**Max**	**Avg**	**Min**	**Time**	**Conditions**
1	Chapel Lift Station	Manhole #1 Upstream of LS	Existing 6” Dia. Force Main (75’ of existing head)	153	85	57	Continuous	Max wet conditions flow = 392 gpm. Design for no more than 4’ of vertical storage in Manhole #1
2	Mystic Hills Lift Station	Manhole #1 upstream of LS	Existing 6” Dia. Force Main (202’ of existing head)	207	115	20	Continuous	Max wet conditions flow = 553 gpm. Design for no more than 4’ of vertical storage in Manhole #1

END OF SECTION

Appendix B

CALCULATIONS

Chapel Lift Station

Flow Rates*

Average Daily Flow	85	gpm	
Maximum Daily Flow (Dry)	153	gpm	
Maximum Daily Flow (Wet)	392	gpm	
Minimum Daily Flow	57	gpm	

* Provided by Sunrise Engineering

Wet Well (Upstream Manhole No. 1)

Volume per Vertical Foot	94	gal	(48" dia manhole)
Operating Range	4	ft	
Operating Volume	50	cu-ft	
Operating Volume	376	gal	

Wet Well (Upstream Manhole No. 2)

Volume per Vertical Foot	94	gal	(48" dia manhole)
Operating Range	2.75	ft	
Operating Volume	35	cu-ft	
Operating Volume	259	gal	

Piping Volume (btwn MH's and CO)

Diameter	8	in	
Volume per Linear Foot	2.61	cu-ft	
Linear Length	416.5	ft	(158'+ 172'+86.5')
Operating Volume	145	cu-ft	
Operating Volume	1088	gal	

Total Available Storage Volume	1722	gal

Pumping Times for Storage

Fill Time @ Min Daily Flow	30	min
Fill Time @ Max Daily Flow (Dry)	11	min
Fill Time @ Max Daily Flow (Wet)	4	min
Fill Time @Average Daily Flow	20	min
Estimated Pump Capacity	450	gpm
Time to Empty @ Min Daily Flow	4.4	min
Time to Empty @ Max Daily Flow (Dry)	5.8	min
Time to Empty @ Max Daily Flow (Wet)	29.7	min
Time to Empty @ Avg Daily Flow	4.7	min
Total Time (Fill & Empty) @ Min Daily Flow	34.6	min
Total Time (Fill & Empty) @ Max Daily Flow (Dry)	17.1	min
Total Time (Fill & Empty) @ Max Daily Flow (Wet)	34.1	min
Total Time (Fill & Empty) @ Avg Daily Flow	25.0	min
Cycles per Hour @ Min Daily Flow	1.7	
Cycles per Hour @ Max Daily Flow (Dry)	3.5	
Cycles per Hour @ Max Daily Flow (Wet)	1.8	
Cycles per Hour @ Avg Daily Flows	2.4	

Mystic Hills Lift Station

Flow Rates*

Average Daily Flow	115	gpm	
Maximum Daily Flow (Dry)	207	gpm	
Maximum Daily Flow (Wet)	553	gpm	
Minimum Daily Flow	20	gpm	

* Provided by Sunrise Engineering

Wet Well (Upstream Manhole No. 1)

Volume per Vertical Foot	94	gal	(48" dia manhole)
Operating Range	4	ft	
Operating Volume	50	cu-ft	
Operating Volume	376	gal	

Wet Well (Upstream Manhole No. 2)

Volume per Vertical Foot	94	gal	(48" dia manhole)
Operating Range	3.1	ft	
Operating Volume	39	cu-ft	
Operating Volume	291	gal	

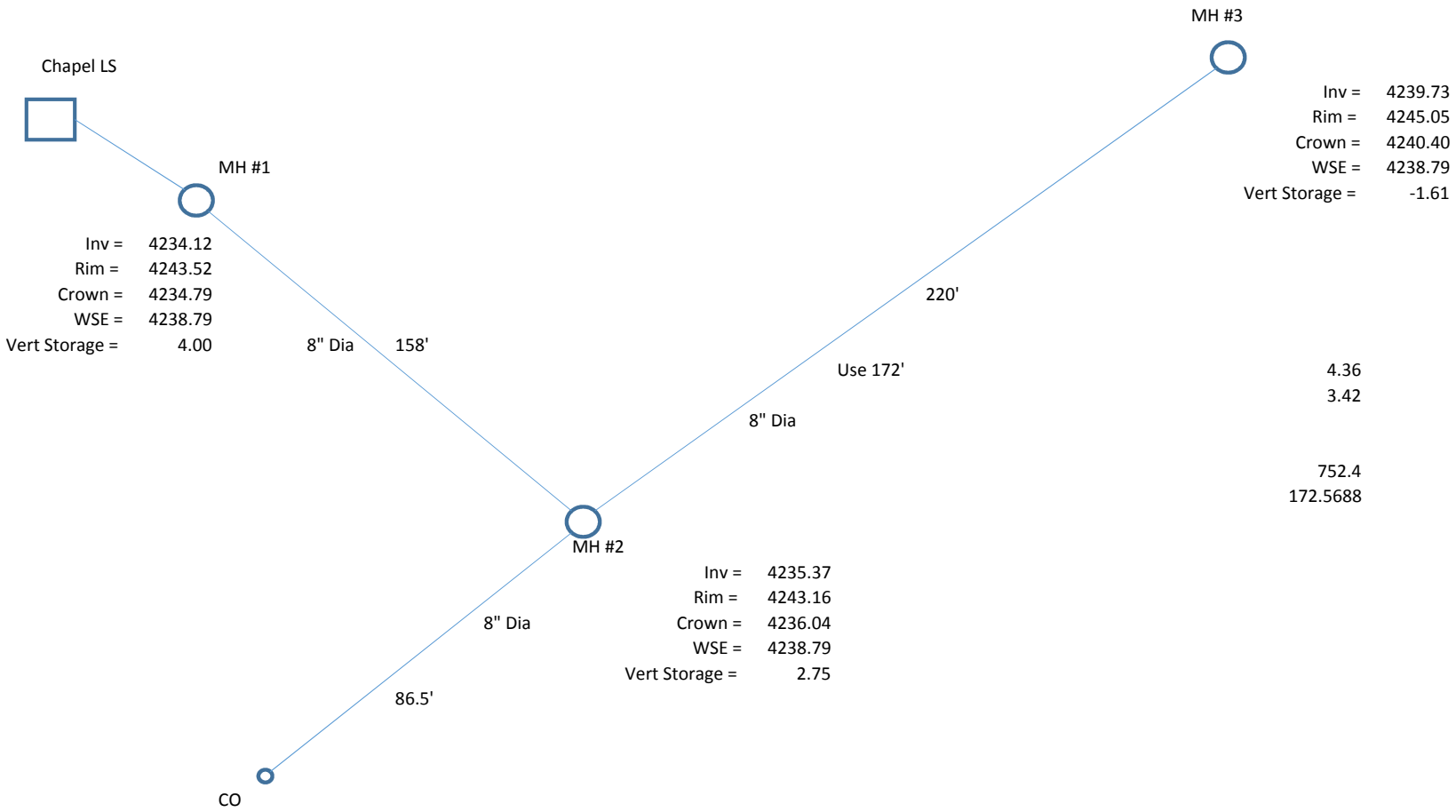
Piping Volume (btwn MH's)

