East Culpepper Flats Regional Water Connection

September 2021

STANDARD SPECIFICATIONS

Incorporation of New Mexico Standard Specifications for Public Works Construction (2006 Edition)

The New Mexico Standard Specifications for Public Works Construction (2006 Edition), General Conditions and Technical Specifications, as updated and amended, are incorporated by reference, the same as if fully written herein and shall govern this Project except where revised, updated or supplemented by the Supplemental Special Provisions, Special Provisions and/or the Supplemental Technical Specifications.

The New Mexico Standard Specifications for Public Works Construction (2006 Edition) may be purchased in bound book format or in CD ROM format by contacting:

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SUPPLEMENTAL TECHNICAL SPECIFICATIONS

The following revisions and/or additions to the Technical Specifications of the Standard Specifications are hereby made a part of the Contract Documents.

SECTION 621
MOBILIZATION/DEMOBILIZATION

PART 1 DESCRIPTION

This work shall consist of preparatory and final work and operations, including, but not limited to, those necessary for the movement of personnel, equipment, supplies and incidentals to and from the project site; for the establishment of all offices, buildings and other facilities necessary for work on the project; and, for all other work and operations which must be performed or costs incurred prior to beginning work on the project, and subsequent to the completion of such work.

1.01 MOBILIZATION/DEMOBILIZATION ADMINISTRATION REQUIREMENTS

A. Definitions. The following definitions shall apply:

1. Total original contract amount shall mean the total amount bid as compensation for the contract.

2. Total original contract amount less mobilization and demobilization shall mean the total amount bid as compensation for the contract less the amounts bid for mobilization and demobilization.

1.02 GENERAL. IT IS THE INTENT OF THIS SPECIFICATION TO PROVIDE FOR THE CONTRACTOR TO:

A. Receive 100% of the amount bid for mobilization by the time the Contractor has performed ten percent (10%) of the total original contract amount bid less the amount bid for mobilization and demobilization.

B. Receive 100% of the amount bid for demobilization by the time the Contractor has performed one-hundred percent (100%) of the total original contract amount bid less the amount bid for mobilization and demobilization.

1.03 PAYMENT PROCEDURES FOR MOBILIZATION. THE FOLLOWING WILL APPLY IN EFFECTING MOBILIZATION PAYMENTS:

A. When the Contractor is eligible for payment of less than five percent (5%) of the total original contract amount bid less mobilization and demobilization, the Contractor will be paid twenty five percent (25%) of the amount bid for mobilization.

B. When the Contractor is eligible for payment of from five percent (5%) to less than ten percent (10%) of the total original amount bid less mobilization and demobilization, the Contractor will be paid fifty percent (50%) of the amount bid for mobilization minus any mobilization amount already paid.

C. When the Contractor is eligible for payment of ten percent (10%) or more of the total original contract amount less mobilization and demobilization, the Contractor will be paid 100% of the amount bid for mobilization minus any mobilization amount already paid.

1.04 Payment Calculations.

$\mathbf{P_M}$	=	Mobilization Payment
M	=	Total amount bid for Mobilization
$\mathbf{f_M}$	=	Mobilization payment percentage factor
	=	0.25, or 0.50, or 1.0, as applicable
$\mathbf{P_M}$	=	$\mathbf{M \times f_M}$

EXAMPLE 1

MOBILIZATION

Total Original Contract Amount Bid $110,000
Amount Bid for Mobilization.....$ 5,000
Amount Bid for Demobilization .....$ 3,000
Total Original Contract Amount Less Mobilization and Demobilization $102,000

Percent of Work Completed	f_M		M	P_M
<5% of $102,000	0.25	x	5,000	=$1,250
>5% to <10% of $102,000	0.50	x	5,000	=$2,500*
≥10% of $102,000	1.00	x	5,000	=$5,000*

*minus previously paid amounts

1.05 PAYMENT PROCEDURES FOR DEMOBILIZATION. THE FOLLOWING WILL APPLY IN EFFECTING DEMOBILIZATION PAYMENTS:

A. When the **Contractor** is eligible for payment of more than ninety percent (90%) of the total original contract amount bid less mobilization and demobilization, the **Contractor** will be paid twenty five percent (25%) of the amount bid for demobilization.

B. When the Contractor is eligible for payment of from ninety-five percent (95%) to less than one hundred percent (100%) of the total original amount bid less mobilization and demobilization, the Contractor will be paid fifty percent (50%) of the amount bid for demobilization minus any demobilization amount already paid.

C. When the Contractor is eligible for payment of one-hundred percent (100%) of the total original contract amount less mobilization and demobilization, the Contractor will be paid 100% of the amount bid for demobilization minus any demobilization amount already paid.

1.06 Payment Calculations.

$\mathbf{P_{DM}}$ = Demobilization Payment

DM = Total amount bid for Demobilization

$\mathbf{f_{DM}}$ = Demobilization payment percentage factor

= 0.25, or 0.50, or 1.0, as applicable

$\mathbf{P_{DM}} = \mathbf{DM \times f_{DM}}$

EXAMPLE 2

DEMOBILIZATION

Total Original Contract Amount Bid $110,000

Amount Bid for Mobilization..... $ 5,000

Amount Bid for Demobilization ..... $ 3,000

Total Original Contract Amount Less Mobilization and Demobilization $102,000

Percent of Work Completed	f_{DM}		DM	P_{DM}
>90% of $102,000	0.25	x	3,000	=$ 750
>95% to <100% of $102,000	0.50	x	3,000	=$1,500*

≥100% of $102,000	1.00	x	3,000	=$3,000*

*minus previously paid amounts

1.07 METHOD OF MEASUREMENT.

A. Mobilization and Demobilization will be measured by lump sum units.

1.08 BASIS OF PAYMENT.

A. Mobilization will be paid for at the contract price per Mobilization Bid Item. Demobilization will be paid for at the contract price per Demobilization Bid Item. No additional payments will be made for demobilization and remobilization due to shutdowns or suspensions of the work or for other mobilization and demobilization activities required to complete the contract satisfactorily.

SECTION 01010
SUMMARY OF WORK

PART 1 GENERAL

1.01 GENERAL

The Work to be performed under this Contract shall consist of furnishing all plant, tools, equipment, materials, supplies, and manufactured articles and furnishing all labor, transportation, and services, including: fuel, power, water, and essential communications, and performing all Work, or other operations required for the fulfillment of the Contract in strict accordance with the Contract Documents. Note: By submitting a bid for this project, the CONTRACTOR hereby acknowledges and assures the OWNER that it has sufficient experience in constructing this type of work and therefore is familiar with all combinations of materials, labor, and equipment that are required for the successful completion of this project. The Work shall be complete, and all Work, materials, and services not expressly indicated or called for in the Contract Documents which may be necessary for the complete, safe and proper construction of the Work in good faith shall be provided by the CONTRACTOR at no increase in cost to the OWNER.

1.02 CONTRACTOR'S REPRESENTATIVES

A. At the Pre-construction Conference, the CONTRACTOR shall provide the OWNER an Organizational Chart of the CONTRACTOR'S PROJECT TEAM for the project, including responsibilities of all related personnel. At a minimum, this organizational chart should include the Project Manager, Project Superintendent, Safety Representative, Scheduler and OWNER or Partner of the CONTRACTOR under Contract. Phone numbers or instructions on how to contact key personnel must be provided. Resumes of all project related personnel should be included for review and approval by the OWNER. All key personnel as identified in the organizational chart are required to have assumed the same level of responsibility on three (3) projects of similar scope and magnitude.

B. An Authorized Representative must be designated, with a clear definition of the scope of this individual's authority to represent or act on behalf of the CONTRACTOR. Any limitations in the authority of this designated representative must also be clearly delineated. At all times when work is underway at the jobsite, the CONTRACTOR'S Project Manager or Superintendent shall be present at the jobsite to supervise the work. The CONTRACTOR shall also supply an alternative Authorized Representative to act on his behalf in an emergency situation or if the prime Authorized Representative is unavailable for any reason. The limits and extent of this individual's authority to act on the CONTRACTOR'S behalf must also be clearly defined. All instructions, determinations, notices and other communications given to the Authorized Representative of the CONTRACTOR shall be binding upon the CONTRACTOR. An Authorized Representative must be

available by cell phone and/or radio on a twenty-four (24) hours a day, seven (7) days a week basis throughout the course of the Contract. In the event that no Authorized Representative is available in an emergency situation requiring the CONTRACTOR'S action or should the CONTRACTOR fail to respond within two (2) hours, the OWNER may take the appropriate actions to remedy the situation at the CONTRACTOR'S expense. The CONTRACTOR, by failing to respond to the call, shall waive any rights to claims caused by the OWNER'S actions.

C. All key personnel as described in the CONTRACTOR'S organizational chart must be approved by the OWNER prior to the commencement of work on the project. Resumes of key personnel should include related experience on three previous projects of similar magnitude and complexity. In the event that a member of the project team proves to be unsatisfactory to the CONTRACTOR and ceases to be in his employ, all substitutions must be reviewed and approved by the OWNER. Key personnel shall not be replaced without prior approval by the OWNER.

1.03 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of this Base Bid Contract comprises construction of the following:

1. Construction of approximately 23,820 LF of 8" transmission pipeline from East Culpepper Flats to the intersection of County Road 3086 and NM 574.
2. All associated ARVs, Valves, and flush hydrants.
3. Prefabricated packaged booster station including RTU, electrical, piping, disinfection equipment, associated appurtenances, foundation, and site improvements.
4. Provide new SCADA terminal at existing East Culpepper Tank, integrate existing East Culpepper tank and new booster station.
5. Water service meter and enclosure, and any appurtenances.
6. Additive Alternate, if awarded, includes:
    a. 40' horizontal directional drill for 1" copper line under NM 574 including a 1" water service, meter and enclosure.

B. The Work is located in San Juan County, New Mexico, as indicated on the Drawings.

1.04 WORK BY OTHERS

The CONTRACTOR'S attention is directed to the fact that work may be conducted at or adjacent to the Site by other contractors during the performance of the Work under this Contract. The CONTRACTOR is to conduct its operations in a manner that will minimize any interference with the Work of other contractors under separate contract with the OWNER or other entities, and shall coordinate its operations and cooperate fully, with such contractors to provide continued safe access to their respective portions of the Site, as required to perform Work under

their respective contracts. The CONTRACTOR shall include in the bid price all costs associated with the successful coordination of its operations with other contractors. Copies of Contract Documents pertaining to Work conducted on or adjacent to the site are available for review upon request.

1.05 COORDINATION

A. Existing Utilities and Structures

Known utilities and structures adjacent to or expected to be encountered in the work are shown on the drawings. The locations shown are taken from existing records or information obtained from the Utility Owner. All existing utility data represented on the profile is approximate field measurements from surveying of manholes. Data points identified as "DEPTH UNK" were based on assumed typical depth of bury and not verified by potholing activities. Prior to construction activities, the CONTRACTOR shall verify the horizontal and vertical locations of all existing utilities and obstructions within or adjacent to the work zone which would impact the proposed alignment. Utilities shown are for the convenience of the CONTRACTOR only, and no responsibility is assumed by either the OWNER or the ENGINEER for their accuracy or completeness. If a conflict with any existing utility is identified during construction, the CONTRACTOR shall submit the existing utility information (referenced by station, offset and TP or invert elevation) to the OWNER AND ENGINEER for review. The CONTRACTOR shall provide a minimum of five (5) working days from when all requested information is provided by the CONTRACTOR for the OWNER to provide a resolution of the conflict.

1. CONTRACTOR shall protect all existing utilities within the boundaries of the work. Utilities damaged, as a result of the CONTRACTOR'S operations due to his negligence or oversight shall be repaired to the satisfaction of the OWNER of said utility at CONTRACTOR'S sole expense.

2. At least 48 hours prior to start of said work, CONTRACTOR shall notify all utilities that may be affected.

3. For location of utilities, CONTRACTOR shall call New Mexico One Call, phone number (800)321-2537 or 811 for coordinating and identifying utility locations.

4. CONTRACTOR shall protect all existing structures within the boundaries of the work and adjacent to the work. CONTRACTOR shall be responsible for visiting the site and becoming familiar with all existing structures. Existing structures damaged that were not part of this contract shall be repaired to their original condition at CONTRACTOR'S sole expense.

5. For convenience, the CONTRACTOR may remove and replace small structures such as mailboxes, signs, gates, walls, fences and valve boxes that indirectly interfere with the pipeline construction. CONTRACTOR shall

notify the OWNER of each structure to be removed seven (7) calendar days prior to removal and provide temporary mailboxes, signs, fences, or other miscellaneous structures until the permanent structures are replaced. If a traffic control sign is removed, CONTRACTOR shall make arrangements to erect a temporary sign acceptable to the OWNER. All small surface structures removed shall be replaced in the same location in as good, or better, than the original condition. The cost for this work shall be considered incidental to the pipeline construction and shall be included in the pipeline unit costs as shown in the bid proposal.

B. Cultural and Archaeological Resources: In the event that cultural material or human remains are encountered during excavation, CONTRACTOR shall immediately stop all work in the vicinity of the discovery, notify ENGINEER of the discovery and protect the area from further disturbance. No work shall proceed in the vicinity of the discovery without written approval of ENGINEER.

C. Physical Resources: Implement temporary and permanent soil erosion and storm-water pollution control measures in accordance with the NPDES storm-water permit process and develop a SWPPP using BMPs.

1.06 WORK SEQUENCE AND SCHEDULING CONSTRAINTS

A. The CONTRACTOR shall schedule and perform the Work in such a manner as to result in the least possible disruption to the public's use of roadways, driveways, and utilities. Utilities shall include but not be limited to water, sewerage, drainage structures, ditches and canals, gas, electric, cable television, and telephone. Refer to all available plan and profile sheets for approximate location of utilities. It is the CONTRACTOR'S responsibility to locate each utility and incorporate as-built locations on the reproducible record plans, in red ink, showing proper location on each sheet where these utilities are located including depths, widths, and lengths of each utility. There is no guarantee as to exact location of each utility and no additional compensation will be made for utilities that are within a reasonable proximity of the area shown on the record plans.

1.07 CONTRACTOR ACCESS AND USE OF PROJECT SITE

The CONTRACTOR'S use of the Project Site shall be limited to its construction operations, including on-site storage of materials, on-site fabrication facilities, and field offices.

1.08 SAN JUAN COUNTY USE OF THE PROJECT SITE

The San Juan County may utilize all or part of the existing Site and existing facilities during the entire period of construction for the conduct of the San Juan County's normal operations and for other projects. The CONTRACTOR shall cooperate and coordinate with the OWNER to facilitate the operations and projects and to minimize interference with the other contractor's operations at the same

time. In any event, the SAN JUAN COUNTY shall be allowed safe access to the Project Site during the period of construction.

1.09 TIME OF WORK AND OVERTIME NOTIFICATION

A. For work on this project, no work shall be performed between 6:00 p.m. and 7:00 a.m., or on Sundays or legal holidays, without the written permission of the OWNER or ENGINEER or unless otherwise noted on the drawings. However, critical maintenance or emergency work may be completed without prior approval.

B. If CONTRACTOR, for convenience, should desire to work outside of normal hours, written authorization must be obtained from the County and ENGINEER prior to start of the work.

1.10 STORAGE

Storage conditions shall be in accordance with the manufacturer's requirements and shall be acceptable to OWNER for all materials and equipment not yet incorporated into the Work but included in Applications for Payment. Such storage arrangements and conditions shall be presented in writing for OWNER review and acceptance and shall afford adequate and satisfactory security and protection. Off-site storage facilities shall be accessible to OWNER. The stored materials shall be insured for full value.

1.11 NOTICES TO OWNERS OF ADJACENT PROPERTIES AND UTILITIES

A. CONTRACTOR shall notify OWNERS of adjacent property and utilities in advance of when prosecution of the Work may affect them.

B. When it is necessary to temporarily interrupt any utility service connection, CONTRACTOR shall give notices sufficiently in advance to enable the affected persons to provide for their needs. Notices shall conform to any applicable local ordinance and, whether delivered orally or in writing, shall include appropriate information concerning the interruption and instructions on how to limit any resulting inconvenience.

C. Utilities and other concerned agencies shall be contacted at least seven days prior to cutting or closing streets or other traffic areas or excavating near underground utilities or pole lines. The CONTRACTOR must submit to the OWNER and each affected utility a written description of the area, time, duration, and proposed method of disruption and reparation. With the exception of emergencies and/or events that may compromise the public safety, no disruption will be allowed without the CONTRACTOR having first obtained the express written approval of the OWNER.

1.12 PROJECT MEETINGS

A. Preconstruction Conference

1. Prior to the commencement of Work at the Site, a preconstruction conference will be held at a mutually agreed time and place which shall be attended by the CONTRACTOR'S Project Manager, its Superintendent, its Safety Representative, and its Subcontractors as the CONTRACTOR deems appropriate. Other attendees will be:

    a. OWNER’S CONSTRUCTION MANAGER;

    b. Representatives of OWNER;

    c. Governmental representatives as appropriate;

    d. Others as requested by CONTRACTOR, OWNER, or OWNER’S CONSTRUCTION MANAGER;

    e. ENGINEER; and

    f. CONTRACTOR’S personnel assigned to Scheduling. In the event CONTRACTOR elects to utilize an outside agency to perform its scheduling requirements, the responsible personnel from such Agency is required to attend.

2. Bring to the conference the submittals indicated in Section 01300 - Contractor Submittals.

3. The purpose of the conference is to designate responsible personnel, discuss contract requirements and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The complete agenda will be furnished to the CONTRACTOR prior to the meeting date. Any additions to the agenda by CONTRACTOR must be forwarded to the OWNER at least 24 hours prior to the scheduled meeting date and time.

4. The CONTRACTOR shall be prepared to discuss all of the items listed below.

    a. CONTRACTOR’S assignments for safety and first aid, including Designated Competent person(s) and CONTRACTOR’S safety Representative.

    b. CONTRACTOR’S schedules as required by Contract.

    c. Transmittal, review, and distribution of all documents between the CONTRACTOR and the OWNER including CONTRACTOR’S submittals, RFI’S, Survey Requests, etc.

    d. Processing applications for payment.

    e. Maintaining record documents.

    f. Critical Work sequencing.

    g. Field decisions and Change Orders.

h. Use of project site, office and storage areas, security, housekeeping, and OWNER'S needs.

i. Major equipment deliveries and priorities.

j. Permits required for construction.

k. Utilities required for construction.

l. Contract Authority and channels of communication.

m. Coordination with others.

n. Conflict resolution procedures.

5. The OWNER'S CONSTRUCTION MANAGER will preside at the pre-construction conference and will arrange for keeping and distributing the minutes to all persons in attendance.

B. Progress Meetings

1. The OWNER'S CONSTRUCTION MANAGER will schedule and hold regular on-Site progress meetings at least weekly and at other times as requested by OWNER'S CONSTRUCTION MANAGER or as required by progress of the Work. The CONTRACTOR, OWNER'S CONSTRUCTION MANAGER and all Subcontractors active on the Site must attend each meeting. CONTRACTOR may at its discretion request attendance by representatives of its Suppliers, manufacturers, and other Subcontractors.

2. The OWNER'S CONSTRUCTION MANAGER will preside at the meetings and will arrange for keeping and distributing the minutes. The purpose of the meetings will be to review the progress of the Work, discuss safety, maintain coordination of efforts, discuss commercial issues, discuss changes in scheduling, and resolve other problems which may develop. During each meeting, the CONTRACTOR is required to present any issues which may impact his Work, with a view to resolve these issues expeditiously.

C. Subcontractor Coordination Meetings

1. The CONTRACTOR is expected to conduct regularly scheduled coordination meetings with Subcontractors, Suppliers, and Manufacturers to manage and ensure the smooth progression of the work. Request representation at each meeting by all applicable parties involved in the coordination of current activities or concerned with the planning of upcoming work. During each meeting the following topics need to be addressed:

a. The development of a four week look-ahead schedule (to be distributed to the OWNER at the subsequent progress meeting).

b. Any concerns relating to the progress of the work.

c. Any other items as deemed necessary by any of the related parties.

D. Pre-Activity/Specialty Coordination Meetings

Pre-Activity meetings are to be held no later than twenty-four (24) hours prior to the execution of any activity requiring inspection or as deemed necessary by the OWNER. Required attendees should include at a minimum the OWNER'S CONSTRUCTION MANAGEMENT TEAM, the CONTRACTOR'S Project Manager, Superintendent and any other related personnel.

1.13 CONTRACTOR'S REQUEST FOR INFORMATION (RFI)

A. In the event that the CONTRACTOR determines that some portion of the Contract Documents requires additional information or interpretation, the CONTRACTOR shall submit a written statement to the OWNER'S CONSTRUCTION MANAGER requesting clarification on the issue. Such request must be provided by the CONTRACTOR to the OWNER immediately upon discovery. Prior to the submittal of the RFI the CONTRACTOR shall carefully study and review the Contract Documents to ensure that the requested information is not contained therein. Submit only one issue to be clarified per form. The CONTRACTOR must include in a properly written RFI the following information:

1. Contract number and title, RFI number (sequentially numbered), date, person requesting clarification and signature.

2. A clear and concise summary of the issue in question and why further clarification or information is required from the OWNER.

3. The specific drawing shall be identified by drawing number and location on the drawing sheet.

4. The specific specification section shall be identified by section number, page and paragraph.

5. Where applicable, the CONTRACTOR shall include his own interpretation of the drawings or specifications and why he believes such an understanding is correct.

6. In cases requesting clarification of coordination issues, the CONTRACTOR shall include a suggested solution with necessary drawings or sketches with the RFI.

B. Only RFI'S submitted by the CONTRACTOR will be accepted. Any clarifications required by the Subcontractors, Manufacturers, or Suppliers of the CONTRACTOR must be properly routed through the CONTRACTOR to the OWNER on the appropriate form. All RFI'S must be limited to clarifications of the Contract Documents. RFI'S shall not be used for the purpose of notifying the OWNER of the following:

1. To request approval of submittals.

2. To request approval of substitutions.

3. To request changes which entail additional cost or credit.

4. To request methods of performing work different than those shown or specified.

C. If the OWNER determines that the RFI is not in relation to clarifications relating to the Contract Documents, such RFI will be returned to the CONTRACTOR with an explanation which may include references to other sections within the Contract for the CONTRACTOR to follow.

D. Improper or frivolous RFI'S that are not properly prepared as detailed above, or request information that is clearly shown in the Contract Documents, will be returned to the CONTRACTOR labeled as either Improper or Frivolous with the reasons for such determination. Should additional costs be incurred by OWNER as a result of reviews of RFI'S that were deemed Improper or Frivolous, OWNER will withhold from CONTRACTOR'S final payment an amount based on ENGINEER'S current fee schedule, including applicable miscellaneous expenses, so that OWNER may reimburse ENGINEER for such reviews.

E. After receipt of the RFI, the OWNER will be allowed fourteen (14) calendar days to review and respond to the issue. If additional time is required by the OWNER, the CONTRACTOR will be notified in writing. Responses by the OWNER shall not be interpreted as authorization to proceed with extra work. In the event that the CONTRACTOR believes that additional cost or time is involved from the clarification provided by the OWNER, the CONTRACTOR shall notify the OWNER in writing that a change order is required and the reasons for his belief that this work constitutes a change in his Contractual requirements. At no point in time is the CONTRACTOR to proceed with extra work without the written consent of the OWNER.

1.14 DAILY ACTIVITIES REPORT

A. Commencing with the date of Notice to Proceed, which shall be considered as Contract Day No. 1, the CONTRACTOR shall prepare and forward to the OWNER'S CONSTRUCTION MANAGER a Daily Activity Report. A Daily Activity Report shall be executed by the CONTRACTOR for each Contract day, for each shift, whether work takes place or not. Report shall be submitted to the OWNER'S CONSTRUCTION MANAGER either at the end of each working day or the following morning prior to the start of operations. This report shall contain not less than the following data:

1. CONTRACTOR.

2. Contract name and number.

3. Contract day, date and shift.

4. All personnel engaged in the Contract, including management, supervisory, clerical, engineering and manual.

5. An exact count of personnel hours by trade, craft, duties, CONTRACTOR or Subcontractor.

6. An exact account of all equipment that is on site or committed to the Contract, indicating hours worked and idle.

7. All personnel hours and equipment hours shall be identified by the activity number or node displayed in the approved construction schedule.

8. List all accidents.

9. List all Subcontractors active on site.

10. Name and Signature of CONTRACTOR'S Authorized Representative.

11. Work performed, including area (i.e. - station).

12. Conflicts encountered.

1.15 AS-BUILT DRAWINGS

The CONTRACTOR shall, during progress of the work keep a careful record of all changes and corrections to the Contract Drawings. This record shall show the actual field locations, all project conditions, configurations, and any other changes or deviations that vary from the details provided in the original Contract drawings. The horizontal and vertical locations of any buried or concealed construction and utility features that were either not shown on the drawings or vary from the locations indicated, shall be carefully recorded. Include detailed sketches to fully illustrate the constructed work. The as-built drawings shall be available for review by the OWNER at all times during the construction period. At the end of each month, prior to each monthly progress payment, these drawings will be inspected by the OWNER. If these drawings are not found to be complete and up-to-date, a non-compliance report will be issued and ten (10) percent will be withheld from the CONTRACTOR'S progress payment. If the OWNER receives a written notice of the correction of the condition that resulted in the withholding, signed by an authorized agent of the CONTRACTOR, the OWNER shall pay the amount withheld within 30 days after receiving the next progress estimate.

The as-built drawing format shall be red-line mark-ups on a set 24" x 36" drawing paper prints.

Upon completion of construction and prior to final payment, the CONTRACTOR shall submit to the OWNER one (1) copy of the red-lined mark-ups showing all changes, including the type, make, model, class, manufacturer, etc., as applicable, of all major items of material used in the project as well as the source of all said items. The as-builts drawings shall be completed and certified by a New Mexico Professional Surveyor.

1.16 NOISE ORDINANCE COMPLIANCE

CONTRACTOR shall comply with the requirements of the San Juan County noise ordinance at all times. CONTRACTOR shall obtain all permits and/or variances required to permit work outside of normal working hours, including Extended Hours of Construction if required on this project.

1.17 PERMITS

The CONTRACTOR shall procure all permits and encroachments except for those already obtained by the OWNER. The OWNER has obtained the following permit:

- SF 299 – BUREAU OF LAND MANAGEMENT RIGHT-OF-WAY

Other permits required:

- NMDOT UTILITY PERMIT

PART 2 - PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 SEQUENCE OF WORK

Sequence of Work shall be determined by the CONTRACTOR and specific sequences of work are not required for this Contract.

3.02 LIQUIDATED DAMAGES

Construction is required to be accomplished within described durations and liquidated damages shall be assessed. Liquidated damages will be cumulative for each calendar day that work within each construction phase remains incomplete beyond either the allowable duration or the allowable dates as set forth below. The scheduling constraints and liquidated damages to be assessed for failure to complete all work within the constraints are as follows:

CONST ACTIVITY	**DURATION CONSTRAINTS**	**DATE CONSTRAINTS**	**LIQUIDATED DAMAGES (per day)**
Entire Project	Max 300 calendar days duration from Notice to Proceed	N/A	$1,500.00
Punch List	Max 30 calendar day duration following substantial completion	N/A	$1,500.00

NOTE: All Liquidated Damages Shall Be Cumulative.

PART 4 – PAYMENT

4.01 GENERAL

Costs for the work in this Section shall not be paid for separately but shall be considered incidental to the contract work to be accomplished.

END OF SECTION

SECTION 01300
CONTRACTOR SUBMITTALS

PART 1 - GENERAL

1.01 GENERAL

A. CONTRACTOR “Submittals” may be Shop Drawings, schedules, surveys, reports, samples, plans, lists, drawings, documents, findings, programs, manuals, data, or any other item or information required by the Contract Documents to be submitted or offered by the CONTRACTOR in accomplishing the Work.

B. Wherever Submittals are required hereunder, all such documents shall be furnished to the OWNER’S CONSTRUCTION MANAGER.

C. The CONTRACTOR shall be responsible for the accuracy, completeness, and coordination of all Submittals, including but not limited to, Submittals of or from an item, product, thing, service, person or firm which is specified in the Contract Documents; such specified Submittals shall not be presumed to be acceptable to the OWNER and shall be subject to the same approval process as all other Submittals. The CONTRACTOR shall not delegate this responsibility in whole or in part to any Subcontractor. Submittals may be prepared by the CONTRACTOR, Subcontractor, or Supplier, but the CONTRACTOR shall ascertain that each Submittal meets the requirements of the Contract and the Project. The CONTRACTOR shall ensure that there is no conflict with other Submittals and shall notify the OWNER’S CONSTRUCTION MANAGER in each case where its Submittal may affect the work of another Contractor or the OWNER. The CONTRACTOR shall ensure coordination of Submittals of related crafts and Subcontractors.

D. Failure to make timely submittals in accordance with the requirements of the specifications shall constitute grounds for the OWNER to withhold 20 percent of compensation for the equipment to which the submittal is related, or, in the case of information lists, record drawings, investigation findings, safety plans, quality plans, and similar items, the OWNER may withhold 20 percent of the value of the information in the submittal.

1.02 PRE-CONSTRUCTION CONFERENCE SUBMITTALS

At the preconstruction conference, submit the following items for review:

A. A preliminary schedule of Shop Drawings, Samples, and proposed Substitute ("Or-Equal") submittals.

B. A list of all permits and licenses the CONTRACTOR shall obtain indicating the agency required to grant the permit, the expected date of submittal for the permit, and required date for receipt of the permit.

C. A preliminary schedule of values.

D. A 60-day plan of operation.

E. A project overview bar chart.

F. The names and qualifications of Designated Safety Representative.

1.03 PROGRESS REPORTS

A. Furnish a progress report to OWNER'S CONSTRUCTION MANAGER with each Application for Payment. If the Work falls behind schedule, submit additional progress reports at such intervals as OWNER'S CONSTRUCTION MANAGER may request.

B. Each progress report shall include sufficient narrative to describe any current and anticipated delaying factors, effect on the construction schedule, and proposed corrective actions. Any Work reported complete, but which is not readily apparent to OWNER'S CONSTRUCTION MANAGER, must be substantiated with satisfactory evidence.

C. Each progress report shall include a list of the activities completed with their actual start and completion dates, a list of the activities currently in progress, and the number of working days required to complete each.

1.04 SHOP DRAWINGS

A. Wherever called for in the Contract Documents, or where required by the ENGINEER, furnish to the OWNER'S CONSTRUCTION MANAGER for review, nine copies of each Shop Drawing Submittal. The term "Shop Drawings" as used herein shall be understood to include detail design calculations, shop drawings, fabrication, and installation drawings, erection drawings, lists, graphs, catalog sheets, data sheets, and similar items. Whenever the CONTRACTOR is required to submit design calculations as part of a Submittal, such calculations shall bear the signature and seal of a professional engineer registered in New Mexico unless otherwise directed.

B. All Shop Drawing Submittals shall be accompanied by a Submittal transmittal form acceptable to the OWNER'S CONSTRUCTION MANAGER. Any Submittal not accompanied by such a form, or where all applicable items on the form are not completed, will be returned for resubmittal.

C. Organization

1. A single Shop Drawing Submittal transmittal form shall be used for each technical specification section, item, or class of material or equipment for which a Submittal is required. A single Submittal covering multiple sections will not be acceptable, unless the primary specification references other sections for components. Example: If a pump section references other

sections for the motor, protective coating, anchor bolts, local control panel, and variable frequency drive, a single Submittal would be accepted; a single Submittal covering vertical turbine pumps and horizontal split case pumps would not be acceptable.

2. On the transmittal form, index the components of the Submittal and insert tabs in the Submittal to match the components. Relate the Submittal components to specification paragraph and subparagraph, drawing number, detail number, schedule title, or room number or building name, as applicable.

3. Unless otherwise approved by OWNER, terminology and equipment names and numbers used in Submittals shall match the Contract Documents.

D. Format

1. Minimum sheet size shall be 8.5 inches by 11 inches. Maximum sheet size shall be 24 inches by 36 inches. Every page in a Submittal shall be numbered in sequence. Each copy of a Submittal shall be collated and stapled or bound, as appropriate. The OWNER'S CONSTRUCTION MANAGER will not collate copies.

2. Where product data from a manufacturer is submitted, clearly mark which model is proposed, with all pertinent data, capacities, dimensions, clearances, diagrams, controls, connections, anchorage, and supports. Sufficient level of detail shall be presented for assessment of compliance with the Contract Documents.

3. Each Submittal shall be assigned a unique number. Submittals shall be numbered sequentially. The Submittal numbers shall be clearly noted on the transmittal. Original Submittals shall be assigned a numeric Submittal number. Resubmittals shall bear an alphanumeric system which consists of the number assigned to the original Submittal for that item followed by a letter of the alphabet to represent that it is a subsequent Submittal of the original. For example, if Submittal 25 requires a resubmittal, the first resubmittal will bear the designation "25-A" and the second resubmittal will bear the designation "25-B" and so on.

E. Disorganized Submittals which do not meet the requirements above will be returned without review.

F. Except as may otherwise be indicated herein, the OWNER'S CONSTRUCTION MANAGER will return each Submittal to the CONTRACTOR, with its comments noted thereon, within 28 calendar days following their receipt by the OWNER'S CONSTRUCTION MANAGER. For resubmittal of Submittals, the OWNER'S CONSTRUCTION MANAGER will be allowed the same review period as for the original Submittal. It is considered reasonable that the CONTRACTOR shall make a complete and acceptable Submittal to the OWNER'S CONSTRUCTION

MANAGER by the second submission of a Submittal item. Should the ENGINEER be required to review third and subsequent submittals, OWNER will withhold from CONTRACTOR'S next payment request an amount based on ENGINEER'S current fee schedule, including applicable miscellaneous expenses, so that OWNER may reimburse ENGINEER for such reviews.

G. If three copies of a Submittal are returned to the CONTRACTOR marked "NO EXCEPTIONS TAKEN," formal revision and resubmission of said Submittal will not be required.

H. If three copies of a Submittal are returned to the CONTRACTOR marked "MAKE CORRECTIONS NOTED," formal revision and resubmission of said Submittal will not be required.

I. If a Submittal is returned to the CONTRACTOR marked "NOTE MARKINGS-RESUBMIT," the CONTRACTOR shall revise said Submittal and resubmit the required number of copies. Resubmittal of portions of multi-page or multi-drawing Submittals will not be allowed. For example, if a Shop Drawing Submittal that consists of ten drawings contains only one drawing that needs to be amended and resubmitted, the Submittal as a whole is deemed as "NOTE MARKINGS-RESUBMIT," and all ten drawings of the Submittal are required to be resubmitted.

J. If a Submittal is returned to the CONTRACTOR marked "REJECTED-RESUBMIT," the CONTRACTOR shall revise said Submittal and resubmit the required number of copies. Resubmittal of portions of multi-page or multi-drawing Submittals will not be allowed. For example, if a Shop Drawing Submittal that consists of ten drawings contains only (one) drawing that is rejected and needs to be resubmitted, the Submittal as a whole is deemed as "REJECTED-RESUBMIT," and all ten drawings of the Submittal are required to be resubmitted.

K. Any changes made on a resubmittal, other than those made or requested by the ENGINEER or OWNER'S CONSTRUCTION MANAGER, shall be identified and flagged on the resubmittal.

L. Fabrication of an item shall commence only after the ENGINEER has reviewed the pertinent Submittals and the OWNER'S CONSTRUCTION MANAGER has returned copies to the CONTRACTOR marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED." Corrections indicated on Submittals shall be considered as changes necessary to meet the requirements of the Contract Documents and shall not be taken as the basis for changes to the Contract requirements.

M. All CONTRACTOR Shop Drawing Submittals shall be carefully reviewed by an authorized representative of the CONTRACTOR prior to submission. Each Submittal shall be dated and signed with the following: "I have verified that the equipment or material in this Submittal meets all the requirements specified or shown in the Contract Documents without exception." In the case of Shop

Drawings, each sheet shall be so dated, signed, and certified. No consideration for review of any submittals will be made for any items which have not been so certified. All non-certified submittals will be returned without action taken, and any delays caused thereby shall be the total responsibility of the CONTRACTOR. Submittals which the CONTRACTOR wishes to have reviewed that cannot bear this certification because they contain an exception or deviation to the Contract Documents shall be submitted in accordance with Section 01600 – Products Requirements.

N. The OWNER'S CONSTRUCTION MANAGER'S and/or ENGINEER'S review of Shop Drawing Submittals shall not relieve the CONTRACTOR of the entire responsibility for the correctness of details and dimensions and for compliance with the Contract Documents. The CONTRACTOR shall assume all responsibility and risk for any problems due to any errors in Submittals. The CONTRACTOR shall be responsible for the dimensions and the design of adequate connections and details.

O. No changes in the Contract times will be considered for schedule delays resulting from non-compliant Submittals.

P. Within 30 Days of the Notice to Proceed, the CONTRACTOR shall submit a complete list of anticipated Submittals which includes Specification and Drawing references. The list shall be updated with "early start" Submittal dates within 15 Days of Submittal of the CONTRACTOR'S construction schedule. The Submittal dates shall be updated whenever the schedule is updated. Any additional Submittals identified after the initial Submittal shall be included in the updates.

Q. If the CONTRACTOR submits an incomplete Submittal, the Submittal may be returned without review. A complete Submittal shall contain sufficient data to demonstrate that the items contained therein comply with the Contract Documents, meet the minimum requirements for Submittals as described in the Contract Documents, and include all corrections as required from previous Submittals.

1.05 CONTRACTOR'S SCHEDULE

A. The CONTRACTOR'S construction schedules and reports shall be prepared and submitted to the OWNER'S CONSTRUCTION MANAGER.

1.06 SAMPLES

A. Whenever in the Specifications samples are required, submit not less than three samples of each item or material to the OWNER'S CONSTRUCTION MANAGER for acceptance at no additional cost to the OWNER.

B. Samples, as required herein, shall be submitted for acceptance a minimum of 21 days prior to ordering such material for delivery to the jobsite, and shall be submitted in an orderly sequence so that dependent materials or equipment can be assembled and reviewed without causing delays in the Work.

C. All samples shall be individually and indelibly labeled or tagged, indicating thereon all specified physical characteristics and Manufacturer's name for identification. Upon receiving acceptance of the ENGINEER, one set of the samples will be stamped, dated, and returned to the CONTRACTOR, and one set of samples will be retained, and one set of samples shall remain at the job site until completion of the Work.

D. Unless indicated otherwise, all colors and textures of specified items presented in sample Submittals shall be from the manufacturer's standard colors and standard materials, products, or equipment lines. If the samples represent non-standard colors, materials, products, or equipment lines and their selection will require an increase in contract time, price, or clearly indicate “same” on the transmittal page of the Submittal.

1.07 SURVEY DATA

The CONTRACTOR shall make available for examination throughout the construction period all field books, notes, and other data developed by CONTRACTOR in performing the surveys required by the Work and shall submit all such data to OWNER’S CONSTRUCTION MANAGER with documentation required for final acceptance of the Work.

1.08 UTILITY INVESTIGATION

The CONTRACTOR shall submit the findings of all utility investigations performed.

1.09 DAILY FORCE REPORT

A. The CONTRACTOR and each Subcontractor shall submit to the OWNER’S CONSTRUCTION MANAGER, or designee, a daily force report. Deliver report not later than 9:00 A.M. of the workday following the report date and include the following:

B. Day of week, date, CONTRACTOR name and Report number.

C. Summary of work in progress (segregated by CONTRACTOR and Subcontractor).

D. Details of work accomplished including quantities of work installed.

E. Summary of equipment working and where working.

F. Summary of manpower by work element and Subcontractor.

G. Receipt of major equipment or materials.

H. All required testing performed and, if available, documented results.

1.10 OPERATIONS AND MAINTENANCE MANUAL

A. The CONTRACTOR shall submit technical operation and maintenance information for each item of mechanical, electrical and instrumentation equipment in an organized manner in the OPERATIONS AND MAINTENANCE MANUAL. It shall be written so that it can be used and understood by the OWNER'S operation and maintenance staff.

B. The initial submittal of the OPERATIONS AND MAINTENANCE MANUALS shall be furnished to the OWNER'S CONSTRUCTION MANAGER upon delivery of the respective equipment. Failure to meet the initial Submittal requirement at the time of equipment delivery will result in withholding 20-percent of compensation for that equipment.

C. The OPERATIONS AND MAINTENANCE MANUAL shall be subdivided first by specification section number; second, by equipment item; and last, by "Part." "Parts" shall conform to the following (as applicable):

1. Part 1 - Equipment Record:

   a. Summary: An Equipment Record Form shall indicate the equipment name, equipment number, and process area in which the equipment is installed.

   b. Form: The CONTRACTOR shall also complete an Equipment Record Form for each item of mechanical, electrical and instrumentation equipment in the Work. The form shall be included in the O&M Manual.

2. Part 2 - Operational Procedures:

   Procedures: Manufacturer-recommended procedures on the following shall be included in Part 2:

   Installation

   Adjustment

   Startup

   Location of controls, special tools, equipment required, or related instrumentation needed for operation

   Operation procedures

   Load changes

   Calibration

   Shutdown

   Troubleshooting

   Disassembly

   Reassembly

Realignment

Testing to determine performance efficiency

Tabulation of proper settings for all pressure relief valves, low and high-pressure switches, and other protection devices

List of all electrical relay settings including alarm and contact settings

Lubrication

3. Part 3 - Preventive Maintenance Procedures:

   a. Procedures: Preventive maintenance procedures shall include all manufacturer-recommended procedures to be performed on a periodic basis, both by removing and replacing the equipment or component, and by leaving the equipment in place.

   b. Schedules: Recommended frequency of preventive maintenance procedures shall be included. Lubrication schedules, including lubricant SAE grade, type, and temperature ranges, shall be covered.

4. Part 4 - Parts List:

   a. Parts List: A complete parts list shall be furnished, including a generic description and manufacturer's identification number for each part. Addresses and telephone numbers of the nearest supplier and parts warehouse shall be included.

   b. Drawings: Cross-sectional or exploded view drawings shall accompany the parts list.

5. Part 5 - Wiring Diagrams:

Diagrams: Part 5 shall include complete internal and connection wiring diagrams for electrical equipment items.

6. Part 6 - Shop Drawings:

Drawings: This part shall include approved shop or fabrication drawings, complete with dimensions.

7. Part 7 - Safety:

Procedures: This part describes the safety precautions to be taken when operating and maintaining the equipment or working near it.

8. Part 8 - Documentation:

All equipment warranties, affidavits, and certifications required by the Technical

Specifications shall be placed in this part.

D. The CONTRACTOR shall furnish to the OWNER'S CONSTRUCTION MANAGER four identical, initial, OPERATIONS AND MAINTENANCE 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 indicating all equipment in the manuals shall be prepared. The title of each volume shall be displayed on the cover and spine.