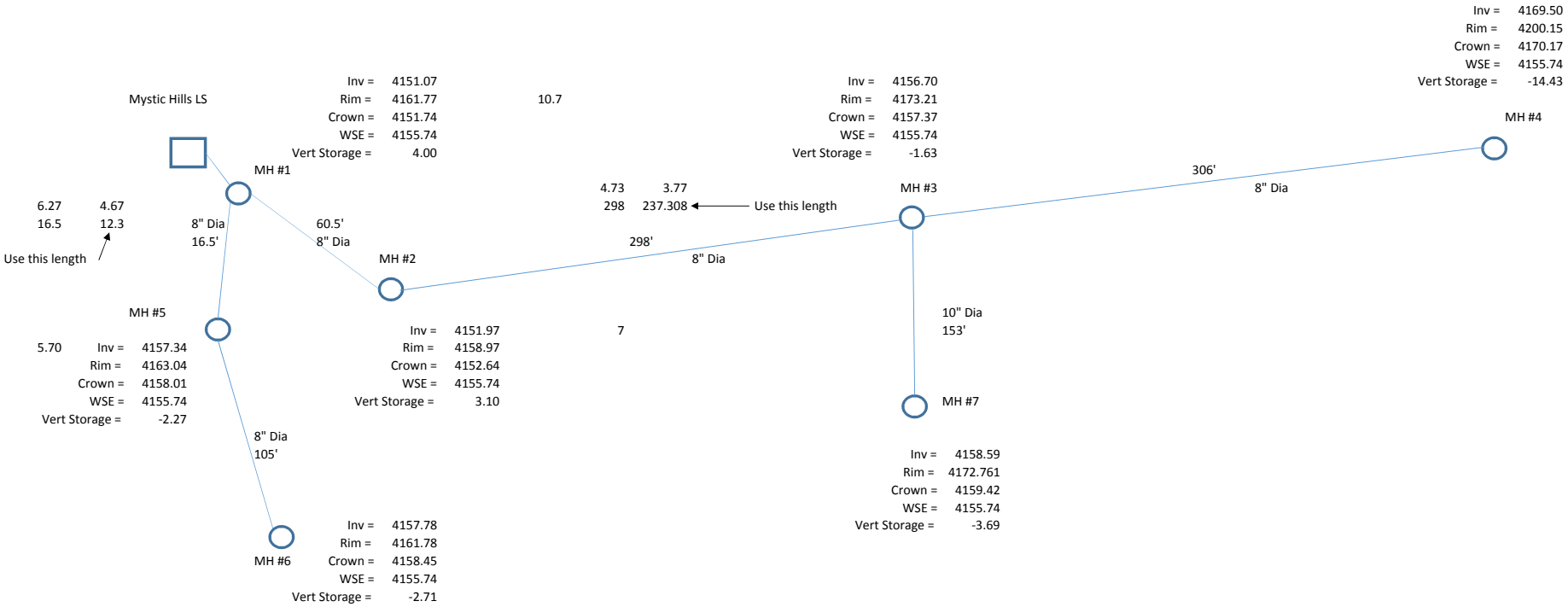
Diameter	8	in	
Volume per Linear Foot	2.61	cu-ft	
Linear Length	309.8	ft	(12.3+60.5+237)
Operating Volume	108	cu-ft	
Operating Volume	809	gal	

Total Available Storage Volume	1476	gal

Pumping Times for Storage

Fill Time @ Min Daily Flow	74	min
Fill Time @ Max Daily Flow (Dry)	7	min
Fill Time @ Max Daily Flow (Wet)	3	min
Fill Time @Average Daily Flow	13	min
Estimated Pump Capacity	600	gpm
Time to Empty @ Min Daily Flow	2.5	min
Time to Empty @ Max Daily Flow (Dry)	3.8	min
Time to Empty @ Max Daily Flow (Wet)	31.4	min
Time to Empty @ Avg Daily Flow	3.0	min
Total Time (Fill & Empty) @ Min Daily Flow	76.4	min
Total Time (Fill & Empty) @ Max Daily Flow (Dry)	10.9	min
Total Time (Fill & Empty) @ Max Daily Flow (Wet)	34.1	min
Total Time (Fill & Empty) @ Avg Daily Flow	15.9	min
Cycles per Hour @ Min Daily Flow	0.8	
Cycles per Hour @ Max Daily Flow (Dry)	5.5	
Cycles per Hour @ Max Daily Flow (Wet)	1.8	
Cycles per Hour @ Avg Daily Flows	3.8	


Chapel LS
MH #1
Inv = 4234.12
Rim = 4243.52
Crown = 4234.79
WSE = 4238.79
Vert Storage = 4.00
8" Dia
158'
MH #2
Inv = 4235.37
Rim = 4243.16
Crown = 4236.04
WSE = 4238.79
Vert Storage = 2.75
8" Dia
86.5'
CO
MH #3
Inv = 4239.73
Rim = 4245.05
Crown = 4240.40
WSE = 4238.79
Vert Storage = -1.61
220'
Use 172'
8" Dia
4.36
3.42
752.4
172.5688


Mystic Hills LS
MH #1
Inv = 4151.07
Rim = 4161.77
Crown = 4151.74
WSE = 4155.74
Vert Storage = 4.00
10.7
6.27 4.67
16.5 12.3
Use this length
8" Dia
16.5'
60.5'
8" Dia
MH #2
Inv = 4151.97
Rim = 4158.97
Crown = 4152.64
WSE = 4155.74
Vert Storage = 3.10
7
4.73 3.77
298 237.308
Use this length
298'
8" Dia
MH #3
Inv = 4156.70
Rim = 4173.21
Crown = 4157.37
WSE = 4155.74
Vert Storage = -1.63
306'
8" Dia
MH #4
Inv = 4169.50
Rim = 4200.15
Crown = 4170.17
WSE = 4155.74
Vert Storage = -14.43
MH #5
5.70
Inv = 4157.34
Rim = 4163.04
Crown = 4158.01
WSE = 4155.74
Vert Storage = -2.27
8" Dia
105'
MH #6
Inv = 4157.78
Rim = 4161.78
Crown = 4158.45
WSE = 4155.74
Vert Storage = -2.71
10" Dia
153'
MH #7
Inv = 4158.59
Rim = 4172.761
Crown = 4159.42
WSE = 4155.74
Vert Storage = -3.69

Bypass Capacity Calculations - Chapel LS - Minimum Flow

Losses

Pipe Nominal Size	6.00	in
DR	17.00	
Pipe ID, D	5.3	in
Hazen Williams Coeff., C	140	
Static Head, H_s	75	ft
Pipe Length, L	150	ft
Fittings Equivalent, L_f	149.000	ft
Equivalent Length, Le	299.0	ft
Total Pressure	32.59	psi

	#	EQ LG	Total
90 Deg Ell	3	16	48
45 Deg Ell	2	7.5	15
Ramps	0	144	0
Gate Valve	1	4	4
Angle Valve	0	82	0
Globe Valve	0	160	0
Entrance Loss	1	9	9
Tee	1	34	34
Check Valve	1	39	39
		Sum	149

HDPE Data

Pressure (psi)	DR
317	7.3
250	9.0
200	11.0
160	13.5
125	17.0
100	21.0
80	26.0
63	32.5

Flow Rate, Q		Velocity	Static Head	Velocity Head	Friction Head	Total Head
GPM	MGD	V, ft/s	H_s, ft	H_v, ft	H_f, ft	H, ft
57	0.08	0.83	75	0.01	0.18	75.19

Hazen Williams Coeff.

PVC	150
HDPE	140
Steel	145
Glass Lined	130
DIP	140
DIP (ML)	120
Cast Iron	100
Cast Iron (ML)	140
Old Pipe	60-80
Small, Corroded	40-50

Flows

Peak Flow	0.1	MGD
	57	gpm
Rain Increase	0	% (usually 35%)
Design Flow	0.1	MGD
	3,417	gph
	57	gpm
No. of Pipe	1	
Avg Flow per Pipe	57	gpm

Bypass Capacity Calculations - Chapel LS - Average Flow

Losses

Pipe Nominal Size	6.00	in
DR	17.00	
Pipe ID, D	5.3	in
Hazen Williams Coeff., C	140	
Static Head, H_s	75	ft
Pipe Length, L	150	ft
Fittings Equivalent, L_f	149.000	ft
Equivalent Length, Le	299.0	ft
Total Pressure	32.68	psi

	#	EQ LG	Total
90 Deg Ell	3	16	48
45 Deg Ell	2	7.5	15
Ramps	0	144	0
Gate Valve	1	4	4
Angle Valve	0	82	0
Globe Valve	0	160	0
Entrance Loss	1	9	9
Tee	1	34	34
Check Valve	1	39	39
		Sum	149

HDPE Data

Pressure (psi)	DR
317	7.3
250	9.0
200	11.0
160	13.5
125	17.0
100	21.0
80	26.0
63	32.5

Flow Rate, Q		Velocity	Static Head	Velocity Head	Friction Head	Total Head
GPM	MGD	V, ft/s	H_s, ft	H_v, ft	H_f, ft	H, ft
85	0.12	1.25	75	0.02	0.38	75.40

Hazen Williams Coeff.