E. OPERATIONS AND MAINTENANCE MANUALS shall be submitted in final form no later than the 75 percent of construction completion date. All discrepancies found by the OWNER'S CONSTRUCTION MANAGER or ENGINEER in the OPERATIONS AND MAINTENANCE MANUALS shall be corrected by the CONTRACTOR within 30 Days from the date of written notification. Final, verified, and complete OPERATIONS AND MAINTENANCE MANUALS shall be submitted in PDF electronic format on CD-ROM. Four copies of the CD's shall be provided to the OWNER'S CONSTRUCTION MANAGER.

1.11 SPARE PARTS LIST

The CONTRACTOR shall furnish to the OWNER'S CONSTRUCTION MANAGER five identical sets of spare parts information for all mechanical, electrical, and instrumentation equipment. The spare parts list shall include the current list price of each spare part. The spare parts list shall be limited to those spare parts which each manufacturer recommends be maintained by the OWNER in inventory at the plant site. Each manufacturer or supplier shall indicate the name, address, and telephone number of its nearest outlet of spare parts to facilitate the OWNER in ordering. Cross-reference all spare parts lists to the equipment numbers designated in the Contract Documents. The spare parts lists shall be bound in standard size, 3-ring, loose-leaf, vinyl plastic hard cover binders suitable for bookshelf storage. Binder ring size shall not exceed 2.5 inches.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

PART 4 – PAYMENT

4.01 GENERAL

Costs for the work in this Section shall not be paid for separately, but shall be considered incidental to the Contract work to be accomplished.

END OF SECTION

SECTION 01600
PRODUCT REQUIREMENTS

PART 1 GENERAL

1.01 RELATED DOCUMENTS

Drawings and general provision of the contract.

1.02 SUMMARY

A. This Section includes the following administrative and procedural requirements: selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; product substitutions; and comparable products, and includes:

1. Substitution requests.
2. Basis-of-design specification.
3. Single source.
4. Product delivery, storage, and handling.
5. Product warranties.
6. Product options.
7. Product selection procedures.
8. Comparable products.
9. Product Substitutions.

B. The use of a brand name within Supplemental Technical Specifications or as identified on the Plans is for the purpose of describing the standard of quality, performance and characteristic desired and is not intended to limit or restrict competition.

1.03 DEFINITIONS

A. Products: Items purchased for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the items "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation, shown or listed in manufacturer's published product literature that is current as of the effective date of the Contract Documents.

2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.

3. Comparable Products: Product that is demonstrated and approved through submittal process, or where indicated as a product substitution, to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product. Burden of proof of acceptability as a comparable product, or better product, is the responsibility of the CONTRACTOR, and shall be fully investigated and documented by the CONTRACTOR prior to submittal to the ENGINEER for consideration.

B. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by CONTRACTOR.

C. Basis-of-Design Product Specification: Where a specific manufacturer's product is named whether accompanied or not by the words "basis of design," including make or model number or other designation to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers. The product named shall be used to judge the minimum standard for compliance of any product used for the application intended. Other products will not be approved for use on the project that are not at least equal to, or better than, the product named; as judged by the ENGINEER.

D. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to OWNER.

E. Special Warranty: Written warranty required by or incorporated into the Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for OWNER.

1.04 SUBMITTALS

A. Substitution Requests: Refer to "Product Substitutions" Article 2.02. With submittal of the bidding documents, the CONTRACTOR shall submit to the office of the ENGINEER (Bohannan Huston, Inc. 7500 Jefferson Street NE, Albuquerque, NM 87109) three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number, title, and Drawing numbers and titles.

1. Substitution Request Form: Use form as provided at the back of this Specification Section. Improperly or incompletely filled out form may be returned to CONTRACTOR, without action by ENGINEER, for correction.

2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

    a. Statement indicating why specified material or product couldn't be provided.

    b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by OWNER and separate contractors that will be necessary to accommodate proposed substitution.

    c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.

    d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.

    e. Samples, where applicable or requested.

    f. List of similar installations for completed projects with project names and addresses and names and addresses of engineers and owners.

    g. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.

    h. Research/evaluation reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.

    i. Detailed comparison of CONTRACTOR'S Construction Schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delays in delivery.

    j. Cost information, including a proposal of change, if any, in the Contract Sum.

    k. CONTRACTOR'S certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.

    l. CONTRACTOR'S waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. By making request for substitution, when forwarded by the CONTRACTOR to the ENGINEER, the CONTRACTOR:

a. Represents that he has personally investigated the proposed substitute product and determined that it is equal or superior in all respects to that specified;

b. CONTRACTOR and the manufacturer will provide the same, or better, guarantee for the substitution that they would for that specified;

c. Certifies that the cost data presented is complete and includes all related costs under this Contract, but excludes costs under any separate contracts and the ENGINEER'S redesign costs, and that he waives all claims for additional costs related to the substitution which subsequently becomes apparent; and;

d. Will coordinate the installation of the accepted substitute making such changes as may be required for the Work to be complete in all respects.

4. OWNER and ENGINEER'S Action: The OWNER and ENGINEER may reject or allow substitutions, at their sole judgment and discretion. If necessary, ENGINEER will request additional information or documentation for evaluation within seven calendar days of receipt of a request for substitution. ENGINEER will notify the CONTRACTOR of acceptance or rejection of proposed substitution within 14 calendar days of receipt of request, or seven calendar days of receipt of additional information or documentation, whichever is later.

a. Form of Acceptance: Submittal marked "No Exceptions Taken".

b. Use product specified if ENGINEER does not render a decision on use of a proposed substitution within time allocated.

5. Substitutions will not be considered if:

a. They are indicated or implied on Shop Drawings, Product Data, or Sample submissions without the formal Substitution Request; or

b. For their implementation, they require a substantial revision of the Contract Documents or work of the OWNER or separate Contractors in order to accommodate their use.

B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 01300 – Contractor Submittals.

1.05 QUALITY ASSURANCE

A. Compatibility of Options: If CONTRACTOR is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

B. Single Source: All materials or products related to a specified warranty shall be from the same prime product manufacturer, or approved in writing by the prime

product manufacturer, and installed by the same entity; providing the OWNER with a single source system warranty.

1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions.

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.

2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.

3. Deliver products to Project site in undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.

4. Inspect products on delivery to ensure compliance with Contract Documents and to ensure that products are undamaged and properly protected.

5. Store products to allow for inspection and measurement of quantity or counting of units.

6. Store materials in a manner that will not endanger Project structure.

7. Store products that are subject to damage by the elements, under cover in a weather tight enclosure above ground, with ventilation adequate to prevent condensation.

8. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.

9. Protect stored products from damage.

B. Storage: Provide a secure location and enclosure, as necessary, at Project site for storage of materials and equipment by OWNER'S construction forces. Coordinate location with OWNER.

1.07 PRODUCT WARRANTIES

A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents, and Manufacturer's standard warranty. Manufacturer's disclaimers and limitations on product warranties do not relieve CONTRACTOR of obligations under requirements of the Contract Documents.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution. Submit a draft for approval before final execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.

2. Specified Form: Forms are included with the Specifications. Prepare a written document using appropriate for properly executed.

3. Refer to Divisions 2 through 16 Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in COA General Conditions Section 13 "Warranty and Guarantee."

PART 2 PRODUCTS

2.01 PRODUCT OPTIONS

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged, and unless otherwise indicated, that are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.

2. Standard Products: If available and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.

3. OWNER reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.

4. Where products are accompanied by the term "as selected," ENGINEER will make selection.

5. Where products are accompanied by the term "match sample," sample to be matched is ENGINEER'S.

6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.

7. Or Equal: Where a product is specified and accompanied by the term "or equal" or "or approved equal" or "or approved," or similar language; comply with provisions in "Comparable Products" and "Substitution Requests" requirements to obtain approval for use of an unnamed product. The term "equal" shall not be construed as requiring products to be exact in every

characteristic, unless the ENGINEER determines that exact matching of all characteristics is required for the intended result. The term “equal” shall, subject to the ENGINEER’S interpretation, mean generally equivalent in essential features for quality and performance for the intended result. The ENGINEER shall be the sole judge of the essential features for quality and performance, and the intended result.

B. Product Selection Procedures: Procedures for product selection include the following:

1. Product: Where Specification paragraphs or subparagraphs titled “product” name a single product and manufacturer, provide the product named.

    a. Substitutions may be considered, unless otherwise indicated as “no substitute,” or similar wording.

2. Manufacturer/Source: Where Specification paragraphs or subparagraphs titled “Manufacturer” or “Source” name single manufacturers or sources, provide a product by the manufacturer or from the source named that complies with requirements.

    a. Substitutions may be considered, unless otherwise indicated as “no substitute,” or similar wording.

3. Products: Where Specification paragraphs or subparagraphs titled “products” introduce a list of names of both products and manufacturers, provide one of the products listed that complies with requirements.

    a. Substitutions may be considered, unless otherwise indicated as “no substitute,” or similar wording.

4. Manufacturers: Where Specification paragraphs or subparagraphs titled “Manufacturers” introduce a list of manufacturers’ names, provide a product by one of the manufacturers listed that complies with requirements.

    a. Substitutions may be considered, unless otherwise indicated as “no substitute,” or similar wording.

5. Available Products: Where Specification paragraphs or subparagraphs titled “Available Products” introduce a list of names of both products and manufacturers, provide one of the products listed or another product that complies with requirements. Comply with provisions in “Comparable Products” and “Substitution Request” Articles to obtain approval for use of an unnamed product.

6. Available Manufacturers: Where Specification paragraphs or subparagraphs titled “Available Manufacturers” introduce a list of manufacturers’ names, provide a product by one of the manufacturers listed or another manufacturer

that complies with requirements. Comply with provisions in "Comparable Products" and "Substitution Requests" Articles to obtain approval for use of an unnamed manufacturer's product.

7. Product Options: Where Specification paragraphs titled "Product Options" indicate that size, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide either the specific product or system indicated or a comparable product or system by another manufacturer. Comply with provisions in "Comparable Products" Article.

8. Basis-of-Design Products: Where Specification paragraphs or subparagraphs titled "Basis-of-Design Products" are included and also introduce or refer to a list of manufacturers' names, provide either the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with provisions in "Comparable Products" and "Substitution Requests" Article to obtain approval for use of a product.

    a. Substitutions will not be considered, unless otherwise indicated

9. Visual Matching Specification: Where Specifications require matching an established Sample, select a product (and manufacturer) that complies with requirements and matches ENGINEER'S sample. ENGINEER'S decision will be final on whether a proposed product matches satisfactorily.

    a. If no product available within specified category matches satisfactorily and complies with other specified requirements, comply with provisions of "Product Substitutions" for selection of a matching product.

10. Visual Selection Specification: Where Specifications include the phrase "as selected from manufacturer's colors, patterns, textures" or a similar phrase, select a product (and manufacturer) that complies with other specified requirements.

    a. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, ENGINEER will select color, pattern, or texture from manufacturer's product line that does not include premium items.

    b. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, ENGINEER will select color, pattern, or texture from manufacturer's product line that includes both standard and custom or premium items.

2.02 PRODUCT SUBSTITUTIONS

A. Timing: Refer to "Substitution Requests." ENGINEER will consider requests for substitution if received during the submittal of the bid for the project. Requests received after that time may be considered or rejected at discretion of ENGINEER. After that time, CONTRACTOR has the burden of proof that the substitution is requested due to events or specified product unavailability beyond the CONTRACTOR'S control.

B. Conditions: ENGINEER will consider CONTRACTOR'S request for substitution when, in the ENGINEER'S judgment, the following conditions are satisfied. If the following conditions are not satisfied, ENGINEER will return requests without action, except to record noncompliance with these requirements:

1. Requested substitution offers OWNER a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities OWNER must assume. OWNER'S additional responsibilities may include compensation to ENGINEER for redesign and evaluation services, increased cost of other construction by OWNER, and similar considerations.

2. Requested substitution does not require extensive revisions to the Contract Documents.

3. Requested substitution is consistent with the Contract Documents and will produce indicated or better results.

4. Substitution request is fully documented and properly submitted.

5. Requested substitution will not adversely affect CONTRACTOR'S Construction Schedule.

6. Requested substitution has received necessary approvals of authorities having jurisdiction.

7. Requested substitution is compatible with other portions of the Work.

8. Requested substitution has been coordinated with other portions of the Work.

9. Requested substitution provides specified or better warranty.

10. Requested substitution is due to events or specified product unavailability beyond the CONTRACTOR'S control.

2.03 COMPARABLE PRODUCTS

Where products or manufacturers are specified by name, submit the following, in addition to other required submittals, to obtain approval of an unnamed product:

1. Evidence that the proposed product does not require extensive revisions to the Contract Documents that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.

2. Detailed comparison of significant qualities of proposed product with those named on the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.

3. Evidence that proposed product provides specified or better warranty.

4. List of similar installations for completed projects with project names and addresses and names and addresses of Engineers and owners, if requested.

5. Samples, if applicable, or requested.

PART 3 EXECUTION

3.01 CONTRACTOR SUBSTITUTION REQUEST FORM IS ATTACHED.

PART 4 PAYMENT

4.01 Costs for the work in this Section shall not be paid for separately, but shall be considered incidental to the contract work to be accomplished.

END OF SECTION

CONTRACTOR SUBSTITUTION REQUEST FORM

The undersigned, as CONTRACTOR for the above project, requests that the following product be accepted for use in the Project in lieu of
_____Specified in Section _____

PRODUCT: _____
MODEL NO: _____
MANUFACTURER: _____
ADDRESS: _____
Reason for substitution request is as follows: _____
_____
_____
_____
_____

The following items are attached:

- Product description including specifications, performance and test data, and applicable reference standards.
- Samples
- Tabulated comparison with specified product.
- Documentation of reason for request.
- Cost data for comparing proposed substitution with specified product.
- Other: _____

The undersigned certifies that unless stated otherwise:

- Proposed substitution has been thoroughly investigated and function, appearance and quality meet or exceed that of specified product.
- Same warranty will be provided for substitution as for specified product.

Use of substitution will not adversely affect:

- Dimensions shown on Drawings.
- Construction schedule and date of completion.
- Work of other trades.
- Maintenance service and replacement parts for proposed substitution will be readily available in Clovis area.

Any changes to Contract Sum related to use of proposed substitution are included in price listed below. CONTRACTOR waives claims for additional costs related to acceptance of substitution which may subsequently become apparent.

Costs of modifying project design caused by use of proposed substitution which subsequently become apparent will be paid for by CONTRACTOR.

If substitution request is accepted:

- Contract Sum will be (decreased, increased) by $ _____
- Contract Time will be (decreased, increased)by $ _____ calendar days _____

Submitted By:
CONTRACTOR/SUPPLIER
ADDRESS: _____
TELEPHONE NUMBER: _____
NAME OF PERSON SUBMITTING REQUEST: _____
TITLE: _____ DATE: _____

SECTION 01650
FACILITY TESTING AND STARTUP

PART 1 GENERAL

1.01 WORK INCLUDED

A. Provide personnel, equipment, supplies, and services for verification and startup of the treatment facility.

B. Plant testing and startup operations shall consist of the following steps:

1. Operational Readiness Testing (ORT)
2. Functional Demonstration Testing (FDT)
3. Performance Testing (PT)

C. The Contractor shall operate the plant throughout plant startup, until Certificate of Substantial Completion is issued.

D. During the plant startup, the Contractor shall comply with New Mexico Environment Department (NMED) regulatory requirements and all applicable permit conditions.

1.02 RELATED WORK

A. Section 01300: Shop Drawings, Product Data, and Samples

B. Section 01650: Equipment Testing and Startup

C. Section 16011: Electrical Acceptance Testing

D. Section 16991: Plant Process Control Commissioning

1.03 STARTUP COORDINATION

A. General Contractor shall designate a Startup Supervisor (SUS) who is responsible to coordinating all plant startup activities required for preparing and conditioning the treatment facilities for proper operation prior to issuing the Certificate of Substantial Completion.

B. The SUS shall overlook and keep records of general methods and procedures in prosecuting, handling erecting and placing in service wastewater treatment facility equipment.

C. The SUS shall coordinate with all equipment suppliers, mechanical subcontractor, electrical subcontractor, Process Control System Integrator (PCSI as defined in Section 16994) Engineer and Owner. The SUS shall be responsible for coordinating the start-up of the equipment listed below, but not limited to:

1. Control system

2. Control valves

3. Mixers

4. Instruments (probes, meters, transducers, floats, etc.)

5. General operation and maintenance of every equipment

D. The SUS shall coordinate and schedule all required testing with the Engineer.

E. The SUS shall coordinate and schedule all required Owner training.

1.04 QUALITY ASSURANCE

A. The SUS shall be an individual who is:

1. Regularly engaged in the installation of mechanical and electrical systems, and their associated subsystems as they are applied to the municipal water and wastewater industry.

2. Has performed work of similar or greater complexity on at least three (3) projects within the last five (5) years.

3. Has been in the water/wastewater industry performing the type of work specified in this specification section for the past five (5) continuous years.

PART 2 PRODUCTS NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. The SUS shall be responsible for providing a detailed start-up schedule for all tasks associated with the startup and commissioning of the equipment in accordance with Section 01650. The schedule shall be submitted a minimum of 30 days prior to commencing Operational Readiness Testing, and shall be updated as often as necessary or requested to ensure appropriate coordination with the Owner and Engineer.

B. The Contractor shall be fully responsible for the proper operation of equipment during tests and instruction periods, and shall neither have nor make any claim for damage which may occur to equipment prior to the time when Owner assumes full operational responsibility thereof.

C. All tests shall be conducted in accordance with prior Engineer-approved procedures, forms and checklists. Each specific test to be performed shall be described and a space provided after it for sign off by the appropriate party after its satisfactory completion. Copies of these sign off test procedures, forms and checklists will constitute the required test documentation to be included in the test reports.

D. Provide all special testing materials and equipment. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical to test with real process variables, equipment and data, provide suitable means of simulation. Define these simulations techniques in the test procedures.

E. The SUS shall coordinate all testing with all affected subcontractors, PCSI, Engineer, and the Owner.

F. All tests for field performance and acceptance shall be coordinated and performed in the presence of the Engineer.

G. The Engineer reserves the right to test or retest all specified functions whether or not explicitly stated in these Specifications.

H. The Engineer's decision shall be final regarding the acceptability and completeness of all testing.

3.02 PRE-STARTUP TESTING

A. All process systems and pipelines shall be filled and flushed with water and hydraulically checked for leaks, cracks, and defects, as specified. All sumps, tanks, and basins, which under normal operating conditions will contain water or process liquids shall also be hydraulically checked using water for leaks, cracks, and defects, as specified. Unless otherwise approved by the Owner, all sumps, tanks, basins, and pipe lines which are hydraulically checked shall be drained and returned to their original condition once the pressure and leakage testing is complete.

B. All mechanical and electrical equipment shall be checked to ensure that it is properly installed and properly connected. Pre-operational testing of the various pumps and other equipment shall be made as specified in their respective equipment specifications. All systems shall be cleaned and purged as specified and required.

C. All instruments and controls shall be calibrated through their full range. Any other adjustments required for proper of all instrumentation and control equipment shall be made.

D. The Contractor shall perform all other tasks needed for preparing and conditioning the treatment plant for start-up testing.

E. No testing or equipment operation shall take place until it has been verified by the Engineer that all specified safety equipment has been installed and is in good working order.

F. No testing or operation of equipment shall take place until all equipment manufacturers have certified that equipment has been installed to their satisfaction and submit a certification form for all equipment furnished.

G. No start-up testing shall take place until it has been verified by the Engineer that all lubricants, tools, maintenance equipment, spare parts, and approved equipment operation and maintenance manuals have been furnished as specified.

3.03 OPERATIONAL READINESS TESTING (ORT)

A. General Requirements

1. The ORT shall be conducted during the work week of Monday through Friday, unless otherwise specified.

2. The SUS, PCSI and Engineer shall jointly perform the ORT and inspect the systems.

B. Preliminary Requirements

1. The tests and procedures specified in the following sections shall be complied and completed to Engineer’s satisfaction before ORT can begin:

a. Equipment field testing and startup procedures

b. Manholes field quality control and testing procedures as specified in Section 02601.

c. Piping systems field quality control and testing procedures as specified in Section 02751.

d. Hydrostatic Leak Testing of Open Concrete Tanks as specified in Section 03352.

e. Electrical Acceptance Testing as specified in Section 16011.

2. The SUS shall be responsible for providing the following documentation to participating parties before and during the ORT:

a. Prior to ORT, submit in accordance with Section 01645, copies of the manufacturer representatives certificates of proper equipment installation.

b. Panel schematic and internal point-to-point wiring interconnect drawings.

c. Electrical control schematics in accordance with NFPA 79 standards.

d. Panel layout drawings.

e. Field wiring diagrams.

f. Instrument loop diagrams.

g. Calibration certificates for field and panel devices that require adjustment or calibration.

h. One set of construction documents including the Specifications and Drawings.

C. ORT Activities

1. Control System shall be checked for the following items:

a. Installation as indicated on Drawings

b. PLC communications system and computer local area network.

c. PLC system components including processors, communications modules, and I/O modules.

d. Control panels.

e. Field located switches, transducers, meters and analytical instruments.

2. Pump(s), blowers, and mixers shall be checked to ensure that the equipment is:

a. Installed correctly as indicated on Drawings.

b. Filled with oil.

c. Rotation is proper.

d. Aligned properly (mechanical seal has been set).

e. Pump rotation is proper.

f. Receives and responds to process control command signals (discrete and/or analog).

g. Mechanical seals are installed properly.

3. Instruments (such as probes, pressure transducers etc) shall be checked to ensure that:

a. Electrical supply is connected.

b. Instrument is software configured.

c. Instrument responds to position and sends discrete and analog signals.

d. Control alarm set point has been established.

e. Instrument is calibrated.

4. Switches (flow, pressure, level and temperature) shall be checked to ensure that:

a. Electrical supply is connected.

b. Switch sends signal upon transition of state.

c. Switches are calibrated.

d. Control alarm set point has been established (if applicable).

5. Manual and automatic valves shall be checked to ensure that:

a. Air and/or electrical supply is connected.
b. Responds to and sends feedback (limit switch) signals.

6. All other mechanical equipment shall be checked to ensure that:

a. Equipment is in good working condition.

b. Equipment is properly connected.

7. The ORT shall also include the following check items:

a. All piping and valve tags are as specified and in accordance with the Drawings.

b. Wiring shall be checked at each termination point for correct wire size, type, color, termination and wire number.

c. Instruments and devices shall be checked to verify compliance with the specifications and approved shop drawings. The calibration of analog devices shall be verified including the zero and span.

d. Analog wiring shall be checked for correct polarity and ground continuity at each termination point in the loop.

e. Analog loops shall be verified at each termination point.

f. Modulating valves shall be tested.

8. Process Control System Commissioning ORT shall be completed as specified in Section 16991.

D. Post ORT Procedures

1. The SUS shall provide a list identifying all equipment that has not been properly installed, detailing the outstanding installation issues on an "ORT punch list" and noting the party who shall be responsible for each correction.

2. A report summarizing the results and observations of the ORT procedures shall be prepared by the SUS within one week and submitted to the Engineer and Owner.

3. The SUS shall be responsible for coordination the completion of any adjustments and / or modifications to all equipment and processes that are identified in the ORT punch list.

4. After making adjustments and modifications, systems will be retested to verify readiness.
5. All systems shall be cleaned and purged as required.

6. A Letter of ORT Certification that certifies successful completion of the ORT and satisfactory operation of each mechanical, electrical, and instrumentation system shall be provided by the SUS.

3.04 FUNCTIONAL DEMONSTRATION TESTING (FDT)

A. General Requirements

1. The FDT shall be conducted during the work week of Monday through Friday, unless otherwise specified.

2. The SUS, PCSI, and Engineer shall jointly perform the FDT and inspect the systems.

3. FDT can immediately follow the ORT as long as the system can be certified to be ready for FDT.

B. Preliminary Requirements

1. FDT can begin only after the Letter of ORT Certification has been provided.

2. The SUS shall be responsible for providing the following documentation to participating parties before and during the FDT:

   a. Updated versions of the documentation specified to be provided for during the ORT shall be distributed to participating parties before the FDT.

   b. One (l) copy of all O&M Manuals shall be made available to the participating parties at the job-site both before and during testing.

C. FDT Activities

1. FDT shall be performed on the complete system to demonstrate that it is operating and in compliance with these Specifications. Each specified function shall be demonstrated on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis. This testing will require active participation by the Contractor, PCSI, Owner, and Engineer.

2. The FDT shall include but will not be limited to the following:

   a. Test and verify all system components for conformance with design requirements under normal operating conditions
   b. Test and verify all system components for conformance with design requirements under emergency (alarm, storm mode etc.) conditions

   c. Test and verify start-up and shut down sequence in normal and emergency conditions

3. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and upon the system's or subsystem's producing the correct result (effect), the specific test requirement will have been satisfied.

4. FDT for Filter System in conjunction with Low Lift and High Lift Pump Operations:

    a. Connect unfiltered reclaimed water supply to the filter system influent.

    b. Set filter assembly at appropriate compressed filter position.

    c. Establish unfiltered influent chemical feed setpoint based on Main WRF outfall flow rate.

    d. Establish filtered effluent chemical feed setpoint based on discharge flow rate.

    e. Maintain an established discharge pressure set-point to maintain. Establish a continuous cycle of outlet water demand from 0 gpm to maximum flow gpm throughout the FDT period.

    f. Simulate power system loss during high flow rate and low flow rate period.

    g. Perform regular filter operations with reclaimed water for seventy- two (72) continuous hours.

5. The FDT shall be witnessed by the SUS, PCSI, Engineer and Contractor.

D. Post FDT Procedures

1. The SUS shall provide a "FDT punch list" identifying all equipment that did not function properly during the FDT, detailing the outstanding issues on the FDT punch list and noting the party who shall be responsible for each correction.

2. A report summarizing the results and observations of the FDT procedures shall be prepared by the SUS within one week and submitted to the Engineer and Owner.

3. The SUS shall be responsible for coordination the completion of any adjustments and / or modifications to all equipment and processes that are identified in the FDT punch list. All non-functioning processes and equipment shall be remediated.

4. Reclaimed water used during the FDT shall not be disposed of and shall remain in the basins unless specifically directed otherwise by the Engineer.

5. A Letter of FDT Certification that certifies successful completion of the FDT and satisfactory operation of the entire treatment facility and all of its mechanical, electrical, and instrumentation systems for 72 continuous hours shall be provided by the SUS.

3.05 PERFORMANCE TESTING (PT)

A. General Requirements

1. The SUS and Engineer shall jointly perform the PT and inspect the systems. The PCSI shall be available via teleconference or shall be available to be at the site within one day, if deemed necessary by the SUS, Contractor, or the Engineer.

2. PT can immediately follow the FDT as long as the system can be certified to be ready for PT.

B. Preliminary Requirements

1. PT can begin only after the Letter of FDT Certification has been provided.

2. The SUS shall be responsible for providing the following documentation to participating parties before and during the PT:

a. Updated versions of the documentation specified to be provided for during the FDT shall be distributed to participating parties before the PT.

b. One (l) copy of all O&M Manuals (including any mark-ups from FDT) shall be made available to the participating parties at the job-site both before and during testing.

C. PT Activities

1. The Contractor shall be responsible for operation of the entire system for a period of 30 consecutive days, under conditions of full plant process operation, without a single non-field repairable malfunction.

2. Throughout the PT period, a designated representative of the SUS shall be present on site during normal working hours.

3. The Owner will furnish operating personnel (other than Contractor's vendor's or subcontractor's service personnel) needed to operate equipment during the test period: however, said personnel will perform their duties under SUS direct supervision.

4. The Owner or an authorized representative of the Owner will be present to witness the PT.

5. While this test is proceeding, the Owner shall have full use of the system. Only facility operating personnel shall be allowed to operate equipment associated with live processes.

6. During this 30 consecutive day PT period, any malfunction which cannot be corrected within 24 hours of occurrence, or more than two similar failures of any duration, will be considered as a non-field-repairable malfunction.

7. Any malfunction during the tests shall be analyzed and corrections made by the SUS. The Engineer and/or Owner shall determine whether any such malfunctions are sufficiently serious to warrant a restart of this test.

8. Upon completion of repairs, by the SUS, the test shall be repeated as specified herein.

9. In the event of rejection of any part or function, the Contractor shall perform repairs or replacement within 90 days.

10. The total availability of the system shall be greater than 99.5 percent (99.5%) during this test period. Availability shall be defined as:

11. Availability = (Total Testing Time - Down Time) ÷ Total Testing Time

12. Down times due to power outages or other factors outside the normal protection devices or backup power supplies provided, shall not contribute to the availability test times above.

D. Post PT Procedures

1. A report summarizing the results and observations of the PT procedures shall be prepared by the SUS within one week and submitted to the Engineer and Owner.

2. A Letter of PT Certification that certifies successful completion of the PT and satisfactory operation of the entire treatment facility and all of its mechanical, electrical, and instrumentation systems for 30 consecutive days shall be provided by the SUS.

3.06 SUBSTANTIAL COMPLETION

A. The Engineer shall review the operation of the equipment to verify that the start-up is complete. The Engineer shall perform random tests to determine if the equipment is operating properly and witness various operational sequences. The Engineer may initiate alarm conditions to determine if the control system is functioning properly.

B. Upon satisfactory completion of the review, the Engineer shall submit to the Contractor a written “Notice of Substantial Completion”.

C. Substantial Completion of the project, with the Owner assuming operation and maintenance of the facilities and equipment shall occur when:

1. A Letter of PT Certification has been issued.

2. All systems are complete and functional.

3. All required startup testing procedures have been completed.

4. Utilities, alarms, electrical, area lighting, monitoring, controls, drains, piping paving, and related components are in place and completed.

5. Facilities can be put to intended use.

6. Owner can use for intended use at no additional cost to Owner.

D. Contractor’s warranty start date for equipment systems will be the date of Substantial Completion accepted by the Owner for that specified equipment system.

3.07 TRAINING OF OPERATIONS AND MAINTENANCE PERSONNEL

A. General

1. The cost of training programs for the Owner's personnel shall be included in the Contract price. Where practical the training and instruction shall be directly related to the system being supplied. The training program shall represent a comprehensive program covering all aspects of the operation and maintenance of the system.

2. Training shall be conducted at the Owner's facilities.

3. All technicians and operators of the facility shall require training on the instrumentation system. The training courses shall address operation, maintenance, and troubleshooting of the instruments provided. The courses shall be designed specifically for the type of personnel attending.

B. Scheduling

1. The PSCI shall coordinate and schedule all required training.

2. All training schedules shall be coordinated with, and at the convenience of the Owner. Shift training may be required to correspond to the Owner's working schedule.

C. Responsibilities of the SUS

1. The SUS shall coordinate with the equipment manufacturers to provide the services of factory-trained specialists to instruct the Owner’s personnel in the recommended operation and the preventive maintenance procedures for all system equipment provided.

2. The SUs shall coordinate the scheduling efforts to commence training of the Owner's personnel within five days after the plant startup period has been initiated, preliminary operation and maintenance manuals have been turned over to the Owner, and PT period has started.

3. The SUS shall coordinate with the equipment manufacturers to provide these services at times acceptable to the Engineer and Owner personnel, with a minimum of seven (7) days prior notice.

D. Responsibilities of the Trainer

1. Provide detailed training manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project.

2. The trainer shall make use of teaching aids, manuals, slide/video presentations, etc. After the training services, all training materials shall be delivered to Owner.

3. The Manufacturer shall fill out and sign a training form for each operator attending the Training Sessions to be used by the Operator to fulfill Professional Development Hours required for Operator Licensing in the State of New Mexico.

4. The Manufacturer shall allow any and all training sessions to be videotaped by the Owner. All training material shall be provided to the Owner in electronic format.

5. The Manufacturer may retain the services of component equipment suppliers’ representative(s) for training on their own equipment, as necessary.

E. Training Content: The training shall include the following as a minimum:

1. Equipment Operation:

a. Describe equipment's operating (process) function.

b. Describe equipment's fundamental operating principals and dynamics.

c. Identify equipment's mechanical, electrical, and electronic components and features.

d. Identify all support equipment associated with the operation of subject equipment (e.g., compressed air intake filters, valve actuators, motors).

e. Recommend standard operating procedures to address start-up, routine monitoring, and shutdown of the equipment.

2. Detailed Component Description:

a. Identify and describe in detail each component's function.

b. Group related components into subsystems, where applicable. Describe subsystem functions and their interaction with other subsystems.

c. Identify and describe in detail equipment safeties and control interlocks.

3. Equipment Preventive Maintenance (PM):

a. Describe PM inspection procedures required to:

i. Perform an inspection of the equipment in operation.

ii. Spot potential trouble symptoms and anticipate breakdowns.

iii. Forecast maintenance requirements (predictive maintenance).

b. Define the recommended PM intervals for each component.

c. Provide lubricant and replacement part recommendations and limitations.

d. Describe appropriate cleaning practices and recommend intervals.

e. Identify and describe the use of special tools required for maintenance of the equipment.

f. Describe component removal / installation and disassembly / assembly procedures.

g. Perform at least two "hands-on" demonstrations of preventive maintenance procedures.

h. Define recommended torque, mounting, calibration, alignment procedures and settings, as appropriate.

i. Describe recommended procedures to check/test equipment following a corrective repair.

4. Equipment Troubleshooting:

a. Define recommended systematic troubleshooting procedures.

b. Provide component specific troubleshooting checklists.

c. Describe applicable equipment testing and diagnostic procedures to facilitate troubleshooting.

END OF SECTION

SECTION 02550

HIGH DENSITY POLYETHYLENE (HDPE) PIPE & FITTINGS

1.01 WORK INCLUDED

This specification includes but is not limited to high density polyethylene (PE 3408) pressure pipe primarily intended for the transportation of water and sewage either buried or above grade.

1.02 REFERENCE STANDARDS

Reference:	Title:
AWWA C901	Polyethylene (PE) pressure Pipe & Tubing, ½ inch through 3 inch for water service
AWWA C906	Polyethylene (PE) pressure Pipe & Fittings, 4inch through 63 inch for water distribution
ASTM D3035	Standard Spec for PE Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM D3261	Butt Heat Fusion PE Fittings for PE Pipe & Tubing
ASTM D3350	Standard Specification for PE Pipe & Fittings Materials
ASTM D1238	Melt Flow Index
ASTM D1505	Density of Plastics
ASTM D2837	Hydrostatic Design Basis
NSF Standard #14	Plastic Piping Components & Related Materials

1.03 SUBMITTALS

A. Submit product data and manufacturer's recommended installation for all supplied items.
   1. HDPE Pipe & Fittings
   2. Warning Tape
   3. Copper Tracer Wire

1.04 GENERAL REQUIREMENTS

A. Use: High Density Polyethylene (HDPE) pipes/fittings shall be allowed for use as water, wastewater and reclaimed water pressure pipe where compatible with the specific conditions of the project. All materials used in the production of water main piping shall be approved by the National Sanitation Foundation (NSF).

B. Documentation:

1. Documentation from the resin's manufacturer showing results of the following tests for resin identification:

    a. Melt Flow Index ASTM D1238
    b. Density ASTM D1505

C. Manufacturer: All HDPE pipe and fittings shall be from a single manufacturer, who is fully experienced, reputable and qualified in the manufacture of the HDPE pipe to be furnished. The pipe shall be designed, constructed and installed in accordance with the best practices and methods and shall comply with these Specifications. Qualified manufacturers shall be PLEXCO Division of Chevron Chemical Company, DRISCOPIPE as manufactured by Phillips Products Co., Inc., or equal as approved by the Owner or Owner's Representative.

D. Finished Product Evaluation:

1. Production staff shall check each length of pipe produced for the items listed below. The results of all measurements shall be recorded on production sheets, which become part of the manufacturer's permanent records.

    a. Pipe process shall be checked visually, inside and out for cosmetic defects (grooves, pits, hollows, etc.)

    b. Pipe outside diameter shall be measured using a suitable periphery tape to ensure conformance with ASTM F714 or ASTM D3035, whichever is applicable.

    c. Pipe wall thickness shall be measured at 12 equally spaced locations around the circumference of both ends of the pipe to ensure conformance with ASTM F714 or ASTM D3035, whichever is applicable.

    d. Pipe length shall be measured.

    e. Pipe marking shall be examined and checked for accuracy.

    f. Pipe ends shall be checked to ensure they are cut square and clean.

    g. Subject inside surface to a "reverse bend test" to ensure pipe is free of

oxidation (brittleness)

E. Stress Regression Testing: The polyethylene pipe manufacturer shall provide certification that stress regression testing has been performed on the specific polyethylene resin being utilized in the manufacture of this product. This stress regression testing shall have been done in accordance with ASTM D2837 and the manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis (HDB) of 1,600 psi as determined in accordance with ASTM D2837.

F. Compatibility: Contractor is responsible for compatibility between pipe materials, fittings and appurtenances.

G. Warranty: The pipe MANUFACTURER shall provide a warranty against manufacturing defects of material and workmanship for a period of ten years after the final acceptance of the project by the Owner or Owner's Representative. The MANUFACTURER shall replace at no expense to the Owner any defective pipe/fitting material including labor within the warranty period.

PART 2 PRODUCTS

2.01 MATERIALS AND CONSTRUCTION

A. Materials for Pipe Sizes 4-inch Diameter and Larger:

1. Materials used for the manufacture of polyethylene pipe and fittings shall be made from a PE 3408 high density polyethylene resin compound meeting cell classification 345464C per ASTM D3350; and meeting Type III, Class C, Category 5, Grade P34 per ASTM D1238.

2. The High Density Polyethylene (HDPE) pipe shall comply with AWWA Specifications C906.

3. Dimensions and workmanship shall be as specified in ASTM F714. HDPE fittings and transitions shall meet ASTM D3261. HDPE pipe shall have a minimum density of 0.955 grams per cubic centimeter. All HDPE pipe and fittings shall have a Hydrostatic Design Basis (HDB) of 1,600 psi.

4. HDPE pipe and accessories 4-inch diameter and larger, shall be 160 psi at 73.4^0F meeting the requirements of SDR 11 as minimum strength unless otherwise noted on the plans. Pipe shall be IPS.

B. Materials for Pipe Sizes 2-inch Diameter and Less:

1. Materials used for the manufacture of polyethylene pipe and fittings shall be made from a PE 3408 high density polyethylene resin compound meeting cell classification 345464C per ASTM D3350; and meeting Type III, Class C, Category 5, Grade P34

per ASTM D1238.

2. The High Density Polyethylene (HDPE) pipe shall comply with AWWA Specifications C901.

3. Dimensions and workmanship shall be as specified in ASTM D3035. HDPE fittings and transitions shall meet ASTM D3261. HDPE pipe shall have a minimum density of 0.955 grams per cubic centimeter. All HDPE pipe and fittings shall have a Hydrostatic Design Basis (HDB) of 1,600 psi.

4. HDPE pipe and accessories 2-inch diameter and less, shall be 200 psi at 73.4^0F meeting the requirements of SDR 9 as minimum strength. Pipe shall be IPS.

C. Pipe Fittings: All molded fittings and fabricated fittings shall be fully pressure rated to match the pipe SDR pressure rating to which they are made. All fittings shall be molded or fabricated by the manufacturer. No Contractor fabricated fittings shall be used unless approved by the Owner or Owner's Representative.

The manufacturer of the HDPE pipe shall supply all HDPE fittings and accessories as well as any adapters and/or specials required to perform the work as shown on the drawings and specified herein.

All fittings shall be installed using butt-fused fittings, thermo-fused fittings/couplings, or flanged adapters and must be approved by the Owner or Owner's Representative. No size on wet taps shall be permitted.

All transition from HDPE pipe to ductile iron or PVC shall be made per the approval of the Owner or his/her representative and per the HDPE pipe manufacturer's recommendations and specifications. A molded flange connector or mechanical joint adapter within a carbon steel back-up ring assembly shall be used for pipe type transitions. Ductile iron back-up rings shall mate with cast iron flanges per ANSI B16.1. A 316 stainless steel back-up ring shall mate with a 316 stainless steel flange per ANSI B16.1.

D. Warning Tape: Metallic impregnated warning tape shall be blue in color with "Caution – Buried Water Line Below" continuously printed on it for water line pipe. Metallic impregnated warning tape shall be green in color with "Caution – Sewerline Below" continuously printed on it for sewer line pipe. Tape shall be a minimum of 3-inches wide, 5 mils total thickness, composed of plastic with a metal foil core, and equal to Traceline Detectable for Underground Utility Marking Tape. Where copper tracer wire is buried with the pipe line, the locator/warning tape shall be plastic without metal foil. The warning tape shall be installed above the pipe with an 18-inch maximum bury depth.

E. Copper Tracer Wire:

1. Wire: 10-guage single strand copper polyethylene insulated tracing wire, type THHN/THWN.

2. Installation/Termination: Tracer wire shall be securely attached to the top of the pipe a minimum of three (3) times for each pipe length. The wire shall be properly grounded at all valve boxes, fire hydrants, and flush hydrants. For terminations at hydrants, the wire is to extend up through the interior and is to be affixed to the safety flange bolt. For gate valve boxes, the wire is to extend up through the interior and is to be affixed to a Contractor installed bolt located 6-inches below the cover. Adequate tracer wire slack shall be maintained to allow for easy access.

2.02 JOINTING METHOD

A. The pipe shall be joined with butt, heat fusion joints as outlined in ASTM D2657. All joints shall be made in strict compliance with the manufacturer's recommendations. A factory qualified joining technician as designated by the pipe manufacturer or experienced, trained technician shall perform all heat fusion joints in the presence of the Owner or Owner's Representative.

B. Lengths of pipe shall be assembled into suitable installation lengths by the butt-fusion process. All pipe so joined shall be made from the same class and type of raw material made by the same raw material supplier. Pipe shall be furnished in standard laying lengths not to exceed 50 feet and no shorter than 20 feet.

C. On days butt fusions are to be made, the first fusion shall be a trial fusion in the presence of the Owner or his/her representative. The following shall apply:

1. Heating plates shall be inspected for cuts and scrapes. The plate temperature shall be measured at various locations to ensure proper heating/melting per manufacturer's recommendations and approval by Owner or Owner's Representative.

2. The fusion or test section shall be cut out after cooling completely for inspection.

3. The test section shall be 12-inches or 30 times (minimum) the wall thickness in length and 1-inch or 1.5 times the wall thickness in width (minimum).

4. The joint shall be visually inspected as to continuity of "beads" from the melted material, and for assurance of "cold joint" prevention (i.e. – joint shall have visible molded material between walls of pipe). Joint spacing between the walls of the two ends shall be a minimum of 1/16 inch to a maximum of 3/16 inch.