PVC	150
HDPE	140
Steel	145
Glass Lined	130
DIP	140
DIP (ML)	120
Cast Iron	100
Cast Iron (ML)	140
Old Pipe	60-80
Small, Corroded	40-50

Flows

Peak Flow	0.1	MGD
	85	gpm
Rain Increase	0	% (usually 35%)
Design Flow	0.1	MGD
	5,125	gph
	85	gpm
No. of Pipe	1	
Avg Flow per Pipe	85	gpm

Bypass Capacity Calculations - Chapel LS - Maximum (Dry) Flow

Losses

Pipe Nominal Size	6.00	in
DR	17.00	
Pipe ID, D	5.3	in
Hazen Williams Coeff., C	140	
Static Head, H_s	75	ft
Pipe Length, L	150	ft
Fittings Equivalent, L_f	149.000	ft
Equivalent Length, Le	299.0	ft
Total Pressure	33.02	psi

	#	EQ LG	Total
90 Deg Ell	3	16	48
45 Deg Ell	2	7.5	15
Ramps	0	144	0
Gate Valve	1	4	4
Angle Valve	0	82	0
Globe Valve	0	160	0
Entrance Loss	1	9	9
Tee	1	34	34
Check Valve	1	39	39
		Sum	149

HDPE Data

Pressure (psi)	DR
317	7.3
250	9.0
200	11.0
160	13.5
125	17.0
100	21.0
80	26.0
63	32.5

Flow Rate, Q		Velocity	Static Head	Velocity Head	Friction Head	Total Head
GPM	MGD	V, ft/s	H_s, ft	H_v, ft	H_f, ft	H, ft
153	0.22	2.23	75	0.08	1.10	76.18

Hazen Williams Coeff.

PVC	150
HDPE	140
Steel	145
Glass Lined	130
DIP	140
DIP (ML)	120
Cast Iron	100
Cast Iron (ML)	140
Old Pipe	60-80
Small, Corroded	40-50

Flows

Peak Flow	0.2	MGD
	153	gpm
Rain Increase	0	% (usually 35%)
Design Flow	0.2	MGD
	9,167	gph
	153	gpm
No. of Pipe	1	
Avg Flow per Pipe	153	gpm

Bypass Capacity Calculations - Chapel LS - Maximum (Wet) Flow

Losses

Pipe Nominal Size	6.00	in
DR	17.00	
Pipe ID, D	5.3	in
Hazen Williams Coeff., C	140	
Static Head, H_s	75	ft
Pipe Length, L	150	ft
Fittings Equivalent, L_f	149.000	ft
Equivalent Length, Le	299.0	ft
Total Pressure	35.47	psi

	#	EQ LG	Total
90 Deg Ell	3	16	48
45 Deg Ell	2	7.5	15
Ramps	0	144	0
Gate Valve	1	4	4
Angle Valve	0	82	0
Globe Valve	0	160	0
Entrance Loss	1	9	9
Tee	1	34	34
Check Valve	1	39	39
		Sum	149

HDPE Data

Pressure (psi)	DR
317	7.3
250	9.0
200	11.0
160	13.5
125	17.0
100	21.0
80	26.0
63	32.5

Flow Rate, Q		Velocity	Static Head	Velocity Head	Friction Head	Total Head
GPM	MGD	V, ft/s	H_s, ft	H_v, ft	H_f, ft	H, ft
392	0.57	5.72	75	0.51	6.32	81.83

Hazen Williams Coeff.

PVC	150
HDPE	140
Steel	145
Glass Lined	130
DIP	140
DIP (ML)	120
Cast Iron	100
Cast Iron (ML)	140
Old Pipe	60-80
Small, Corroded	40-50

Flows

Peak Flow	0.6	MGD
	392	gpm
Rain Increase	0	% (usually 35%)
Design Flow	0.6	MGD
	23,542	gph
	392	gpm
No. of Pipe	1	
Avg Flow per Pipe	392	gpm

Bypass Capacity Calculations - Chapel LS - Design Flow (450 gpm)

Losses

Pipe Nominal Size	6.00	in
DR	17.00	
Pipe ID, D	5.3	in
Hazen Williams Coeff., C	140	
Static Head, H_s	75	ft
Pipe Length, L	150	ft
Fittings Equivalent, L_f	149.000	ft
Equivalent Length, Le	299.0	ft
Total Pressure	36.33	psi

	#	EQ LG	Total
90 Deg Ell	3	16	48
45 Deg Ell	2	7.5	15
Ramps	0	144	0
Gate Valve	1	4	4
Angle Valve	0	82	0
Globe Valve	0	160	0
Entrance Loss	1	9	9
Tee	1	34	34
Check Valve	1	39	39
		Sum	149

HDPE Data

Pressure (psi)	DR
317	7.3
250	9.0
200	11.0
160	13.5
125	17.0
100	21.0
80	26.0
63	32.5

Flow Rate, Q		Velocity	Static Head	Velocity Head	Friction Head	Total Head
GPM	MGD	V, ft/s	H_s, ft	H_v, ft	H_f, ft	H, ft
450	0.65	6.56	75	0.67	8.14	83.81

Hazen Williams Coeff.

PVC	150
HDPE	140
Steel	145
Glass Lined	130
DIP	140
DIP (ML)	120
Cast Iron	100
Cast Iron (ML)	140
Old Pipe	60-80
Small, Corroded	40-50

Flows

Peak Flow	0.6	MGD
	450	gpm
Rain Increase	0	% (usually 35%)
Design Flow	0.6	MGD
	27,000	gph
	450	gpm
No. of Pipe	1	
Avg Flow per Pipe	450	gpm

Bypass Capacity Calculations - Mystic Hills LS - Minimum Flow

Losses

Pipe Nominal Size	6.00	in
DR	11.00	
Pipe ID, D	4.9	in
Hazen Williams Coeff., C	140	
Static Head, H_s	202	ft
Pipe Length, L	55	ft
Fittings Equivalent, L_f	165.000	ft
Equivalent Length, Le	220.0	ft
Total Pressure	87.57	psi

	#	EQ LG	Total
90 Deg Ell	4	16	64
45 Deg Ell	2	7.5	15
Ramps	0	144	0
Gate Valve	1	4	4
Angle Valve	0	82	0
Globe Valve	0	160	0
Entrance Loss	1	9	9
Tee	1	34	34
Check Valve	1	39	39
		Sum	165

HDPE Data

Pressure (psi)	DR
317	7.3
250	9.0
200	11.0
160	13.5
125	17.0
100	21.0
80	26.0
63	32.5

Flow Rate, Q		Velocity	Static Head	Velocity Head	Friction Head	Total Head
GPM	MGD	V, ft/s	H_s, ft	H_v, ft	H_f, ft	H, ft
20	0.03	0.34	202	0.00	0.03	202.03

Hazen Williams Coeff.