D. The polyethylene flange adapters at pipe material transitions shall be backed up by stainless steel flanges conforming to ANSI B16.1 and shaped as necessary to suit the

outside dimensions of the pipe. The flange adapter assemblies shall be connected with corrosion resisting bolts and nuts of Type 316 Stainless Steel as specified in ASTM A726 and ASTM A307. All bolts shall be tightened to the manufacturer's specified torques. Bolts shall be tightened alternatively and evenly. After installation apply a bitumastic coating to bolts and nuts.

PART 3 EXECUTION

3.01 INSTALLATION

A. High Density Polyethylene (HDPE) Pipe shall be installed in accordance with the instruction of the manufacturer, as shown on the drawings and as specified herein. A factory qualified joining technician as designated by the pipe manufacturer shall perform all heat fusion joints.

B. HDPE shall be installed either by Open Trench Construction or Directional Bore Method as outlined in Section TP-2805, Item P – Open Trench Installation or Item Q – Directional Bore Installation.

C. Care shall be taken in loading and transporting and unloading to prevent injury to the pipe. Pipe or fittings shall not be dropped. All pipe or fittings shall be examined before installation, and no piece shall be installed which is found to be defective. Any damage to the pipe shall be repaired as directed by the Owner or Owner's Representative. If any defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner by the Contractor, at his own expense.

D. Under no circumstances shall the pipe or accessories be dropped into the trench or forced through a directional bore upon "pull-back".

E. Care shall be taken during transportation of the pipe such that it will not be cut, kinked or otherwise damaged.

F. Ropes, fabric or rubber protected slings and straps shall be used when handling pipes. Chains, cables or hooks inserted into the pipe ends shall not be used. Two slings spread apart shall be used for lifting each length of pipe.

G. Pipes shall be stored on level ground, preferably turf or sand, free of sharp objects, which could damage the pipe. Stacking of the polyethylene pipe shall be limited to a height that will not cause excessive deformation of the bottom layers of pipes under anticipated temperature conditions. Where necessary due to ground conditions, the pipe shall be stored on wooden sleepers, spaced suitably and of such width as not to allow deformation of the pipe at the point of contact with the sleeper or between supports.

H. Pipe shall be stored on clean level ground to prevent undue scratching or gouging.

The handling of the pipe shall be in such a manner that the pipe is not damaged by dragging it over sharp and cutting objects. The maximum allowable depth of cuts, scratches or gouges on the exterior of the pipe is 5 percent of the wall thickness. The interior pipe surface shall be free of cuts, gouges or scratches.

I. Pipe shall be laid to lines and grade shown on the drawings with bedding and backfill as shown on the drawings.

J. When laying pipe is not in progress, including lunchtime, the open ends of all on-site pipe shall be closed by fabricated plugs, or by other approved means.

K. Sections of pipe with cuts, scratches or gouges exceeding 5 percent of the pipe wall thickness shall be removed completely and the ends of the pipeline rejoined.

L. The pipe shall be joined by the method of thermal butt fusion, as outlined in Section 2.01 above. All joints shall be made in strict compliance with the manufacturer's recommendations.

M. Mechanical connections of the polyethylene pipe to auxiliary equipment such as valves, pumps and tanks shall be through flanged connections which shall consists of the following:

1. A polyethylene flange shall be thermally butt-fused to the stub end of the pipe.

2. A 316 stainless steel back up ring shall mate with a 316 stainless steel flange.

3. 316 stainless steel bolts and nuts shall be used.

N. Flange connections shall be provided with a full-face neoprene gasket.

O. All HDPE pipe must be at the temperature of the surrounding soil at the time of backfilling and compaction.

P. If defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional cost to the Owner. All pipe and fittings shall be thoroughly cleaned before installation, shall be kept clean until they are used in the work and when laid, shall conform to the lines and grades required.

Q. Open Trench Installation:

1. Trenching and backfilling operations shall be performed as specified in Section 02210 – TRENCHING, BACKFILLING, AND COMPACTING of the Technical Provisions.

2. The centerline of the pipe shall not deviate from a straight line drawn between the centers of the openings at the ends of the pipe by more than 1/16-inch per foot of length. If a piece of pipe fails to meet this requirement check for straightness, it shall be rejected and removed from the site. Laying instructions of the manufacturer shall be explicitly followed.

3. Good alignment shall be preserved during installation. Deflection of the pipe shall occur only at those places on design drawings and as approved by the Owner or his/her representative. Fittings, in addition to those shown on the drawings, shall be used only if necessary or required by the Owner or Owner's Representative.

4. Each length of the pipe shall have the assembly mark aligned with the pipe previously laid and held securely until enough backfill has been placed to hold the pipe in place. Joints shall not be "pulled" or "cramped".

5. Precautions shall be taken to prevent flotation of the pipe in the trench.

6. When moveable trench bracing such as trench boxes, moveable sheeting, shoring or plates are used to support the sides of the trench, care shall be taken in placing and moving the boxes or supporting bracing to prevent movement of the pipe, or disturbance of the pipe bedding and the backfill. Trench boxes, moveable sheeting, shoring or plates shall not be allowed to extend below top of the pipe. As trench boxes, movable sheeting, shoring and plates are moved, pipe bedding shall be placed to fill any voids created and the backfill shall be recompacted to provide uniform side support for the pipe.

7. Restrained joints shall be installed where shown on the drawings or as directed by the Owner or Owner's Representative.

3.02 PIPE CLEANING

At the conclusion of the work, thoroughly clean all of the new pipe lines to remove all dirt, stones, pieces of wood or other material which may have entered during the construction period by forcing a cleaning swab through all mains 6-inch or greater. Flushing velocities shall be a minimum of 2.5 feet per second. All flushing shall be coordinated with the Owner or Owner's Representative. Debris cleaned from the lines shall be removed from the job site.

3.03 TESTING

A. Pressure testing shall be conducted per the Manufacturer's recommendations and as approved by the Owner or his/her representative.

B. All HDPE water mains shall be disinfected prior to pressure testing in accordance

with AWWA C651.

C. All HDPE mains shall be field-tested. Contractor shall supply all labor, equipment, material, gages, pumps, meters and incidentals required for testing. Each main shall be pressure tested upon completion of the pipe laying and backfilling operations, including placement of any required temporary roadway surfacing.

D. All mains shall be tested at 150 percent of the operating design pressure of the pipe unless otherwise approved by the Owner or Owner's Representative.

E. Pressure testing procedure shall be per manufacturer's recommendations or as follows:

1. Fill line slowly with water. Maintain flow velocity less than 2 feet per second.

2. Expel air completely from the line during filling and again before applying test pressure. Air shall be expelled by means of taps at points of highest elevation.

3. Apply initial test pressure and allow to stand without makeup pressure for two to three hours, to allow for diametric expansion or pipe stretching to stabilize.

4. After this equilibrium period, apply the specified test pressure and turn the pump off. The final test pressure shall be held for one to three hours.

5. Upon completion of the test, the pressure shall be bled off from a location other than the point where the pressure is monitored. The pressure drop shall be witnessed by the Owner or his/her representative at the point where the pressure is being monitored and shall show on the recorded pressure read-out submitted to the Owner.

F. Allowable amount of makeup water for expansion during the pressure test shall conform to Chart 6, Allowance for Expansion Under Test Pressure, Technical Report TR 31/9-79, published by the Plastic Pipe Institute (PPI). If there are no visual leaks or significant pressure drops during the final test period, the installed pipe passes the test.

G. If any test of pipe laid disclosed leakage significant pressure drop greater than the manufacturer's recommended loss, the Contractor shall, at his/her own expense, locate and repair the cause of leakage and retest the line. The amount of leakage, which will be permitted, shall be in accordance with AWWA C600 Standards.

H. All visible leaks are to be repaired regardless of the amount of leakage.

3.04 SITE CLEAN UP

Upon completion of the work, the entire site shall be cleared of all debris, and the ground surface shall be finished to smooth and uniform slopes. Cleanup shall be considered an incidental item and no additional payment shall be made for it

3.05 AS-BUILT INFORMATION

The Contractor shall be responsible for keeping accurate records of all installed items under this section of the specifications and indicating revisions of the furnished construction drawings in sufficient detail to be accepted by the Owner for as-built drawings. Sufficient detail under this contract means that the Contractor shall take accurate measurements and record them on the drawings to provide the minimum information of at least two swing ties and distances to permanent objects and/or marker posts for all valves, pressure reducing valves, air and vacuum valves, hydrants, connections to other lines, and bends; the beginning, end of any stabilization material placed; the beginning, end, and depth to rock encountered; the beginning, end, and depth of any encasement installed; and the location and depth of any other utilities encountered.

The recording of the as-built information is considered an integral part of the progress of this construction and shall be reviewed with the Owner or Owner's Representative in determining progress under this contract.

PART 4 MEASUREMENT AND PAYMENT

A. HDPE PIPE: The HDPE pipe shall be measured in linear feet along the centerline of the pipe, including fittings, for each of the various sizes of HDPE pipe installed. Payment for HDPE pipe shall be at the contract unit price shown on the Bid Schedule. This price shall be full compensation for furnishing all labor, equipment, materials, and incidentals required for a complete installation, including excavation, bedding, stabilization material, pipe installation, fittings, thrust blocks, water main warning tape, restraints, tracer wire, hydrostatic testing, disinfection, rock excavation, trench backfilling, as-builts, and final cleanup.

END OF SECTION

SECTION 02641
VALVES

PART 1 - GENERAL

1.01 SCOPE

This section of the specifications shall be supplemental to Sections 801.3.4 to 801.3.7 of the Standard Specifications. All requirements of Section 801 shall apply except as modified herein.

The work covered by this section includes motor operated butterfly valves, check valves, pump control valves, and miscellaneous manual valves.

1.02 RELATED WORK

A. Section 09900 – Painting and Coating

B. Section 09961 - Fusion Bonded Epoxy Linings and Coatings

C. Section 16010 – General Electrical Requirements

D. Section 16141 - Wiring Devices

E. Section 16993 – Process Instrumentation and Controls - Field Instruments

1.03 SUBMITTALS

Shop drawing submittals shall be in accordance with Section 01300 of these specifications.

1.04 REFERENCES

Standard references shall conform to the current edition of the AWWA Specifications, C-504.

PART 2 - PRODUCTS

2.01 MISCELLANEOUS SMALL VALVES

A. Gauge Cock: Val-Matic No. 600, size as required.

B. Corporation Stops: Ford, F-600, size as required.

C. Ball Valves:

1. Val-Matic No. 600, size as required.

2. Plast-O-Matic, True Blue, MVP[XXX]VT-CP, size as required.

2.02 CHECK VALVES

A. General

This specification is intended to cover the design, manufacture, and testing of 2 in. (50 mm) through 36 in. (900 mm) Surgebuster Swing Check Valves suitable for cold working pressures of 250 psig, 150 psig for 30 in. (800mm) and larger in water, wastewater, abrasive, and slurry service. The Check Valve shall be of the full body type, with a domed access cover and only two moving parts, the flexible disc and the disc accelerator.

B. Code and Standards

1. The valves shall be designed, manufactured and tested in accordance with American Water Works Association Standards ANSI/AWWA C508.

C. Design

1. The valve body shall be full flow equal to nominal pipe diameter at all points through the valve. The seating surface shall be on a 45 degree angle to minimize disc travel. A threaded port with pipe plug shall be provided on the bottom of the valve to allow for field installation of a backflow actuator, air cushion or hydraulic cushion without special tools or removing the valve from the line.

2. The top access port shall be full size, allowing removal of the disc without removing the valve from the line. The access cover shall be domed in shape to provide flushing action over the disc for operating in lines containing high solids content. A threaded port with pipe plug shall be provided in the access cover to allow for field installation of a mechanical, disc position indicator.

3. The disc shall be of one-piece construction, precision molded with an integral o-ring type sealing surface, and contain alloy steel and nylon reinforcement in the flexible hinge area. The flex portion of the disc shall be warranted for twenty-five years. Non-Slam closing characteristics shall be provided through a short 35 degree disc stroke and a disc accelerator.

4. The disc accelerator shall be of one piece construction and provide rapid closure of the valve in high head applications. The disc accelerator shall be enclosed within the valve and shall be field adjustable and replaceable without removal of the valve from the line. The disc accelerator shall be securely held in place by being captured between the cover and disc. It shall be formed with a large radius to

allow smooth movement over the disc surface.

5. The valve disc shall be cycle tested 1,000,000 times in accordance with ANSI/AWWA C508 and show no signs of wear, cracking, or distortion to the valve disc or seat and shall remain drop tight at both high and low pressures. The test results shall be independently certified.

6. Valves shall be provided with flanges in accordance with ANSI B16.1, Class 125 or as appropriate to mate with adjoining appurtenances.

D. Materials

1. The valve body and cover shall be constructed of ASTM A536 Grade 65-45-12 ductile iron.

2. The disc shall be precision molded Buna-N (NBR), ASTM D2000-BG.

3. The disc accelerator shall be type 302 stainless steel.

E. Manufacturer

1. The manufacturer shall demonstrate a minimum of five (5) years experience in the manufacture of resilient, flexible disc check valves with air and hydraulic cushions.

2. All valves shall be hydrostatically tested and seat tested to demonstrate zero leakage. The manufacturer shall provide test certificates, dimensional drawings, parts list drawings, and operation and maintenance manuals in accordance with Section 1300 of these specifications.

3. The exterior and interior of the valve shall be coated with an ANSI/NSF 61 approved fusion bonded epoxy coating.

4. Swing check valves shall be Surgebuster Series #7200 as manufactured by Val-Matic® Valve & Manufacturing Corporation, Elmhurst, IL. USA or approved equal.

2.03 AWWA (RESILIENT) SEAT GATE VALVES (4" through 48")

A. General

1. All resilient seat gate valves shall be full compliance with the latest revision of AWWA Standard C515 except as modified herein.

B. Valve Bodies

1. All gate valve iron components shall be manufactured from Ductile Iron in compliance with ASTM A536.

a) Fusion Bond Epoxy Coated Interior and Exterior, AWWA C550. Epoxy powder certified to NSF-61.

b) Stuffing Box Gland shall have a minimum of three (3) O-rings capable of replacement under pressure while gate is in the full open position.

c) EPDM O-ring Seals shall be located between Stuffing box Gland, Bonnet, and Body.

d) Wedge Nut shall be C-54400 bronze cast integrally to a ductile iron gate with a fully Encapsulated Rubber EPDM Seat.

e) Mechanical joint shall be in accordance with ANSI /AWWA C111 / A21.11 Standard; flanged faced ends shall be in accordance with AWWA C110/A21.10 / ANSI B16.1, 125 lb. drilling pattern.

f) Mechanical joints and flanged faced ends shall be provided as required in the Drawings.

C. Operating Stems

1. Operating Stem shall be 420 stainless steel with (3) machined grooves located just above the lower stem O-ring to accept and mate with a 2 piece bronze C-54400 split ring.

D. Pressure Classes

1. Valves contained in these specifications shall be designed to provide a tight shut-off with a minimum differential across the valve of 200 psi. The classification state above is as described in AWWA C515, Section 1.1.2.

F. Maximum Input Torque

1. The maximum input torque to open and/or close the valve shall not exceed 150 ft-lbs under the minimum working pressure stated in these specifications.

F. Manufacturers

1. Rubber seated butterfly valves shall be as manufactured by American Flow Control, United Water Products or Engineer Approved Equal.

2.04 AWWA QUARTER-TURN BUTTERFLY VALVE (4" through 48")

A. General

1. All quarter-turn butterfly valves shall be in full compliance with the latest revision of AWWA Standard C504 except as modified herein.

B. Valve Bodies

1. Valve bodies shall be of ASTM A126 Class B cast iron or ASTM A536 Grade 65-45-12 ductile iron construction.

2. Valves shall be short bodied laying length according to AWWA C504-87 Table 2, with full face flanges drilled per ANSI B16.1.

3. Bolt holes shall be drilled through the flanges. Tapped holes will be acceptable on either side of the shaft where drilled holes would penetrate the shaft, bearing or packing area of the body.

4. Each body shall have integrally cast hubs for shaft bearings.

5. Valve body shall be epoxy coated internally.

C. Valve Discs

1. Valve discs shall be ASTM A48 Class 40 cast iron or ASTM A436 Type 1 or 2 ductile iron. The valve disc and shaft shall be installed horizontally.

2. Disc edge shall be 18-8 Stainless Steel or Monel except when Ni - Resist disc or valve with seat on the disc are furnished.

D. Pressure Classes

1. Valves contained in these specifications shall be designed to provide a tight shut-off with a minimum differential across the valve of 150 psi. The classification state above is as described in AWWA C504-87, Section 1.1.2.

E. Valve Shafts

1. Valve shafts shall be 304 or 316 Stainless Steel and may be of the through shaft or stub shaft design. Where stub shafts are used, they shall be inserted into the disc hub a minimum of 1-1/2 shaft diameters and shall be affixed to the disc with a minimum one taper pin at each end.

2. For all valves, the minimum shaft diameter shall be as listed for particular valve size in AWWA C504-87 Class 150B Table 3 and the shaft torque capabilities will not exceed those listed for the particular valve size in AWWA C504-87 Class 150B Table 4.

F. Valve Seats

1. Valves shall have seats which are mounted in the valve body or affixed to the disc edge. Where seats are mounted in the valve body, the seat shall be cemented or bonded. Where seat is mounted on the valve disc, the seat shall be retained as specified in AWWA C504.

G. Maximum Input Torque

1. The maximum input torque to open and/or close the valve shall not exceed 150 ft-lbs under the minimum working pressure stated in these specifications.

H. Manufacturers

1. Rubber seated butterfly valves shall be as manufactured by Pratt, Mueller or ValMatic.

2.05 MANUAL OPERATORS

A. Manual operators shall be of the worm gear or traveling nut type, utilizing spur or bevel gearing as necessary to produce a maximum input of 150 ft. - lbs. to the driver. Operators shall meet the specified torque requirements as listed in Table 1 AWWA C504. The housing and cover plate shall be cast steel and provide a watertight construction. The driver assembly shall comply to AWWA C504 strength and operations. The valve shall be supplied with a handwheel. The operator shall be supplied with an external position indicator. Extension stems and stem guides shall be as manufactured by Pratt, Mueller or approved equal. All butterfly valve operators shall be capable of being maintained in any position between full open and full close and shall be as manufactured by Pratt, Mueller or ValMatic.

2.06 VALVE FLANGE AND PIPE SUPPORTS

A. Valve and pipe supports shall be provided where shown on the drawings and shall be Standon S-92 or S-96 or equal, unless otherwise shown on the drawings, where pipe supports shall be fabricated from steel with a corrosion resistant, galvanized finish. The saddle shall be replaced with a flange cradle encompassing a 120 degree coverage around the perimeter of the flange at the end of the adjustable shank for valve supports. Adjustable height and diameter of supporting pipe and shank shall depend on the particular item to be supported and its weight.

B. Pipe supports shall have a corrosion resistant, galvanized finish.

2.07 PAINTING AND COATING

A. Coat metal valves and accessories located above ground or in vaults and structures per Specification Section 09900: PAINTING AND COATING. Apply the specified prime coat at the place of manufacture. Finish coat shall match the color of the adjacent piping. Coat handwheels the same as the valves.

B. Line the interior and exterior metal parts of metal valves 4 inches and larger, excluding seating areas and bronze and stainless-steel pieces, according to Specification Section 09961 - Fusion Bonded Epoxy Linings and Coatings

C. Test the valve interior linings at the factory with a low-voltage (22.5 to 80 volts, with approximately 80,000-ohm resistance) holiday detector, using a sponge saturated with a 0.5% sodium chloride solution. The lining shall be holiday free.

D. Repair fusion bond epoxy coated areas according to Specification Section 09961 - Fusion Bonded Epoxy Linings and Coatings.

PART 3 - EXECUTION

3.01 JOINTS

A. Bolt holes of flanged valves shall straddle the horizontal and vertical centerlines of the pipe run to which the valves are attached. Clean flanges by wire brushing before installing flanged valves. Clean flange bolts and nuts by wire brushing, lubricate threads with oil and graphite, and tighten nuts uniformly and progressively. If flanges leak under pressure testing, loosen or remove the nuts and bolts, reseat or replace the gasket, reinstall or retighten the bolts and nuts, and retest the joints. Joints shall be watertight.

B. Clean threaded joints by wire brushing or swabbing. Apply Teflon joint compound or Teflon tape to pipe threads before installing threaded valves. Joints shall be watertight.

C. Install grooved-end couplings for valves in accordance with the coupling manufacturer's recommendations. Clean rust, oil, grease, dirt, and loose scale from the pipe and valve grooves before installing coupling. Apply the coupling manufacturer's gasket lubricant to the gasket exterior including lips, pipe ends, and housing interiors. Fasten coupling alternately and evenly until coupling halves are seated.

3.02 INSTALLING EXPOSED VALVES

A. Unless otherwise indicated in the drawings, install valves in horizontal runs of pipe having centerline elevations 4'-6" or less above the floor with their operating stems vertical. Install valves in horizontal runs of pipe having centerline elevations between 4'-6" and 6'-9" above the floor with their operating stems horizontal.

B. Install valves on vertical runs of pipe that are next to walls with their stems horizontal, away from the wall. Valves on vertical runs of pipe that are not located

next to walls shall be installed with their stems horizontal, oriented to facilitate valve operation.

3.03 MOUNTING ACTUATORS

A. The valve manufacturer shall select and mount the actuator and accessories on each valve and stroke the valve from fully open to fully closed prior to shipment.

3.04 FIELD INSTALLATION OF ACTUATOR

A. Provide the actuator manufacturers recommended lubricating oil in each actuator before commencing the field testing.

3.05 VALVE LEAKAGE TESTING

A. Test valves for leakage at the same time that the connecting pipelines are tested. Protect or isolate any parts of valves, actuators, or control and instrumentation systems whose pressure rating is less than the pressure test. Valves shall show zero leakage. Repair or replace any valves and retest.

3.06 VALVE FIELD TESTING

A. Operate manual valves through 10 full cycles of opening and closing. Valves shall operate from full open to full close without sticking or binding. If valves stick or bind, repair or replace the valve and repeat the tests.

B. Actuators shall operate valves from full open to full close through 10 cycles without binding or sticking. The pull required to operate handwheel- or chainwheel-operated valves shall not exceed 80 pounds. The torque required to operate valves having 2-inch AWWA nuts shall not exceed 150 ft-lbs. If actuators stick or bind or if pulling forces and torques exceed the values stated previously, repair or replace the actuators and repeat the tests. Operators shall be fully lubricated in accordance with the manufacturer's recommendations prior to operating.

3.07 MEASUREMENT AND PAYMENT

A. Work covered in this section of the specifications, and associated costs therewith, shall be included in the lump sum bid item to which the work applies. No separate payment shall be made.

END OF SECTION

SECTION 05120
STRUCTURAL STEEL

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes miscellaneous structural steel not governed by the steel joist specifications. Types of steel required include the following:

1. Plate.

2. Angles.

B. When outriggers, angles, or other components are not attached to the open web steel joists in the shop in such a way that they actually are a component part of the joists, they are to be provided under this Section.

C. The Work includes Outrigger supports and wall anchors not associated with steel joists.

D. Section includes: structural steel framing members, and structural steel support members with required bracing, welds, and fastenings.

1.02 RELATED SECTIONS

A. Section 05125 - Metal Fabrications

1.03 REFERENCES

A. American Institute of Steel Construction:

1. AISC S302 - Code of Standard Practice for Steel Buildings and Bridges.

2. AISC S326 - Specification for Design, Fabrication and Erection of Cold-Formed Structural Members for Buildings.

3. AISC S329 - Specification for Structural Joints Using ASTM A325 or A490 Bolts.

B. American Society for Testing and Materials:

1. ASTM A36 - Structural Steel.

2. ASTM A307 - Carbon Steel, Bolts and Studs, 60,000 psi Tensile Strength.

3. ASTM A325 - High-Strength Bolts for Structural Steel Joints.

4. ASTM A500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.

C. American Welding Society, Inc.:

1. AWS D 1. 1 - Structural Welding Code.

D. Federal Specifications:

1. FS TT-P-31 - Paint, Oil: Iron Oxide, Ready Mix, Red and Brown.

E. SSPC - Steel Structures Painting Council.

1.04 SUBMITTALS

A. Submit in accordance with Section 01300 – Contractor Submittals.

1. Shop drawings:

a. Indicate profiles, sizes, spacing, and locations of structural members, connections, attachments, fasteners, cambers, and loads.

b. Indicate welded connections using standard AWS welding symbols. Indicate net weld lengths.

2. Product data on primer.

3. Certificates for welders employed on Work verifying AWS qualification within previous 12 months.

1.05 QUALITY ASSURANCE

A. Except as indicated otherwise, comply with provisions of AISC S302, AISC S326, AISC S329, and AWS D1.1.

B. Qualify welding processes and welding operators in accordance with AWS.

C. Design connections not detailed on Drawings under direct supervision of Professional Structural Engineer currently licensed in the State of New Mexico.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Structural Steel Members: Conform with ASTM A36, minimum yield strength of 36,000 psi.

B. Structural Tubing: Conform with ASTM A500, Grade B, minimum yield strength of 46,000 psi.

C. Bolts, Nuts, and Washers: Conform with ASTM A325.

D. Welding Materials: Conform AWS D1.1; type required for materials being welded.

E. Primer: FS TT-P-31, red oxide.

F. Grout: Non-shrink type, pre-mixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing additives, capable of developing a minimum compressive strength of 5,000 psi at 28 days.

2.02 FABRICATION

A. Fabricate structural steel members in accordance with AISC Specifications.

B. Fabricate and assemble structural members in shop to greatest extent possible. Properly mark and match-mark the materials for field assembly.

C. Completely assemble, including welding of units before start of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs, and other defects.

D. Connections: Weld or bolt shop connections as indicated on Drawings. Install high strength threaded fasteners in accordance with AISC S329.

E. Welded construction: Comply with AWS welding code for procedures, appearance, and quality of welds and methods used in correcting welding work.

F. Holes for other work: Provide holes required for securing other work to structural steel framing and for passage of other work through steel framing members as shown on approved shop drawings. Cut, drill, or punch hole perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning.

2.03 FINISH

A. Shop paint structural steel, except those members or portions of members to be embedded in concrete or mortar. Do not paint surfaces to be welded or high strength bolted with friction type connections.

B. Preparation: After inspection and before shipping, clean steel work to be painted, Remove loose rust, loose mill scale, spatter slag, and flux deposits.

Clean steel in accordance with SSPC standards.

PART 3 - EXECUTION

3.01 ERECTION

A. Erect structural steel in accordance with AISC Specifications.

B. Make provisions for erection loads and for sufficient temporary bracing to maintain structure safe, plumb, and in true alignment until completion of erection and installation of permanent bracing.

C. Do not field cut or alter structural members without approval of the ENGINEER.

D. Tighten anchor bolts after supported members have been positioned and plumbed.

E. Pack non-shrink grout solidly between bearing surfaces and base plates to ensure that no voids remain.

F. Set structural frames accurately to lines and elevations indicated. Align and adjust various members forming a part of a complete frame or structure before permanently fastening. Clean the bearing surfaces and other surfaces which will be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment. Level and plumb individual members of structure within specified AISC tolerances.

G. Splice members only where indicated on approved shop drawings.

H. On exposed welded construction, remove erection bolts, fill holes with plug welds, and grind smooth at exposed surfaces.

I. Do not enlarge holes by burning or use of drift pins . Ream holes that must be enlarged to admit bolts.

3.02 TOUCH-UP

A. After erection, clean field welds, bolted connections, and abraded areas of shop paint. Apply paint to exposed area with same materials as used for shop painting. Apply by brush or spray to provide minimum dry film thickness of 2.0 mils.

PART 4 – MEASUREMENT & PAYMENT

A. Work covered in this section of the specifications, and associated costs therewith, shall be included in the lump sum bid item to which the work applies. No separate payment shall be made.

END OF SECTION

SECTION 05125
METAL FABRICATIONS

PART 1 - GENERAL

1.01 DESCRIPTION

This section describes materials, fabrication, and installation of structural steel, structural aluminum, steel tubing, aluminum tubing, connecting bolts, drilled anchors, capsule anchors, eyebolts, handrail, stainless-steel fasteners, aluminum sheet, grating and floor plates, ladders, access hatches, stair nosings, and stair treads.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Sepcification Section 01300: CONTRACTOR SUBMITTALS

1.03 SUBMITTALS

A. Submit shop drawings in accordance with Specification Section 01300: CONTRACTOR SUBMITTALS.

B. Submit drawings of fabricated items, such as ladders, concrete anchors, and access hatches. Show dimensions and reference materials of construction by ASTM designation and grade.

PART 2 - MATERIALS

2.01 STRUCTURAL STEEL

Material for all-purpose bolted or welded construction shall conform to ASTM A 36.

2.02 BOLTS

A. Steel anchor bolts shall conform to ASTM F1554 Grade 36. Anchor bolts shall be 5/8 inch minimum unless shown otherwise.

B. Steel connection bolts shall conform to ASTM A 307.

C. Provide self-locking nuts or lockwashers and plain nuts where shown in drawings.

D. Provide galvanized bolts where shown in drawings. Galvanizing shall be by the hot-dipped process.

E. Stainless-steel bolts shall be ASTM A 193, Grade B8M, or ASTM F 593, Type 316. Nuts shall be ASTM A 194, Grade 8M, or ASTM F 894, Type 316. Use ASTM A 194 nuts with ASTM A 193 bolts; use ASTM F 594 nuts with ASTM F 593 bolts. Provide washer for each nut and bolthead. Washers shall be of the same material as the nuts.

2.05 LADDERS

Fabricate ladders of galvanized aluminum as shown on the drawings. All ladders into vaults shall be equipped with a Bilco Ladder-Up safety extension post (No Exceptions). Ladders shall be as indicated on the drawings. Minimum diameter of rungs shall be 1-3/8 inch. The rungs shall be flat Type "D" with slip resistant surface. The slip resistant surface must be manufactured into the rungs. Field applied slip resistance surface is NOT ACCEPTABLE. The distance between rungs, cleats, and steps shall not exceed 12 inches and shall be uniform throughout the length of the ladder. The minimum clear length of rungs or cleats shall be 16 inches.

Where the ladder is attached to the vault surface, a ¼" thick chloroprene (neoprene) pad shall be placed between the concrete and the ladder post.

2.06 ACCESS HATCHES:

The single leaf series access frames and covers shall have a 1/4 inch thick one-piece, mill finish, extruded aluminum channel frame, incorporating a continuous concrete anchor. A 1-1/2 inch drainage coupling shall be located in the front left corner of the channel frame. The CONTRACTOR shall install piping from the drainage coupling to the nearest vault drain or sump. Piping shall be attached to the roof or wall with supports and shall not protrude across any access opening within the vault. Drainage piping shall be PVC SCH 40 with glued joints and sloped to drain. Penetrations through a concrete vault shall be core drilled and sealed with a rubber annular hydrostatic sealing device such as a Link Seal in accordance with Specification Section 15125: WALL PENETRATIONS.

A bituminous coating shall be applied to the frame exterior where it will come in contact with concrete. Door panel shall be 1/4" (7mm) aluminum diamond plate, reinforced to withstand a live load of 300 lbs. psf (1464 kg. psm). Door shall open to 90 degrees and automatically lock with a T-316 stainless steel hold open arm with an aluminum release handle. For ease of operation, the hold open arm shall incorporate an enclosed stainless steel compression spring assist. Doors shall close flush with the frame and rest on a built-in neoprene gasket to insure odor resistance. The gasket shall limit air infiltration to less than 1 cfm. per lineal foot of opening perimeter with a pressure differential equal to a 1" column of water. Hinges and all fastening hardware shall be T-316 stainless steel. Unit shall lock with a T-316 stainless steel slam lock with removable key and have a non-corrosive handle. Unit shall carry a lifetime guarantee against defects in material and/or workmanship.

For all double leaf access hatches, a safety chain (3/8") shall be attached to the open sides of the access hatch with a caribiner. A ½" hole shall be drilled into theaccess cover to attach the caribiners. All materials shall be stainless steel.

Hatches shall be Bilco Type J-3, Halliday Series W1S, or approved equal. A padlock device shall be provided with each hatch for security..

2.07 DRILLED ANCHORS

Unless otherwise indicated on the drawings, drilled anchors shall be Type 316 stainless-steel wedge anchors as manufactured by Phillips Drill Company, Hilti, or equal. Minimum size for pipe hangers NPS 6 inches and smaller shall be 3/8 inch minimum; size for all other applications shall be 5/8 inch.

2.08 CHLROPRENE (NEOPRENE) PADS OR SHEET

Provide chloroprene (neoprene) pads or sheet in conformance with MIL-R-6855.

PART 3 - EXECUTION

3.01 STORAGE OF MATERIALS

Store structural material, either plain or fabricated, above ground on platforms, skids, or other supports. Keep material free from dirt, grease, and other foreign matter and protect from corrosion.

3.02 FABRICATION AND ERECTION

A. Fabricate miscellaneous metal items to straight lines and true curves. Drilling and punching shall not leave burrs or deformations. Continuously weld permanent connections along the entire area of contact. Exposed work shall have a smooth finish with welds ground smooth. Joints shall have a close fit with corner joints coped or mitered and shall be in true alignment. Unless specifically indicated on the drawings there shall be no bends, twists, or open joints in any finished member nor any projecting edges or corners at intersections. Conceal fastenings wherever possible. Built-up parts shall be free of warp. Exposed ends and edges of metal shall be slightly rounded. All boltholes shall be 1/16 inch in diameter larger than bolt size. Measure cast-in-place bolt locations in the field before drilling companion holes in structural steel beam or assembly.

B. Clean the surface of metalwork to be in contact with concrete of rust, dirt, grease, and other foreign substances before placing concrete.

C. Set embedded metalwork accurately in position when concrete is placed and support it rigidly to prevent displacement or undue vibration during or after the placement of concrete. Unless otherwise specified where metalwork is to be installed in recesses in formed concrete, said recesses shall be made, metalwork installed, and recesses filled with dry-pack mortar.

D. Ordinary type mortar (dry pack) shall consist of one part portland cement to two parts sand (100% passing a No. 8 sieve). Add sufficient water to form a damp formable consistency.

3.03 WELDING

A. Perform welding on steel by the Shielded Metal Arc Welding (SMAW) process. Welding shall conform to the AWS Structural Welding Code D1.1.

B. Perform welding on aluminum by the Gas Metal Arc (MIG) or Gas Tungsten Arc (TIG) process, per the AWS Welding Handbook.

C. Provide a minimum of two passes for metal in excess of 5/16 inch thickness.

D. Produce weld uniform in width and size throughout its length with each layer of weldment smooth; free of slag, cracks, pinholes, and undercuttings; and completely fused to the adjacent weld beads and base metal. Avoid irregular surface, nonuniform bead pattern, and high crown. Form fillet welds of the indicated size of uniform height and fully penetrating. Accomplish repair, chipping, and grinding of welds in manner that will not gouge, groove, or reduce the base metal thickness.

3.04 INSTALLING LADDERS

A. Mount ladders to provide clearance in back of ladder so that the distance from the centerline of rungs, cleats, or steps to the nearest permanent object in back of the ladder shall be not less than 7 inches.

B. Where the ladder is attached to the vault surface, a ¼" thick chloroprene (neoprene) pad shall be placed between the concrete and the ladder post.

3.05 INSTALLING ANCHOR BOLTS

A. Preset bolts and anchors by the use of templates. For mechanical equipment (pumps, compressors, blowers), do not use concrete anchors set in holes drilled in the concrete after the concrete is placed.

B. For static items, use preset anchor bolts or drilled wedge anchors as shown on the drawings.

C. After anchor bolts have been embedded, protect their threads by applying grease and by having the nuts screwed on until the time of installation of the equipment or metalwork.

3.06 CONTROL OF FLAME CUTTING

Do not use a gas-cutting torch in the field for correcting fabrication errors on any member in structural framing. Use a gas-cutting torch only on minor members when the member is not under stress.

3.07 REPAIR OF GALVANIZED SURFACES

Repair or replace metal with damaged galvanized surfaces at no additional cost to the Owner. Accomplish repair of galvanized surfaces by use of DRYGALV as

manufactured by the American Solder and Flux Company; Cold Galvanizing Repair Compound as manufactured by Rust-Oleum; or equal. Apply in accordance with the manufacturer's instructions.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT

Payment for the work in this section shall not be paid for separately, but shall be included as part of the lump-sum bid amount for each concrete structure or vault, per associated Bid Items, as stated in the Bid Proposal.

END OF SECTION

SECTION 09900
PAINTING

PART 1 - GENERAL

1.01 SCOPE

A. Paint exposed surfaces whether or not colors are designated in "schedules", except where a surface or material is specifically indicated not to be painted or is to remain natural. Where an item or surface is not specifically mentioned, paint the same as similar adjacent materials or surfaces. If color or finish is not designated, the Architect will select from standard colors or finishes available.

B. Painting includes field painting exposed bare and covered pipes and ducts (including color-coding), hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment.

C. Metal work, together with Mechanical and Electrical Systems.

D. Priming of damaged or abraded shop coats.

E. Touch-up painting of all factory finishes damaged in shipment or installation and repainting if colors are not satisfactory.

F. Interior piping, pumps, motors, valves and miscellaneous equipment.

G. Interior and exterior building walls including complete awning assembly.

H. Doors, transoms, louvers, door frames, window frames and window inserts.

1.02 WORK NOT COVERED

A. Materials, equipment and surfaces painted or finished completely under other sections.

B. Painting of aluminum, chromium plate, copper, bronze, brass, galvanized, or stainless steel surfaces.

C. Finished metal surfaces.

D. Concealed surfaces.

E. Operating parts.

F. Labels.

G. Light Fixtures, Switchgear, and Distribution Cabinets.

1.03 RELATED SECTIONS

A. Section 07920 - Sealants and Caulking.

B. Factory prefinished items as specified.

C. Section 05120 - Structural Steel.

D. Section 05500 - Metal Fabrications.

E. Section 08100 - Metal Doors and Frames.

F. Section 10200 - Louvers and Vents.

1.04 QUALITY ASSURANCE

A. Include on label of containers:

1. Manufacturer's name.

2. Type of paint.

3. Manufacturer's stock number.

4. Color.

5. Instructions for reducing, where applicable.

B. Sampling of Materials:

1. When requested by the Architect, furnish test samples from source of supply.

2. Furnish from materials designated by the Architect:

a. 5 gal. - from batches of 50 gallons or less

b. 10 gal. - from batches over 50 gallons

1.05 PRODUCTS DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:

1. Deliver sealed containers with labels legible and intact.

B. Storage of Materials:

1. Store only acceptable project materials on project site.

2. Store in a suitable location.

3. Restrict storage to paint materials and related equipment.

4. Comply with health and fire regulations.

1.06 JOB CONDITIONS

A. Environmental Requirements:

1. Comply with manufacturer's recommendations as to environmental conditions under which coatings and coating system can be applied.

2. Do not apply finish in areas where dust is being generated.

3. Lighting. Provide not less than 20 foot-candles illumination for all surfaces to be painted or coated.

B. Protection:

1. Cover or otherwise protect finished work of other trades and surfaces not being painted concurrently or not to be painted.

PART 2 - PRODUCTS

2.01 ACCEPTABLE PAINTING SYSTEMS

A. For purposes of establishing quality, Sherwin Williams Industrial Maintenance Coatings Colors are used as a basis for this specification, but bids may be based on the use of these brands:

1. Wellborn

2. Deer-O-Company

3. Glidden

4. Martin-Senour Paint Company

5. Pittsburgh Paint Company

6. Pratt and Lambert Paint Company

B. All material shall be the product of one manufacturer.

C. Exterior Surfaces:

1. Block-Natural Finish: Block shall receive two coats of Sherwin Williams "Prime-a-Pell" 200.

2. Metal: Metal surfaces, except those that are galvanized or finished with an asphaltic type protective coating, shall receive one coat of Sherwin Williams Kem Kromik Primer (B50N2/B50W1) followed by two coats of Sherwin Williams Industrial Enamel (B-54 Series).

3. Metal: Metal surface finished with an asphaltic type protective coating shall receive one coat of Sherwin Williams K1LZ Primer followed by two coats of Sherwin Williams Industrial Enamel (B-54 Series).

4. Metal: Galvanized metal surfaces shall receive one coat of Sherwin Williams Galvite Primer followed by two coats of Sherwin Williams Industrial Enamel (B-54 Series). Or two coats of Sherwin Williams Metalastic II Enamel (B-53 Series).

5. Metal: High Gloss steel plate window inserts and acoustic louver shall receive one coat of Sherwin Williams Kem Kromik Primer (B50N2/B50W1) followed by two coats of Sherwin Williams Metalastic II Enamel (B-53 Series).

D. Interior Surfaces:

1. Block and Concrete Wall Panels: All interior block and concrete wall panel surfaces shall receive one coat of Sherwin Williams "Prime-a-Pell" 200.

2. Metal: Metal surfaces, except those that are galvanized or finished with an asphaltic type protective coating, shall receive one coat of Sherwin Williams Kem Kromik Primer (B50N2/B50W1) followed by two coats of Sherwin Williams Industrial Enamel (B-54 Series).

3. Metal: Metal surfaces finished with an asphaltic type protective

coating shall receive one coat of Sherwin Williams K1LZ Primer followed by two coats of Sherwin Williams Industrial Enamel (B-54 Series).

4. Metal: Galvanized metal surfaces shall receive one coat of Sherwin Williams Galvite Primer followed by two coats of Sherwin Williams Industrial Enamel (B-54 Series).

5. Concrete: Concrete floors shall receive Tile-Clad II Epoxy non-skid coating system.

2.02 SUBMITTALS AND SUBSTITUTIONS

A. Submit substitute paint schedules listing all surfaces and proposed products.

B. Obtain Architect approval prior to purchase and delivery of any substitutions.

C. Submit samples of each color and material to be applied, with texture to simulate actual condition, on representative samples of the actual substrate. Define each separate coat, including block fillers and primers. Use representative colors when preparing samples for review. Resubmit until required sheen, color, and textures are achieved.

2.03 MIXING AND TINTING

A. Deliver paints and enamels ready-mixed to job site.

B. Accomplish job mixing and job tinting only when acceptable to the Architect.

C. Mix only in mixing pails placed in suitable sized non-ferrous or oxide resistant metal pans.

D. Use tinting colors recommended by manufacturer for the specific type of finish.

2.04 COLOR SCHEDULE

Except as noted, the color names and numbers listed are those of Sherwin Williams. Paint shall be Industrial Enamel as manufactured by Sherwin Williams, or approved equal.