PVC	150
HDPE	140
Steel	145
Glass Lined	130
DIP	140
DIP (ML)	120
Cast Iron	100
Cast Iron (ML)	140
Old Pipe	60-80
Small, Corroded	40-50

Flows

Peak Flow	0.0	MGD
	20	gpm
Rain Increase	0	% (usually 35%)
Design Flow	0.0	MGD
	1,208	gph
	20	gpm
No. of Pipe	1	
Avg Flow per Pipe	20	gpm

Bypass Capacity Calculations - Mystic Hills LS - Average Flow

Losses

Pipe Nominal Size	6.00	in
DR	11.00	
Pipe ID, D	4.9	in
Hazen Williams Coeff., C	140	
Static Head, H_s	202	ft
Pipe Length, L	55	ft
Fittings Equivalent, L_f	165.000	ft
Equivalent Length, Le	220.0	ft
Total Pressure	87.88	psi

	#	EQ LG	Total
90 Deg Ell	4	16	64
45 Deg Ell	2	7.5	15
Ramps	0	144	0
Gate Valve	1	4	4
Angle Valve	0	82	0
Globe Valve	0	160	0
Entrance Loss	1	9	9
Tee	1	34	34
Check Valve	1	39	39
		Sum	165

HDPE Data

Pressure (psi)	DR
317	7.3
250	9.0
200	11.0
160	13.5
125	17.0
100	21.0
80	26.0
63	32.5

Flow Rate, Q		Velocity	Static Head	Velocity Head	Friction Head	Total Head
GPM	MGD	V, ft/s	H_s, ft	H_v, ft	H_f, ft	H, ft
115	0.17	1.94	202	0.06	0.69	202.75

Hazen Williams Coeff.

PVC	150
HDPE	140
Steel	145
Glass Lined	130
DIP	140
DIP (ML)	120
Cast Iron	100
Cast Iron (ML)	140
Old Pipe	60-80
Small, Corroded	40-50

Flows

Peak Flow	0.2	MGD
	115	gpm
Rain Increase	0	% (usually 35%)
Design Flow	0.2	MGD
	6,875	gph
	115	gpm
No. of Pipe	1	
Avg Flow per Pipe	115	gpm

Bypass Capacity Calculations - Mystic Hills LS - Maximum (Dry) Flow

Losses

Pipe Nominal Size	6.00	in
DR	11.00	
Pipe ID, D	4.9	in
Hazen Williams Coeff., C	140	
Static Head, H_s	202	ft
Pipe Length, L	55	ft
Fittings Equivalent, L_f	134.000	ft
Equivalent Length, Le	189.0	ft
Total Pressure	88.41	psi

	#	EQ LG	Total
90 Deg Ell	3	16	48
45 Deg Ell	0	7.5	0
Ramps	0	144	0
Gate Valve	1	4	4
Angle Valve	0	82	0
Globe Valve	0	160	0
Entrance Loss	1	9	9
Tee	1	34	34
Check Valve	1	39	39
		Sum	134

HDPE Data

Pressure (psi)	DR
317	7.3
250	9.0
200	11.0
160	13.5
125	17.0
100	21.0
80	26.0
63	32.5

Flow Rate, Q		Velocity	Static Head	Velocity Head	Friction Head	Total Head
GPM	MGD	V, ft/s	H_s, ft	H_v, ft	H_f, ft	H, ft
207	0.30	3.51	202	0.19	1.77	203.96

Hazen Williams Coeff.

PVC	150
HDPE	140
Steel	145
Glass Lined	130
DIP	140
DIP (ML)	120
Cast Iron	100
Cast Iron (ML)	140
Old Pipe	60-80
Small, Corroded	40-50

Flows

Peak Flow	0.3	MGD
	207	gpm
Rain Increase	0	% (usually 35%)
Design Flow	0.3	MGD
	12,417	gph
	207	gpm
No. of Pipe	1	
Avg Flow per Pipe	207	gpm

Bypass Capacity Calculations - Mystic Hills LS - Maximum (Wet) Flow

Losses

Pipe Nominal Size	6.00	in
DR	11.00	
Pipe ID, D	4.9	in
Hazen Williams Coeff., C	140	
Static Head, H_s	202	ft
Pipe Length, L	55	ft
Fittings Equivalent, L_f	134.000	ft
Equivalent Length, Le	189.0	ft
Total Pressure	92.87	psi

	#	EQ LG	Total
90 Deg Ell	3	16	48
45 Deg Ell	0	7.5	0
Ramps	0	144	0
Gate Valve	1	4	4
Angle Valve	0	82	0
Globe Valve	0	160	0
Entrance Loss	1	9	9
Tee	1	34	34
Check Valve	1	39	39
		Sum	134

HDPE Data

Pressure (psi)	DR
317	7.3
250	9.0
200	11.0
160	13.5
125	17.0
100	21.0
80	26.0
63	32.5

Flow Rate, Q		Velocity	Static Head	Velocity Head	Friction Head	Total Head
GPM	MGD	V, ft/s	H_s, ft	H_v, ft	H_f, ft	H, ft
553	0.80	9.37	202	1.36	10.88	214.24

Hazen Williams Coeff.