A. Exterior Surfaces to be painted (including enclosure walls, interior and exterior):

1. Masonry Block-Natural Unpainted: Prime-a-Pell 200 Clear Water Repellant.

2. Masonry Block-Painted: Townhouse Tan SW-2186.

3. Door Frames: Yearling SW-2183.

4. Doors: Townhouse Tan SW-2186.

5. Air Conditioning Duct: (match block).

6. Misc. Roof Pipes and Vents: (match block).

7. Radio Antenna Mast: (match block).

8. Acoustic Wall Louver and Steel Plate Window Inserts: (Math Block).

9. Flashing (Match Block).

10. Valve Covers (as appropriate to coordinate with discharge and wash line interior piping colors).

11. Other small miscellaneous items as directed by the Architect using the above listed colors.

B. Interior Surfaces:

1. Discharge Piping: Maritime Blue MC-83.

2. Wash line Piping and Supports: Bermuda MC-73.

3. Motor: Factory applied paint and color.

4. All Drain and Wastewater Piping including valves: Spice MC-57.

5. Mag Meter: Safety Blue.

6. Electrical Box Plate Covers: Safety Red.

7. Concrete Wall Panels: Prime-a-Pell 200 clear water repellant.

8. Masonry Block: Prime-a-Pell 200 clear water repellant.

9. Door Frames: (see exterior).

10. Doors, Door Transoms and Door Louvers: (see exterior).

11. Air Conditioning Duct and Louvers: (see mechanical drawings and specifications otherwise Marble MC-62).

12. Roof Opening Covers: Marble MC-62.

13. Heater Mounting Bracket: Desert Sand MC-43.

14. Pressure Gage Stand: Desert Sand MC-43.

15. Jib Crane: Safety Yellow.

16. Concrete Wall Panel Connecting Metals: Marble MC-62

17 Roof Deck and Connecting Metals: Marble MC-62.

18. Roof Joists and Connecting Metals: Marble MC-62.

19. Air Compressor, Wall Louvers: Std. Manufacturer's finish.

20. Natural Gas Lines: Deck Red MC-8.

21. Compressed Air Lines: Pine MC-31.

22. Other small miscellaneous items as directed by the Architect or Engineer using the above listed colors.

2.05 PIPING SYSTEM IDENTIFICATION

A. Means of Identification: All piping within the Reuse Building and within the surrounding 50 ft, the Low Lift Pump Station, and within accessable vaults along the transmission line and the distribution lines , whether installed and/or modified as part of this construction project or as part of a previous phase of this construction project (Phase 1A), shall be identified by each of the means described below.

B. Piping identification shall meet the standards of the Federal Occupational Safety Health Act (OSHA) which refers to the ANSI Standard A13.1.

C. Inside or weather-protected piping systems shall be identified by means of an identifying legend on color background appropriately worded to indicate the "service" name of the pipe as shown on the Drawings.

1. Labels shall be Seton - CODE STANDARD MARKERS, Styles CC, EE, FF, properly sized to fit the pipe being labeled.
2. Each pressure-sensitive label shall be applied to clean, dry pipe or insulation.
3. The applied label shall then be banded on both ends using SETON-ARROWS-ON-A-ROLL TAPE of the same color as the label. The banding shall wrap

completely around the pipe or insulation and shall ovelap for a secure bond. The arrows on the band shall indicate the direction of flow in the piping system.

D. Outdoor or non-weather-protected piping systems shall be identified by means of an identifying legend on color coded background appropriately worded to indicate the "service" name of the pipe as show on the Drawings.
   1. Labels shall be SETON-ULTRA-MARK, properly sized to fit the pipe being labeled.
   2. Each pressure-sensitive label shall be applied to clean, dry pipe or insulation. The label shall wrap completely around the pipe or insulation and shall overlap for a secure bond. The arrows on the label shall indicate the direction of flow in the piping system.

E. Locations of Piping System Identification: The identifying legend and directional arrows described in the paragraphs preceding shall be located at the following points on each piping system:
   1. Adjacent to each valve in piping system
   2. At every point of entry and exit where piping passes through a wall.
   3. On each pipe riser and junction.
   4. At a maximum interval of 20 feet on pipe lines exposed and concealed above accessible ceilings.
   5. Adjacent to all special fittings (regulating valves, etc.) in piping systems.
   6. At every access door.
   7. All piping that is Electrically heat traced shall have the designation "ELECTRIC TRACED" on 20 feet centers.

F. Attach pipe markers to lower quarter of the pipe on horizontal runs located 4’ above finish floor, to upper quarter on horizontal runs located 4’ below finish floor and within buried vaults, and on the centerline of vertical piping where view is not obstructed.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine surfaces scheduled to receive paint and finishes for conditions that will adversely affect execution, permanence or quality of work and which cannot be put into an acceptable condition through preparatory work as included in Article 3.02, PREPARATION OF SURFACES.

B. Do not proceed with surface preparation or coating application until

conditions are suitable. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

3.02 PREPARATION OF SURFACES

A. General Procedures: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items in place that are not to be painted, or provide surface-applied protection prior to surface preparation and painting. Remove these items if necessary for complete painting of the items and adjacent surfaces. Following completion of painting operation in each space or area, have items reinstalled by workers skilled in the trades involved.

B. Ferrous Metal Surfaces:

1. Prepare surface in accordance with recommendations or directions of manufacturer.

C. Galvanized Metal:

1. Clean surfaces with mineral spirits to remove oily residue.

2. Dry with clean cloth.

D. Concrete Surfaces:

1. Prepare surface in accordance with recommendations or directions of manufacturer.

E. Wood Surfaces:

1. Clean surface to remove all dirt and debris.

3.03 APPLICATION

A. General Requirements:
1. Environment:

a. Do not apply coating until moisture content of surface is within limitations recommended by paint manufacturer. Do not apply coating in damp, rainy weather.

b. Do not apply coating when temperature is below 50 degrees F.

c. Do not apply coating when dust conditions prevent favorable workmanship.

2. Apply paint with suitable brushes, rollers, or spraying equipment.

   a. Rate of application shall not exceed that as recommended by paint manufacturer for the surface involved less 10% allowance for losses.

   b. Keep brushes, rollers, and spraying equipment clean, dry, free from contaminates and suitable for the finish required.

3. Comply with recommendation of product manufacturer for drying time between succeeding coats.

4. Vary slightly the color of successive coats.

5. Sand and dust between each coat to remove defects visible from a distance of 5 feet.

6. Finish coats shall be smooth, free of brush marks, streaks, laps or pile-up of paints, and skipped or missed areas.

7. Inspection:

   a. Do not apply additional coats until completed coat has been inspected by the Architect.

   b. Only inspected coats of paint will be considered in determining number of coats applied.

8. Make edges of paint adjoining other materials or colors clean and sharp with no overlapping.

3.04 CLEANING

A. Touch up and restore finish where damaged.

B. Remove spilled, splashed, or splattered paint from all surfaces.

C. Do not mar surface finish of item being cleaned.

END OF SECTION

SECTION 09961
FUSION BONDED EPOXY LININGS AND COATINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes materials, application, and testing of one part, fusion bonded, heat cured, thermosetting, 100% solids epoxy linings and coatings on steel, cast iron and ductile iron equipment, such as valves, flexible pipe couplings, slide gates, and steel pipe.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Specification Section 09900: Painting and Coating

1.03 SUBMITTALS

A. Submit shop drawings in accordance with the Specification Section 01300: Contractor's Submittals.

B. Submit manufacturer's catalog literature and product data sheets, describing the physical and chemical properties of the epoxy coating. Describe application and curing procedure.

C. Submit coating application test records for measuring coating thickness and holiday detection for each item or pipe section and fitting. Describe repair procedures used.

1.04 MEASUREMENT AND PAYMENT

Costs for the work in this section shall not be paid for separately, but shall be considered incidental to the contract work to be accomplished.

PART 2 - PRODUCTS

2.01 PIPING AND EQUIPMENT SURFACES

A. The Contractor shall require the equipment suppliers to provide equipment that is free of salts, oil, and grease to the coating applicator.

B. The contractor shall require pipe suppliers to provide bare pipe that is free of salts, oil, and grease to the coating applicator.

2.02 SHOP-APPLIED EPOXY LINING AND COATING

Lining and coating shall be a 100% solids, thermosetting, fusion bonded, dry powder epoxy resin: Scotchkote 134 or 206N, Lilly Powder Coatings "Pipeclad

1500 Red," H. B. Fuller 1f-3003, or equal. Epoxy lining and coating shall meet or exceed the following requirements:

Hardness (minimum)	Barcol 17 (ASTM D 2583) Rockwell 50 ("M" Scale)
Abrasion Resistance (maximum value)	1,000 cycles: 0.05 gram removed 5,000 cycles: 0.115 gram removed ASTM D 1044, Tabor CS 17 Wheel, 1,000-gram weight
Tensile Strength	7,300 psi (ASTM D 2370)
Penetration	0 mil (ASTM G17)
Adhesion Overlap Shear, 1/8 inch Steel panel, 0.010 Glue line	4,300 psi, ASTM D 1002
Impact (minimum Value)	100 inch-pounds (Gardner 5/8-inch diameter tup)

2.03 FIELD-APPLIED EPOXY COATING FOR PATCHING

Line and coat couplings the same as pipe. Color shall match the color of the pipe fusion epoxy coating.

PART 3 - EXECUTION

3.01 SHOP APPLICATION OF FUSION-BONDED EPOXY LININGS AND COATING GENERAL

A. Grind surface irregularities, welds, and weld splatter smooth before applying the epoxy. The allowable grind area shall not exceed 0.25 square foot per location, and the maximum total grind area shall not exceed 1 square foot per item or piece of equipment. Do not use any item, pipe or piece of equipment in which these requirements cannot be met

B. Remove surface imperfections, such as slivers, scales, burrs, weld spatter, and gouges. Grind outside sharp corners, such as the outside edges of flanges, to a minimum radius of ¼ inch.

C. Uniformly preheat the pipe, item, or piece of equipment prior to blast cleaning to remove moisture from the surface. The preheat shall be sufficient to ensure that the surface temperature is at least 5 degrees F above the dew pint temperature during blast cleaning and inspection.

D. Sandblast surfaces per SSPC SP-5. Protect beveled pipe ends from the abrasive blast cleaning.

E. After cleaning and surface penetration, test the surface for residual chloride concentration. If the residual chloride concentration exceeds 5 $\mu g/cm^2$, then apply a phosphoric acid wash to the surface after sandblasting. Apply a phosphoric acid wash to the pipe, item, or piece of equipment after sandblasting. The average temperature measured in three different locations, shall be 80 degrees F to 130 degrees F during the acid wash procedure. The acid wash shall be 5% by weight phosphoric acid solution. The duration in which the acid is in contact with the surface shall be determined by using the average temperature as tabulated below:

SURFACE TEMPERATURE (ºf)	CONTACT TIME (SECONDS)
80	52
85	45
90	36
95	33
100	28
105	24
110	21
130	10

After the acid wash has been completed, remove the acid with demineralized water having a maximum conductivity of 5 micromhos/cm at a minimum nozzle pressure of 2,500 psi.

F. Apply lining and coating by the electrostatic spray or fluidized bed process. Minimum thickness of lining or coating shall be 15 mils. Heat and cure per the opxy manufacturer's recommendations. The heat source shall not leave a residue or contaminant on the metal surface. Do not allow oxidation of surfaces to occur prior to coating. Do not permit surfaces to flash rust before coating.

3.02 SHOP APPLICATION OF FUSION-BONDED EPOXY LINING AND COATING TO PIPE—ADDITIONAL REQUIREMENTS

A. Apply lining and coating per AWWA C213 except as modified herein.

B. Grind 0.020 inch (minimum) off the weld caps on the pipe weld seams before beginning the surface preparation and heating of the pipe.

3.03 QUALITY OF LINING AND COATING APPLICATIONS

A. The cured lining or coating shall be smooth and glossy, with no graininess or roughness.

B. The lining or coating shall have no blisters, cracks, bubbles, under fill voids, mechanical damage, discontinuities, or holidays.

3.04 PROCEDURES FOR ITEMS HAVING SHOP-APPLIED PRIME COATS

A. Test linings and coatings with a low-voltage wet sponge holiday detector.

1. Test pipe linings and coatings per AWWA C213, Section 5.3.3.

a. If the number of holidays or pinholes is fewer than one per 20 square feet of coating surface, repair the holidays and pinholes by applying the coating manufacturer's recommended patching compound to each holiday or pinhole and retest.

b. If the number of pinholes and holidays exceeds one per 20 square feet of coating surface, remove the entire lining or coating and recoat the item or pipe.

B. Measure the coating thickness at three locations on each item or piece of equipment or pipe section using a coating thickness gauge calibrate at least once per eight-hour shift.

1. Record each measured thickness values are less than the specified minimum thickness, measure the coating thickness at three additional points around the defective area.

2. The average of these measurements shall exceed the specified minimum thickness value, and no individual thickness value shall be more than 2 mils below the specified minimum value.

3. If a section of the pipe, item, or piece of equipment does not meet these criteria, remove the entire lining or coating and recoat the entire item or piece of equipment.

3.05 FIELD REPAIRS

A. Patch scratches and damaged areas incurred while installing fusion bonded epoxy coated items with a two component, 80% solids (minimum), liquid epoxy resin.

B. Wire brush or sandblast the damaged areas per SSPC SP-10.

C. Lightly abrade or sandblast the coating or lining on the sides of the damages area before applying the liquid epoxy coating.

D. Apply a two-part epoxy coating to defective linings and coatings to areas smaller than 20 square inches.

E. Patched areas shall overlap the parent or base coating a minimum of 0.5 inch.

F. If a defective area exceeds 20 square inches, remove the entire lining and coating and recoat the entire pipe, item or piece of equipment.

G. Apply the liquid epoxy coating to a minimum dry-film thickness of 15 mils.

END OF SECTION

SECTION 11200

FACTORY - BUILT BOOSTER PUMP STATION

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The contractor shall furnish and install one (1) factory-built, factory delivered, water booster pump station in a modular building with base frame with all necessary internal piping, valves, fittings, supports, meters, control valves, pumps, motors, controls, chlorine feed equipment and other necessary appurtenances as shown on the plans and specified herein.

B. The booster pump station shall be complete when delivered and will not require internal contractor construction except to install the power service through the floor or wall opening provided for that purpose, connect the main water service to the required points and other work as may be listed in the Section for CONTRACTORS INSTALLATION REQUIREMENTS.

C. Where applicable, contractor shall provide and install electrical components in accordance with Division 16 electrical specifications.

D. Related Work:
1. Section 16011: Electrical Acceptance Testing.
2. Section 16075: Electrical Identification.
3. Section 16111: Conduit.
4. Section 16141: Wiring Devices.
5. Section 16160: Cabinets and Enclosures.

1.02 CONTRACTOR INSTALLATION REQUIREMENTS

A. The contractor shall be required to provide a crane and spreader bars to set the station on the foundation designed by the engineer. The foundation shall be built by the contractor as directed by the engineer. Following setting of the station, the contractor will be required to anchor the station to the foundation. The contractor shall supply the anchor bolts.

1.03 QUALITY ASSURANCE

A. The equipment and materials covered by these specifications are intended to be standard equipment of proven reliability and as manufactured by reputable manufacturers having experience in the production of such equipment. The

equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on the contract drawings and operated in accordance with the manufacturer's recommendations.

B. The manufacturer of the selected equipment shall be regularly engaged in the manufacture, assembly, construction, start-up, and maintenance of water distribution equipment of the type required for this project and possess at least ten years of successful experience in providing stations of the type, design, function, and quality as required for this project.

C. The pump station manufacturer shall be required to affix an Underwriters Laboratories (UL) label attesting to its compliance with the UL-QCZJ standard for packaged pumping systems.

1.04 BASIS OF DESIGN MANUFACTURER

A. Station shall be as manufactured by USEMCO, Inc., Tomah, Wisconsin, or approved equal.

1.05 ALTERNATE MANUFACTURERS

A. Alternate manufacturers may propose on the equipment set forth in these documents provided these alternate manufacturers take no exceptions to the contract documents and provide the PRE-BID SUBMITTAL information listed below. In order to be eligible to propose to the bidding contractors, alternate manufacturers must have provided a PRE-BID SUBMITTAL to the Engineer of Record at least fourteen (14) days prior to the bid date. PRE-BID SUBMITTAL documents will not be accepted after the date set. The Engineer of Record shall review the PRE-BID SUBMITTALS for adherence to the contract documents and issue an addendum seven (7) days prior to the bid date stating the eligibility of any alternate manufacturers to propose on this equipment.

1.06 PRE-BID SUBMITTAL DOCUMENTS

A. In addition to the requirements for post bid submittal documents provided for elsewhere in these documents, all alternate manufacturers offering equipment proposals, without exception, for this equipment shall provide the below listed PRE-BID SUBMITTAL documents specific to this pump station, containing at a minimum:

1. "11" x 17", station general arrangement drawing sheets fully to scale and fully annotated showing:
    a. A PLAN VIEW of all mechanical equipment, piping, and devices necessary to system operation and with NEC Electrical Clearances;
    b. A lengthwise SECTION VIEW;

c. A Sidewise SECTION VIEW;
d. A complete STRUCTURAL PLAN VIEW of the steel base for the pump stations.

2. 11” x 17” Electrical drawings to include:
   a. A POWER ONE LINE DIAGRAM annotated and showing all power components;
   b. A PROCESS & INSTRUMENTATION DIAGRAM (P&ID) showing all components, devices and circuit for the controls and instrumentation for the control and monitoring equipment including the PLC equipment.
   c. A PLAN VIEW of all electrical equipment and devices necessary to station and system operation with NEC Electrical Clearances.
3. A detailed drawing of the buildings to be used to house the station including anchoring and assembly methods.
4. A list of five (5) installations similar in size and type, complete with the name, address, and phone number for Owner / operator responsible for the operation and maintenance of the equipment.
5. Calculations of pump station losses and final design TDH and operating point.
6. Substitution request submittal documents will not be accepted after the bid opening.

B. The PRE-BID SUBMITTAL shall be provided in one (1) hard paper copy bound in a three ring binder with a Table of Contents and tabs for each individual pump station and with one (1) electronic copy on CD placed inside the three ring binder in a suitable pocket.

C. The Engineer of Record shall review all Submittals for adherence to the contract documents. For any manufacturers that are approved for proposing on the specified equipment, the approval of their PRE-BID SUBMITTAL in no way excuses them from providing a full set of submittal documents being in full conformance to the contract documents for detailed review by the Engineer post bid.

1.07 POST BID SUBMITTAL

A. Equipment submittals shall be bound and in a minimum of two (2) hard paper copies and two (2) electronic copies on CD. The submittal shall contain at a minimum, the following project specific, 24” x 36” full size scaled drawings:

B. Booster pump station plan and elevation views, including equipment layout, lighting and receptacle layout, instrument locations and illustrating the National Electrical Code (NEC) clearances per Section 110-26.
   1. Booster pump station electrical control schematics.
   2. Booster pump station piping and instrument diagram, including work being done at the associated water tank.

3. Booster pump station power one line diagram.

C. The submittal books will be complete with data sheets covering all major components within the booster pump station, the UL/ETL file number under which the manufacturer is listed, service department personnel statement as detailed in the specifications and be complete with the manufacturer's formal warranty policy. The submittal booklets shall be complete with a full-size photocopy of the manufacturer's combination UL/manufacturer logo Packaged Pumping Systems label.

D. Two (2) submittal reviews of this item will be accomplished at no cost to the submitting contractor. However, all subsequent reviews will be charged to the submitting contractor at the design engineer's standard hourly billing rate.

E. Provide letter confirming that cellular data provider has been contacted and service has been initiated.

F. Catalog Data:
1. Submit catalog literature and data sheets for pump station and associated components as specified in Part 2. Include complete manufacturer's part and model numbers.
2. Submit catalog literature and data sheets for the photovoltaic system and associated components as specified in Part 2. Include complete manufacturer's part and model numbers.

G. Shop Drawings:
1. Pump Station Design: Provide drawings of pump station detailing all aspects of design.

H. Calculations:
1. Provide calculations detailing pump station design including pump station losses and final design TDH and operating point.
2. Photovoltaic System Design: Provide calculations indicating that panel and battery have been sufficiently sized to provide reserve time at rated power as specified in Part 2.

I. Samples / Colors:
1. Exterior Components Paint: Submit paint color samples for selection by Owner.

1.08 SUBMITTALS FOR CLOSEOUT

A. Operations and Maintenance (O&M) Manuals: Submit manufacturer’s standard installation, O&M manuals for specified components.

B. Warranty Certificates: Submit manufacturer’s warranty certificate or a statement of warranty for equipment specified herein. Indicate warranty terms, warranty period, date on which warranty term began, and contact information necessary to execute a warranty claim.

1.09 QUALITY ASSURANCE

A. The equipment furnished shall be designed, constructed, and installed in accordance with the best practices and methods and shall operate satisfactorily when installed and operated per manufacturer's recommendations.

1.10 THIRD PARTY INSPECTION LISTING

A. The station manufacturer shall be required to affix to the station an UNDERWRITERS LABORATORIES (UL) LABEL attesting to the compliance of the station equipment under the PACKAGED PUMPING SYSTEMS (QCZJ) UL Listing Category and/or INTERTEK TESTING SERVICES (ETL) LABEL attesting to the compliance of the station equipment under PACKAGED PUMPING SYSTEMS. The ETL label shall state the station conforms to UL STD 778 and is certified to CAN/CSA STD C22.2 NO. 108.

1.11 SHIPPING AND DELIVERY

A. The specified equipment shall be delivered by the manufacturer FOB and the station manufacturer shall hold the full responsibility for the condition and completeness of the equipment upon its delivery.

B. The Engineer shall hold the right to inspect the equipment prior to unloading and setting so as to assure the quality and condition of the equipment is in no way deficient.

C. If in the view of the Engineer or Engineer’s inspector the equipment is deficient when delivered, delivery shall be refused.

1.12 SPECIFIED COMPONENTS

A. Within the body of this specification and on the drawings, certain components are listed by name and/or model number for at least one (1) manufacturer’s specific product. As such, no “OR EQUAL” is listed or allowed.

B. These listed components have been chosen because of the Engineer’s and Owner’s knowledge of and experience with these listed components.

C. No other components other than those listed are acceptable.

1.13 FACTORY START - UP AND TRAINING SERVICE

A. Without exception, the station manufacturer is directly responsible for station start-up and operator training. Third party contractors, agents or representatives are not allowed to start up the station nor the equipment therein. As such:
   1. Factory Service Technician shall be a regular employee of the station manufacturer.
   2. The manufacturer shall provide two (2) copies of the complete O&M Manual in electronic form.

1.14 MANUFACTURER'S WARRANTY

A. The warranty is the sole responsibility of the station manufacturer and that manufacturer's warranty shall be provided in written form, being placed in both the submittal documents covering the specified equipment and the O&M manuals provided with that equipment.

B. The station warranty shall provide the Owner with a single source responsibility for all components specified herein and the system as a whole. That single source shall be the station manufacturer. Third party suppliers, service contractors and “pass-through” warranties are not acceptable.

C. The manufacturer's warranty shall at a minimum cover:
   1. A period of one (1) year commencing upon successful start-up, not to exceed eighteen (18) months from the date of shipment.
   2. The warranty period shall be inviolate regardless of any component manufacturer's warranty for equipment and components within the station.
   3. The manufacturer's warranty shall cover all equipment, components and systems provided in or with the station by the manufacturer of the station, exclusive of those components supplied by and/or installed by others independent of the manufacturer of record for this station.
   4. The warranty shall provide for the station manufacturer to bear the full cost of labor and materials for replacement and/or repair of faulty or defective components so there shall be no cost incurred by the Owner for this work during the warranty period.
   5. The manufacturer's warranty policy is amended only by the items considered consumable, i.e., light bulbs, pump seals, pump packing, lubricants and other maintenance items consumed by usage.
   6. No assumption of contingent liabilities for any component failure during manufacturer's warranty is made.
   7. The warranty pertains only where the equipment has been operated in strict accordance with the manufacturer’s instructions and requirements. Evidence of misuse or modification to the equipment voids the warranty.

D. If the submitted written manufacturer's warranty does not meet the minimum requirements set forth above, that submittal will be rejected forthrightly.

1.15 GENERAL LIABILITY INSURANCE

A. The station manufacturer shall furnish premises/operations and products/completed operations general liability insurance from an insurance company with a rating of A-V according to the most recent Best's Key Rating Guide, in an amount equal to $10,000,000 per occurrence.

B. The insurance certificate must be included with the manufacturer's submittal. The coverage must be provided by an insurance carrier licensed and admitted in the state of manufacture.

PART 2 PRODUCTS AND COMPONENTS

2.01 BUILDING DESIGN CRITERIA

A. Building Manufacturer shall supply plans and calculations stamped by a Registered Professional Engineer for the State of New Mexico and shall be responsible for obtaining any State Industrial Building Commission Approvals and Third Party Inspections if required by the State where building is installed.

B. The building enclosure shall be a factory assembled, modular structure of two (2) compartments attached to the station base structure and requiring no additional assembly at the job site.

C. The building design shall: (1.) Withstand snow load based on ASCE 7-10 Ground Snow Loads for the state and county of installation; (2.) Withstand wind loads based on ASCE 7-10 for wind speeds; (3.) include site specific seismic requirements based on local conditions as dictated by the Available Ground Motion Parameters according to ASCE 7 and IBC 2006 and 2009 established by zip code and a live floor load of 125 PSF; and (4.) Be designed to IECC 2015 version of the energy code.

D. The modular building is shown at its minimum size so that National Standards mandated clearances are maintained above, below and around equipment for proper and safe servicing, removal, and reinstallation of this equipment.

E. The building specified shall be of the size shown on the drawings. Building sizes less than those shown will not be allowed.

2.02 BUILDING CONSTRUCTION

A. The booster pump station will be complete with a factory assembled modular building affixed to the steel equipment base supporting the booster pumps as shown on the plans. The completed booster station shall be one piece when

delivered and require only off loading, installation on the prescribed foundation slab, pipe line hook up and electrical service to complete the installation. Field erected buildings or buildings using steel C studs as wall framing members and C joists as roof trusses will not be acceptable.

B. The polyurethane foam core shall be classified by Underwriters Laboratories as having flame spread of 25 or lower and smoke generation of less than 450 when tested in accordance with UL Standard 723 (ASTM Standard E-84).

C. All sidewall and ceiling panels shall consist of interior and exterior metal skins formed with steel dies and roll-forming equipment and checked with gauges for uniformity and accuracy. The panel shall be furnished with an embossed finish pressed into the galvanized steel panel. Polyurethane shall be foamed-in-place (poured, not frothed) and, when completely heat-cured, shall bond to the metal skins to form a rigid 4" thick insulated panel. Overall coefficient of heat transfer ("U" factor) shall be a minimum of .033 (R-30) for 4" thick walls. Wood reinforcement shall be placed inside the wall and ceiling panels where required to support the station equipment loads. Any wood reinforcement in a wall and ceiling panel shall be totally enclosed within the panel and cladded with the exterior and or interior metal skins. To ensure tight joints, panel edges must have foamed-in-place tongues and grooves with a flexible vinyl gasket also foamed-in-place on the interior and exterior of all tongue edges.

D. Panels shall be equipped with cam lock joining devices. The distance between locks shall not exceed 46". Each locking device shall consist of a cam-action, hooked locking arm placed in one panel, and a steel rod positioned in the adjoining panel, so that when the locking arm is rotated, the hook engages over the rod and draws the panel tightly together with cam action. The locking arms and steel rods shall be housed in individual steel pockets set into the panel. Press fit caps shall be provided to close lock wrench holes. A cam lock wrench shall be supplied with the building.

E. Exterior of building shall be a minimum of 26-gauge galvanized steel panel, protected by a spray and baked tan color polyester protective coating.

F. Interior of building shall be a minimum of 26-gauge galvanized steel panel, protected by a spray and baked white color polyester protective coating. The use of FRP (fiberglass reinforced plastic) sheeting attached to plywood sheets as an interior finish is not acceptable. FRP sheeting may be applied over the galvanized steel panel in chemical feed rooms only.

G. Hinged entrance door shall be a steel commercial type, insulated hollow core. Matching metal jambs shall be furnished to fit prefab panels without the use of any interior framing. Jamb members shall attach to panels with sheet metal screws. The door shall be supplied with weather-stripping and a wiper gasket. Entrance opening shall be a minimum 36" x 78" clear opening size. Hardware for doors shall be cylindrical lockset with satin stainless-steel finish. Each door shall

have three tamper-proof pinned butt hinges. All doors for outdoor structures shall be supplied with a metal shield above the door to divert rain and snow from the door opening. An extruded aluminum sill plate shall be provided on outdoor buildings.

H. The ceiling panels shall be covered by a single piece EPDM rubber membrane to provide a waterproof covering. The membrane shall be white and a minimum of 45 mil. The roof shall be peaked with a center ridge 12" high.

I. The building shall be warranted by the station manufacturer for a period of ten (10) years from the date of delivery.

2.03 HEAVY DUTY STEEL DOORS

A. Single leaf doors shall be of the size shown and manufactured of 18-gauge galvanized steel. The doors shall be full flush construction and 1-3/4” thick. Doors shall be reinforced, stiffened, insulated, and sound deadened with a solid polystyrene foam board permanently bonded to the inside of each face skin. The lock and hinge edge of the door shall be welded with a center hairline seam the full height of the door. The lock edge shall be reinforced full height by a 14-gauge continuous one-piece channel extruded templating. The hinge edge shall be reinforced full height by a 14-gauge continuous one-piece channel, formed and tapped for hinges. Top and bottom of the door shall be closed with 16-gauge channels. The doors shall be thoroughly cleaned and receive an iron phosphate treatment prior to receiving one coat of prime paint. Door closures and rim panics are reinforced with 14-gauge channels.

B. Doors shall be fully-mounted in frames produced for pre-hanging of commercial 1-3/4" doors. Frames are formed to 16-gauge commercial quality cold rolled steel conforming to ASTM A366 or A620 and A568. Frames are produced in two welded units, to be mechanically joined during installation. The base side is prepared for all required hardware. Both units, base and trim, are furnished with welded mitered faces. Frame anchoring includes compression anchors and stud screws. Door hinges shall be continuous gear hinges, fabricated of extruded 6063-T6 aluminum alloy/temper with pinless assembly. The doors shall have a lockset, exterior handle, and top mounted-door closer withhold-open device.

C. Doors and frames shall be finished with a two-component, aliphatic/acrylic polyurethane coating, white in color, with a high gloss finish. The coating shall be resistant to a wide range of solvents and chemicals under splash and spill conditions. The coating system is V.O.C. compliant.

2.04 PASSAGE OF PIPES THROUGH INTERNAL WALLS

A. Where transmission pipes pass through walls, the passage shall consist of the pipe with a weld sleeve passing through and welded to a steel plate. The pipe passage

plate shall extend down to the floor and be welded to the floor. The pipe passage plate shall have welded to it on the three sides a channel iron frame which shall accept the building wall set into the channel flanges to lap over the building wall. Where the flange overlaps the building wall, the edge of the channel flange shall be caulked to the wall on all three edges on both sides of the wall.

2.05 REGISTERED PROFESSIONAL ENGINEER REVIEW

A. The base substructure, building and the means of attaching the building to the foundation shall be reviewed and stamped by a New Mexico Registered Professional Engineer.

2.06 BUILDING SUBSTRUCTURE

A. The base/floor system substructure shall be fabricated of steel plate and standard structural steel shapes of the sizes and weights sufficient to bear the loading placed on the base by shipping and operation. The substructure shall be designed to support the building live and dead loads plus the burden imposed by loading, transporting, and unloading of this equipment.

B. All steel plates used in the substructure shall meet or exceed the requirements of ASTM-A36. The structural shapes (channels and angles) shall be of sufficient thickness/weight and shall meet or exceed the requirements for ASTM A-36. The structural rectangular or square tubing shall be of the wall gauge as shown on the plans for this item and shall meet or exceed the requirements for ASTM A-500 Grade B.

C. On the substructure on the floor plate, indented approximately 6”, there shall be welded a 1-1/2” x 2” x 1/8” steel angle iron with drilled holes. This angle steel piece shall be the bracket through which the building is attached to the base substructure.

2.07 FLOOR DRAIN

A. The station shall have floor drains as shown on the drawing. The floor drains shall be a 4” grated opening with 4” I.D. threaded hub for connection of a drain line under the station floor.

2.08 PIPING FLOOR PENETRATIONS

A. Where suction and discharge piping, or any other pressure piping, passes through the station floor plate and base sub-structure, that area of the floor shall be provided with a grout sleeve fabricated of steel pipe of 9” height and of sufficient annular diameter to pass a full-size pipe flange for the pipe size shown.

B. The steel sleeve shall be welded into the floor plate with a 1" projection above the floor in the station. Following installation of the inlet and outlet pipes, the installing contractor shall be responsible for furnishing and installing grout to close the opening around the installed pipe.

2.09 SAFETY FLOOR MATTING

A. The walkway areas and the entire NEC clearance area shall be covered with a rubber drainage runner. The runner shall be medium duty, 1/2" minimum thickness of open slot design allowing fluids to drain under standing or walking surfaces. The runner shall have a tread design to promote sure footing. The underside of the runner shall have a raised knob design to permit aeration and drainage and to reduce runner fatigue. The runner shall not be glued to the floor.

2.10 PUMP OPERATING CONDITIONS - PUMP STATION

A. The pump station shall be capable of delivering the fluid medium at the following capacities and head when operating at 10 feet minimum suction pressure.

B. PUMPS #1 AND #2:

1. The pumps shall be vertical, multistage centrifugal pumps as manufactured by Grundfos, Wilo, Webtrol or equal.
    a. Design Point: 120 GPM @ 244 feet TDH
    b. NPSHr: 13.0 feet
    c. Suction Pressure: 50 PSI
    d. Discharge Pressure: 110 PSI
    e. Pump Efficiency at Design Point:70%
    f. Rated Motor Power: 15 HP, 480V, 3 Phase, 60 Hz.
    g. Motor Speed: 3500 RPM nominal
2. Forged steel flanges shall conform to material specification ASTM A-105 Class 60 and/or ASTM A-181 for carbon steel forgings and to the dimensions and tolerances of ANSI Standards B16.5 as amended in 1992 for Class 150 and Class 300 flanges.

2.11 PUMP SUPPORT STANDS

A. The pump support stands shall be structural steel C-channel, standard weight or steel plate bent to form a channel. The bent steel plate shall be of sufficient thickness to support the pump and motor. The base of the legs shall be continuously welded to the steel floor.

2.12 BOOSTER PUMPS - VERTICLE, CENTRIFUGAL DIFFUSER, MULTI - STAGE

A. The booster pumps employed within the station shall be of the vertical centrifugal diffuser type, multi stage, designed specifically for low flow/high head operation. The pumps shall conform to the detailed specifications as set forth below.

B. The pump suction/discharge chamber, motor stool and pump shaft coupling shall be constructed of cast iron. The impellers, pump shaft, diffuser chambers, outer discharge sleeve and impeller seal rings or seal ring retainers shall be constructed of stainless steel. The impellers shall be secured directly to the pump shaft by means of a stainless steel tapered split cone and locking nut. Intermediate and lower shaft bearings shall be Tungsten Carbide and Ceramic or Silicon Carbide. Pumps shall be equipped with a high temperature mechanical balanced cartridge seal assembly with Silicon Carbide/Silicon Carbide seal faces mounted in stainless steel seal components with EPDM or Viton elastomers.

2.13 PUMP MOTOR CONFIGURATION

A. The pump driver shall be a NEMA Design B, three phase, alternating current, (squirrel cage) induction motor, continuous duty rated with motor insulation as Class F for Class B Heat Rise.

B. Motor efficiencies shall be standard as stated in NEMA MG 1, 2011 Part 12, Table 12-12 for the motor enclosure, open or closed. Motor Service factor shall be 1.15 on the nameplate, reduced to 1.0 when used with variable frequency drives per NEMA MG 1 – 2011, Part 31.3.7. The motor enclosure shall be Open Drip Proof (ODP).

C. Motors of 600 volts or less shall meet the requirements of NEMA MG 1 2011 Part 31.4.4.2 for ability to sustain voltage spikes when used with variable frequency drives under usual conditions.

2.14 PIPING - TRANSMISSION

A. Piping shall be steel and conform to material specification ASTM A-53(CW) for nominal pipe size 4” and smaller and ASTM A-53(ERW) Grade B for nominal pipe size 5” and larger. Steel butt-welding fittings shall conform to material specification ASTM A-234 Grade WPB and to the dimensions and tolerances of ANSI Standards B16.9 and B16.28 respectively.

B. B. The piping sizes shall be as shown on the drawing.
1. Size 10” and below Schedule 40
2. Size 12” thru 20” Standard weight (.375" wall)
3. Size 24” and above - Standard weight (.500" wall)

2.15 PIPE WELDING

A. All welding shall be in accordance with standard AWS practices, with proper fillet section and continuity to assure a sound, watertight structure. All welds shall be sound and free from embedded scale or slag, shall have tensile strength across the weld not less than that of the thinner of the connected sections, and shall be watertight. Butt welds shall be used for all welded joints in line pipe assemblies. Fillet welds shall be used for flange attachment in accordance with AWWA C207. All welds in contact with soil or water shall be tested with a dye penetrant to assure the watertight integrity of the weld system. All pipe and fittings shall be welded by welders certified for ASME type IX pipe welding.

2.16 PIPE SURFACE PREPARATION

A. All piping inside and outside surfaces shall be prepared by grit blasting, or other abrasive blasting, prior to any welds taking place to minimum SP-6 finish.

2.17 PIPE CUTTING

A. Piping of 4" diameter and smaller may be cut by saw. Piping of 6" diameter and larger shall be bevel cut, and Oxyfuel or Plasma-arc cutting techniques shall be used to assure and facilitate bevel pipe cuts.

2.18 SADDLE CUTS AND WELDS

A. Saddle cuts in pipe made in preparation for a saddle weld of a pipe at an angle to a pipe shall be made with numerically controlled, plasma cutting machines. Similarly, saddle end cuts to pipes to make a saddle mating piece shall be done with the same numerically controlled plasma cutting equipment.

B. When the two saddle cut pieces are mated and welded with the MIG process, the internal finished weld shall be smooth and free of inclusions, crevices, and other corrosion sites.

2.19 PIPE WELDING TECHNIQUES

A. Pipe welds shall be performed by metal added, inert gas shielded arc welding (MIG) techniques wherein the weld heat settings, the wire feed speed, and the traverse speed of the work below the welding are numerically set to assure proper weld fusion and penetration and repeatable welds.

B. In all cases, short circuit transfer, spray transfer or pulse-arc transfer modes of the gas metal arc welding process shall be used.

C. When utilizing the short circuit mode, shielding gas consisting of 50% carbon dioxide and 50% argon gas shall be used. When utilizing the spray or pulse-arc transfer modes, a shielding gas consisting of 5% carbon dioxide and 95% argon shall be used.

D. In all cases, welding wire with a minimum tensile strength of 70,000 psi shall be employed.

E. All flange welds and butt welds of equal size pipe shall be a single continuous nonstop weld around the complete circumference of the pipe. Whenever possible, vertical up weld passes will be applied to all pipe welds. No vertical down weld passes will be allowed.

F. Completed pipe welded assemblies shall create no internal obstruction, restriction or create any unintended sources of water deflection.

G. Piping of 6” diameter and larger shall require a minimum of two (2) weld passes to complete each weld. The first pass, or root pass, shall be applied at the bottom of the bevel cut using the short circuit transfer welding mode, and the second pass, or cap pass, shall be applied over the root pass using the spray or pulse arc transfer welding modes to insure that at a minimum the total weld thickness shall be equal to thinnest of the two pieces being welded together.

H. The pipe shall be sand blasted, as specified elsewhere, before pipe weld and after pipe weld, before fusion bonded epoxy is applied.

2.20 WELD STANDOFFS

A. No welding shall be performed on fusion bonded coated piping after the coating process has been performed.

B. Where any piping is to be welded after the application of fusion bonded epoxy coating to the inside of the pipe, at the point of the weld, a weld standoff must be welded to the pipe prior to the coating. The weld shall be made to the standoff and not onto the pipe.

2.21 WALL PENETRATION COATING PROTECTIVE SLEEVE

A. Where a fusion bonded epoxy interior coated pipe passes through the wall section, prior to fusion bonded coating of that pipe, a pipe sleeve shall be welded over the pipe in the area where the pipe passes through the wall.

B. The sleeve shall be ½" inch thickness and fit closely over the transmission pipe. The sleeve shall be seal welded to the transmission pipe at each end with a full and continuous fillet weld.

C. Following the welding of the sleeve to the transmission piping, the sleeve welds and the sleeve shall be grit blasted to an SP-6 finish so the pipe is prepared for fusion bonded epoxy coating by the process specified elsewhere in these documents.

2.22 RISER PIPE VERTICLE SUPPORTS

A. The inlet and outlet vertical riser pipes shall be provided with two (2) structural steel, angle pipe supports welded to the weldment plates on the vertical riser pipe and to the floor. These supports shall be opposed by at least 120 degrees around the pipe. The minimum member size for these supports shall be 3" x 4" x 1/4" tubular steel.

2.23 FUSION BONDED EPOXY INTERNAL PIPE COATING

A. The internal surfaces of piping to be fusion bonded coated shall be grit blasted to an SP-10 finish with the finish profile required by the coating material manufacturer.

B. The internal, wetted surfaces of the steel transmission piping shall have applied to it a Fusion Bonded Epoxy Coating on the interior pipe surface. The coating shall be applied and meet the testing requirements of Table 1 and Table 2 with the exception of Table 2 section 7 per AWWA C-213.

C. The powder coating product shall be National Sanitation Foundation (NSF) Standard 61 certified material.

D. Prior to shipment of the station, the station manufacturer shall provide in writing to the Engineer certification that the fusion bonded epoxy coating has been applied to all internal surfaces of the steel piping using the proper method. Said certification shall show under the station manufacturer's letterhead:
   1. Date of application;
   2. Material manufacturer and product designation including a product data sheet for the coating;
   3. Applier of the fusion bonded coating, name, address, and phone number
   4. Notarized signature of an officer of the station manufacturing company stating the fusion bonded epoxy coating was applied to AWWA Standard C213-91 or the latest revision.

2.24 COATINGS - CORROSION PROTECTION

A. All interior and exterior surfaces of the exposed steel structure, transmission piping and fittings shall be grit blasted equal to commercial blast cleaning (SSPC SP6). Following fabrication all exposed surfaces of the station, interior and exterior, shall be coated according to the following requirements.

2.25 WELDMENT PRIME COATING

A. All weldments will be pretreated by hand to provide additional corrosion protection using the same product as the base coat. Following the pretreatment full coating application shall take place.

B. Base Coating
   1. The base coating shall take place immediately after surface preparation. The protective coating shall consist of a two-component, high solids, high build, fast drying epoxy system for protection and finishing of steel and having excellent corrosion resistant properties. The epoxy system shall be self-priming and require no intermediate coatings.