PVC	150
HDPE	140
Steel	145
Glass Lined	130
DIP	140
DIP (ML)	120
Cast Iron	100
Cast Iron (ML)	140
Old Pipe	60-80
Small, Corroded	40-50

Flows

Peak Flow	0.8	MGD
	553	gpm
Rain Increase	0	% (usually 35%)
Design Flow	0.8	MGD
	33,167	gph
	553	gpm
No. of Pipe	1	
Avg Flow per Pipe	553	gpm

Bypass Capacity Calculations - Mystic Hills LS - Design Flow (600 gpm)

Losses

Pipe Nominal Size	6.00	in
DR	11.00	
Pipe ID, D	4.9	in
Hazen Williams Coeff., C	140	
Static Head, H_s	202	ft
Pipe Length, L	55	ft
Fittings Equivalent, L_f	134.000	ft
Equivalent Length, Le	189.0	ft
Total Pressure	93.74	psi

	#	EQ LG	Total
90 Deg Ell	3	16	48
45 Deg Ell	0	7.5	0
Ramps	0	144	0
Gate Valve	1	4	4
Angle Valve	0	82	0
Globe Valve	0	160	0
Entrance Loss	1	9	9
Tee	1	34	34
Check Valve	1	39	39
		Sum	134

HDPE Data

Pressure (psi)	DR
317	7.3
250	9.0
200	11.0
160	13.5
125	17.0
100	21.0
80	26.0
63	32.5

Flow Rate, Q		Velocity	Static Head	Velocity Head	Friction Head	Total Head
GPM	MGD	V, ft/s	H_s, ft	H_v, ft	H_f, ft	H, ft
600	0.86	10.17	202	1.61	12.66	216.26

Hazen Williams Coeff.

PVC	150
HDPE	140
Steel	145
Glass Lined	130
DIP	140
DIP (ML)	120
Cast Iron	100
Cast Iron (ML)	140
Old Pipe	60-80
Small, Corroded	40-50

Flows

Peak Flow	0.9	MGD
	600	gpm
Rain Increase	0	% (usually 35%)
Design Flow	0.9	MGD
	36,000	gph
	600	gpm
No. of Pipe	1	
Avg Flow per Pipe	600	gpm

Appendix C

TEMPORARY BYPASS PUMP CUT SHEETS

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DATA SHEET

GENERAL DESCRIPTION

Diesel engine driven centrifugal pump equipped with a mechanical priming system that uses a compressor and an eductor to create vacuum. Pump is capable of handling solids up to 3-inches in diameter.

PUMP FEATURES

* Programmable control panel with automatic start-stop functions from pressure/level transducers or float signals

* Fuel level, engine load, run time, oil and coolant temperature monitoring is available from the control panel

BP44LS-GD66AT

BakerPrime 4x4 Low Pressure Solids Handling Unit (Attenuated, Trailer)

PERFORMANCE DATA		
>> Flow (max):	-	925 gpm
>> Flow (min):	-	60 gpm
>> Maximum Shutoff Head:	-	152 feet (66 psi) @ 2100 rpm (1)
>> Minimum Shutoff Head:	-	87 feet (38 psi) @ 1550 rpm (1)
>> Maximim Casing Press:	-	99 psi
>> Maximum Temperature:	-	160°F (7)
>> Maximum Suction Lift:	-	25 feet (2)
>> Maximim Speed:	-	2100 rpm
>> Minimum Speed:	-	1550 rpm
>> Impeller Diameter:	-	9.75
>> Maximum Solids Size:	-	3" spherical diameter

ENGINE SPECIFICATIONS		
>> Engine Make:	-	Deere
>> Engine Model:	-	4024H
>> Total Displacement:	-	2.4 Liter
>> Aspiration:	-	Turbocharged
>> Max. Continuous BHP:	-	66 @ 2400 rpm (4)
>> Crankcase Oil:	-	SAE 10W40
>> Coolant:	-	Peak Fleet Charge/John Deere Cool Gard II
>> Safety Shutdowns:	-	High Water Temp & Low Oil Pressure
>> Fuel consumption:	-	2.78 gal/hr @ 1800 rpm (6)
>> Run Time:	-	32 hours at 1800 rpm at 80% Engine Load
>> Fuel Type:	-	No. 2 Diesel: ***NO BIODIESEL***
>> Fuel Capacity:	-	90 U.S. gals
>> Number of Cylinders:	-	Four
>> Sound Rating:	-	67 dBA at 23 feet

PUMP SPECIFICATIONS		
>> Suction Size:	-	4" flange
>> Discharge Size:	-	4" flange
>> Approximate Weight:	-	5250 lbs dry / 5889 lbs wet
>> Overall Height:	-	90" (to top of lifting eye)
>> Overall Width:	-	63"
>> Overall Length:	-	137" (nose to tail)
>> Pump Casing Material:	-	Gray Iron No. 30
>> Impeller Material:	-	Ductile Iron No. 4140
>> Wear Ring Material:	-	Carbon Steel No. 1018
>> Pump Shaft Material:	-	Alloy Steel No. 4140
>> Shaft Sleeve Material:	-	17-4 PH S.S.
>> Check Valve Body Material:	-	Gray Iron No. 30
>> Check Valve Flapper Material	-	Buna-N
>> Mechanical Seal Faces:	-	Silicon-Carbide/Silicon-Carbide
>> Mechanical Seal Lube:	-	SAE No. 30 Oil
>> O-ring Material:	-	Buna-N
>> Bearing Lubrication Type:	-	SAE No. 30 Oil
>> Vacuum System:	-	8.5 cfm Compressor/Venturi

Notes:

(1) Based on 1.0 specific gravity.