C. Top Coating
   1. Following the base coating application, a full finish coating application shall take place. The protective coating shall consist of a two-component, high solids, high build, fast drying epoxy system for protection and finishing of steel and having excellent corrosion resistant properties. The epoxy system shall be self-priming and require no intermediate coatings. The base and finish coats shall provide a total dry mil thickness of 8.0 mils.

D. Post Assembly Coating
   1. Following assembly and just prior to shipping, there shall take place a thorough cleaning of the floor of the station followed by a rolled on coating of the two part epoxy coating to cover over any scuffing or scaring that might have occurred during assembly.

E. Floor Coating and corrosion protection system

1. The exposed surfaces of the structural steel base shall have a non-skid coating of a two-component, 100% high performance aromatic polyurea spray elastomer system with zero VOC (Volatile Organic Compounds), 100% solid. The coating shall offer outstanding performance and superior elastomeric protection for various substrates. The coating shall be designed as a user-friendly product for moisture insensitive applications because of its pure polyurea chemistry and offer exceptional adhesion properties for properly prepared substrates. The high performance formulation shall produce an excellent skin formation for chemical resistance and moisture protection.

F. Both the Iso "A" Side and Resin "B" Side shall be preconditioned between 70-90°F before application. Iso "A" and Polyol "B" components must be pumped by low-pressure transfer pumps to a suitable high-pressure proportional pumping system.

TEMPERATURE SETTINGS:	
Iso "A" Block Heater:	140-160°F
Resin "B" Block Heater:	140-160°F
Hoses (Iso and Polyol):	140-150°F
Hydraulic Pressure Setting:	
Equipment Hydraulic Pressure:	2,000-2,500PSI

CHEMICAL TECHNICAL DATA:	
Mix Ratio by Volume: Gel Time:	1A:1B 6-9 Sec
Tack Free Time:	9-12 Sec
Viscosity (cps) @ 77°F	
"A" Iso Side:	1,000±100
"B" Resin Side:	370±50
Material Density (lbs/gal) @ 77°F "A"	9.5 lbs/gal
"A" Iso Side:	
"B" Resin Side:	

BASIC PHYSICAL PROPERTIES:		
All tests are performed by OCM Test Laboratories. • ISO 17025 Certified • American Association for Laboratory Accreditation (A2LA)		
Test Name	**Test Methods**	**Value**
Hardness Shore D	ASTM D2240	60±1
Coefficient of Friction	ASTM D1894	
Static		0.305
Kinetic		0.127
Dielectric Const.	ASTM D150	3.6
Dissipation Factor	ASTM D150	0.031
Volume Resistance	ASTM D257	2.3x1014 ohm cm
Elongation	ASTM D412	162%
Flexural Strength ASTM D790		2,630 PSI
Flexural Modulus	ASTM D790	0.056 MSI
Fungus Test	MIL-STD 810F	Pass
Pull-off Test–Adhesion	ASTM C297	
To Metal – No Primer		1,800 PSI
To Metal – XPM Primer		1,910 PSI
To Metal – LXSF515 Primer		1,870 PSI
Taber Abrasion (gm Loss/1000 cycles)	ASTM D4060	0.06980
Tear Strength	ASTM D624	783 PSI
Tensile Strength	ASTM D412	3,432 PSI
Water Vapor Trans.	ASTM E96	0.499 Grains/Hr Sq.Ft.

G. The chemical resistance testing for the coating shall be per ASTM D543 for immersion in fluids methods. Additional product certifications shall include USFDA Coatings for Incidental Food Contact Applications Certified by Keller and Heckman LLP and MIL-STD-810F.

2.26 SERVICE CONNECTIONS ON INTERNAL PIPING

A. All plumbed devices within the station eventually requiring service, such as meters, control valves, pumps and like equipment, shall be easily removed from the piping by the presence of appropriately placed and sufficient quantity of adaptors and couplings. No fewer than the quantity of couplings and adaptors shown shall be allowed.

2.27 RESTRAINING POINTS

A. The main inlet and outlet piping to the station shall each be provided with two (2) restraining points as welded on "eyes" or similar device welded to the underside of the base structure framing to facilitate the attachment of joint restraint tie rods or other device to be used in retarding any pipe movement at the connections.

2.28 COMPRESSION COUPLINGS

A. The station piping shall include a variety of compression type, flexible couplings to prevent binding and facilitate removal of associated equipment. In lieu of a compression coupling, a flanged coupling adapter (FCA) may be used.

B. All compression couplings or flanged coupling adapters (FCA) and flexible connectors/expansion joints shall include a minimum of two (2) zinc coated steel threaded rods across the joint with appropriate bolted restraining points.

2.29 ELASTOMER PIPE CONNECTOR

A. The inlet side of each booster pump shall include an elastomer connector to help isolate vibration and noise in the piping system. The elastomer connector shall be of single sphere design, constructed of neoprene and nylon with bias-ply tire reinforcing cord to provide a 225 psi working pressure rating to a minimum of 120 degrees F. The elastomer connector shall pass through the plate steel flanges designed to grip the connector so the connector seals without gaskets when the flange bolts are drawn up.

B. A control joint limiting pipe connector movement shall be supplied with each pipe connector.

2.30 LINE PRESSURE GAUGES

A. Combination pressure gauges shall have a built-in pressure snubber and have 4 1/2" minimum diameter faces and turret style case, black fiberglass-reinforced thermoplastic with a clear acrylic window with Buna-N gasket. The movement shall be rotary; the bourdon tube shall be copper alloy C-type. The gauge shall have a 1/4" MNPT lower mount process connection and contain a 0.6mm copper alloy restrictor. Combination pressure gauge range and scale graduations shall be in psi and feet of water. Gauge ranges shall be as follows:

Suction Pressure Range: 0 – 100 PSI or 0 – 231 feet of water

Discharge Pressure Range: 0-200 PSI or 0 – 462 feet of water

B. All gauges will be panel mounted off the pipeline and be connected to their respective sensing point. The gauge trim tubing shall be complete with both isolating and vent valves and the tubing shall be so arranged as to easily vent air and facilitate gauge removal.

C. Gauges mounted directly to the pipeline or at the sensing point will not be accepted.

2.31 STATIC AND SENSING LINES

A. All gauge, switch and transmitter sensing lines shall be minimum 1/4" OD white polypropylene tubing run from the sensing point and a ball valve to the point of device mounting.

B. The pilot tubing shall be run in a workmanlike manner with elastomeric/stainless steel mounting straps to securely hold the tubing to be free of stress and vibration. The alignment and organization of the sensing lines shall be continuously rising.

2.32 SAMPLE TAP

A. A single, right angle outlet, smooth nose, brass sample tap shall be affixed to the suction header.

2.33 HOSE BIBB WITH VACUUM BREAKER

A. There shall be provided a standard hose bibb with valve and vacuum breaker on the discharge piping. The hose bibb connection shall be through a pressure regulator.

2.34 BALL VALVES

A. Ball valves will be 2-piece, full-port design with blow-out proof stem. The seats, packing and seal shall be PTFE. Ball valves shall be provided with an adjustable stem packing nut. The body and retainer shall be lead free brass (DZR). The ball shall be lead free brass (DZR), chrome plated for sizes ¼"-1" and 316SS for sizes 1-1/4"-4". The handle shall have a distinctive white "lead free" handle grip and blue "lead free" hanging tag. The valves will be NPTxNPT threaded pattern. Maximum working pressure shall be 600 psi up to 2" and 400 PSI for sizes 2-1/2" to 4".

2.35 BUTTERFLY VALVES

A. Valve body shall be one-piece wafer design. Flange locating holes shall be provided on wafer bodies to allow for quick and precise alignment during valve installation. Flange hole drilling per international flange standard as specified. A non-corrosive bushing and a self-adjusting stem seal shall be provided. No field adjustment shall be necessary to maintain optimum field performance.

B. The disc edge and hub on metal discs shall be spherically machined and hand polished for torque and maximum sealing capability. Disc shall be Nylon 11 coated ductile iron.

C. The stem shall be one-piece design. Disc to stem connection shall be and internal double "D" design with no possible leak paths in the disc-to-stem connection. External disc-to-stem connections such as disc screws or pins are not allowed. Stem shall be mechanically retained in the body neck and no part of the stem shall be exposed to the line media.

D. The seat shall be tongue-and-groove seat with a primary hub seal and a molded flange O-ring for weld-neck and slip-on flanges. The seat shall totally encapsulate the body isolating it from the line media and no flange gaskets shall be required.

E. The valve shall be rated for bubble-tight shut-off at pressures of 175 PSI for 2"-12" and 150 PSI for 14"-20".

F. Valve manufacturer:
1. Bray Series 30/31
2. Keystone

2.36 MANUAL VALVE ACTUATORS

A. Manually operated butterfly valves size 6” and smaller shall be equipped with lever style operators capable of withstanding 450 ft. lbs. of input torque and mounted to the valve trunnion with 4 bolts.

2.37 SILENT CHECK VALVES - WAFER STYLE

A. Silent check valves shall be wafer style, non slam and fabricated to set between ANSI Class 150 flanges.

B. B. The body of the check valve shall be cast iron. The plug and seat shall be bronze and conform to ASTM Designation B 584. The seat shall contain a Buna-N seal to provide zero leakage. The seal design shall provide for both a metal to metal low and high pressure without over-loading or damaging the Buna-N seal. The guide bushings shall be bronze copper alloy and conform to ASTM Designation B-584. The valve spring and seat retainers shall be stainless steel and conform to ASTM Designation A 313. The valve plug shall be guided at both ends by a center shaft integral with the valve plug. Alignment of the center shaft shall be provided by guide bushings.

C. C. Silent Check Valve manufacturer:
1. Val-Matic Model 1400
2. APCO

2.38 METER ISOLATING GATE VALVE

A. The meter isolating valve shall be a full ported gate valve meeting the requirements of AWWA C-515. The body, bonnet, wedge, and seal plate shall be ductile iron in accordance with ASTM A536. The wedge shall be totally encapsulated in rubber. The rubber coating shall be permanently bonded to the ductile iron wedge casting and shall meet ASTM D429 tests for rubber to metal bonding. No paint shall be allowed in the wedge and the wedge must not be hollow. All gaskets shall be O-ring seals. All fasteners are to be 304 stainless steel. The body, bonnet and seal plate shall be epoxy coated in accordance with ANSI/AWWA C550 certified to NSF 61. The coating shall be on the interior and exterior of the valve.

B. The valves are to be non-rising stem with handwheel operator, opening left. The valve body shall be flanged and drilled to ANSI B16.1, Class 125. Valve maximum working pressure rating shall be 250 psi.

2.39 HYDRAULIC ACTUATED CONTROL VALVES - GENERAL

A. The valve configuration shall be hydraulically operated, single diaphragm actuated. The valve shall consist of three major components: the body with seat installed, the cover with bearing installed, and the diaphragm assembly. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure. Packing glands and/or stuffing boxes are not permitted and there shall be no pistons operating the main valve or pilot controls. Valve body and cover shall be epoxy coated. The stainless steel seat with integral bearing shall be of the solid, one piece design.

B. The diaphragm assembly shall contain a non-magnetic stainless steel stem of sufficient diameter to withstand high hydraulic pressures. The stem shall be fully guided through its complete stroke by a removable bearing in the valve cover and an integral bearing in the valve seat. No center guides shall be permitted. The stem shall be drilled and tapped in the cover end to receive and affix such accessories as may be deemed necessary.

C. The flexible, non-wicking, FDA approved diaphragm shall consist of nylon fabric bonded with synthetic rubber compatible with the operating fluid. The diaphragm shall be fully supported in the valve body and cover by machined surfaces which support no less than one-half of the total surface area of the diaphragm in either the fully open or fully closed position.

D. The pilot control system shall include CK2 isolation valves and a closing speed control. Pilot controlled sensing shall be upstream of the pilot system strainer so accurate control may be maintained if the strainer is partially blocked.

E. The pressure relief pilot shall be a direct-acting, adjustable, spring-loaded, diaphragm valve designed to permit flow when controlling pressure exceeds in the adjustable spring setting. The pilot control is normally held closed by the force of the compression on the spring above the diaphragm and it opens when the pressure acting on the underside of the diaphragm exceeds the spring setting. The pressure relief valve shall be supplied with the Dura-Kleen® stem (KD option).

F. A valve position indicator shall be installed on the main valve cover and shall consist of a brass indicator rod fastened to the main valve stem which moves up and down inside a clear Pyrex tube contained in a bar brass housing open on two sides to permit clear vision of the brass indicator rod.

G. The pressure relief valve shall be a Cla-Val Model 50G-01.

2.40 PUMP STRAINER

A. Each pump shall be equipped with a strainer on the suction pipe. The strainer shall be ANSI Class 150 flanged rated for 250# operating pressure. the strainer body material shall be ANSI 16.42 Ductile iron with epoxy coating. the strainer shall 316 stainless steel 10 mesh/2000 micron/0.078 inch openings. he cap hardware shall be stainless steel with a lid sealing gasket of Buna N.

B. The strainer shall be a Cla-Val Model X43H.

2.41 MAGNETIC FLOW METER

A. A magnetic flow meter shall be installed in the common discharge line, sized as shown on the plans. The flowmeter shall be of the low frequency electromagnetic induction type and shall produce a DC pulse signal directly proportional and linear to the liquid flowrate. The meter shall be designed for operation on 24 VDC + 1-10%, 60 Hertz with a power consumption of less than 15 watts.

B. The meter shall be provided with a neoprene liner, metering tube and electrodes of 316 stainless steel construction. Ultrasonic cleaning of the electrodes shall be provided. The electronics portion of the magnetic flowmeter shall include both a magnetic driver to power the magnetic coils and signal converter. The output signal shall be 4-20 MA D.C. analog frequency.

C. The signal converter shall be completely solid state with integrated circuitry.

D. The meter shall be hydraulically calibrated and shall be in accordance with the national bureau of standards. The accuracy of the metering system shall be 1% of rate for maximum range settings of 3 to 31 feet per second.

E. Complete zero stability shall be an inherent characteristic of the meter system to eliminate the need to zero adjust the system with a full pipe at zero flow.

F. The magnetic meter shall be Tek-Trol series 1400 or approved equal.

2.42 PROPER METER INSTALLATION

A. The station manufacturer shall be required to have the approval of the meter manufacturer for each of the meter installations attesting to the fact that stated accuracy limits will be met.

B. Substituting another manufacture's meter with different and more upstream-downstream straight pipe run diameters being required will change flow meter accuracy to below the stated accuracy limits.

2.43 SODIUM HYPOCHLORITE FEED SYSTEM

A. Metering Pump
1. Shall be a positive displacement, peristaltic type tubing pump with a variable speed motor, non-spring loaded roller assembly located in the pumphead, integral tube failure detection system, and flexible tubing with attached connection fittings.
2. There shall be no valves, diaphragms, springs, or dynamic seals in the fluid path. Process fluid shall contact the pump tubing assembly and connection fittings only.
3. Capable of self-priming at the rated maximum pressure.
4. Capable of running dry without damage.
5. Suction lift shall be 30 feet of water.
6. Pump shall have a one year manufacturer's warranty that includes chemical damage to the pump head and roller assembly caused by a ruptured pump tube assembly.
7. Metering pump shall be JESCO MENDOS LB SERIES or approved equal.

B. Chemical Feed Pumping
1. All piping shall be Schedule 80 PVC installed by the station supplier. Piping shall be designed and installed to provide optimum pump operation and ease of maintenance. Piping layout shall prevent the entrapment of chemical between any closed sections of the system without a relief system. Piping system shall be specifically designed to reduce the entrance of bubbles to pump suction.
2. Unions shall be provided each side of pumps, pressure relief valves and back pressure sustaining valves. All valves shall be true union type with drilled and de-burred balls to prevent the buildup of pressure inside the ball when the valve is closed. Valves shall be provided to allow drainage of chemical prior to servicing equipment. Pressure relief piping shall provide operator with visual indication of relief without spillage. Piping configuration shall vent pressure relief and calibration column to sight glass and storage tank.

3. A 1.5” clear PVC sight glass/suction accumulator shall be provided in pump suction line of adequate height to show liquid level in tank. Configuration of piping to sight glass shall vent gas bubbles from pump supply before the pump suction. Piping and components shall be supported by corrosion resistant brackets and fasteners.
4. The output piping shall be passed through the side wall of the station at an escutcheon plate. Outside the station shall run the Sch. 80 PVC line to the point of injection and into a Corporation Stop inserted at the 3/9 o’clock position on the pipe. The Corporation Stop and a perforated injection quill with safety chain will all be supplied by the pump station manufacturer for field installation by the contractor.

2.44 PRESSURE TESTING

A. When the station plumbing is completed, the pressure piping within the station (including valves, pumps, control valves, fittings and connections that make up the entire system) shall be hydrostatically tested at a pressure of 150 psi or a pressure equal to the lowest test pressure rating of the equipment within the tested system, whichever is lesser pressure. The test pressure shall be applied for a minimum of 20 minutes, during which time all joints, connections and seams shall be checked for leaking. Any deficiencies found shall be repaired and the system shall be retested.

B. The results of this testing shall be transmitted in writing to the Engineer prior to shipment of the station and shall note test pressure, time at full pressure and be signed by the Quality Control Manager or test technician.

2.45 ELECTRICAL DESIGN, ASSEMBLY & TEST

A. The electrical apparatus and control panel design, assembly, and installation, and the integration of component parts will be the responsibility of the manufacturer of record for this booster pumping equipment. That manufacturer shall maintain at his regular place of business a complete electrical design, assembly, and test facility to assure continuity of electrical design with equipment application. Control panels designed, assembled, or tested at other than the regular production facilities or by other than the regular production employees of the manufacturer of record for this booster pumping equipment will not be approved.

2.46 CONFORMANCE TO BASIC ELECTRICAL STANDARDS

A. The manufacturer of electrical control panels and their mounting and installation shall be done in strict accordance with the requirements of UL Standard 508A and the National Electrical Code (NEC), NFPA 70 latest revision so as to afford a measure of security as to the ability of the eventual Owner to safely operate the equipment.

B. No exceptions to the requirements of these codes and standards will be allowed; failure to meet these requirements will be cause to remove the equipment and correct the violation.

2.47 U.L. Listing

A. All service entrance, power distribution, control and starting equipment panels shall be constructed and installed in strict accordance with Underwriter's Laboratories (UL) Standard 508A "Industrial Control Equipment." The UL label shall also include an SE "Service Entrance" rating stating that the main distribution panel is suitable for use as service entrance equipment. The panels shall be shop inspected by UL, or constructed in a UL recognized facility. All panels shall bear a serialized UL label indicating acceptance under Standard 508A and under Enclosed Industrial Control Panel or Service Equipment Panel.

B. A photocopy of the UL labels for this specific project shall be transmitted to both the project engineer and the contractor for installation within their permanent project files, prior to shipment of the equipment covered under these specifications.

C. Each completed control panel shall bear a listing label stating that the panel conforms to UL STD 508A. The listing label shall include the manufacturer's name, address, and telephone number.

2.48 EQUIPMENT GROUNDING

A. Each electrical equipment item in the station shall be properly grounded per Section 250 of the National Electrical Code. Items to be grounded include, but are not limited to, pump motor frames, control panel, transformer, convenience receptacles, dedicated receptacle for heater, air conditioner, dehumidifier, lights, light switch, exhaust fans and pressure switches.

B. All ground wires from installed equipment shall be in conduit and shall lead back to the control panel to a copper ground buss specific for grounding purposes and so labeled. The ground buss shall be complete with a lug large enough to accept the installing electrician's bare copper earth ground wire. The bus shall serve as a bond between the earth ground and the equipment ground wires.

2.49 PANEL MOUNTING HARDWARE

A. Metal framing channel and hangers shall be used exclusively for mounting of electrical panels and electrical components except for those specifically designated otherwise. When mounting panels in buildings with ¾" plywood interior sheathing, certain panels and components may be mounted by screwing these devices into the wall. The maximum weight of a panel mounted with four lag screws cannot exceed 250#. The lag screws must either be 5/16" or 3/8" diameter and be fully threaded.

2.50 ELECTRICAL SERVICE

A. The incoming electrical service provided for this station will be 480 volt, 1 phase, 3 wire, 60 Hertz, electrical service.

2.51 VARIABLE FREQUENCY DRIVE (VFD)

A. General Description
   1. VFD's shall be used to convert single phase power to three phase power to run the pumps.
   2. The VFD's shall convert the input AC mains power to an adjustable frequency and adjustable voltage as defined in the following sections.
   3. The input power section shall utilize a full wave 6-pulse bridge design incorporating diode rectifiers. The diode rectifiers shall convert AC line power of fixed voltage and frequency to fixed DC voltage. This power section shall be insensitive to phase sequence of the AC line voltage.
   4. The DC bus shall have external connections for external braking and allow for customer common DC Bus for multiple drive regeneration.
   5. The output power section shall change fixed DC voltage to adjustable frequency AC voltage. This section shall utilize insulated gate bipolar transistors (IGBT's).

B. Quality Assurance
   1. The manufacturer of the VFD shall be a certified ISO 9001 and ISO 14000 facility.
   2. The VFD, including its internal electronic thermal overload protection circuit, shall be UL and cUL Listed in accordance to UL 508C - Power Conversion Equipment.
   3. UL / cUL labels shall be attached on the outside of each VFD as verification.
   4. The VFD shall be designed in accordance with NEMA, IEC, EN, UL, and CSA standards.
   5. The VFD manufacturer shall have 20 years of experience, minimum, in the design, construction and application of variable frequency drives.
   6. The VFD manufacturer shall have an existing service organization.

7. The manufacturer of the VFD shall have the ability to design and manufacture insulated gate bipolar transistors (IGBT) to be incorporated into the construction of the VFD.
8. The manufacturer of the VFD shall have the ability to evaluate any component failure at their own analysis lab. The services available shall include x-ray magnification of components, complete electrical testing, and the ability to analyze failures within the components.

C. Construction
1. The VFD shall be rated UL Type 1 and shall be UL Listed as a plenum rated VFD.
2. The VFD shall employ built-in RS-485 communication via an RJ45 connection or terminal block.
3. The VFD shall employ built-in Modbus-RTU communication via a terminal block connection.
4. The VFD shall employ a standard control panel with built-in parameter copy functionality.
5. The VFD shall utilize one (1) connector slots for internally mounting plug-in options.
6. The VFD shall employ a removable control terminal block.
7. The VFD shall employ sink/source selectable control logic.
8. The VFD shall employ modular cooling fans – no tools required to exchange (up to 75Hp).
9. The VFD shall include a standard DC link reactor.

D. Application Data
1. The VFD shall be sized to operate a Variable Torque load.
2. The speed range shall be from a minimum speed of 0.5 Hertz to a maximum speed of 400Hertz.

E. Environmental Ratings
1. The VFD shall be designed to operate in the following Ambient Temperature range: Non-freezing.
    a. Variable Torque and Constant Torque loads: –10C to +50C (14 to 122F).
2. The storage temperature shall be –20C to +65C (-4 to 149F), non-condensing. Applicable for short periods, such as during transit.
3. The maximum relative humidity shall be 90% at 50C (122F), non-condensing.
4. The VFD shall be rated to operate at altitudes less than or equal to 1000m (3280ft). For altitudes above 1000m (3280ft):
    a. Sizes up to 75Hp: Reduce the rated output current (Amperes) by 3% for every 500m (1640ft), up to 2500m (8200ft) maximum (91% of rated).
    b. Sizes 100Hp and larger: Reduce the rated output current (Amperes) by 2% for every 500m (1640ft), up to 3000m (9842ft) maximum (92% of rated).

c. Consult factory for higher altitudes.

5. The VFD shall be designed according to IEC 60068-2-6 to resist vibration.

F. VFD Ratings

1. The VFD shall be designed for operation with the following input voltages.
   a. FR-F720, 1Hp to 75Hp: 170-242Vac 50HZ, 170-264Vac 60Hz, 200-240Vac (+10%/-15%).
   b. FR-F740, 1Hp to 800Hp: 323-528Vac 50/60Hz, 380-480Vac (+10%/-15%).
2. The speed range shall be from a minimum of 0.5 Hz to a maximum of 400Hz, adjustable by increments of 0.01Hz. Operation above 60Hz shall require programming changes to avoid over speeding the application.
3. The input voltage frequency range shall be 47.5 to 63 Hz.
4. The displacement power factor shall not be less than 0.93 with optional DC line reactor at 100% load factor. (DC reactor included as standard for VFD's.)
5. The efficiency of the VFD at 100% speed and load shall not be less than 95%.
6. The VFD shall conform to the European Union ElectroMagnetic Compatibility directive, CE labeled. The VFD shall meet product standard EN61800-3 for Second (2nd) Environmental.
7. Frequency precision shall not be less than:
   a. Using analog input: Within +/- 0.2% of maximum output frequency. (25C +/-10C)
   b. Using digital input: Within +/- 0.01% of set output frequency.
8. The Over-current capacity shall be:
   a. Variable torque (LD): 120% for 1 min or 150% for 3sec, at 50C (continuous).
   b. Variable torque (SLD): 110% for 1 min or 120% for 3sec, at 40C (continuous).
9. The VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency.
10. The Speed Control Range shall be:
    a. 20:1 while running between 3 and 60 Hz.

G. Protection

1. The VFD shall be UL 508C Listed for use on distribution systems with 65kArms available fault current, based upon the UL short-circuit test.
2. Upon power-up and before operational control is allowed to begin, the VFD shall check for valid operation of memory, pre-charge circuit, fan operation, and option board communication.
3. The VFD shall be protected against short circuits between the output phases & ground and the logic & analog outputs.
4. Once operational, monitoring shall continually take place and an abnormality will result in an alarm.
5. The following Circuit protection shall be allowed:

a. The VFD shall be rated for use with the appropriate UL class fuse.
b. Alternately, circuit breakers may be used, provided that they are listed or certified by an accredited electrical testing laboratory such as Underwriters Laboratories.

6. For a fault condition other than an internal fault, an auto restart function shall provide up to 10 programmable restart attempts. The programmable time delay before each restart shall range from 0 to 10 seconds.
7. The deceleration ramp of the VFD shall be programmable for normal and fault conditions. Stop modes shall include: dc injection braking, controlled deceleration to stop and coast to stop.
8. Upon loss of the analog speed reference signal:
   a. The VFD shall follow the programmed deceleration ramp to a controlled stop.
   b. Hold the VFD speed based upon the last good value and trigger a warning alarm.
9. The VFD shall have solid state I2t protection that is evaluated in accordance with UL 508C. The minimum adjustment range shall be from 0 to 150% of the current output of the VFD.
10. The VFD shall include Metal Oxide Varistors (MOVs) wired to the incoming AC terminals.
11. STOP key on the keypad shall be functional at all time, drive mode insensitive.
12. The VFD shall be insensitive to input power phase sequence.
13. The VFD shall include 3 skip frequency ranges that can each be programmed with a selectable bandwidth of the user's choice. The skip frequencies shall allow independent programming for back-to-back or overlap.
14. The output frequency shall be parameter setting enabled to fold back when the motor is overloaded.
15. The VFD shall monitor the main circuit capacitors, control circuit capacitor, in-rush suppression circuit, and cooling fan and shall provide a pre-alarm so that maintenance can be scheduled.
16. The VFD shall include an output timer function so that peripheral equipment maintenance can be scheduled.
17. The VFD shall include parameter selectable input and output phase loss protection.
18. The VFD basic insulation level shall be tested based upon ANSI/IEEE C62.41-1999.

H. Adjustments and Configurations

1. The VFD shall be factory pre-set to operate most common applications.
2. Choice of four (4) types of acceleration and deceleration patterns shall be available: linear, S-curve shaped – two types, and backlash compensated.
3. The acceleration and deceleration ramps shall be individually adjustable from 0.00 to 3600 seconds.
4. The volts per hertz ratios shall be user selectable.
5. The VFD shall store the last eight (8) alarm faults and data at time of fault. The data shall include output frequency, output current, output voltage and VFD operation time at fault occurrence.
6. The VFD shall have user programmable DC injection braking to stop the motor's rotation. DC injection braking voltage is adjustable between 0 to 30% and up to 10 seconds of continuous operation.
7. Cooling fan control shall be selectable: Operates continuously during run operation, and dependent upon temperature at stop.
8. The VFD shall have adjustable accel/decel ramp profiles.
9. The VFD shall have the ability to start into a reverse rotating motor (anti-windmill) and achieve the set speed.
10. The VFD shall have two (2) different selectable settings for accel/decel times, torque boost, base frequency, stall prevention frequency and current, and output frequency detection functions.
11. The VFD shall have coast to stop functionality by parameter setting.
12. The VFD shall automatically compute the motor's slip compensation.
13. The VFD shall be able to limit motor rotation to only one direction.
14. The VFD shall have two (2) output current detection functions which are able to trigger individual alarms.
    a. Zero current detection level.
    b. High output current detection.
15. The VFD shall include two (2) parameters for user entry. (Unit or machine number, install date).

I. Operational Features

1. The VFD shall allow the motor to be switched in sequence to line power when operating at the base frequency.
2. The VFD shall be able to start into a rotating motor (any speed or direction) and accelerate (decelerate) to set speed without tripping or component loss.
3. There shall be a regenerative avoidance function to minimize the effect of opposite rotation of another fan within the same duct.
4. The VFD shall allow for automatic optimization of the VFD output, during accel/decal and constant speed, characteristic based upon the application and load.
5. The VFD shall incorporate PID control for process controls such as flow rate, air volume, or pressure.
    a. The VFD shall include programmable PID shutoff for energy savings in low speed region. (PID sleep)

b. The VFD shall include the capability to monitor values of PID setpoint, process value, and deviation.
c. The VFD shall include PID forward/reverse operation switchover by external signal.

6. The VFD shall allow for controlled deceleration to stop following an input power loss.
7. The VFD shall include automatic pump sequencing, which will allow the VFD to sequence up to 4 pumps across the line without additional controllers or software.
8. The VFD shall contain three (3) skip frequency ranges that can be programmed within a selectable range of 0-400Hz with a minimum bandwidth of 0.01Hz. Each skip range shall be independently programmable.
9. The VFD shall be able to perform bi-direction rotation following a –10 to +10Vdc input.
10. The VFD shall be able to run for at set hold time at the start frequency to smooth motor start.
11. Communication options include:
    a. RS-485 (standard).
    b. Modbus RTU.
    c. LonWorks™
    d. CC-Link
    e. Profibus DP
    f. DeviceNet™
    g. Metasys-N2
12. The VFD output signals shall be able to be utilized in lieu of a remote output terminal of a programmable logic controller when the VFD is being controlled via RS 485 or network.

J. Operator Interface
1. Six (6) key Control Panel, with setting dial, shall be mounted on each drive and shall be removable & interchangeable regardless of the Hp rating. The customer control shall include the following functionality:
    a. Furnished with each VFD as standard.
    b. Batch parameter read, copy and verification functionality.
    c. Four (4) digit numerical display.
    d. Standard RS-485 communication through a RJ 45 port.
    e. Allows direct access for parameter changes.
    f. Includes an electronic parameter write disable feature.
    g. Stores/displays last four (4) alarm faults and data at time of fault. The data shall include output frequency, output current, output voltage and VFD operation time at fault occurrence.
    h. Forward, Reverse and Stop keys command normal starting and stopping as programmed when the VFD is in keypad control mode.
    i. Display of I/O and output terminal ON/OFF states.
    j. STOP key is functional at all time, drive mode insensitive.
    k. Can be mounted at a distance of 20 meters from the VFD.

2. Twenty-four (24) key parameter unit shall be available as an optional accessory and shall be removable & interchangeable regardless of the Hp rating. The customer control shall include the following functionality:
    a. Batch parameter read, copy and verification functionality.
    b. Standard RS-485 communication through a RJ 45 port.
    c. Alpha numeric LCD display.
        i. 4 Lines x 16 characters.
        ii. Adjustable LCD contrast.
    d. Includes a parameter write disable feature.
    e. Stores last eight (8) alarm faults and operation data (frequency, voltage, current, and VFD run time) at time of fault occurrence.
    f. Forward, Reverse and Stop keys command normal starting and stopping as programmed when the VFD is in keypad control mode.
    g. STOP key is functional at all time, drive mode insensitive.
    h. Can be mounted at a distance of 20 meters from the VFD.
    i. Eight (8) languages available selectable among English, Japanese, German, French, Spanish, Italian, Swedish and Finnish.
    j. Allows direct access for parameter changes individually, by function set and by user selected groups. Parameters can be listed by definition, factory default setting, or user changed values.
    k. Calibration of frequency meter or bias/gain settings.
    l. Arrow keys shall provide the ability to scroll through menus and screen, select or activate functions or change the value of a selected parameter.
    m. HELP functionality shall include the following:
        i. Monitoring of data: Running frequency, motor current, output voltage, set frequency, running speed (RPM), DC bus voltage, over-current load %, peak output current, peak dc bus voltage, input & output power used (kW), input and output signal state (ON or OFF).
        ii. Stores/displays last eight (8) alarm faults and data at time of fault. The data shall include output frequency, output current, output voltage and VFD operation time at fault occurrence.
        iii. Troubleshooting hints shall reference alarm definitions in plain English and point to applicable parameter settings.
        iv. Display of installed options and software version shall be available.
3. Computer interface via RS-485 option
    a. An optional VFD Software program shall be available which supports serial communication between a PC and network of 1 to 32 variable frequency drives (VFD's) through the Parameter Unit ports.
    b. Capabilities include:
        i. Edit drive parameters, transfer settings to and from the drive, and save them to disk.

ii. Monitoring of I/O, analog outputs, and VFD status using a variety of available displays.
iii. Diagnostics.
iv. Help screens that include detailed parameter descriptions.
v. Access to parameters grouped by function (for example, all parameters related to accel / decel, braking, or options).

K. Control

1. The control power for the digital inputs and outputs shall be 24Vdc, selectable to sink or source. Optional 120Vac control power for the digital inputs and outputs shall be available.
2. All logic connections shall be furnished on a removable terminal strip.
3. External devices shall be able to be connected to the terminal strip for starting/stopping the VFD, speed control and indicating operation status.
4. Speed command input shall be by means of:
   a. Keypad.
   b. Analog input.
   c. Serial communications.
   d. Floating point input shall accept a three-wire input
   e. There shall be three (3) parameter assignable analog inputs.
      i. The selection consists of the following configurations: 0-5Vdc, 0-10Vdc, 4-20mA dc, -5 to +5 Vdc, and –10 to +10 Vdc.
      ii. Two (2) terminals shall be selectable for either voltage or current reference input.
      iii. Combinations of the above speed references can be selected and be switched via remote terminal.
5. There shall be twelve (12) logic inputs that are parameter assignable.
   a. The selection consists of PTC, 15 preset speeds (up to four inputs), second functions, jog, current input selection, auto restart, external thermal relay, PID control, Advanced PID control to allow motor sequencing, PU to external switch-over.
   b. Optional 3-digit BCD or 12-bit binary input terminals (3) shall be available as relay contact or open collector signals.
6. Output signals shall consist of:
   a. Five (5) open collector outputs shall be available, which are parameter assignable and are optically isolated.
      i. Can be selected for positive or negative logic.
      ii. The selection of assignments shall consist of: Running, Up to speed, Power failure/Under-voltage, Overload, Output frequency detection (first & second), Electronic over-current pre-alarm, PU mode, Inverter ready, Zero current detection, PID upper limit, PID lower limit, PID reverse rotation output, Commercial power supply switch over (MC1-MC3), Fan fault, Fin (heatsink) overheat pre-alarm, Power savings, Minor and Major fault outputs as standard selections.

iii. The VFD's output terminals shall allow control through network commands.
iv. Optional relay output contact signals (3) shall be available and selectable.
v. Optional digital outputs (5) shall be available and selectable through open collector terminals.

b. Pulse or Analog output signal shall be selectable in the form of either:
i. Analog output signal, 4-20mAdc.
ii. Analog output signal, 0-10Vdc.

c. Two (2) Form (C) relay outputs with selectable Normally Open or Normally Closed alarm outputs shall be available.
i. Alarm terminals shall be individually parameter assignable.

L. Braking
1. The VFD shall provide terminals for adding an external braking unit to allow for dissipation of excessive electrical energy from the motor.
2. The following shall be available:
a. DC dynamic braking – Including adjustable operation frequency, time, and voltage.
b. External line regeneration.
c. Can be used for common bus systems for multiple drive regeneration.

M. Drive Operation
1. With the H-O-A switch in the "HAND" position, the drive shall be controlled by the manual speed potentiometer on the drive door.
2. With the H-O-A switch in "AUTOMATIC", the drive shall start from the automatic pump controller and its speed shall be controlled by a 4-20mA signal from this controller.
3. With the H-O-A switch in the "OFF" position, the run circuit will be open and the VFD will not operate.

2.52 SURGE PROTECTION DEVICE

A. A secondary surge arrester shall be provided. Housing shall be Noryl and be ultrasonically sealed. Valve blocks shall be metal oxide with an insulating ceramic collar. Gap design shall be annular. The lead wire shall be permanently crimped to the upper electrode forming part of the gap structure.

B. Arresters shall be UL and CSA listed Lightning Protective Devices.

2.53 ELECTRICAL CONDUIT AND WIRING

A. All service entrance conduits power and signal, shall be rigid steel conduit, individually sized to accept the inbound service conductors and telemetry/telephone/radio cables.

B. These service entrance conduits shall be installed from the main power or control panel through the capsule steel sidewall or the building floor and terminate exterior to the equipment enclosure as a thread hub. The service entrance exterior conduit connection points shall be capped or plugged for shipment.

C. All wiring within the equipment enclosure and outside of the panel enclosures shall be run in conduit except where watertight flexible conduit is properly used to connect pump drivers, fan motors, solenoid valves, limit switches, etc., where flexible connections are best utilized.

D. Devices and appliances where furnished by the original manufacturer and being equipped with a UL approved rubber cord and plug, may be plugged into a receptacle.

E. Equipment enclosure conduits shall be as follows: For pump room, use rigid metallic conduit (RMC) in accordance with Specification Section 16111, in minimum size 3/4" or larger, sized to handle the type, number and size of equipment conductors to be carried. For chemical room, use rigid Sch 80 PVC nonmetallic conduit (RNMC) in accordance with Specification Section 16111, in minimum size 3/4" or larger, sized to handle the type, number and size of equipment conductors to be carried.

F. The conduit shall be in compliance with Article 347 of the National Electrical Code and NEMA TC 2, Federal WC 1094A and UL 651 Underwriters Laboratory Specifications.

G. Where flexible conduit connections are necessary, the conduit used shall be Liquid tight, flexible, totally nonmetallic, corrosion resistant, nonconductive, U.L. listed conduit sized to handle the type, number, and size of equipment conductors to be carried in compliance with Article 351 of the National Electrical Code.

H. Motor circuit conductors shall be sized for load. All branch circuit conductors supplying a single motor of one (1) horsepower or more shall have an ampacity of not less than 125 percent of the motor full load current rating, dual rated type THHN/THWN, as set forth in Article 310 and 430 B of the National Electrical Code, Schedule 310 13 for flame retardant, heat resistant thermoplastic, copper conductors in a nylon or equivalent outer covering.

I. Control and accessory wiring shall be sized for load, type MTW/AWM (Machine tool wire/appliance wiring material) as set forth in Article 310 and 670 of the National Electrical Code, Schedule 310 13 and NFPA Standard 79 for flame retardant, moisture, heat and oil resistant thermoplastic, copper conductors in compliance with NTMA and as listed by Underwriters Laboratories (AWM),

except where accessories are furnished with a manufacturer supplied UL approved rubber cord and plug.

2.54 STATION EXTERIOR LIGHTING

A. An exterior light shall be provided over each door. The light shall be 3800 Lumens, 4000K, 70 CRI, LED, full cutoff, Dark Sky compliant. Housing shall be one piece, injection molded, bronze polycarbonate. A button type photo control and toggle switch on interior wall shall be provided.

2.55 STATION INTERIOR LIGHTING

A. Provide 4’ industrial Vaportite LED fixtures, 4000K, 80 CRI, enclosed and gasketed, installed within the equipment enclosure. Provide number of fixtures required to maintain an average foot candle level of 50. The light switch shall be of the night glow type and be located conveniently adjacent to the door.

B. Fluorescent or incandescent fixtures will not be accepted.

2.56 STATION 120V RECEPTACLES

A. Provide 120V, heavy duty, specification grade duplex receptacles for general use, in accordance with Specification Section 16141, along interior walls 10’ on center, with a minimum of (1) receptacle per wall. Provide additional dedicated receptacles, as required for installed equipment. Provide (1) exterior GFI receptacle with weatherproof cover 3’ from station entrance.

2.57 ELECTRICAL ACCEPTANCE TESTING

A. Provide the following power system studies for the pump station as required in Specification Section 16011:
   1. Short circuit study.
   2. Equipment evaluation study.
   3. Protective device coordination study.
   4. Arc-flash hazard analysis.

2.58 ELECTRICAL IDENTIFICATION

A. Provide tags/nameplates for electrical equipment and wiring in accordance with the requirements of Specification Section 16075.

2.59 GAUGE PRESSURE TRANSMITTERS

A. Pressure transmitters shall be supplied to measure pump station suction and discharge pressure. The transmitters shall sense gauge pressure and transmit a 4-20 mA dc signal. The instruments shall measure pressure of a predetermined span. Range is to be fully adjustable throughout using allowable span and range limits. The accuracy shall be ±0.20% of span.

B. Each transmitter shall provide an analog output and include a standard LCD with pushbuttons to provide Intelligent transmitter configuration directly from the on-board pushbuttons. The two-line digital indicator shall display the measurement in any selected units. The pushbuttons shall provide calibration of zero and span, setting of linear output, forward or reverse direction, external zero enable or disable, damping, failsafe action and local display including upper and lower range value selection.

C. All process-wetted parts of each instrument shall be Type 316L stainless steel. The transmitter shall be protected by a gasketed, weatherproof NEMA 4X enclosure.

D. The transmitter shall have 1/2 inch NPT female threaded tapping ports.

E. Gauge pressure transmitter manufacturer:
   1. Tek-Trol 3120 Series.

2.60 ELECTRICAL DEVICES

A. Multi-position switches including Hand Off-Automatic switches shall be oil tight, 3 position maintained, and be located on the main control panel door.

B. Indicating lights shall be oil tight, with a full voltage pilot light.

C. Nameplates shall be furnished on all panel front mounted switches and lights.

D. Switches, lights, and pushbuttons shall be Schneider Electric, Series XB, 22 mm, Die Cast Chrome plated devices. Pilot lights shall be with protected LED's for 120 Vac operation as XB4BVG, pushbuttons shall be non-illuminated, momentary contact, extended lens as ZB4BL and the switches shall be 2-position maintained, 2-position right-to-left, 3-position maintained, 3-position momentary-to-center, 3-position momentary from left to center, and 3-position momentary from right to center with standard black lever as ZB4BD.

E. Switches
   1. Pump #1, 3-position
   2. Pump #2, 3-position

F. Lights
   1. Red – Low Suction Pressure
   2. Green – Pump #1 in Operation

3. Green – Pump #2 in Operation
4. Green – Pump #3 in Operation
5. Red – High Discharge Pressure

G. The control panel door shall be complete on the interior with a stick-on transparency containing an "as-built" reproduction of the electrical control panel schematic. The wiring diagram shall be a corrected "as built" copy & contain individual wire numbers, circuit breaker numbers, switch designation & control function explanations.

2.61 TELEMETRY CONTROL INTERFACE PANEL

A. The station manufacturer shall provide the following for telemetry requirements:
1. 1" telemetry entrance conduit complete to telemetry panel.
2. Size 12" x 12" NEMA 12 Hinged Cover Enclosure – Type 2 telemetry interface panel, in accordance with Specification Section 16160.
3. Separate 120 volt single phase power circuit in conduit to the telemetry interface panel.
4. Metal framing channel to mount telemetry equipment.

B. Coordinate activation of cellular data service.

C. Provide radio path study from cellular provider with recommendation for antennas to be used on project.

D. Supplier of factory-built booster pump station shall be responsible for monthly charges related to the cellular data service throughout the pump station warranty period and shall coordinate the transfer of service to Owner when warranty period expires.

2.62 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A. Scope
1. Provide one (1) complete Programmable Logic Controller (PLC) based control system as described herein. The system shall employ industry standard Programmable Logic Controllers as described herein. The system shall be completely factory integrated and tested in the factory and field run-in with factory personnel.

B. Basis of Design PLC Equipment
1. Industrial Control Links Modulus Programmable Logic Controllers, no substitutions. Communications, interface, input/output and other peripheral devices have been proven to be 100% compatible.

2.63 GENERAL PLC SYSTEM REQUIREMENTS

A. Complete System Responsibility
   1. The Station manufacturer will assume full and complete responsibility for the Station PLC. Control System and related control functions for the full scope of supply.
   2. This assumption of full responsibility shall include identifying all electrical, mechanical, and plumbing schematics and wiring inter-connect diagrams, providing instrument installation details, preparing input/output listings, writing software, performing software and hardware integration, installation in the station at the factory, debugging, calibrating, and tuning the various components and subsystems and providing training and warranty services.

B. UL Listing Requirement
   1. The system integrator shall produce panels that fully comply with Underwriters Laboratory Standard for Industrial Control Panels #508A.
   2. All panels shall be UL 508A listed. The UL 508A "sticker" shall be clearly displayed in the appropriate location within the panel. The UL 508A listing shall be in the name of the equipment manufacturer.

C. System Integrator Facility & Staff
   1. The station manufacturer shall have on staff Control System Engineers who are dedicated to the development of PLC programs, SCADA software, Instrumentation configuration and control logic development. The system integrator shall have electrical engineers on staff dedicated to the development of panel wiring diagrams, panel layouts and general electrical design.
   2. The manufacturer shall have a field service department fully equipped, trained, and competent field service technicians able to work on any and all devices provided with this system.

D. Control Panel - Design, Assembly & Test
   1. The PLC panel design, assembly, the integration of component parts and startup will be the responsibility of the manufacturer of record for the factory-built water distribution equipment. That manufacturer shall maintain at its regular place of business a complete PLC design, assembly, and test facility to assure continuity of control design with equipment application.

2.64 GENERAL EQUIPMENT SPECIFICATIONS FOR PLC CONTROL SYSTEMS

A. Enclosures:
   1. Enclosures shall be NEMA 12 Hinged Cover Enclosure – Type 2 in accordance with Specification Section 16111 for indoor and NEMA 4 for outdoor locations. Enclosure shall be fabricated from a minimum of 14-gauge cold rolled steel with a baked enamel finish in the manufacturer's standard color. Units shall include a single gasket front door. Hinges, locking hasp and door clamping hardware shall be included.

B. Incoming Power Requirements & UPS:
   1. Controls shall operate from a source of 120 volts, 1 phase, 60 Hz. Each panel shall be accompanied with an uninterruptible power supply (UPS). The UPS shall condition the power as well as provide 500 VA of power during outages. A 6-amp control power circuit breaker shall be employed as both a method of equipment protection and as a means of power disconnection. The circuit breaker shall be a single pole, thermal, magnetic type with a 10,000 Amp Interrupt Current rating. The circuit breaker shall be UL listed.

C. Power Supplies:
   1. All DC power supplies required for operation shall be provided. Units shall provide sufficient voltage regulation and ripple control to assure powered components can operate within their required tolerances.

D. Wiring Requirements:
   1. All wiring shall be in complete conformance with the National Electrical Code, state, local and NEMA electrical standards. All incoming and outgoing wires shall be connected to numbered terminal blocks and all wiring neatly tied and fastened to chassis as required.

2.65 PLC COMPONETS

A. General
   1. Provide a programmable logic controller and associated cellular modem in a NEMA 12/3R Hinged Cover Enclosure in accordance with Specification Section 16160, at both the pump station and tank site, where shown on the Drawings.
   2. Confirm that there is reliable communication path between the pump station site and the existing water tank site using the equipment specified.
   3. PLC at tank shall send tank level status to PLC at pump station a minimum of one (1) time per minute.
   4. PLC at pump station shall shut down pumping at pump station if there is a loss of tank level status that lasts longer than (5) five minutes.

B. The following inputs/outputs shall be connected to the SCADA PLC at the pump station, plus 20% minimum expansion:

1. Digital Inputs:
    a. Pump 1 Run.
    b. Pump 2 Run.
    c. Pump 1 Fail.
    d. Pump 2 Fail.
    e. Pump 1 in Auto.
    f. Pump 2 in Auto.
    g. Power Fail.
    h. Intrusion.
    i. Flood.
    j. Totalized Flow.
2. Digital Outputs:
    a. Pump 1 Start.
    b. Pump 2 Start.
    c. Chemical Pump On.
3. Analog Inputs:
    a. Pump 1 Speed.
    b. Pump 2 Speed.
    c. Suction Pressure.
    d. Discharge Pressure.
    e. Chemical Pump Feed Back.
    f. Chemical Tank Level.
    g. Flow Rate.
4. Analog Outputs:
    a. Pump 1 Speed Command.
    b. Pump 2 Speed Command.
    c. Chemical Pump Speed Command.

C. The following inputs/outputs shall be connected to the SCADA PLC at the existing tank site, plus 20% minimum expansion:
1. Digital Inputs:
    a. Photovoltaic System Error.
2. Digital Outputs:
    a. Two Digital Outputs.
3. Analog Inputs:
    a. Tank Level.
4. Analog Outputs:
    a. Two Analog Outputs.

D. Each controller shall consist of one or more interconnected modules on a common bus. Each module shall be capable of standalone operation or coordinated operation with up to 253 other modules on the shared bus. Each module shall have:
1. Local I/O
2. I/O Expansion Capability
3. Ethernet and at least one serial port
4. Alarming by Text Messaging and E-mail

5. OLED Human Machine Interface (HMI) on the front face
6. Graphical Web Human Machine Interface (HMI)
7. Text Message/E-mail Human Machine Interface (HMI)
8. Historical Trending and Retrieval
9. Report Generation
10. Floating point and 32-bit integer math
11. Programmable Logic – Ladder Logic, Function Block and Text
12. PID Control
13. Triplex Pump Control

E. Each module shall be fully configurable with just a standard web browser. No other software programs or applications shall be required. There shall be no licenses or software fees. Each module shall support configuration by PC computer, laptop, tablet, or smart phone.

F. Any modules configuration web pages shall be accessible via a web browser device connected to any module on the bus.

G. Each module shall accept DC power shall ranging from 10Vdc to 30Vdc. An AC power supply shall be available that snaps onto the DIN rail bus, powering Each modules with no DC power wiring.

H. Each module shall be DIN rail mounting on standard 35mm DIN rail. A snap-in connector which interconnects data and power to form a common controller bus shall be provided with Each module.

I. The controller bus shall be extendable over a distance of up to 1000 feet using a pair of shielded twisted-pair cables.

J. Each module shall be rated for operation in harsh environments with an operating temperature range of -40oC to +70 oC.

K. The internal circuitry of every module shall have a protective conformal coating for improved reliability and operation in dirty and corrosive environments.

L. All internal connector contacts shall be gold plated.

M. The modules shall have no DIP switches or potentiometers.

N. Each module shall provide a built-in web-based configuration backup and restoration/cloning mechanism.

O. All controller modules and associated components shall be backed by a factory parts and labor warranty of at least 3 years.

P. The controller shall be Modulus modules from Industrial Control Links, Inc., Roseville, CA

Q. I/O

1. Each module shall provide a mix of analog and/or discrete input and output points directly accessible by any other module on the bus.
2. All local discrete inputs and outputs shall include signal presence indicators on a local OLED display.
3. All local analog inputs and outputs shall include percent-of-full-scale level indication on a local OLED display.
4. The state or level of every I/O point shall be "forcible" from the front panel HMI of the module as well as via the built-in web interface.
5. Each module shall provide access to at least 500 discrete and 500 analog I/O points to/from any other I/O modules on the bus.

R. Communications

1. Each module shall include at least one Ethernet port and one serial port. Some modules will have additional ports as well as built-in radios and modems as described in their individual I/O specifications.
2. Each module, via any local serial port or the first general purpose serial port in any other module, shall support communications utilizing any of the following industry standard register data exchange protocols:
    a. Modbus RTU - Master and Slave
    b. DF1 - Slave (Allen-Bradley)
    c. SDX - Master and Slave (AES-128 encryption)
    d. SNP - Master (GE)
3. Each module, via a local Ethernet port, or internal cellular modem if present, shall support simultaneous IP based communications utilizing any of the following industry standard protocols:
    a. Modbus TCP/IP and UDP - Master and Slave
    b. Ethernet IP - Master and Slave (Ethernet port only)
    c. MQTT - Publisher and Subscriber, includes support for Sparkplug B
    d. SDX - Master and Slave (AES-128 encryption)
    e. HTTP
    f. FTP - Server and Client
    g. TFTP - Server
    h. E-mail - Client (POP3/SNMP)
    i. NTP- Client
    j. DHCP (Server and Client)
    k. ICMP
4. When acting as a master, Each module shall support communications with up to 32 slave devices. Each module shall support both polled and on-change communications with any slave device.
5. Each module shall provide IP routing services to up to 8 module Ethernet devices per module.
6. Each module shall provide Ethernet - Serial Port bridging services
7. Each module shall automatically maintain and display by web page, the communications statistics for all Master and Slave communications, including but not limited to:

a. Current communications Status
b. Number of Transmitted Messages
c. Number of Successfully Received Messages
d. Number of Communications Failures
e. Last and maximum round-trip message latency

8. Each module shall automatically detect, log, and optionally alarm all communications link failures for all master and slave communications.

S. Oled HMI Display and Keypad

1. Each module shall have a built-in OLED HMI
2. The OLED HMI display shall be graphical with variable size fonts of up to 4 lines of 20 characters each
3. The OLED HMI display shall have a configurable automatic shut-off with no keypad activity
4. The OLED HMI shall be configurable for read/write access to up to 50 user selected variables within Each, with configurable rolling scan display of any or all of these variables.
5. The OLED HMI shall display the state or level of every discrete or analog local I/O point and provide for forcing the value of any of these points.
6. The OLED HMI shall annunciate any and all alarms, and allow for acknowledgement of alarms.

T. Graphical Web HMI

1. Each module shall provide a built-in graphical user interface which can be configured with and whose final end-product web pages can be used with any standard web browser on desktop PCs, laptops, tablets, and smart phones.
2. Each module shall include all of the tools required to create the graphical HMI web pages including a web-based graphical drag-and-drop editor and a complete library of high-resolution graphical SCADA elements. All graphical elements shall be in Scalable Vector Graphics (SVG) format for lossless scaling. At a minimum, the library shall contain the following elements:
   a. Register displays and entry elements
   b. Links to other HMI pages and external web sites
   c. Display of user graphics and documents
   d. Display of live video feeds
   e. Embedded trend charts and trend display tools
   f. Display of alarms with time stamps, individually and in an automated “grid”
   g. Bar graphs and color panels
   h. Buttons, Switches and Lights
   i. Chasers (animated flow displays)
   j. Meters
   k. Pipes
   l. Tanks
   m. Valves

n. Pumps and Fans
o. Slider Controls

3. The Graphical Web HMI shall support custom user-supplied graphics in standard formats including JPEG, TIFF, BMP, and PNG formats.
4. Each HMI page and every element on an HMI page may be assigned a security access level to control who can see individual pages or elements on a page, and who can make value changes to controlled elements.

U. Mobile HMI
1. Each module shall provide a built-in textual mobile Interface for small screen devices such as cell phones.
2. The mobile interface shall be capable of displaying and optionally modifying up to 50 internal register values (Boolean, 32-bit integer, and floating point), as well as alarms.
3. The mobile interface shall provide for customization of verbiage and colors for display of Boolean states.
4. Each module shall include all of the tools required to create the mobile HMI displays without programming.
5. The mobile interface shall support user access control for security.

V. Alarming
1. Each module shall annunciate alarms by text message and e-mail via Ethernet Internet connection, or cellular Internet connection if available locally or on another module accessed over the bus.
2. Each module shall support detection and annunciation of at least 500 user configurable alarm conditions and 200 system detected alarm conditions.
3. Each module shall support acknowledgement of alarms by messaging, web page, Boolean register, and discrete input.
4. Each module shall support grouping of alarms by category; up to eight groups.
5. Each module shall annunciate alarms to up to 64 contacts with individually configurable schedules and associated alarm groups.
6. Unacknowledged alarms shall be re-annunciated at a user configurable interval, for a user configurable number of attempts.
7. Alarms that have not been acknowledged after a user selectable number of attempts shall automatically be re-alarmed to a second “elevated” group of contacts.
8. Each module shall include a daily self-test function that verifies alarming operation from Each module through to any or all groups of alarm contacts.

W. Trending
1. Each module shall record up to 63 traces (“pens”) of I/O and register data on a standard micro SD memory card.
2. All trend data shall be recorded at a user selectable rate of 1 second and 8 seconds.

3. At an 8 second recording rate, Each module shall record all 63 channels of data for at least 120 years without memory card reset, formatting or replacement.
4. Each module shall include the graphical tools to display trend data as a continuously updating strip chart, and historical data with user selectable start and end dates.
5. Each module shall provide for at least 8 trend groups to associate common trend data points together and regulate the data access by user type.
6. Each module shall provide for easy retrieval of recorded trend data with selectable date range and data resolution as standard CSV files compatible with most spreadsheets and data base programs. Retrieval shall only require a web browser. No separate programs or applications shall be required.
7. Each module shall provide for automatic formatted display of historical trend data in automatic and manually triggered reports. (see Reporting).
8. Each module shall provide a means of automatically transferring trend data as files to a Host computer system using FTP protocol and e-mail without operator intervention.
9. Each module shall display the percentage of trending storage used on a user status web page.

X. Event Logging
1. Each module shall provide 800KB of built-in storage for user-defined events in a user defined format.
2. The event log storage shall be “circular”, where the oldest data is overwritten first.
3. Each module shall provide for easy retrieval of recorded event log data as standard CSV files compatible with most spreadsheets and data base programs. Retrieval shall only require a web browser. No separate programs or applications shall be required.
4. Each module shall provide a means of automatically transferring trend data as files to a Host computer system using FTP protocol and to users by e-mail and text messaging, without operator intervention.
5. Each module shall display the percentage of event logging storage used on a user status web page.

Y. System Logging and Alarm Journaling
1. Each module shall maintain its own records of system events and alarms saved to an internal flash disk.
2. Each module shall provide for operator retrieval of all, or portions of the system and alarm logs in CSV spreadsheet format via a web page.
3. Each module shall provide a means of automatically sending all or portions of the system or alarm logs as files or e-mail attachments without operator intervention.

Z. Reporting

1. Each module shall support the storage and retrieval of custom reports that include snap-shots of real-time data, system logs and alarm journal entries, custom logos and graphics, and tables of historical trend and event data.
2. Each module shall include all of the tools required to create simple text and fully formatted reports, including a web based report editor. No separate program or application shall be required.
3. Each module shall provide a means of automatically sending custom reports as e-mails and text messages, as well as file transfers to host computers, automatically or by operator request.

AA. Programmable Logic

1. Each module shall support custom user programming in Ladder Logic, Function Block and Text languages.
2. Each module shall include all tools required to create and debug custom logic programs including a web-based graphical drag-and-drop editor and a complete library of control elements, including:
    a. Contacts (standard and transitional) and Coils (standard, transitional and set/reset).
    b. Timers and Counters
    c. 32-bit integer and floating point math
    d. Numeric comparison functions
    e. Conversion (Float to Int, Int to Float, etc.) and Move functions
    f. Shift and Bit manipulation functions
    g. Runtime, Totalizer, Change Detection and Compare with Hysteresis functions
    h. Goto and Gosub functions
    i. Special functions such as non-linear scaling
3. Each module shall provide built-in graphical program debugging tools to display variables and “power flow” in real time, set break points and single step, force I/O, and set register values and states.
4. Each module shall provide a means of securing individual pages of logic in any format to protect intellectual property.

BB. Triplex Pump Control

1. Each module shall provide a built-in pump control module for one, two or three pumps with alternation.
2. Pump alternation shall be selectable for round robin, by number of starts, and by runtime operation.
3. Pump control shall support both level sensor and float switch operation.
4. The pump control module shall support dual set points and dual level sensor signal sources with configurable selection between the set points/sources based on time of day, communications link failure, user command, or any other Boolean status.
5. The pump control module shall detect, log and alarm on any pump failures by monitoring a feedback contact from the pump motor starters.
6. The pump control module shall detect, log and alarm for any float switch failures by monitoring float switch sequence of activation and timing.

7. The pump control module shall provide an internal “soft” Hand-Off-Auto (HOA) selector with a secured user web page for manual or automatic control. Pumps not in Auto status shall be automatically taken out of the alternation sequence.
8. The pump control module shall support an external hardwired Hand-Off-Auto (HOA) selector. Pumps not in Auto status shall be automatically taken out of the alternation sequence.

CC. PID Control
1. Each module shall provide control of four independent Proportional-Integral-Derivative (PID) loops.
2. The PID controls shall support both analog and digital (Pulse Width Modulation) outputs with the option of reverse action and configurable dead band.
3. The PID controls shall update at rates of at least 100 times per second.

DD. Project Specific Modules (8X-3012 Discrete I/O and Analog in Plus 4 Analog Out I/O Module - 12/24V DI)
1. The module shall provide the following communications ports:
2. The module shall provide one 10/100 Mb/s Ethernet port.
3. The module shall provide an RS-485 bus port, usable as a general purpose serial port when not configured for bus operation with other I/O modules
4. The module shall provide a general purpose serial port, software selectable for RS-232, RS-485, RS-422 and SDI-12 operation.
5. The module shall provide 8 optically isolated discrete inputs supporting AC or DC input signals of up to 30V. The inputs shall totalize pulses up to 4KHz and calculate their rate, interval, and runtime automatically. Each input shall have individually settable digital filtering from 5Hz to >2KHz. The inputs shall have isolated commons shared between groups of four inputs.
6. The module shall provide 4 relay outputs rated to switch up to 3A at up to 30Vdc or 240Vac. The outputs shall have an isolated common shared by the outputs.
7. The module shall provide eight 16-bit analog inputs, software configurable for measurement ranges of 20mA, 5V, +/- 5V, 10V, and +/- 10V. The analog inputs shall share a common, isolated from the rest of the module.
8. The analog inputs shall support configurable "boxcar" style averaging of up to 8 readings.
9. The analog inputs shall support configurable linear scaling to engineering units.
10. The analog inputs shall have configurable high and low alarm levels and hysteresis.
11. The module shall provide four 12-bit analog outputs, software configurable for output ranges of 0 to 20mA or 4 to 20mA.

EE. Project Specific Modules (8X-5011 - 2110 Comm Module with 4G/LTE Cellular Modem)

1. The module shall provide one 10/100 Mb/s Ethernet port.
2. The module shall provide an RS-485 bus port, usable as a general purpose serial port when not configured for bus operation with other I/O modules
3. The module shall provide a general purpose serial port, software selectable for RS-232, RS-485, RS-422, and SDI-12 operation.
4. The module shall include a built-in 4G/LTE cellular modem compatible with and end-point approved for operation on the Verizon cellular network. The modem shall support both data and text messaging operation.
5. The module shall provide the two high-speed pulse/discrete inputs supporting contact closures and DC input signals of up to 30Vdc. The inputs shall totalize pulses up to 10KHz and calculate their rate, interval, and runtime automatically. Each input shall have individually settable digital filtering from 5Hz to >2KHz.
6. The module shall provide one discrete output capable of sourcing up to 1A from the input power. The output shall include automatic overload, over-temperature, and transient protection.
    a. The module shall provide one 16-bit analog input, software configurable for measurement ranges of 20mA, 5V, +/- 5V, 10V, +/- 10V, and 30V.
7. The analog input shall support configurable "boxcar" style averaging of up to 8 readings.
8. The analog input shall support configurable linear scaling to engineering units.
9. The analog input shall have configurable high and low alarm levels and hysteresis.

2.66 ETHERNET SWITCH

A. Ethernet switch to have 5 TP RJ45 ports minimum. Switch shall be an unmanaged switch with auto negotiation, in compliance with IEEE 802.3, store and forward switching mode.

B. Ethernet switch shall be Weidmuller p/n IES-150B, or equal.

2.67 OPERATION DESCRIPTION FOR PLC BASED PUMPING SYSTEM

A. There shall be control algorithms programmed into the Programmable Logic Controller to operate the system based on an operator adjustable Local Pressure setting based on tank level through manual, local setting. The tank is roughly 4 miles away from the station.

B. The system shall locally monitor level in the tank by means of a pressure transmitter located on the discharge of the pump station.

C. The system shall control pump starting and stopping and the cascading of pumps based on programmable tank fill setpoints on the HMI display located at the booster station or through the web browser.

D. The VFD motor controllers shall be operated by the PLC and pumps will operate at full speed. The pumps call to run shall also operate the chemical pumps. The chemical pumps shall be as described elsewhere within this specification. Manual speed control of the chemical pumps shall be done locally at the chemical pump display. The operator is manually responsible for adjusting dosage rates as necessary.

E. The pumps shall be brought on and offline in a cascading sequence as controlled by the pump selection/alternation portion of the control algorithm. The pumps shall be capable of operating in a lead-lag scenario if the tower continues to lose volume as the lead pump is running.

F. Pumps going offline shall be done in the opposite manner to avoid pressure surges in the system.

G. Major Equipment at this site:
1. Industrial Control Link Modulus;
2. NEMA enclosure;
3. Pressure transmitters (2);
4. Complete configuration & programming;
5. Operator Interface Unit
6. Other devices as needed to provide a complete and operable installation.

2.68 HEATING UNIT (PUMP ROOM)

A. The equipment chamber and chemical feed room shall be provided with a 3000-watt electric heater suitable for 240 volt, single-phase service. The heater shall be of the fan-forced, with fan delay, and complete with an integral, automatic, snap action thermostat. Fan motor is to be totally enclosed and impedance protected. The heater shall be wall mounted, with an 18-gauge steel grille surface-mounting frame. Heater shall be hard wired into the station electrical system.

2.69 DEHUMIDIFIER (PUMP ROOM)

A. One (1) each.

B. Capacity 30 pints per 24 hours.

C. Compressor rated 115 volts, 60 Hz, 4.3 operating amps.

D. 106 CFM fan, 2 fan speed.

E. Humidity range 35 to 80% RH, ambient temperature range of 41 to 95 F, Type R410A refrigerant.

F. Washable filter.

G. Condensate piped direct to drain.

H. UL listed rubber cord.

2.70 CONVENIENCE GROUP - SHUTTER MOUNTED EXHAUST FAN (CHLORINE FEED ROOM)

A. One (1) each.

B. 2Capacity each 470 CFM of free air at 0.125 inch static pressure.

C. 120 volt, 60 Hz, 1550 rpm, totally enclosed, shaded pole, sleeve bearing motors, Class A insulation.

D. Gray polyester coated steel guard.

E. Cold rolled galvanized steel frame.

F. 12" diameter, stamped aluminum, 3-blade propeller.

G. Hard wired in conduit to conduit box on motor per UL 400-1.

H. UL Listed.

I. 120 volt AC operation from wall mount thermostat and HAND/AUTO switch on main control panel.

J. One (1) 12" x 12" automatic shutter with exterior mounted, aluminum shroud and insect screen.

2.71 CONVENIENCE GROUP - MOTOTIZED AIR RETURN SHUTTER (CHLORINE FEED ROOM)

A. One (1) each installed as shown.

B. 12" x 12" 16 gauge extruded aluminum frame.

C. Aluminum blades.

D. 120 volt AC, 60 cycle, single phase electric motor.

E. Operation of shutter from start/stop of exhaust fan described above.

F. One (1) exterior mounted, aluminum shroud and insect screen.

2.72 EMERGENCY EYE WASH

A. A double bottle eyewash station shall be provided. The unit shall be wall mounted.

B. Eyewash station shall be Honeywell Emergency Eye/Face Wash Model 116270 or equal.

2.73 ADDITIONAL ACCESSORIES

A. HMI Touchscreen Panel
   1. Provide HMI touchscreen panel meeting the following requirements:
      a. 10” HMI panel, 800 x 480, ethernet, IP65, pre-configured web browser.
   2. Manufacturer’s Reference: Industrial Control Links Viewpoint III.

B. Photovoltaic System
   1. Provide a complete photovoltaic system (solar panel, controller, batteries, enclosure, mounting hardware, charger, etc.) at the water tank site, meeting the following minimum requirements. Size system to generate power required to operate 200% of required components (minimum):
      a. Rated power generation: As required to meet reserve time requirements.
      b. Reserve time at rated power: 100 hours.
      c. Output voltage: 24V or 48V DC.
      d. Battery capacity (Amp Hours): As required to meet reserve time requirements.
      e. Battery voltage: 12V.
      f. Over-charge protection: 14.4V.
      g. Over-discharge protection: 11V.
      h. Over-discharge recovery volts: 12V.
      i. Relay Output: System error alarm.
      j. Enclosure Type: NEMA Type 12/3R hinged cover enclosure.
      k. Mounting:
         i. Enclosure: Rack mount.
         ii. Solar panel: Pole mount.
      l. Wind speed rating: 90 mph.

C. Antennas, Cables, Lightning Suppressors
   1. Provide antennas and associated mounting hardware, cables, lightning suppressors, etc., as required to provide a fully operational communications and operations system at both the pump station and water tank site.

PART 3 EXECUTION

3.01 INSTALLATION

A. To the extent that it is applicable, install work in accordance with the NECA Standards of Installation, unless otherwise noted.

B. Drawing locations are approximate only. Determine exact locations of equipment by examining all other Drawings, taking physical measurements and coordinating Work in same and adjacent locations.

C. Installation equipment and material in accordance with manufacturer's written installation instructions and recommendations.

D. Provide complete raceway system (conduit, wire/cable, boxes, etc.) associated with instrumentation and control work in accordance with the requirements of Division 16.

3.02 CALIBRATION, TESTING, AND START-UP

A. General: Furnish personnel and equipment required to perform calibrations and tests for equipment specified in this Section in accordance with manufacturer's recommendations. Owner personnel may witness these calibrations/tests; notify the Owner a minimum of two weeks in advance of these calibrations/tests.

B. Qualifications: Furnish a field representative who is currently certified as a Control System Technician, Level 3, by the Instrument Society of America to do the calibration, wiring checks, and start up.

C. Cleaning and Touch Up Painting:
   1. Prior to energizing control panels, clean dust, dirt, and debris from the interior of all panels with a vacuum cleaner and dry cloth. Do not use compressed air.
   2. Touch up scratched or marred exterior surfaces of control panels to match original finish. Buff exterior surfaces to a clean shine.

D. Calibration: Calibrate instrumentation in accordance with manufacturer's recommendations.

E. Control Wiring Tests: Ring out all control wiring to substantiate that wiring has been terminated in the correct locations.

F. Notice of Completion: Submit letter to Owner indicating that instrumentation and control work is complete and facility is ready for operational testing.

G. SCADA System Testing: Assist Owner with SCADA System Testing described later in this section of the specifications.

H. Start-up Assistance: Provide start-up and site acceptance testing, including assistance to the OWNER in the start-up of this Project, as described in Section 01650.

3.03 SCADA SYSTEM TESTING

A. General:

1. Work on this project involves modifications to the Owner's SCADA System and field devices connected to the SCADA system. In order to ensure all wiring work has been installed correctly by the Contractor and Owner programming is correct, all of the SCADA inputs and outputs (I/O) associated with this wiring will be tested. The following is a list of the tests that will need to be performed. The Owner will be responsible for directing the tests, interacting with the SCADA system and documenting the results. The Contractor will be responsible for modifying the field conditions of each I/O point to allow Owner to observe the results.
2. In the following list of tests, the responsibilities of the Contractor and Owner are indicated to provide the Contractor with an understanding of the scope of work. The following tests are representative of the tests that will be performed; the actual tests for this project may vary for this list, as directed by Owner.
3. Following initial tests, the Contractor shall rectify any wiring problems that were discovered during the tests. It may also be necessary for the Contractor to change the state of auxiliary contacts associated with digital inputs to the SCADA system (that is, change a normally open field contact to a normally closed field contact). In some cases, this may mean swapping wires on a relay or selector switch, while in other cases field convertible contacts on a relay may have to be changed from a normally open state to a normally closed state. Following field modifications to resolve these problems, the Contractor and Owner shall retest the associated points.

B. Tests:

1. Analog Inputs:
    a. Contractor shall use a 4-20 mA loop calibrator to simulate analog alarms (high-high, high, low, low-low, and out-of-range) as applicable. Owner will verify SCADA response to the alarm condition.
    b. Owner will click the value out of service. Contractor shall use a 4-20 mA loop calibrator to simulate analog alarms (high-high, high, low, low-low, and out-of-range) as applicable. Owner will verify SCADA response to the alarm condition.

c. Owner will check override function by entering an override value and showing that it displays correctly, is used in the PLC logic, and is properly logged.
d. Owner will check calibration function by entering calibration mode, simulating changing inputs for the point, and verifying that the value does not change on the screen, alarms are not activated, and control action is not taken.
e. Owner will spot check that calibration alarms are issued if points are left in calibration mode too long.

2. Digital Inputs:
a. Using switches and devices where possible and jumper wires when necessary, Contractor shall force field condition to inactive state. Owner will verify screens show the device as off/closed/normal.
b. Using switches and devices where possible and jumper wires when necessary, Contractor shall force field condition to active state and verify screens show the device as on/open/alarm.
c. For alarm points, Owner will verify that the active state resulted in proper alarm indication and callout, if applicable.

3. Digital Outputs:
a. Owner will click on screen icon and put in SCADA manual control.
b. Owner will click open/start command to activate DO point.
c. Owner will verify DO point changes state at the I/O module.
d. Contractor shall verify DO point change resulted in expected action in the field (that is, motor stop/start, valve open/close, etc.).
e. Owner will click close/stop command to de-activate DO point.
f. Owner will verify DO point changes state at the I/O module.
g. Owner will click on screen icon to put point in SCADA automatic control, if applicable, and verify that start/stop or open/close commands are unavailable.
h. Owner will click on screen icon to put point out of service and verify that start/stop or open/close commands are unavailable.

3.04 TRAINING

A. In addition to training required in specific sections, provide one day of training to OWNER personnel in the general operation and maintenance of the equipment specified in this section.

END OF SECTION

SECTION 15050
GENERAL PIPING REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

This section describes the general requirements for selecting piping materials; selecting the associated bolts, nuts, and gaskets for flanges for the various piping services in the project; and miscellaneous piping items.

1.02 SUBMITTALS

A. Submit shop drawings in accordance with Specification Section 01300: CONTRACTOR SUBMITTALS.

B. Submit affidavit of compliance with referenced standards (e.g., AWWA, ANSI, ASTM, etc.).

C. Submit certified copies of mill test reports for bolts and nuts, including coatings if specified. For materials originating outside of the United States, provide recertification by an independent domestic testing laboratory.

D. Submit manufacturer's data sheet for gaskets supplied showing dimensions and bolting recommendations.

E. Submit manufacturer's data sheet for insulating unions, showing recommended installation procedures.

1.03 DEFINITIONS OF BURIED AND EXPOSED PIPING

A. Buried piping is piping buried in the soil, commencing at the wall or beneath the slab of a structure. Where a coating is specified, provide the coating up to the structure wall. Do not coat buried piping encased in concrete.

B. Exposed piping is piping in any of the following conditions or locations:

1. Above ground.

2. Inside buildings, vaults, or other structures.

3. In underground concrete trenches or galleries.

1.04 DEFAULT PIPING MATERIALS

If no material is shown in the drawings, use the following piping materials:

Service	Size Range (inches)	Material	Specification Section
Buried	3 and smaller	Copper-Type K	802
	4	PVC (AWWA C900)	801
	6 and larger	DIP or CML & C Steel	15263
Exposed	3 and smaller	Stainless Steel	802
	4	DIP	801
	6 and larger	CML Painted steel	09900 & 15263

1.05 MEASUREMENT AND PAYMENT

Payment for the work in this section shall not be paid for separately, but shall be included as part of the several unit prices and or lump sum amounts to which the work pertains to as stated in the Bid Proposal and no additional compensation will be made therefor.

PART 2 - MATERIALS

2.01 MATERIALS SELECTION AND ALTERNATIVE MATERIALS

The drawings may show alternative piping materials for certain services. In such cases, the same pipe material shall be used for all pipe sizes in all locations for the given piping service. Do not intermix piping materials.

2.02 THREAD FORMING FOR STAINLESS STEEL BOLTS

Form threads by means of rolling, not cutting or grinding.

2.03 BOLTS AND NUTS FOR FLANGES FOR STEEL AND DUCTILE IRON PIPING

A. Bolts and nuts for Class 150 flanges (including AWWA C207, Class D) located indoors and in vaults and structures shall be carbon steel, ASTM A 307, Grade B.

B. Bolts and nuts for buried or submerged Class 150 flanges shall be Type 304 stainless steel conforming to ASTM A 193 (Grade B8) for bolts and ASTM A 194 (Grade 8) for nuts.

C. Hex head machine bolts for use with lugged valves shall comply with ASTM A 193, Grade B7.

D. Fit shall be Classes 2A or 2B per ANSI B1.1 when connecting to cast-iron valves having body bolt holes.

E. Bolts for AWWA C207 Classes E and F flanges and ANSI B16.5 and B16.47 Class 300 flanges located indoors, and in vaults and structures shall be chrome molybdenum conforming to ASTM A 193, Grade B7, with nuts conforming to ASTM A 194, Grade 2H.

F. Bolts and nuts for buried or submerged Class 300 flanges and Class 300 flanges shall be Type 304 stainless steel conforming to ASTM A 193, Grade 8, Class 2, for bolts and ASTM A 194, Grade 8 for nuts.

G. Bolts used in flange insulation kits shall conform to ASTM A 193 (Grade B8). Nuts shall conform to ASTM A 194 (Grade 8).

H. Provide washers for each nut and bolt. Washers shall be of the same material as the nuts.

2.04 LUBRICANT FOR STAINLESS STEEL BOLTS AND NUTS

Lubricant shall be chloride free and shall be TRX-Synlube by Ramco, Anti-Seize by Ramco, Husk-It Husky Lube O'Seal, or equal.

2.05 GASKETS FOR FLANGES FOR STEEL PIPING IN WATER SERVICE

A. Gaskets for flat face and raised face flanges shall be 1/8-inch thick and shall be one of the following nonasbestos materials:

1. Acrylic or aramid fiber bound with nitrile. Products: Garlock "Bluegard," Klinger "Klingersil C4400," or equal.

2. Gaskets shall be suitable for a pressure of 500 psi at a temperature of 400°F.

2.06 GASKETS FOR FLANGES FOR DUCTILE-IRON PIPING AND FITTINGS IN WATER SERVICE

1. Gaskets shall be full face, 1/8-inch thick, cloth-inserted rubber, with a Shore "a" hardness of 75 to 85.

2. Gaskets shall be suitable for a water pressure of 200 psi at a temperature of 180°f.

3. Gaskets shall have "nominal" pipe size inside diameters not the inside diameters per ANSI B16.21.

4. Products: Garlock style 19 or equal.

2.07 THREADED CAPS FOR PROTECTION OF NUTS AND BOLT THREADS

1. Caps shall be high-density polyethylene, color gray.

2. The caps shall be filled with an anticorrosive lubricant to prevent nuts and bolts from rusting and corroding.

3. Lubricant shall be suitable for use in potable water.

4. Caps shall withstand temperatures from -40°F to 200°F.

5. Caps shall be suitable to use in exposed, buried, and submerged service conditions.

6. Products: Sap-Seal Products, Inc.; Advance Products and Systems, Inc., "Radolid"; or equal.

2.09 HEAT SHRINKABLE SLEEVES

Heat shrinkable sleeves when used shall comply with AWWA C216.

PART 3 - EXECUTION

3.01 INSTALLING PIPE SPOOLS IN CONCRETE

Install pipes spools in walls and slabs before placing concrete. See Specification Section 15125: WALL PIPES, SEEP RINGS AND PENETRATIONS.

3.02 RAISED FACE AND FLAT FACE FLANGES

The CONTRACTOR shall be responsible for verifying the mating flanges are of the same type.

3.03 INSTALLING ABOVEGROUND OR EXPOSED PIPING

Install pipe without springing, forcing, or stressing the pipe or any adjacent connecting valves or equipment.

3.04 INSTALLING FLANGED PIPING

A. Set pipe with the flange bolt holes straddling the pipe horizontal and vertical centerline.

B. Install pipe without springing, forcing, or stressing the pipe or any adjacent connecting valves or equipment.

C. Before bolting up, align flange faces to the design plane within 1/16 inch per foot measured across any diameter.

D. Align flange boltholes within 1/8-inch maximum offset.

E. Clean flanges by wire brushing before installing flanged fittings.

F. Clean flange bolts and nuts by wire brushing, lubricate carbon steel bolts with oil and graphite, and tighten nuts uniformly and progressively.

G. Bolt lengths shall extend completely through their nuts by at least one complete thread for complete engagement. Any which fail to do so shall be considered unacceptable.

H. Do not use more than one gasket between contact faces in assembling a flanged joint.

I. If flanges leak under pressure testing, loosen or remove the nuts and bolts, reset or replace the gasket, reinstall or retighten the bolts and nuts, and retest the joints.

J. Joints shall be watertight.

K. Install threaded nut and bolt thread protection caps after completing the bolt, nut, and gasket installation as set forth herein. Install on buried and submerged piping.

3.05 INSTALLING BLIND FLANGES

A. At outlets not indicated to be connected to valves or to other pipes and to complete the installed pipeline hydrostatic test, provide blind flanges with bolts, nuts, and gaskets.

B. Coat the inside face of blind flanges per Specification Section 09900: PAINTING AND COATING, System 10.

3.06 INSTALLATION OF STAINLESS STEEL BOLTS AND NUTS

Prior to assembly, coat threaded portions of stainless steel bolts and nuts with lubricant as specified in Article 2.04 herein.

3.07 INSTALLING POLYURETHANE SEALANT FOR FLANGE INSULATION KITS IN PIPING 24 INCHES AND LARGER

Apply sealant into the gap between the two flanges inside the pipe. Apply sufficient sealant to fill the gap to the thickness of the pipe lining; trowel to provide a smooth and even layer between the two pieces of pipe.

END OF SECTION

SECTION 15108
AIR-RELEASE AND VACUUM-RELIEF VALVES

PART 1 – GENERAL

1.01 DESCRIPTION

This Section of the specification shall be supplemental to Section 801 of the Standard Specifications and includes materials and installation of air and vacuum valves and air-release valves for water service.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Specification Section 09900: PAINTING

B. Specification Section 15050: GENERAL PIPING REQUIREMENTS

1.03 SUBMITTALS

A. Submit shop drawings in accordance with Specification Section 01300 - Contractor Submittals.

B. Submit manufacturer's catalog data. Show dimensions, materials of construction by ASTM reference and grade, and coatings.

1.04 MEASUREMENT AND PAYMENT

Payment for the valves in this section shall not be paid for separately, but shall be included in the unit or lump sum amounts for each vault or manhole included in the Bid Proposal and no additional payment therefor will be made accordingly.

PART 2 – MATERIALS

2.01 COATING

Coat valves located above ground or in vaults and structures in accordance with Specification Section 09900: PAINTING. Apply prime coat at the place of manufacture. Color of finish coat shall match the color of the adjacent piping. Do not coat stainless-steel pieces.

2.02 LINING

Coat interior surfaces of cast-iron valves at the place of manufacture per Specification Section 09900: PAINTING. Do not coat seating areas and plastic, bronze, stainless steel, or other high alloy parts.

2.03 BOLTS AND NUTS FOR FLANGED VALVES

See specification for the pipe to which the valve is attached.

2.04 GASKETS FOR FLANGED END VALVES

Gaskets for flanged end valves shall be as described in Specification Section 15050: GENERAL PIPING REQUIREMENTS of these specifications.

2.05 VALVE DESIGN AND OPERATION

A. Air-release valves for water service shall function to slowly release pockets of air which accumulate at high points in piping systems.

1. Valves larger than 3/4 inch shall have a float-actuated compound lever with linkage mechanism to release air.

2. Float shall withstand an external pressure of 1,000 psig without collapsing.

3. Air-release valves 2 inches in size shall incorporate a body with flanged top cover, screened mushroom-type cap outlet, and replaceable orifice and a synthetic rubber needle or disc actuated by the float and linkage mechanism.

4. Top cover shall include a 1/2-inch threaded outlet with bronze plug.

5. Body shall include a 1/2-inch threaded drain outlet near the bottom with a bronze plug.

B. Air and vacuum valves for water service shall have a float assembly and large venting orifice to exhaust large quantities of air from pipelines when being filled and to admit large quantities of air when pipelines are being drained.

1. Valve shall have a body with a flanged top containing the air-release orifice.

2. The float shall rise with the water level in the valve body to close the orifice by sealing against a synthetic rubber seat.

3. Float shall be protected by a baffle to prevent premature closing and shall withstand an external pressure of 1,000 psig without collapsing.

4. Do not use designs having levers and weights attached to the floats.

5. Float shall have a one-piece guide rod extending out of the bottom end to engage the guide bushings in the valve body at all times.

C. Air and vacuum valves larger than 4 inches shall have a 1-inch threaded drain outlet with bronze plug near the bottom of the valve body and a 2-inch threaded outlet with bronze plug on the side of the valve body above the minimum water level in the valve which forces the float against the valve seat. The valve outlet shall have a protective steel hood to prevent entry of foreign material.