(2) Depends on flow rate, pump speed, and elevation. See performance curve.

(3) Should always be visible and clear in appearance thru sight glass.

(4) WARNING - this is the rated speed for the ENGINE ONLY. The rated speed of the pump is less. See curve for max pump RPM.

(5) Must be changed every 250 hours of runtime.

(6) Run time fluctuates with speed and engine loads.

(7) Equipment material limitation. Lower max temperature may be necessary due to application conditions and pump NPSH requirements.

BakerCorp Reference # 404-0105 *Drawing Reference # 1607*

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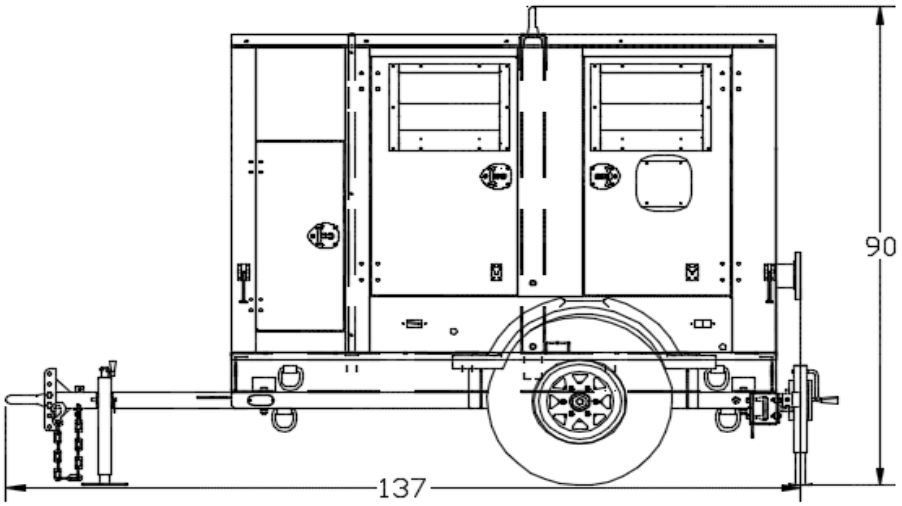
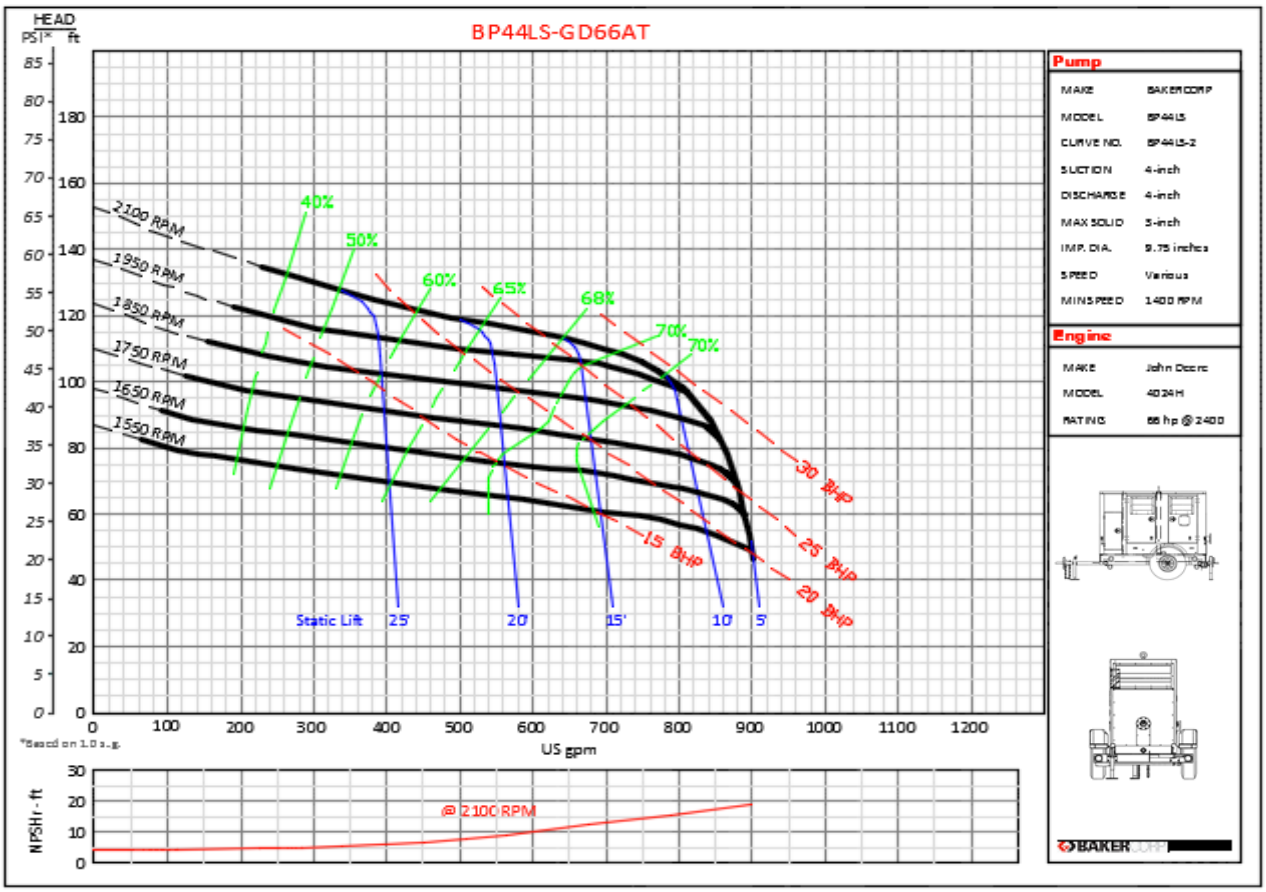
DATA SHEET

BP44LS-GD66AT

PHYSICAL SPECIFICATIONS



PERFORMANCE CURVE



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DATA SHEET

GENERAL DESCRIPTION

Diesel engine driven centrifugal pump equiped with a mechanical priming system that uses an air diaphragm pump to create vacuum. Pump is capable of handling solids up to 3-inches in diameter.