2.06 MATERIALS AND CONSTRUCTION

A. Materials of construction for air-release valves for water service shall be as follows:

ITEM	MATERIAL	SPECIFICATION
Body and cover	Cast Iron	ASTM A 126, Grade B
Float	Stainless steel	AISI Type 316, ASTM A 240 or A 276
Linkage, orifice air-release mechanism	Stainless steel	AISI Type 316, ASTM A 240 or A 276
Needle	Buna-N	--

B. Materials of construction for air and vacuum valves for water service shall be as follows:

ITEM	MATERIAL	SPECIFICATION
Body and cover	Cast Iron	ASTM A 48, Class 30
Float, guide rod, guide bushings	Stainless steel	AISI Type 316, ASTM A 240 or A 276
Seat	Buna-N	--

2.07 VALVES

A. AIR RELEASE VALVES, 2 INCHES AND SMALLER, CLASS 300:

Valves shall have an operating pressure of 300 psi. Orifice size shall be 5/32 inch or size indicated on plans. Valves shall be APCO 200, Val-Matic Model 38.6 or approved equal.

B. COMBINATION AIR AND VACUUM VALVES, 2 Inches through 6 Inches, Class 300:

1. Valves shall have an operating pressure of 300 psi.

2. Provide steel hood above the top cover and orifice.

3. The valves shall be single body type with the air relief built into the valve.

4. The 2" air and vacuum valve shall have an orifice size shall of 3/32 inch for Phase 1B.

5. For the distribution lines, a 1" air release and vacuum valve shall be used with a 1/32" orifice, EXCEPT for the 10" and 12" lines which shall be a 2" air and vacuum valve with a 1/16" orifice, or as identified on the plans.

6. The valves shall be APCO Series 143C to 151C, Val-Matic Models 201 through 208, or approved equal.

C. SURGE RELIEF AIR RELEASE VALVE, 2 Inches through 6 Inches, Class 150:

Valves shall be suitable for water service where water column separation is anticipated. This valve combines the operating features of both an air and vacuum valve and air release valve. Air and vacuum valve is designed to automatically exhaust air during filling of system and allow air to re-enter during draining or when vacuum occurs. The air release (slow release) function will automatically exhaust entrained air that accumulates in system.

1. For a dual body valve, the air release valve shall be mounted within the air and vacuum valve, between the dual valves.

2. 1-Inch through 3 inch valves shall have NPT threaded inlet and outlet.

3. 4-Inch and larger valves shall be connected with ASME B16.1 Class 125 flanged inlet and cover outlet.

4. Valves shall be rated to 150 psi minimum working pressure, cast iron or ductile iron body and cover, stainless steel float and trim, built and tested to AWWA C512.

5. Valves shall be Valmatic Series VM-1800VB, Vent-o-mat Series RBX, or approved equal.

6. If air release valve is separate from surge relief valve, air release valve shall be in accordance with Section 2.07.A of this specification.

PART 3 – EXECUTION

3.01 INSTALLATION

A. Clean flanges by wire brushing before installing flanged valves. Clean flange bolts and nuts by wire brushing, lubricate threads with oil and graphite, and tighten nuts

uniformly and progressively. If flanges leak under pressure testing, loosen or remove the nuts and bolts, reseat or replace the gasket, reinstall or retighten the bolts and nuts, and retest the joints. Joints shall be watertight.

B. Clean threaded joints by wire brushing or swabbing. Apply Teflon joint compound or Teflon tape to pipe threads before installing threaded valves. Joints shall be watertight.

3.02 VALVE PRESSURE TESTING

Test valves at the same time that the connecting pipelines are pressure tested. Protect or isolate any parts of valves, operators, or control and instrumentation systems whose pressure rating is less than the test pressure.

END OF SECTION

SECTION 15122
FLEXIBLE PIPE COUPLINGS AND EXPANSION JOINTS

PART 1 - GENERAL

1.01 DESCRIPTION

This section includes materials and installation of flexible gasket sleeve-type compression pipe couplings for steel pipe and couplings for connecting different pipe materials.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Specification Section 09900: PAINTING.

B. Specification Section 15050: GENERAL PIPING REQUIREMENTS.

1.03 SUBMITTALS

A. Submit shop drawings in accordance with Specification Section 01300: CONTRACTOR SUBMITTALS.

B. Submit manufacturer's catalog data on flexible pipe couplings. Show manufacturer's model or figure number for each type of coupling or joint for each type of pipe material for which couplings and joints are used. Show coatings.

C. Submit manufacturer's recommended torques to which the coupling bolts shall be tightened for the flexible gasket sleeve-type compression pipe couplings.

D. Show materials of construction by ASTM reference and grade. Show dimensions.

E. Show number, size, and material of construction of tie rods and lugs for each thrust harness on the project.

1.04 MEASUREMENT AND PAYMENT

Payment for the work in this section shall not be paid for separately but shall be included as part of the several unit prices and or lump sum amounts to which the work pertains to as stated in the Bid Proposal and no additional compensation/ payment will be made.

PART 2 - MATERIALS

2.01 COUPLING SYSTEM DESIGN AND COMPONENT UNIT RESPONSIBILITY

1. Gaskets, bolts, nuts, glands, end rings, and hardware for pipe couplings of all types shall be furnished by the manufacturer of the pipe coupling and shall be designed as an integral system by the pipe-coupling manufacturer.

2. Gaskets shall be designed for the coupling and appropriately sized to provide a watertight seal at the design pressure and temperature.

3. Gaskets, bolts, nuts, glands, end rings, and hardware for pipe couplings shall be shipped with the pipe coupling and shall be clearly labeled indicating the origin of the material, including place and date of manufacture.

4. Manufacturer's printed installation instructions shall be packaged with each pipe coupling.

2.02 STEEL FLEXIBLE PIPE COUPLINGS

A. Steel couplings shall have center sleeves and end rings made of carbon steel conforming to AWWA C219, Section 4.

B. Minimum center sleeve length shall be 5 inches for pipe sizes 3/4 inch through 4-1/2 inches, 7 inches for pipe sizes 5 inches through 24 inches, and 10 inches for pipe sizes larger than 24 inches.

C. Sleeve bolts in exposed service shall be carbon steel per AWWA C219, Section 4.

D. Sleeve bolts in buried or submerged service shall be Type 304 stainless steel per AWWA C219, Section 4.

E. Steel end rings shall be cast, forged, or hot rolled in one piece. Do not use rings fabricated from two or more shapes.

F. Wall thickness of sleeve shall be at least that specified for the size of pipe in which the coupling is to be used.

2.03 JOINT HARNESSES

A. Tie bolts or studs shall be as shown in the following table.

B. Bolt or stud material shall conform to ASTM A 193, Grade B7.

C. Nuts shall conform to ASTM A 194, Grade 2H.

D. Lug material shall conform to ASTM A 36, ASTM A 283, Grade B, C, or D, or ASTM A 285, Grade C.

E. Lug dimensions for steel pipe shall be as shown in AWWA Manual M11 (1989 edition), Figure 13-17, using the number and size of lugs as tabulated below.

F. Lugs for steel pipe shall be Type P for pipes 6 through 10 inches and Type RR for pipes 12 inches and larger.

TIE BOLTS OR STUD REQUIREMENTS FOR FLEXIBLE PIPE COUPLINGS FOR STEEL PIPE				
Nominal Pipe Size (inches)	**Tie Bolt or Stud Minimum Requirements**			
	150 psi		**300 psi**	
	No. Bolts or Studs and Size (inches)	**Minimum Pipe Wall Thickness (inches)**	**No. Bolts or Studs and Size (inches)**	**Minimum Pipe Wall Thickness (inches)**
6	2 x 5/8	0.193	2 x 5/8	0.282
8	2 x 5/8	0.239	2 x 5/8	0.354
10	2 x 5/8	0.312	2 x 3/4	0.466
12	2 x 3/4	0.188	4 x 7/8	0.250
14	2 x 7/8	0.188	4 x 1	0.250
16	2 x 1	0.250	4 x 1-1/8	0.250
18	2 x 1-1/8	0.250	4 x 1-1/8	0.250
20	2 x 1-1/4	0.250	4 x 1-1/8	0.250
24	4 x 7/8	0.250	4 x 1-1/8	0.250
30	4 x 1-1/8	0.250	4 x 1-3/8	0.375
36	4 x 1-3/8	0.313	6 x 1-3/8	0.375
42	6 x 1-1/4	0.375	6 x 1-5/8	0.375
48	6 x 1-3/8	0.375	6 x 1-3/4	0.500
54	6 x 1-1/2	0.375	8 x 1-3/4	0.625
60	8 x 1-1/2	0.438	8 x 2-1/4	0.625
64	8 x 1-5/8	0.438	8 x 2-1/4	0.688
66	8 x 1-5/8	0.500	8 x 2-1/4	0.875
72	8 x 1-7/8	0.625	10 x 2-1/4	0.875

G. Select number and size of bolts based on the test pressure shown in the Plans.

Stagger bolts equally around pipe circumference. Where odd number is tabulated, place odd bolt at top. For test pressures less than or equal to 150 psi, use the 150-psi design in the table above.

For test pressures between 150 and 300 psi, use the 300-psi design in the table above.

H. Provide washer for each bolt and nut. Washer material shall be the same as the nuts. Minimum washer thickness shall be 1/8 inch.

2.04 FLEXIBLE PIPE COUPLINGS FOR PLAIN-END STEEL PIPE

A. Couplings shall be steel, Dresser Style 38, Smith-Blair Type 411, Baker Series 200, or equal.

2.05 TRANSITION COUPLINGS

1. Couplings for connecting pipes having different outside diameters shall be steel: Dresser Style 62 or 162, Smith-Blair Series 413, Baker Series 212 or 220, or equal.

2. Couplings shall have an internal full circumference ring pipe stop at the midpoint of the coupling.

3. ID of coupling pipe stop shall equal ID of smaller diameter pipe.

2.06 DISMANTLING JOINTS

A. The dismantling joint shall consist of a flanged steel spigot piece, a flanged sleeve, and a follower ring containing a gasket through which the sleeve slides into the spigot piece.

1. The joint shall accommodate up to 2 inches of longitudinal movement.

2. The longitudinal adjustability shall be provided by a telescopic action of a flanged spigot and associated sleeve, which inserts into the spigot.

3. A system of tie bolts or rods shall connect the end flange on the sleeve to the end flange on the spigot piece.

4. Provide washers and nuts on the tie bolts on both sides of the sleeve and flange and the spigot end flange to allow for adjustment of the extension length for the sleeve.

B. The minimum design pressure shall be the same as the adjacent piping.

1. Design stresses shall not exceed 40% of the yield strength of the materials.

2. Minimum factory test pressure shall be 150% of the design pressure.

C. The gasket shall be compressed by a separate bolting and gland system, independent of the tie bolts. Gasket shall be EPDM.

D. Fabrication, assembly, and erection shall comply with Specification Section 15050 - General Piping Requirements.

E. Dismantling joints shall have spigot pieces and flange adapters made of steel and having a minimum yield strength of 30,000 psi conforming to ASTM A 36, A 53 (Type E or S), or A 283, Grade C.

F. Sleeve and follower ringbolts shall have a minimum yield strength of 105,000 psi, a minimum tensile strength of 125,000 psi, and shall conform to ASTM A 193, Grade B7.

G. Steel flanges and gasket follower rings shall be cast, forged, or hot rolled in one piece. Do not use flanges or rings fabricated from two or more shapes.

H. Wall thickness of spigot piece and sleeve shall be at least that specified for the size of pipe in which the coupling is to be used.

I. Flanges shall be AWWA Class E Flanges with a ANSI Class 125 / 150 ANSI B16.1 Bolt Hole pattern.

J. Manufacturers: Romac Style DJ 400 or Equal

2.07 SEGMENTED RESTRAINED SLEEVE COUPLINGS AND FLANGED ADAPTER COUPLINGS FOR STEEL PIPE

A. The coupling shall be of the split or segmented sleeve type with a double arch cross-section, which closes around plain steel pipe ends.

1. The design pressure and wall thickness of the body shall be at least that specified for the size of pipe on which the coupling is to be used.

2. Provide welded steel restraint rings on the pipe ends for end restraint. As the coupling closes, it shall confine an elastomeric gasket on each pipe end to create a radial seal.

3. The axial seal shall be affected at the closure plates as bolts pull the coupling snug round the pipe. Provide shoulders on each end of the couplings.

4. Flanged adapter couplings shall incorporate a flange on one end (instead of an end ring and shoulder) to match the flange on the connecting pipe or valve.

5. Products: Victaulic “Depend-O-Lok” Model F x F Type 2 for sleeve couplings or Victaulic “Depend-O-Lok” Model F x F flanged adapter coupling for flanged adapter couplings.

B. Carbon steel piping includes steel pipe lined with cement mortar.

C. Body, flange, and closure plates for couplings used with carbon steel pipe in exposed service shall be carbon steel per ASTM A 36. Body, flange, and closure plates for couplings used with carbon steel pipe in buried service shall be Type 304 or 304L stainless steel per ASTM A 240 or A 666.

D. End restraint rings for couplings used with carbon steel pipe shall be carbon steel per ASTM A 108, Grade 1020. Provide end restraint rings on each of the connecting pipes. The end rings shall be welded to the pipe ends using a welding procedure complying with the ASME Pressure Vessel Code, Section IX. Weld the end restraint rings to the pipe before applying the lining and coating (if any is specified) to the pipe. The welded end restraint rings shall have at least the pressure rating of the pipe to which the coupling is attached.

E. Fasteners for couplings used with carbon steel pipe in exposed service shall be carbon steel per ASTM A 325, with carbon steel nuts and washers per ASTM A 563. Fasteners for couplings used with carbon steel pipe in buried service shall be Type 304 stainless steel per ASTM A 276, F 593, or F 738 with stainless steel nuts per ASTM F 594 or F 836.

F. Gaskets shall be Buna-N or EPDM conforming to ASTM D 2000 for water and sewage service and having a temperature range of –20°F to +180°F.

G. Provide joint sealant between the pipe ends for piping 24 inches and larger after the sleeve coupling is installed: Sikaflex 2C with Sikaflex 429 primer.

2.08 RUBBER MOLDED EXPANSION JOINT

A. The rubber molded expansion joint shall be a non-metallic, single spherical design to:

1. Absorb pipe movement / stress,

2. Reduce system noise

3. Isolate vibration

4. Compensate alignment / offset

5. Eliminate electrolysis

6. Protect against start-up/surge forces

B. The cover elastomer and tube elastomer shall be constructed of EPDM

C. The minimum allowable axial compression shall be 1.0 inches.

D. The minimum allowable axial extension shall be 0.625 inches.

E. The minimum lateral deflection shall be 0.75 inches.

F. The minimum angular deflection shall be 3 degrees.

G. The pressure rating of the expansion joint shall be the same as adjacent piping.

H. Flange faces shall be flat-face drilled to conform to ANSI B16.1 Class 125 / 150.

I. Manufacturers: Proco Style “240-HW” or equal

2.09 BOLTS AND NUTS FOR FLANGES

See Section 15050: GENERAL PIPING REQUIREMENTS.

PART 3 - EXECUTION

3.01 INSTALLATION OF FLEXIBLE PIPE COUPLINGS AND SEGMENTED SLEEVE COUPLINGS

A. Clean oil, scale, rust, and dirt from pipe ends. Clean gaskets in flexible pipe couplings before installing.

B. Lubricate bolt threads per Specification Section 15050: GENERAL PIPING REQUIREMENTS prior to installation.

C. Install threaded nut and bolt thread protection caps after completing the bolt, nut, and gasket installation. Install on buried and submerged flexible pipe couplings, transition couplings, flanged coupling adapters, dismantling joints, and segmented restrained sleeve couplings.

3.02 PAINTING AND COATING

A. Coat buried flexible pipe couplings (including joint harness assemblies), transition couplings, segmented sleeve couplings, insulation flanges, and flanged coupling adapters per Specification Section 09900: PAINTING.

B. Coat flexible pipe couplings (including joint harness assemblies), transition couplings, segmented sleeve couplings, and flanged coupling adapters located indoors, in vaults and structures, and above ground with the same coating system as specified for the adjacent pipe. If the adjacent pipe is not coated, coat couplings per Specification Section 09900: PAINTING. Apply prime coat at factory.

C. Line carbon steel flexible pipe couplings and segmented sleeve couplings with epoxy per Specification Section 09900: PAINTING.

D. Alternatively, line and coat steel flexible pipe couplings and segmented sleeve couplings with fusion-bonded epoxy per AWWA C213.

3.03 HYDROSTATIC TESTING

Hydrostatically test flexible pipe couplings, expansion joints, segmented sleeve couplings, and expansion compensators in place with the pipe being tested.

END OF SECTION

SECTION 15240
DUCTILE-IRON PIPE

PART 1 – GENERAL

1.01 DESCRIPTION

This section describes materials, testing, and installation of ductile-iron pipe and fittings 60 inches and smaller. This section shall be supplemental to Section 129 of the COA Standard Specifications.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Specification Section 09900: PAINTING AND COATING.

B. Specification Section 15050: GENERAL PIPING REQUIREMENTS.

1.03 SUBMITTALS

A. Submit shop drawings in accordance with Supplemental Specification Section 01502: Submittals.

B. Provide an affidavit of compliance with standards referenced in this specification, e.g., AWWA C151. Submit copy of report of pressure tests for qualifying the designs of all sizes and types of AWWA C153 fittings that are being used in the project. The pressure test shall demonstrate that the minimum safety factor described in AWWA C153, Section 5.5, is met.

C. Submit piping layout profile drawings showing location and dimensions of pipe and fittings; submit after equipment and valve submittals have been reviewed and marked "Resubmittal not required." Label or number each fitting or piece of pipe. Piping having identical design pressure class, laying lengths, and bell-and-spigot dimensions that is to be placed in long straight reaches of alignment may have the same identifying label or number.

D. Provide the following information:

1. Mortar lining thickness.
2. Wall thickness.
3. Material test data for this project.
4. Show deflections at push-on and mechanical joints.
5. Submit joint and fitting details and manufacturer’s data sheets.

E. Submit copy of manufacturer's quality control check of pipe material and production. Include hydrostatic test records and acceptance test records. For each acceptance test, submit a stress-strain diagram showing yield strength, yield point, tensile strength, elongation, and reduction in area. Provide specimen test section dimensions and speed and method used to determine speed of testing, method used for rounding of test

results, and reasons for replacement specimens, if any. Submit ring bending test of pipe of the same diameter and pressure class as the pipe required for this project to prove ring bending stress at 48 ksi results in a factor of safety of 2.0.

F. Submit certificate that cement for mortar lining complies with ASTM C 150, designating type.

G. Submit test report on physical properties of rubber compound used in the gaskets.

H. Submit drawing or manufacturer's data sheet showing flange facing, including design of facing serrations.

I. Submit weld procedure specification, procedure qualification record, and welder's qualifications prior to any welding to ductile-iron pipe.

PART 2 - MATERIALS

2.01 PIPE

A. Pipe shall be cast ductile (nodular) iron, conforming to AWWA C151 and produced in the United States.

B. Provide pipe in nominal 18- or 20-foot laying lengths.

2.02 PIPE MARKING

Plainly mark each length of straight pipe and each fitting at the bell end to identify the design pressure class, the ductile-iron wall thickness, and the date of manufacture, and the proper location of the pipe item by reference to the layout schedule. Mark the spigot end of restrained joint pipe to show clearly the required depth of insertion into the bell.

2.03 DESIGN CRITERIA

A. Obtain the following information from the contract documents:

1. Elevation of the top of pipe and of the completed ground.
2. Alignment of the pipeline.
3. Nominal internal diameter, ID.
4. Joint types(s).

2.04 PIPE WALL THICKNESS

A. Minimum wall thickness for pipe having push-on or mechanical joints, restrained joints or plain ends shall be Pressure Class 150, unless otherwise shown in the drawings.

B. Minimum wall thickness for pipe having threaded flanges shall be Special Class 53 or Pressure Class 350.

2.05 FITTINGS

A. Fittings 48 inches and smaller shall conform to AWWA C110 with a minimum pressure rating of 250 psi. Fittings 54 inch and 60 inch pipe shall conform to AWWA C153 with a minimum pressure rating of 150 psi. Material shall be ductile iron, Grade 70-50-05 as specified in ASTM A536. Flanges shall be flat faced.

B. Mechanical joint ductile-iron fittings 18 through 48 inches conforming to AWWA C110 (except for laying length) with a minimum pressure rating of 250 psi may also be used.

2.06 FLANGES

A. Flanges shall be solid back, 250 psi working pressure per AWWA C115. Flanges on pipe shall be either cast or threaded. Material shall be ductile iron.

B. Flanged pipe and fittings shall be shop fabricated, not field fabricated. Threaded flanges shall comply with AWWA C115. Flanges shall be individually fitted and machine tightened in the shop, then machined flat and perpendicular to the pipe barrel. Flanges shall be backfaced parallel to the face of flange. Prior to assembly of the flange onto the pipe, apply a thread compound to the threads to provide a leak-free connection. There shall be zero leakage through the threads at a hydrostatic test pressure of 250 psi without the use of the gasket.

C. Material for blind flanges shall be ductile iron.

2.07 PIPE LINING--CEMENT MORTAR

A. Line pipe interior and fittings with cement-mortar per AWWA C104. Lining thickness shall be the double thickness listed in AWWA C104, Section 4.7. Lining material shall conform to ASTM C 150, Type II.

B. Line blind flanges per Specification Section 09900: PAINTING AND COATING, System No. 7.

C. Maintain a moist environment inside the lined pipe and fittings by sealing the ends with polyethylene sheet.

D. Loose areas of cement mortar lining are not acceptable. Remove and reconstruct lining in areas where quality is defective, such as sand pockets, voids over sanded areas, blisters, drummy areas, cracked areas, and thin spots. Longitudinal cracks in excess of 1/32 inch in width or where crack extends to metal shall be repaired with epoxy. Repair all cracks larger than 1/16 inch with epoxy.

2.08 GASKETS FOR FLANGES

See Specification Section 15050: GENERAL PIPING REQUIREMENTS.

2.09 GASKETS FOR MECHANICAL, PUSH-ON, AND RESTRAINED JOINTS

Synthetic rubber in accordance with AWWA C111.

2.10 BOLTS AND NUTS FOR FLANGES

See Specification Section 15050: GENERAL PIPING REQUIREMENTS.

2.11 JOINTS

A. Joints in piping located in vaults and structures shall be flanged end as noted on the plans.

B. Joints in buried piping shall be of the restrained, push-on or mechanical-joint type per AWWA C111 except where flanged joints are required to connect to valves, meters, and other equipment. Provide unrestrained buried joints except where restrained joints are specifically shown in the drawings.

C. Restrained joints for piping 6 inches and larger shall be American Cast Iron Pipe "Lok-Ring" or "Flex-Ring," U.S. Pipe "TR-Flex," or equal. All weldments for restrained joints shall be tested by the liquid penetrant method per ASTM E 165. Restrained joints may also consist of mechanical joints with restraint system using follower ring and wedges.

D. Restrained joints in 4-inch-diameter buried piping shall be American Cast Iron Pipe Company “Fast-Grip,” U.S. Pipe Field-lok gasket within Tyton joint pipe and fittings, or equal. Joint restraint shall be certified to four times rated pressure of 200 psi by Factory Mutual.

E. Provide thrust restraint as called for on the drawings.

2.12 MECHANICAL JOINT RESTRAINT SYSTEM USING FOLLOWER RING AND WEDGES

The restraining mechanism shall consist of a follower gland having a seal gasket and individually actuated wedges that increase their resistance to pullout as pressure or external forces increase. The system manufacturer shall provide all the components (follower ring, wedges, and gaskets) for the restraining device. The device shall be capable of full mechanical joint deflection during assembly and the flexibility of the joint shall be maintained after burial. The joint restraint ring and its wedging components shall be constructed of ductile iron conforming to ASTM A 536, Grade 60-42-10. The wedges shall be ductile iron, heat-treated to a minimum hardness of 370 BHN. Dimensions of the gland shall be such that it can be used with mechanical joint bells conforming to AWWA C111 and AWWA C153. The design shall use torque

limiting twist-off nuts to provide actuation of the restraining wedges. The mechanical joint restraint shall be available in the size range of 3 through 48 inches. Minimum rated pressure shall be 350 psi for sizes 16 inches and smaller and 150 psi in sizes 18 inches and larger. Products: Megalug Series 1100 as manufactured by EBAA Iron, Inc., or equal.

2.13 DUCTILE-IRON PIPE WELDMENTS

A. All welding to ductile-iron pipe, such as for bosses, joint restraint, and joint bond cables, shall be done at the place of manufacture of the pipe. Perform welding by skilled welders who have experience in the method and materials to be used. Welders shall be qualified under the standard qualification procedures of the ASME Boiler and Pressure Vessel Code, Section IX, Welding Qualifications.

B. Welds shall be of uniform composition, neat, smooth, full strength, and ductile. Completely grind out porosity and cracks, trapped welding flux, and other defects in the welds in such a manner that will permit proper and complete repair by welding.

C. Completed welds shall be inspected at the place of manufacture by the liquid penetrant method. Conform to the requirements specified in ASTM E 165, Method A, Type I or Type II. The materials used shall be water washable and nonflammable.

PART 3 - EXECUTION

3.01 DELIVERY, UNLOADING, AND TEMPORARY STORAGE OF PIPE AT SITE

A. Limit onsite pipe storage to a maximum of thirty days.

B. Use unloading and installation procedures that avoid cracking of the lining. If necessary, use plastic sheet bulkheads to close pipe ends and keep cement-mortar lining moist.

C. Deliver the pipe alongside the pipelaying access road over which the pipe trailer-tractors can travel under their own power. Place the pipe in the order in which it is to be installed and secure it from rolling.

D. Do not move pipe by inserting any devices or pieces of equipment into the pipe barrel. Field repair linings damaged by unloading or installation procedures.

3.02 SANITATION OF PIPE INTERIOR

A. During laying operations, do not place tools, clothing, or other materials in the pipe.

B. When pipelaying is not in progress, close the ends of the installed pipe by a child- and vermin-proof plug.

3.03 INSTALLING FLANGED PIPE AND FITTINGS

Install in accordance with Specification Section 15050: GENERAL PIPING REQUIREMENTS. Cut the bore of the gaskets such that the gaskets do not protrude into the pipe when the flange bolts are tightened.

3.04 INSTALLING GROOVED-END PIPE AND FITTINGS

See Specification Section 15050: GENERAL PIPING REQUIREMENTS.

3.05 INSTALLING BURIED PIPING

A. Install in accordance with COA Specification Section 701: TRENCHING, EXCAVATION AND BACKFILL and as follows.

B. When installing piping in trenches, do not deviate more than 1 inch from line or 1/4 inch from grade. Measure for grade at the pipe invert.

C. Assemble restrained joints per manufacturer's instructions.

3.06 JOINT DEFLECTIONS FOR BURIED PIPE

A. Do not exceed the following deflection angles for unrestrained buried pipe joints:

Pipe Size (inches)	**Maximum Deflection (degrees)**	
	Push-On Joint	**Mechanical Joint**
16	2-1/2	3
24	2-1/2	2

B. For restrained joints, do not exceed 80% of the manufacturer's recommended maximum deflections.

C. Small angular changes (less than 7 degrees) in horizontal alignment defined in the drawings by a point of inflection (PI) with no accompanying curve data shall be approximated as a curve by deflecting by equal amounts equal length pipe segments to create a curve equally distributed on both sides of the given PI. Accomplish a larger (greater than or equal to 7 degrees) change in horizontal alignment where a curve is not called for in the drawings through the use of an elbow placed at the station of the PI shown in the drawings. Provide thrust restraint as required in the drawings.

D. Small angular changes (less than 5 degrees) in vertical alignment may be accomplished by the use of pulled joints. For larger vertical deflections, place an elbow at the station and elevation of the vertical PI shown in the drawings. Provide thrust restraint as required in the drawings.

E. Assemble joints in accordance with AWWA C600 and the manufacturer's recommendations.

3.07 INSTALLING ABOVEGROUND OR EXPOSED PIPING

See Specification Section 15050: GENERAL PIPING REQUIREMENTS.

3.08 PAINTING AND COATING

A. Provide asphaltic coating on buried pipe per AWWA C151.

B. Coat buried flanges and buried mechanical and restrained joint bolts, nuts, and glands per Specification Section 09900: PAINTING AND COATING, System No. 21.

C. Coat pipe located aboveground and vaults or structures per Specification Section 09900: PAINTING AND COATING, System 10. Apply prime coat in shop before transporting pipe to job site. Apply intermediate and finish coats in field before installing the pipe, then touch up after installation.

3.09 CLEANING PIPE

Sweep pipe clean of all dirt and debris. If hardened mud exists in the pipe, remove with the use of pressurized water hoses.

3.10 HYDROSTATIC TESTING

Test in accordance with NMPWSS Section 801. Test pressure shall be 150 psi or based on the test pressure HGL identified in the plans.

PART 4 – PAYMENT

Payment for the work in this section shall not be paid for separately but shall be included as part of the unit price cost for piping. No additional compensation will be made.

END OF SECTION

SECTION 16010

GENERAL ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. This Section includes general administrative and procedural requirements of electrical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1:
   1. Submittals
   2. Coordination Drawings
   3. Record Documents
   4. Maintenance Manuals
   5. Rough-Ins
   6. Electrical Installations
   7. Cutting and Patching

1.02 RELATED WORK

A. Drawings and general provisions of Contract, including General Conditions, Supplementary Conditions, and Division 1 Specification Sections apply to all Sections of Division 16.

B. The requirements listed under General Conditions and Supplementary Conditions and the General Requirements are applicable to this section and all subsequent sections of Division 16 and form a part of the contract.

C. Section 02221: Trenching, Backfilling and Compacting.

D. See Division 1, Coordination for additional requirements.

E. See Division 1, Cutting and Patching for additional requirements.

F. See Division 11.

G. See Division 13.

H. See Division 15.

I. Section 01340: Shop Drawings, Product Data and Samples.

1.03 CODES AND PERMITS

A. Perform electrical work in strict accordance with the applicable provisions of the National Electrical Code, Latest Edition; National Electric Safety Code, Latest Edition; the Uniform Building Code, Latest Edition as adopted and interpreted by the State of New Mexico, and the National Fire Protection Association (NFPA Regulations), current adopted edition. Provide all materials and labor necessary to comply with rules, regulations and ordinances. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern. The Contractor shall hold and save the Engineer free and harmless from liability of any nature or kind arising from his failure to comply with codes and ordinances.

B. Secure and pay for all permits necessary for performance of the work. Pay for all utility connections unless otherwise specified herein.

C. The following lists applicable codes and standards that, as a minimum, shall be followed.
1. Applicable county and state electrical codes, laws and ordinances.
2. National Electrical Manufacturer's Association Standards.
3. National Electrical Code.
4. National Electrical Safety Code.
5. Underwriters Laboratories, Inc. Standards.
6. American National Standards Institute.
7. American Society for Testing Materials Standards.
8. Standards and requirements of local utility companies.
9. National Fire Protection Association Standards.
10. Institute of Electrical and Electronics Engineers Standards
11. Insulated Cable Engineers Association
12. Occupational Safety and Health Act.
13. Uniform Fire Code.
14. Americans with Disabilities Act
15. Commercial and Industrial Insulation Standards (MICA).

1.04 RECORD DRAWINGS

A. See Division 1, for requirements associated with Project Record Drawings.

B. Maintain a complete and accurate set of marked up blue-line prints showing information on the installed location and arrangement of all electrical work, and in particular, where changes were made during construction. Keep record drawings accurate and up-to-date throughout the construction period. Record drawings may be reviewed and checked by the Engineer during the construction and in conjunction with review and approval of monthly pay requests. Include copies of all addenda, RFI's, bulletins, and change orders neatly taped or attached

to record drawing set. Transmit drawings to the Engineer at the conclusion of the project for delivery to the Owner's representative.

C. Prepare record documents in accordance with the requirements in Division 1, Section 01700: Contract Closeout. In addition to the requirements specified in Division 1, indicate installed conditions for:
   1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
   2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
   3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

1.05 QUALIFICATIONS

A. All electricians shall be skilled in their respective trade.

1.06 SUBSTITUTIONS

A. Identification of Division 16 equipment, fixtures, and materials listed within this Specification and in the Equipment Schedules on the drawings, which are identified by manufacturer's name, trade name, and/or model numbers are generally not meant to give preference to any manufacturer, but are provided to establish the design requirements and standards. Additional manufacturers judged to be "equivalent" to the specified product may also be listed.

B. Equipment submitted for substitution must fit the space conditions leaving adequate room for maintenance around all equipment. A minimum of 36 inches, or more if required by Code, must be maintained clear in front of all electrical panels, starters, gutters, or other electrical apparatus. Submit drawings showing the layout, size and exact method of interconnection of conduit, wiring and controls, which shall conform to the manufacturer's recommendations and these specifications. The scale of these drawings shall be scale of Contract Drawings. The Contractor shall bear the excess costs, by any and all crafts, of fitting the equipment into the space and the system designated. Where additional labor or material is required to permit equipment submitted for substitution to function in an approved manner, this shall be furnished and installed by the Contractor without additional cost to the Owner.

C. Equipment submitted for substitution shall be approved in writing by the Owner or his representative and shall be accompanied by the following:
   1. A sample of each item submitted for substitution shall accompany the submittal.
   2. Provide a unit price quotation with each item intended for substitution. Include a unit price for the specified item and a unit price for the intended

substitute item. Provide a total (per item) of the differential payback to the Owner should the intended substitute item be equivalent to that which is specified.

D. Substitutions shall be approved in writing by the Owner or his representatives. The determination of the Owner shall be final.

1.07 PRIOR APPROVAL

A. Requests for prior approval received after the specified due date may not be considered.

B. Division 16 prior approval equipment, fixtures, and materials which are submitted as specified herein and accepted will be included in an Addendum. Equipment, fixtures and materials which are accepted under this prior approval process are accepted for bidding purposes only, subject to all requirements, terms, and conditions of the Contract Documents.

1.08 DEFINITIONS

A. Definitions of terms will be found in the National Electric Code, Electrical Safety Orders.

B. Whenever a term is used in this Specification which is defined in the Code, the definition given will govern its meaning in this Specification.

C. Whenever a technical term is used which does not appear in the Code, the definition to govern its meaning in these Specifications will be found in the Standard Dictionary of Electrical and Electronic Terms, published by the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, New Jersey 08855-1331.

D. "Provide" means furnish, install, connect and test unless otherwise noted.

E. Wet Interior Locations: Underground or below grade structure locations subject to submergence or which contain water/liquid piping with the possibility for submergence.

F. Dry Interior Locations: All interior locations not defined as “Wet Interior Locations.”

G. Damp Exterior Locations: All locations beneath a protective roof structure preventing direct rain exposure, but does not have protective walls preventing indirect exposure.

H. Wet Exterior Locations: All locations exterior to buildings not under a protective roof structure and directly exposed to rain.

I. Corrosive Locations: Locations defined by Engineer to have a corrosive atmosphere due to gases or liquids.

J. Hazardous Locations: Areas considered to be classified as Class 1, Division 1 or 2 as defined in the NEC (NFPA 70, most current edition).

K. Voltage Classes: System voltages referenced as “Low Voltage”, “Medium Voltage” and “High Voltage” shall be defined as identified in ANSI C84.1-2011.3 “System voltage classes”.

1.09 SUBMITTALS

A. The Contractor shall submit to the Engineer submittal brochures of equipment, fixtures and materials to be furnished under Division 16 as indicated in Section 01340.

B. Unauthorized Substitutions: If substitute materials, equipment or systems are installed without prior review or are installed in a manner which is not in conformance with the requirement of this Specification and for which the Contractor has not received a written review, removal of the unauthorized materials and installation of those indicated or specified shall be provided at no change in contract amount.

C. Install equipment in accordance with the manufacturer's recommendations. Provide accessories and components for optimum operation as recommended by the manufacturer.

D. Costs for the preparation, correction, delivery, and return of the submittals shall be borne by the Contractor.

E. Complete data must be furnished showing performance, quality and dimensions. No equipment or materials shall be purchased prior to receiving written notification from the Engineer that submittals have been reviewed and marked either "NO EXCEPTIONS TAKEN" or "EXCEPTIONS AS NOTED". Submittals returned marked "EXCEPTIONS AS NOTED" do not require resubmittal provided that the Contractor agrees to comply with all exceptions noted in the submittal, and so states in a letter to the Engineer.

F. Review of Submittals: Submittals will be reviewed with reasonable promptness, but only for conformance with the design concept of the Project and for conformance with the information indicated on the Drawings and stated in the Specifications. Review of a separate item as such will not indicate review of the assembly in which the item functions. Review of submittals shall not relieve the Contractor of responsibility for any deviation from the requirements of the

Contract Documents, nor for errors or omissions in the submittals; or for the accuracy of dimensions and quantities, the adequacy of connections, and the proper and acceptable fitting, execution, functioning and completion of the work. Review shall not relieve the Contractor of responsibility for the equipment fitting within the allotted space shown on the drawings with all clearances required for equipment operation, service and maintenance including a minimum of 3 feet clear in front of all electrical equipment and panels as defined by the National Electric Code. Any relocation of mechanical and/or electrical equipment, materials and systems required to comply with minimum clearances shall be provided by the Contractor without additional cost under the Contract.

G. Shop Drawings: Unless the following information is included, shop drawings will be returned unchecked:

1. Cover sheet for each submittal, listing equipment, products, and materials, and referencing data and sections in Specifications and drawings. Clearly reference project name and provide space for a review stamp.
2. Cover sheet shall clearly identify deviations from specifications, and justification.
3. Include all related equipment in a single submittal to allow complete review. Similar equipment may be submitted under a common cover sheet.
4. Size, dimensions, and weight of equipment.
5. Equipment performance under specified conditions, not a copy of scheduled data on drawings.
6. Indicate actual equipment proposed, where data sheets indicate more than one (1) device or equipment.

H. Use of substitutions reviewed and checked by the Engineer does not relieve the Contractor from compliance with the Contract Documents. Contractor shall bear all extra expense resulting from the use of any substitutions where substitutions affect adjoining or related work required in this Division or other Divisions of this Specification.

I. If Contractor substitutes equipment for that drawn to scale on the drawings, he shall prepare a 1/4" = 1' 0" installation drawing for each equipment room where a substitution is made, using dimensions of substituted equipment, and including piping, and electrical equipment requirements, to verify that equipment will fit space with adequate clearances for maintenance. This 1/4" = 1' 0" fabrication drawing shall be submitted, for review by the Engineer, with the shop drawing submittals of the substituted. Failure to comply with this requirement will result in the shop drawings being returned unchecked.

1.10 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1, Section 01730 Contract Closeout. In addition to the requirements specified in Division 1, include the following information for equipment items:
   1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
   2. Servicing instructions and lubrication charts and schedules.

1.11 DRAWINGS AND SPECIFICATIONS

A. Electrical drawings are diagrammatic, but shall be followed as closely as actual construction and work of the other sections shall permit. Size and location of equipment is drawn to scale wherever possible. Do not scale from electrical drawings.

B. Drawings and specifications are for the assistance and guidance of the Contractor. Exact locations, distances, and levels will be governed by the building. The Contractor shall make use of data in all the Contract Documents to verify information at the building site.

C. In any case where there appears to be a conflict between that which is shown on the electrical drawings, and that shown in any other part of the Contract Documents, the Contractor shall notify and secure directions from the Engineer.

D. Drawings and specifications are intended to complement each other. Where a conflict exists between the requirements of the drawings and/or the specifications, request clarification. Do not proceed with work without direction.

E. The Engineer shall interpret the drawings and the specifications. The Engineer's interpretation as to the true intent and meaning thereof and the quality, quantity, and sufficiency of the materials and workmanship furnished thereunder shall be accepted as final and conclusive.

F. Where items are specified in the singular, this division shall provide the quantity as shown on drawings plus any spares or extras indicated on the drawings or in the specifications.

G. Investigate structural and finish conditions and arrange work accordingly. Provide all fittings, equipment, and accessories required for actual conditions.

1.12 SIMILAR MATERIALS

A. All items of a similar type shall be products of the same manufacturer.

B. Contractor shall coordinate among suppliers of various equipment to assure that similar equipment type is product of the same manufacturer.

C. Examples of similar equipment types include but are not limited to:
   1. Power Circuit Breakers
   2. Enclosed Case Circuit Breakers
   3. Batteries
   4. UPS
   5. Surge Protection Devices
   6. Motor Starters
   7. Transformers
   8. Panelboards
   9. Switchboards
   10. Disconnects
   11. Fuses
   12. Transfer Switches

1.13 PRODUCT STORAGE, HANDLING AND DELIVERY

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

1.14 WARRANTY

A. Following guarantee is a part of the specifications and shall be binding on the Contractor:
   1. "The Contractor guarantees that this installation is free from ALL defects. He agrees to replace or repair to the satisfaction of the Owner's Representative any part of the installation which may fall within a period of one year after date established below, provided that such failure is due to defects in the materials or workmanship or to failure to follow the specifications and drawings. Warranty of the Contractor furnished equipment or systems shall begin on the date the system or equipment is placed in operation for beneficial use of the Owner or occupancy by the Owner, whichever occurs first; such date to be determined in writing by the Owner's Representative by means of issuing a 'Certificate of Substantial Completion'."

B. The extent of guarantees or warranties by Equipment and/or Materials Manufacturers shall not diminish the requirements of the Contractor's guarantee warranty to the Owner.

C. All items of electrical equipment furnished and installed under Division 16 shall be provided with a full two (2) year parts and labor warranty unless extended by other divisions of this specification.

PART 2 PRODUCTS

2.01 QUALITY OF MATERIALS

A. All equipment and materials shall be new, and shall be the standard product of manufacturers regularly engaged in the production of electrical equipment, and shall be the manufacturer's latest design. Specific equipment, shown in schedules on drawings and specified herein, is to set forth a standard of quality and operation.

2.02 EQUIPMENT REQUIREMENTS

A. The electrical requirements for equipment specified or indicated on the drawings are based on information available at the time of design. If equipment furnished for installation has electrical requirements other than those indicated on the electrical drawings, make all adjustments to wire and conduit size, controls, over current protection and installation as required to accommodate the equipment supplied. Delineate all adjustments to the drawings reflecting the electrical system in a submittal to the Contract Administrator immediately upon knowledge of the required adjustment.

PART 3 EXECUTION

3.01 COOPERATION WITH OTHER TRADES

A. Coordinate all work so that the construction operations can proceed without harm to the Owner from interference, delay, or absence of coordination. The Contractor shall be responsible for the size and accuracy of all openings.