PUMP FEATURES

* Programmable control panel with automatic start-stop functions from pressure/level transducers or float signals

* Fuel level, engine load, run time, oil and coolant temperature monitoring is available from the control panel

SS64HS-CD140OT

BakerPrime 6x4 High Pressure Solids Handling Unit (Open, Trailer)

PERFORMANCE DATA

>> Flow (max):	-	1500 gpm
>> Flow (min):	-	260 gpm
>> Maximum Shutoff Head:	-	352 feet (152 psi) @ 2100 rpm (1)
>> Minimum Shutoff Head:	-	112 feet (48 psi) @ 1200 rpm (1)
>> Maximim Casing Press:	-	200 psi
>> Maximum Temperature:	-	400°F (7)
>> Maximum Suction Lift:	-	25 feet (2)
>> Maximim Speed:	-	2100 rpm
>> Minimum Speed:	-	1200 rpm
>> Impeller Diameter:	-	14"
>> Maximum Solids Size:	-	3" spherical diameter

ENGINE SPECIFICATIONS

>> Engine Make:	-	Deere
>> Engine Model:	-	4045H
>> Total Displacement:	-	4.5 Liter
>> Aspiration:	-	Turbocharged
>> Max. Continuous BHP:	-	140 @ 2400 rpm (4)
>> Crankcase Oil:	-	SAE 10W40
>> Coolant:	-	Peak Fleet Charge/John Deere Cool Gard II
>> Safety Shutdowns:	-	High Water & Low Oil
>> Fuel consumption:	-	5.22 gal/hr @ 1800 rpm (6)
>> Run Time:	-	25 hours at 1600 rpm at 80% Engine Load
>> Fuel Type:	-	No. 2 Diesel: ***NO BIODIESEL***
>> Fuel Capacity:	-	120 U.S. gals
>> Number of Cylinders:	-	Four

PUMP SPECIFICATIONS

>> Suction Size:	-	6" flange
>> Discharge Size:	-	4" flange
>> Approximate Weight:	-	4248 lbs dry / 5100 lbs wet
>> Overall Height:	-	93" (to top of lifting eye)
>> Overall Width:	-	73.2"
>> Overall Length:	-	143.3" (nose to tail)
>> Pump Casing Material:	-	CD4MCu
>> Impeller Material:	-	CD4MCu
>> Wear Ring Material:	-	CD4MCu
>> Pump Shaft Material:	-	17-4 PH Stainless Steel
>> Shaft Sleeve Material:	-	CD4MCu
>> Check Valve Body Material:	-	Gray Iron No. 30
>> Check Valve Flapper Material	-	Buna-N
>> Mechanical Seal Faces:	-	Tungsten/Silicon-Carbide
>> Mechanical Seal Lube:	-	SAE No. 30 Oil
>> O-ring Material:	-	Viton
>> Bearing Lubrication Type:	-	Grease
>> Vacuum System:	-	12.5 cfm Compressor/Venturi

Notes:

(1) Based on 1.0 specific gravity.

(2) Depends on flow rate, pump speed, and elevation. See performance curve.

(3) Should always be visible and clear in appearance thru sight glass.

(4) WARNING - this is the rated speed for the ENGINE ONLY. The rated speed of the pump is less. See curve for max pump RPM.

(5) Must be changed every 250 hours of runtime.

(6) Run time fluctuates with speed and engine loads.

(7) Equipment material limitation. Lower max temperature may be necessary due to application conditions and pump NPSH requirements.

BakerCorp Reference # 406-3401 *Drawing Reference # 1530-A*

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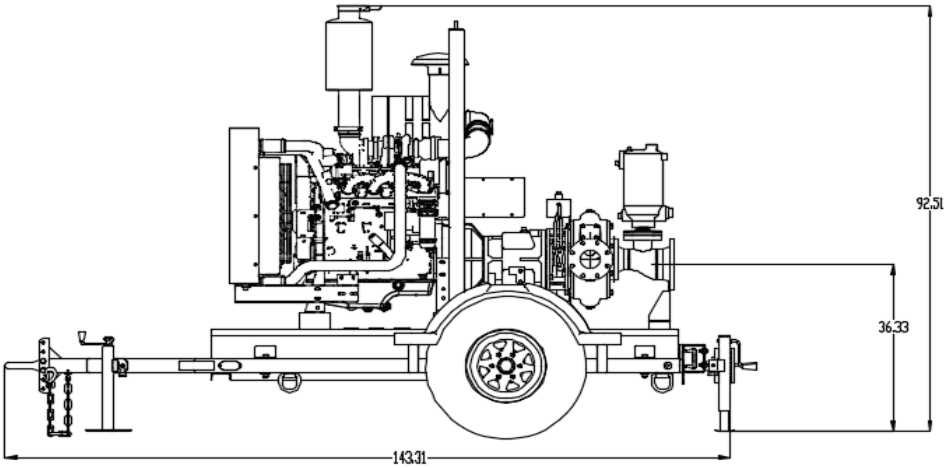
2.9.9.17

DATA SHEET

SS64HS-CD140OT

PHYSICAL SPECIFICATIONS



PERFORMANCE CURVE