3.02 DRAWINGS

A. The electrical drawings show the general arrangement of all lighting, power, special systems, equipment, etc., and shall be followed as closely as actual building construction and work of other trades will permit. Whenever discrepancies occur between plans and specifications, the most stringent shall govern. All Contract Documents shall be considered as part of the work. Coordinate with architectural, mechanical, and structural drawings. Because of the small scale of the electrical drawings, it is not possible to indicate all offsets, fittings and accessories, which may be required. Provide all fittings, boxes, and accessories as may be required to meet actual conditions. Should conditions necessitate a rearrangement of equipment, such departures and the reasons therefor, shall be submitted by the contractor to the Engineer for review in the form of detailed drawings showing the proposed changes. No changes shall be made without the prior written approval of the Engineer. All changes shall be marked on record drawings.

B. Should any doubt or question arise in respect to the true meaning of the drawings or specifications, the question shall be submitted to the Engineer, whose decision shall be final and conclusive.

C. Installation of all equipment shall be arranged to provide all clearances required for equipment operation, service, and maintenance, including minimum clearance, as defined by the National Electric Code (NEC).

D. The installation of all concealed electrical systems shall be carefully arranged to fit within the available space without interference with adjacent structural and mechanical systems.

3.03 ELECTRICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of electrical system, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, and materials installation with all other building components.
2. Verify all dimensions by field measurements.
3. Arrange for chases, slots, and openings in all other building components during progress of construction, to allow for electrical installations.
4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.
5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum clearance possible.
7. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Engineer.
9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.
10. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

11. Install access panel or doors where units are concealed behind finished surfaces.
12. Install systems, materials, and equipment giving right-of-way priority to systems requiring installation at a specified slope.

B. Install items level, plumb and parallel, and perpendicular to the building.

3.04 FIELD MEASUREMENTS

A. No extra compensation shall be claimed or allowed due to differences between actual dimensions, including dimensions of equipment, fixtures and materials furnished, and those indicated on the drawings. Contractor shall examine adjoining work, and shall submit to Engineer any work which must be corrected. Review of submittal data in accordance with paragraph "Submittals" shall in no manner relieve the Contractor of responsibility for the proper installation of the electrical work within the available space. Installation of equipment and systems within the building space shall be carefully coordinated by the Contractor.

3.05 EQUIPMENT SUPPORT

A. Provide support for equipment to the building structure. Provide all necessary structures, inserts, sleeves, firestops and hanging devices for installation of equipment. Coordinate installation of devices. Verify with the Engineer that the devices and supports are adequate as intended and do not overload the building's structural components in any way.

3.06 PAINTING

A. All finish painting of electrical systems and equipment will be under "Painting", unless equipment is hereinafter specified to be painted.

B. All equipment shall be provided with factory applied standard finish, unless otherwise specified.

C. Touch Up: If the factory finish on any equipment is damaged in shipment or during construction of the building, the equipment shall be refinished to the satisfaction of the Engineer.

3.07 PROTECTION OF MATERIALS AND EQUIPMENT

A. The Contractor shall be responsible for the protection of all work, materials and equipment furnished and installed under this section of the specifications, whether incorporated in the building or not.

B. All items of electrical equipment shall be stored in a protected weatherproof enclosure prior to installation within the building, or shall be otherwise protected from the weather in a suitable manner approved by the Engineer.

C. The Contractor shall provide protection for all work and shall be responsible for all damage done to property, equipment and materials. Storage of materials within the building shall be approved by the Engineer prior to such storage.

D. Conduit openings shall be closed with caps or plugs, or covered to prevent lodgment of dirt or trash during the course of installation. At the completion of the work, fixtures, equipment and materials shall be cleaned and polished thoroughly and delivered in a condition satisfactory to the Engineer.

3.08 EXCAVATION

A. Provide all excavation, trenching and backfilling required.

B. Slope sides of excavations to comply with codes and ordinances. Shore and brace as required for stability of excavation.

3.09 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code".

3.10 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.11 APPLICATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturer’s printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.
2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

B. Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

C. Firestopping Sealant: Provide sealant, including forming, packing, and other accessory materials, to fill openings around electrical services penetrating floors and walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.12 INSTALLATION OF ACCESS DOORS

A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

B. Adjust hardware and panels after installation for proper operation.

3.13 CUTTING AND PATCHING

A. Perform cutting and patching per requirements below:
1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
    a. Uncover Work to provide for installation of ill-time Work.
    b. Remove and replace defective Work.
    c. Remove and replace Work not conforming to requirements of the Contract Documents.
    d. Remove samples of installed Work as specified for testing.
    e. Install equipment and materials in existing structures.
    f. Upon written instructions from the Contracting Officer, uncover and restore Work to provide for Contracting Officer observation of concealed Work.
2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.
3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

5. During cutting and patching operations, protect adjacent installations.
6. Patch existing finished surfaces and building components using new materials matching existing materials and experienced installers.

3.14 MANUFACTURER'S INSTRUCTIONS

A. All equipment shall be installed in strict accordance with recommendations of the manufacturer. If such recommendations conflict with plans and specifications, the Contractor shall submit such conflicts to the Engineer who shall make such compromises as he deems necessary and desirable.

3.15 CONCRETE BASES AND HOUSEKEEPING PADS

A. Install concrete bases and housekeeping pads under all freestanding electrical equipment unless otherwise noted.

B. Contractor shall be responsible for the accurate dimensions of all pads and bases and shall furnish and install all anchor bolts, etc. Coordinate weight of concrete bases and housekeeping pads with the structural Engineer.

C. All concrete bases and housekeeping pads shall conform to the requirements specified under Division 3, Concrete, portions of these specifications. Pad foundations shall be 4" high minimum, unless otherwise indicated on the drawings. Chamfer edges shall be 1". Faces shall be free of voids and rubbed smooth with Carborundum block after stripping forms. Tops shall be level. Provide dowel rods or other required material in floor for lateral stability and anchorage.

D. Equipment anchor bolts shall be set in a galvanized pipe or sheet metal sleeves 1" larger than bolt diameter. Anchor bolts shall be high strength steel J shape. Anchor bolt design shall be arranged and paid for by the Contractor.

3.16 TESTS

A. All tests shall be conducted in the presence of the designated and authorized Owner’s representative. The Contractor shall notify the Engineer one week in advance of all tests. The Contractor shall furnish all necessary equipment, materials, and labor to perform the required tests.

3.17 OPERATION AND MAINTENANCE INSTRUCTIONS

A. The Contractor shall furnish the Engineer complete operating and maintenance instructions covering all units of electrical equipment herein specified together

with parts lists. Furnish four (4) copies of all the literature; each shall be suitably bound in loose-leaf book form.

B. Operating and maintenance manuals as required herein shall be submitted to the Engineer for review not less than two (2) weeks prior to the date scheduled for the Contractor to provide Operating and Maintenance Instructions to the Owner as specified herein.

C. Upon completion of all work and all tests, Contractor shall furnish the necessary skilled labor and helpers for operating the electrical systems and equipment for a period of five (5) days of eight (8) hours each. During this period, the Contractor shall instruct the Owner or his representative in the operations, adjustment and maintenance of all equipment furnished. Contractor shall provide at least two weeks notice to the Engineer in advance of this period, with a written schedule of each training session, the subject of the session, the Contractors' representatives who plan to attend the session, and the time for each session.

3.18 CERTIFICATIONS

A. Before receiving final payment, certify in writing that all equipment furnished and all work done is in compliance with all applicable codes mentioned in these specifications. Submit certifications and acceptance certificates to the Contracting Officer, including proof of delivery of O&M manuals, spare parts required, and equipment warranties, which shall be bound with O&M manuals.

3.19 INTERRUPTING SERVICES

A. The Contractor shall coordinate the installation of all work within the facility in order to minimize interference with the operation of existing electrical telephone, fire alarm, and utility systems during construction. Connections to existing systems requiring the interruption of service within the facility shall be carefully coordinated with the owner to minimize system downtimes. Requests for the interruption of existing services shall be submitted to the Engineer in writing a minimum of two (2) weeks before the scheduled date. Absolutely no interruption of the existing services will be permitted without the written review of the Engineer.

3.20 OPERATION PRIOR TO ACCEPTANCE

A. Operation of equipment and systems installed by the Contractor for the benefit of the Owner prior to substantial completion will be allowed providing a written agreement between the Owner and the Contractor has established warranty and other responsibilities to the satisfaction of both parties.

3.21 SITE VISITS AND OBSERVATION OF CONSTRUCTION

A. The Engineer will make periodic visits to the project site at various stages of construction in order to observe the progress and quality of various aspects of the Contractor's work, in order to determine in general if such work is proceeding in accordance with the Contract Documents. This observation by the Engineer, however, shall in no way release the Contractor from his complete responsibility to supervise, direct, and control all construction work and activities, nor shall the Engineer have authority over, or a responsibility to means, methods, techniques, sequences, or procedures of construction provided by the Contractor or for safety precautions and programs, or for failure by the Contractor to comply with all law, regulations, and codes.

3.22 MEASUREMENT AND PAYMENT

A. Work covered under this section of the specifications, and costs associated therewith, shall be included in the contract price for the item to which the work applies. No separate payment shall be made.

END OF SECTION

SECTION 16011

ELECTRICAL ACCEPTANCE TESTING

PART 1 GENERAL

1.01 SCOPE OF WORK

A. The Electrical Testing Firm (ETF) shall test, inspect and calibrate electrical equipment and material installed and connected under Division 16. The purposes of these inspections, tests and calibrations are to assure that the installed electrical systems and equipment, both Contractor and Owner supplied if applicable, are:
   1. Installed in accordance with design specifications and manufacturer's instructions.
   2. Ready to be energized.
   3. Operational and within industry and manufacturer's tolerances.

B. The Contractor shall provide power system studies that include a complete short-circuit study, equipment evaluation study and protective device coordination study.
   1. It is the responsibility of the Contractor to obtain the electrical equipment sizes from the approved Contractor submittals. The approved equipment sizes and related power system components shall be incorporated into the power system studies.

C. Perform all studies using SKM Systems Analysis software, or Engineer approved equal.

D. Provide all material, equipment, labor, and technical supervision to perform specified tests, inspections, studies, labeling, and calibration.

E. Provide the services of an electrical testing firm (ETF) to perform the acceptance testing, inspection and calibration of electrical systems as specified in this Section. The ETF shall perform this work under the direction of the manufacturer.

F. The following is a list of equipment and systems to be inspected, tested and calibrated by the ETF; refer to Part 3 of this Section for detailed requirements:
   1. Low Voltage Power Circuits and Connections.
   2. Low Voltage Control Circuits and Connections.
   3. Grounding System and Connections.

1.02 RELATED WORK

A. Division 01

B. Division 11

C. Section 16010: General Electrical Requirements

D. Section 16075: Electrical Identification

E. Section 16452: Grounding

F. Section 16476: Disconnect Switches and Circuit Breakers

G. Section 16477: Fuses

H. Section 16478: Surge Protection Devices

1.03 REGULATORY REQUIREMENTS

A. Make inspections and tests in accordance with the applicable codes and standards of the following agencies except as provided otherwise herein:
   1. InterNational Electrical Testing Association - NETA ATS-2017: Acceptance Testing Specifications
   2. National Fire Protection Association - NFPA
      a. ANSI/NFPA 70: National Electrical Code
      b. ANSI/NFPA 70B: Recommended Practice for Electrical Equipment Maintenance
      c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces

B. Use the following references:
   1. Project design specifications.
   2. Project design drawings.
   3. Project short-circuit and coordination study.
   4. Manufacturer's instruction manuals applicable to each particular apparatus.
   5. Project list of equipment to be inspected and tested.

1.04 SUBMITTALS FOR RELEASE

A. Make submittals in accordance with the provisions of Division 1.

B. Within 30 days after Notice to Proceed, submit certification of the qualifications of the ETF and personnel as described in the QUALITY ASSURANCE paragraph of this Section.

C. Short Circuit Study: Prepare and submit study prior to or in conjunction with electrical distribution equipment (switchgear, transformers, motor control centers,

panelboards, etc.) Submittals for this equipment will not be reviewed until an approved Short Circuit Study is submitted.

1. Include Motor Contribution for Motors with power rating of 50 HP or larger.
2. Include Short Circuit Contribution when Solid State Soft Starters and Variable Frequency Drives that have an external mechanical bypass or if the device has an internal bypass. It is responsibility of Contractor to obtain documentation from manufacturer and/or supplier of short circuit contribution for motor controllers with internal bypass.

D. Equipment Evaluation Study: Prepare and submit study prior to or in conjunction with electrical distribution equipment (switchgear, transformers, motor control centers, panelboards, generators, etc.) and all other electrically powered equipment (pumps, light fixtures, etc.) Submittals for this equipment will not be reviewed until an approved Equipment Evaluation Study is submitted.

E. Arc-Flash Hazard Analysis: Prepare and submit study within 30 calendar days after approval of Short Circuit Study and electrical distribution equipment.

F. Protective Device Coordination Study: Prepare and submit study within 30 calendar days after approval of Short Circuit Study concurrent with electrical distribution equipment submittals. Electrical distribution submittals will not be approved until power system studies have been submitted. All electrically powered equipment and generators must be approved prior to review of Protective Device Coordination Study.

G. Submit an electronic copy of the study in the format used to perform the study. Convert and submit file in SKM format.

1.05 SUBMITTALS FOR CLOSEOUT

A. Submit a final report of the power system studies. Sign the final report and include the following information: description, purpose, basis, written scope, and a single-line diagram of the portion of the power system which is included within the scope of the study.

B. Submit copies of field reports, test data, calculations, plots and evaluations within 48 hours of the completion of each test for information and project coordination.

C. Submit an electronic copy of the final study in the format used to perform the study. Convert and submit file in SKM format.

D. Submit a final report of testing and inspection at the completion of the project. Include the following information:

1. Summary of the project.
2. Description of the equipment tested.
3. Visual inspection report.

4. Description of the tests.
5. Test results.
6. Conclusions and recommendations.
7. Appendix including appropriate test forms.
8. Identification of the test equipment used and calibration date.
9. Signature of test Engineer.

1.06 QUALITY ASSURANCE

A. The ETF shall be a corporately and financially-independent testing organization which shall function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.

B. The ETF shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

C. The ETF shall have successfully completed not less than five acceptance testing, inspection and calibration projects of similar scope to this project.

D. The ETF shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, 1910, and 1936 or be a Full Member company of the InterNational Electrical Testing Association.

E. The ETF lead, on-site, technical person shall be currently certified by the InterNational Electrical Testing Association (NETA) or National Institute for Certification in Engineering Technologies (NICET) in electrical power distribution system testing.

F. The ETF shall only utilize engineers and technicians who are regularly employed by the firm for testing services.

G. Power System Studies shall be performed by the power distribution manufacturer or a State of New Mexico Registered Professional Electrical Engineer.

H. Submit certification of the above qualifications; refer to SUBMITTALS Paragraph of this Section.

1.07 DIVISION OF RESPONSIBILITY

A. Perform routine insulation-resistance, continuity, and rotation tests for distribution and utilization equipment prior to and in addition to tests performed by the ETF specified in this Section.

B. Supply a suitable and stable source of electrical power to each test site. Coordinate specific power requirements with the ETF.

C. Schedule project to allow adequate time for electrical acceptance testing. Notify the ETF when equipment becomes available for acceptance tests. Coordinate work to expedite inspection and test scheduling.

D. The Contractor will supply one set of the following for use in conjunction with electrical acceptance testing: preliminary short-circuit analysis, preliminary coordination study, preliminary protective device setting table, complete set of electrical Drawings, Specifications, and any pertinent Change Orders.

E. Notify the Engineer not less than 24 hours prior to commencement of any testing.

F. Report to the Engineer any system, material, equipment or workmanship which is found defective on the basis of acceptance tests or inspections by the ETF.

G. Within 15 days of direction from the Engineer, rework, repair or replace any system, material, equipment or workmanship which is found defective on the basis of acceptance tests or inspections.

H. Upon direction from the Engineer, re-test any system, material, equipment or workmanship which did not pass acceptance tests or inspections.

I. Maintain a written record of all tests and, upon completion of project, assemble and submit a certified final test report that includes the test procedures and test results for each system and equipment item.

1.08 SAFETY AND PRECAUTIONS

A. Comply with required safety practices which include, but are not limited to, the following:
   1. Occupational Safety and Health Act.
   2. Accident Prevention Manual for Industrial Operations, National Safety Council.
   3. Applicable state and local safety operating procedures.
   4. National Fire Protection Association - NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces.
   5. American National Standards for Personnel Protection.

B. Perform tests with apparatus de-energized.

C. Provide a designated safety representative on the project to supervise testing operations with respect to safety.

1.09 TEST EQUIPMENT

A. Suitability of Test Equipment

1. Use only test equipment that is in good mechanical and electrical condition.
2. Use true RMS measuring meters.
3. Field test metering used to check power system meter calibration shall have an accuracy higher than that of the instrument being checked.
4. Use test equipment with accuracy of metering that is appropriate for the test being performed.
5. Use test equipment with waveshape and frequency output that are appropriate for the test and tested equipment.

B. Test Instrument Standards
1. Use only equipment for testing and calibration procedures that has the following characteristics:
   a. Maintained in good visual and mechanical condition.
   b. Maintained in safe operating condition.
2. Use test equipment having operating accuracy equal to, or better than, the following limits:
   a. Portable multimeters: true RMS measuring.
   b. Multimeters shall have the following accuracy limits, or better:
      i. AC voltage ranges: .75% ± 3 last single digits @ 60 Hz.
      ii. AC current ranges: .90% ±3 last single digits @ 60 Hz, including adapters, transducers.
      iii. DC voltage ranges: .25% ± 1 last single digit.
      iv. DC current ranges: .75% ± 1 last single digit.
      v. Resistance ranges: .50% ± 1 last single digit.
      vi. Frequency range: .10% ± 1 last single digit @ 60 Hz.
   c. Ground electrode test equipment: ± 2% of range.
   d. DC high potential test equipment: ± 2% of full scale.
   e. Power quality analyzer: comply with the specifications of IEC 61000-4-7 and IEC 61000-4-30.

C. Test Instrument Calibration
1. Establish and maintain a calibration program which assures that all applicable test instruments are maintained within rated accuracy which is directly traceable to the National Institute of Standards and Technology.
2. Calibrate instruments in accordance with the following schedule:
   a. Field instruments: 6 months maximum.
   b. Laboratory instruments: 12 months.
   c. Leased specialty equipment: 12 months (where accuracy is guaranteed by lessor).
3. Place dated calibration labels at visible locations on all test equipment.
4. Keep up-to-date records which show date and results of instruments calibrated or tested; have such records available for review by the Engineer.
5. Maintain up-to-date instrument calibration instructions and procedures for each test instrument.

6. Use calibration standards of higher accuracy than the accuracy of the test instrument being calibrated.

1.10 POWER SYSTEM STUDIES

A. Provide power system studies that include a complete short-circuit study, equipment evaluation study and protective device coordination study based on the installed electrical distribution system.

B. Include in the study all portions of the electrical distribution system from the utility transformer and from alternate sources of power in the electrical distribution system under study.

C. Cover normal system operating configuration plus any plausible alternate configurations and operations that could result in maximum fault condition.

D. Short-Circuit Study
   1. Perform short circuit study using methods outlined in ANSI/IEEE Std. 141, IEEE Recommended Practice for Electrical Power Distribution for Industrial Plants.
   2. Include the following study input data: the utility source short-circuit single- and three-phase contribution, with the X/R ratio, the resistance and reactance components of each branch impedance, motor and generator contributions, base quantities selected, and other circuit parameters as applicable.
   3. Calculate the short-circuit momentary and interrupting duty on the basis of maximum available fault current at each bus in the distribution system down to the following points in the low-voltage system:
      a. 480 volt system busses where available short circuit current is less than 14,000 amperes RMS symmetrical.
      b. 208 or 240 volt system busses where available short circuit current is less than 10,000 amperes RMS symmetrical.

E. Equipment Evaluation Study
   1. Perform an equipment evaluation study to determine the adequacy of circuit breakers, controllers, surge arresters, busways, switches and fuses.
   2. Tabulate and compare the short-circuit ratings of the devices with the available fault currents.
   3. Notify the Engineer of any problem areas or inadequacies in the electrical distribution system equipment.

F. Protective Device Coordination Study
   1. Perform protective device coordination study to select or to check the selections of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated voltage and current transformers, and low-voltage breaker trip characteristics and settings.

2. Perform protective device coordination study using methods outlined in ANSI/IEEE Std. 141, IEEE Recommended Practice for Electrical Power Distribution for Industrial Plants.
3. Include in the coordination study all voltage classes of equipment from the utilities incoming line protective device down to and including each low voltage load protective rated 100 amperes and larger.
4. Provide time-current characteristic plots of the specified protective devices on 11"x17" log-log coordination paper.
    a. Provide coordination plots for both phase and ground protective devices on a complete system basis.
    b. Include on plots complete titles, representative one-line diagram and legend, associated utility relay or fuse characteristics, significant motor starting characteristics, complete parameters of transformers, complete operating bands of circuit breaker trip curves, and fuse curves.
    c. Indicate on the plots the types of protective devices selected, proposed relay taps, time dial and instantaneous trip settings, ANSI transformer magnetizing inrush and withstand curves per ANSI C37.91, cable damage curves, symmetrical and asymmetrical fault currents.
    d. Comply with NFPA-70, National Electrical Code. Maintain reasonable coordination intervals and separation of characteristic curves.
    e. Use sufficient curves to clearly indicate the coordination achieved to each utility breaker or fuse, primary feeder breaker or fuse, transformer primary protective device, main and tie secondary breakers, low-voltage feeder breakers, and load protective device rated 100 amperes or more. Use a maximum of eight protective device characteristic curves per plot.
5. Provide the selection and settings of the protective devices in a separately tabulated form listing circuit identification, IEEE device number, current transformer ratios, manufacturer, type, range of adjustment, and recommended settings.
6. Alert the Engineer to coordination discrepancies, problem areas, or inadequacies.
7. Submit a final report power system studies as described in the SUBMITTALS article of this Section.

G. Arc-Flash Hazard Analysis
1. Perform an arc-flash hazard analysis in compliance with the latest edition of NEC 110.16 and NFPA 70E 110.8 (B) (1) for the electrical equipment in accordance with Annex D of NFPA 70E and IEEE 1584 to identify:
    a. The arc-flash protection boundaries, defined in Article 130.3(A) as “an approach limit at a distance from exposed live parts within which a person could receive a second-degree burn if an arc-flash were to occur.”
    b. The shock hazard boundaries.

c. The personal protection equipment (PPE) and protective clothing necessary, based on the incident energy present at the working distance for the task to be performed, as described in Article 130.3(B) and Article 130.7.

d. Switchboards, panelboards, industrial control panels, stand-alone VFDs, motor control centers, individually mounted starters, and instrument control panels shall be included in the study and shall be provided with arc flash labels as defined in Section 16075. Labels shall be provided for each section of the switchboard, VFD, and motor control center. Arc flash study shall not exclude equipment exempted by NFPA 70(E) and IEEE 1585, which allow exclusion of equipment that operates at 240 volts maximum and is fed from a transformer smaller than 125 kVA.

2. Reevaluation of Analysis

i. Owner will have the right to request reevaluation of any part of the coordination and arc-flash analysis to improve coordination or to reduce arc flash risk category or to eliminate cable protection inadequacy. Owner reserves the right to contact the individual who performed the study or to witness the actual reevaluation at the premises of the organization performing the study and shall be allowed to make suggestions. All these services shall be provided at no extra cost.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Test, inspect and calibrate the following electrical equipment in strict accordance with applicable sections of NETA ATS-2017, including applicable optional tests:
1. Electrical equipment specified in Division 16 of the Specifications.
2. Electrical equipment shown on the electrical Drawings.
3. Electrical equipment furnished under other Divisions of the Specifications and connected under Division 16.

B. Perform acceptance tests and inspections prior to energizing equipment.

C. Final acceptance will not occur before completion of the electrical acceptance tests, inspections and calibrations specified in this Section.

D. Detailed requirements for electrical acceptance tests, inspections and calibrations are specified in the following paragraphs.

3.02 TRANSFORMERS

A. Test and inspect low voltage dry-type transformers in accordance with NETA ATS-2017 Chapter 7.2.1, and manufacturer's instructions.

B. Test and inspect medium voltage oil-filled transformers in accordance with NETA ATS-2017 Chapter 7.2.2, and manufacturer's instructions.

3.03 PANELBOARDS

A. Inspect panelboards in accordance with NETA ATS-2017 Chapter 7.1.1, and manufacturer's instructions.

B. Test and inspect 150 ampere and larger circuit breakers and all main circuit breakers in accordance with NETA ATS-2017 Chapter 7.6.1.1, and manufacturer's instructions.

3.04 MEDIUM VOLTAGE POWER CABLE

A. Not Used

3.05 LOW VOLTAGE POWER CABLE

A. Test and inspect low voltage power cable in accordance with NETA ATS-2017 Chapter 7.3.2.

3.06 GROUNDING SYSTEMS

A. Test and inspect grounding systems in accordance with NETA ATS-2017 Chapter 7.13.

3.07 GROUND-FAULT PROTECTION SYSTEMS

A. Test and inspect ground fault protection systems in accordance with NETA ATS-2017 Chapter 7.14, and manufacturer's instructions.

3.08 SYSTEM FUNCTION TESTS

A. Perform function tests on each system provided in this contract and covered by this Section to ensure total system operation.

B. Perform the system functional tests upon satisfactory completion of equipment acceptance tests. It is the intent of system functional tests to prove the proper interaction of all sensing, processing, and action devices to effect the designed end product or result.

C. Test interlocks, safety devices, fail-safe functions, and design functions.

END OF SECTION

SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Provide and install:

1. Component identification tags.

2. Equipment nameplates.

3. Wire markers

4. Voltage markers.

5. Warning signs.

6. Arc flash warning labels.

7. Floor marking.

8. Underground warning tape.

1.02 SUBMITTALS FOR RELEASE

A. Submit the following:

1. Catalog Data: Submit manufacturer’s catalog literature for each product required.

2. Electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.

3. Samples: Submit

a. Submit two samples of each type of identification products applicable to project.

b. Submit two nameplates illustrating materials and engraving quality.

B. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.03 REGULATORY REQUIREMENTS

A. Conform to requirements of the National Electrical Code (NEC) and OSHA.

B. Conform to applicable requirements of the following ANSI Standards:

1. Z535.1 Safety Color Code.

2. Z535.2 Environmental and Facility Safety Signs.

3. Z535.3 Criteria for Safety Symbols and Labels.

4. Z535.4 Product Safety Signs and Labels.

5. Z535.5 Safety Tags and Barricade Tapes (for Temporary Hazards).

1.04 GENERAL

A. Device, panel, circuit numbers, etc. shown in examples provided herein are for illustration purposes only. Use actual device, panel, circuit numbers, etc. based on installed project.

PART 2 - PRODUCTS

2.02 LIGHTING AND POWER WIRE IDENTIFICATION

A. Phase Identification (600 Volt Class):

1. Type:

a. #12 AWG Through #6 AWG Wire: Solid color insulation throughout conductor length.

b. #4 AWG and Larger Wire: Vinyl plastic electrical color coding tape, 3/4” wide.

2. Colors:

a. 120/240 Volt, Single-Phase Conductors:

1) Line 1: Black.

2) Line 2: Red.

3) Neutral: White.

4) Ground: Green.

b. 120/208 Volt Conductors:

1) Phase A: Black.

2) Phase B: Red.

3) Phase C: Blue.

4) Neutral: White.

5) Ground: Green.

c. 480 Volt, 3-Phase, 3-Wire:

1) Phase A: Brown.

2) Phase B: Orange.

3) Phase C: Yellow.

d. 277/480 Volt, Three-Phase Conductors:

1) Phase A: Brown.

2) Phase B: Orange.

3) Phase C: Yellow.

4) Neutral: Gray.

5) Ground: Green.

B. Phase Identification (4160 and 12470 Volt Class):

1. Type: Vinyl plastic electrical coding tape, 3/4” wide.

2. Colors:

a. 4.160 KV Conductor:

1) Phase A: (1) Red band.

2) Phase B: (2) Red bands.

3) Phase C: (3) Red bands.

b. 12.47 KV Conductor:

1) Phase A: (1) Blue band.

2) Phase B: (2) Blue bands.

3) Phase C: (3) Blue bands.

C. Circuit Identification (600 Volt Class):

1. Print technology: Thermal transfer.

a. Type: Polyolefin heat-shrink tubing.

b. Shrink Ratio: 3:1.

c. Color: White.

d. Size: As required for application.

e. Compliance: UL224 recognized.

f. Manufacturer's Reference: Brady B-342 PermaSleeve PS.

2. Legend: Panel and circuit number.

D. Circuit Identification (4160 and 12470 Volt Class): None.

2.03 CONTROL WIRE AND CABLE IDENTIFICATION

A. Wire Identification – Panel Interior:

1. Type: Solid color insulation throughout conductor length.

a. 120 Volt:

1) Line: Red.

2) Neutral: White.

3) Ground: Green.

b. 24 Volt:

1) Direct Current Positive Supply: Blue.

2) Direct Current Negative Supply: Black.

3) 24 VDC Output Signal Wire: Yellow.

4) 24 VDC Input Signal Wire: Orange.

5) Ground (AC or DC): Green.

B. Wire Identification – Field Wiring:

1. Analog cable, in accordance with Specification Section 16123: Low-Voltage Wire and Cable.

   a. Color: Manufacturer's standard color.

2. Discrete cable, in accordance with Specification Section 16123: Low-Voltage Wire and Cable.

   a. Colors:

   b. 120 Volt:

      1) Line: Red.

      2) Neutral: White.

      3) Ground: Green.

   c. 24 Volt:

      1) Direct Current Positive Supply: Blue.

      2) Direct Current Negative Supply: Black.

      3) 24 VDC Output Signal Wire: Yellow.

      4) 24 VDC Input Signal Wire: Orange.

      5) Ground (AC or DC): Green.

C. Circuit Identification:

1. Print technology: Thermal transfer.

   a. Type: Polyolefin heat-shrink tubing.

   b. Shrink Ratio: 3:1.

   c. Color: White.

   d. Size: As required for application.

   e. Compliance: UL224 recognized.

   f. Manufacturer's Reference: Brady B-342 PermaSleeve PS.

2. Legend: “Source/Destination”: Ensure that manufacturer’s actual wire terminal designations are included.

a. Example: (Replace “##” with actual wire terminal designations)

(DS-MIX-S2)##/(HU-MIX-S2)##

2.04 EQUIPMENT IDENTIFICATION

A. General:

1. Provide nameplates in accordance with the following requirements, unless otherwise noted on the Drawings.

2. Center nameplate lettering on nameplate, vertically and horizontally.

3. Use same font type/style for all nameplates.

4. Use normal font spacing. Do not use condensed font.

5. Use tags/nameplates of the same size and with same font size and letter spacing for nameplates of a similar purpose, for example, the nameplates for all of the individual sections (or cubicles) of a motor control center.

B. Type:

1. Interior Locations: Rectangular, engraved two-layer UV stabilized Gravoply™. Block style white lettering, text size as indicated below, on black background, unless otherwise noted.

2. Exterior Locations: Rectangular Type 316 stainless steel nameplate, 0.047 inch minimum thickness. Laser etched with minimum 1/32 inch etch width block style lettering, text size as indicated below.

C. Legends:

1. Primary Distribution Equipment and Motor Control Centers: Provide main nameplate with specific description shown on One-Line Diagram on the Drawings. 3/8” high text.

a. Example:

MCC-4A

MOTOR CONTROL CENTER

2. Transformers: Provide main nameplate with specific description shown on One-Line Diagram on the Drawings and source description as shown below. 3/8” high text.

Description on Drawings

SERVED FROM: Description of Power Source

a. Example:

TF-1

DISTRIBUTION TRANSFORMER

480V – 120/208V

45 KVA

SERVED FROM: PP-1

3. Motor Control Center Incoming Sections: Label with device number and source description as shown below. 3/8” high text.

Device Number

SERVED FROM: Description of Power Source

a. Example:

MCC-4A/MAIN

SERVED FROM: SWBD-1

4. Motor Control Center Individual Sections (or Cubicles): Label with device number and load description as shown below. 3/8” high text.

Device Number

LOAD: Identification of Load Served

a. Example:

MCU-BLOG1

LOAD: GRIT CHAMBER BLOWER 1 (BLO-G1)

5. Panelboards: Label with device number and source description as shown below. 3/8” high text.

Device Number

SERVED FROM: Description of Power Source

a. Example:

LP-1

SERVED FROM: TF-1

b. Circuit Breaker Directory:

1) Type: Manufacturer's standard directory card supplied with panelboard Typewritten or process printed, except "SPARE" and "SPACE" circuits, which shall be hand lettered in erasable pencil.

2) Legends: In accordance with panel schedule in Drawings.

c. Circuit Breaker Identifications

1) Type: Engraved three-layer laminated plastic strip installed vertically along left and right hand sides of panelboard, adjacent to circuit breakers. Block style white lettering, minimum 1/4 inch high, on black background.

2) Numbering Conventions: In accordance with panel schedule in Drawings.

6. Disconnect Switches, Including Fractional Horsepower Manual Motor Starting Switches: Label with device number, source, and load description as shown below. 1/4” high text for disconnect switches, 3/16” high text for fractional horsepower manual motor starting switches. Use “Exterior Locations” Type label for fractional horsepower manual motor starting switches.

Device Number

SERVED FROM: Description of Power Source

LOAD: Identification of Load Served

a. Example:

DS-MIX-S1

SERVED FROM: MCC-4B/MCU-MIXS1

LOAD: MIX-S1

7. Discrete Motor Starters, Including Fractional Horsepower Manual Motor Starters: Label with device number, source, and load description as shown below. 1/4" high text for discrete motor starters, 3/16" high text for fractional horsepower manual motor starters. Use "Exterior Locations" Type Label for fractional horsepower manual motor starters.

Device Number

SERVED FROM: Description of Power Source

LOAD: Identification of Load Served

a. Example:

MCU-AC1

SERVED FROM: MCC-4A/SECT 2

LOAD: AC-1

8. Fuse Identification: Indicate fuse size and type as shown below. 1/4" high text.

a. Example:

FUSE: 35A, LPN-RK-SP (250V)

9. Other: Provide other nameplates as indicated on the drawings. Unless otherwise indicated, use 1/4" text.

2.05 INSTRUMENT NAMEPLATES

A. Type: Rectangular Type 316 stainless steel nameplate, 0.047 inch minimum thickness. Laser etched with minimum 1/32 inch etch width block style lettering, 3/16 inch high text.

B. Legend: Instrument identification as indicated on the Drawings.

Example:

LAH-S1

2.06 OUTLET IDENTIFICATION

A. Furnish a typewritten or machine printed label for each switch and receptacle outlet indicating circuit number, panelboard, and voltage.

B. Provide labels of the following materials:

1. Laminated plastic adhesive tape with machine printed letters.

2. Manufacturer: Brother.

C. Provide black, 10 point minimum size lettering on a white background.

2.07 VOLTAGE IDENTIFICATION

A. Type: Self adhesive vinyl cloth printed with black characters on an orange background.

B. Manufacturer's Reference: Brady Series 44000, B-500 vinyl cloth labels.

C. Legends: "120 V", "120/208V", “4160V”, “12470V”, etc.

2.08 EMERGENCY SYSTEM IDENTIFICATION

A. Furnish identification for emergency system generators, transfer switches, transformers, switchgear, panelboards, starters, motor control centers, safety switches, pull boxes, junction boxes, enclosures, and cabinets as require by NEC Article 700.

B. Provide flexible pressure sensitive vinyl markers with minimum 1-1/8 inch X 4-1/4 inch orange background and black letters indicating EMERGENCY SYSTEM.

2.09 WARNING SIGNS

A. Furnish warning signs for low-voltage and medium-voltage transformers, switchgear, switchboards, panelboards, motor starters, motor control centers, safety switches, pull boxes, and cabinets.

B. Use flexible warning signs that conform to ANSI Z535.4 and OSHA Danger and Caution specifications.

C. Provide minimum 2 inches by 4 inches warning signs.

D. Provide warning signs with format and lettering as follows:

1. Signal word: DANGER

2. Signal word panel color: red with safety alert symbol.

3. Word message: “Keep Out! Hazardous voltage inside. Will shock, burn, or cause death.”

4. Safety symbol: ISO 3864 “lightning bolt” in yellow triangle.

E. Materials:

1. For indoor applications use flexible, pressure sensitive, polyester base with polyester overlaminate.

2. For outdoor applications use aluminum signs.

F. Manufacturer: Seton Name Plate Co., Safety Label Solutions, Hazard Communication Systems, Electromark.

2.10 ARC FLASH WARNING LABELS

1. Furnish arc flash and electrocution hazard warning labels for switchgear, transformers, panelboards, motor starters, motor control centers, safety switches, and other locations as required by the NEC.

2. Provide warning labels that comply with Z535.4. Color in top part of sign shall be ANSI “safety orange”. All lettering on labels shall be black; red is used below to indicate application-specific information.

3. Provide labels that are printed on self-adhesive polyester with pressure-sensitive adhesive back and covered with a clear polyester film. Outdoor labels shall be suitable for a high-UV environment.

4. Label dimensions shall be approximately 4 inches high by 5 inches wide.

5. Provide labels similar in design to that below complete with the information. Contractor must coordinate with Engineer for the information. Use a black, UV-resistant, permanent marker to legibly fill in the application-specific information indicated in the notes.

A. EXAMPLE:

Arc Flash and Shock Hazard.
Wear Appropriate PPE.

Determine appropriate protective clothing and personal protective equipment (PPE) for the task from NFPA 70E.

50 inch [1]	**Flash Hazard Boundary**
46 kA [2]	**Short Circuit Current Available**
480 VAC [3]	**Shock Hazard when Cover is Removed [4]**
42 inch [5]	**Limited Approach Boundary**
12 inch [5]	**Restricted Approach Boundary**
1 inch [5]	**Prohibited Approach Boundary**

Equipment Identification Code: **WWTP-SWBD-1**

Notes:

1. Flash hazard boundary per NFPA 70E.
2. Available short circuit current (RMS symmetrical amperes).
3. System phase-to-phase voltage.
4. Condition that exposes worker to electrical shock hazard.
5. From NFPA 70E based on nominal system phase-to-phase voltage.
6. Manufacturer: Summit Electric Supply, Seton Name Plate Co., Safety Label Solutions, Hazard Communication Systems, Electromark.

2.02 FLOOR MARKING TAPE

A. Interior Locations: Provide 2-inch wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay, for marking NEC clear working space at electrical equipment.

B. Manufacturer: 3M Safety Stripe Tape 5700.

2.03 UNDERGROUND CONDUIT IDENTIFICATION

A. Type: Metal detectable polyester tape with subsurface graphics, 6 inches wide, 4.5 mil thick, continuously imprinted on one side of tape. Black letters on red background.

B. Manufacturer's Reference: Dottie Detectable warning tape.

C. Legends:

1. Power Conduit:

CAUTION: BURIED ELECTRIC LINE BELOW

2. Controls and Communication Conduit:

CAUTION: BURIED DATA LINE BELOW

2.04 MISCELLANEOUS NAMEPLATES AND LABELS

A. In addition to nameplates and labels required herein, provide additional nameplates and labels as required to by ANSI/NFPA 70, ANSI C2, OSHA, and the authority having jurisdiction.

B. Add the following labels to service entrance equipment:

1. Maximum available fault current.

2. Date on which fault current was calculated.

PART 3 – EXECUTION

3.01 GENERAL

A. Do not install nameplates or labels until samples have been submitted and approved.

B. Install nameplates and labels parallel to equipment lines.

3.02 WIRE IDENTIFICATION

A. General:

1. Power Wire: Identify phasing of all power wiring. Identify circuiting of all 600 volt class power wiring.

2. Control Wire and Cable: Identify all control wire and cable.

B. Location:

1. At or within 6 inches of conductor point of termination and on each side of an approved splice (for example, splicing the factory cable of an intrusion switch to field wiring) in an intermediate junction or pull box. (Labels are not required on wire that passes unspliced through an intermediate junction or pull box.)

2. Apply so that identifications are clearly visible with equipment or box cover opened or removed.

C. Application:

1. Color Coding Tape: Tightly wind tape around insulation and extend 2 inches along conductor.

2. Heat Shrink Labels: Install in accordance with manufacturer's instructions. Do not shrink labels.

3.03 EQUIPMENT IDENTIFICATION

A. General: Identify all Division 16 equipment. In addition to nameplates specifically required in the Specifications or on the Drawings, provide an additional 36 nameplates, maximum dimension 3” x 9”, with nameplate and text color, text size, mounting location, and legend to be determined by Owner. These nameplates are in addition to any additional nameplates that may be required in Section 13401.

B. Nameplate Locations:

1. General: In general, nameplates shall be located in the top-center portion of the enclosure. Review exact nameplate locations with the Owner prior to installation.

2. Fuse Nameplates: In general, locate in lower right-hand corner of motor control center cubicle or safety switch door. Review exact nameplate locations with the Owner prior to installation.

C. Fixing: Use one of the following mechanical attachments (Adhesive attachment is not acceptable.):

1. Bolt, lock-washer, and nut.

2. Drill, tap, and bolt.

3.04 INSTRUMENT AND SMALL EQUIPMENT NAMEPLATES

A. Install nameplates on instruments and small equipment shown on drawings.

B. Attach nameplate to instrument with 316 stainless steel wire. Attachment point may be on conduit attached to instrument or equipment, as long as nameplate as adjacent to instrument or equipment.

3.05 VOLTAGE IDENTIFICATION

A. General: Identify all Division 16 electrical equipment, Contractor and Owner furnished, and other electrical equipment which is served from power circuits. Install voltage markers at the following locations and position markers so marker can be read from floor:

1. Front and rear of each medium-voltage switchgear.

2. Front of each medium-voltage transformer.

3. Front and rear of each free-standing low-voltage switchgear or switchboard section.

4. Front of each low-voltage transformer, switchboard, panelboard, motor control center, enclosed circuit breaker, safety switch and starter enclosure.

5. Cover of each pull box containing low-voltage or medium-voltage conductors.

6. Each 2 inch and larger conduit longer than 6 feet; space markers not more than 20 feet on center.

3.06 WARNING SIGNS

1. Install warning signs at the following locations and position signs so they can be read from floor:

a. Front and rear of each medium-voltage switchgear.

b. Front of each medium-voltage transformer.

c. Front and rear of each low-voltage switchgear or switchboard section.

d. Front of each low-voltage transformer, switchboard, panelboard, motor control center, enclosed circuit breaker, safety switch, and motor starter enclosure.

e. Cover of each pull box containing exposed low-voltage or medium-voltage conductors.

3.07 ARC FLASH WARNING LABELS

1. Install arc flash warning labels at the following locations and position signs so they can be read from floor:

a. Front and rear of each medium-voltage switchgear.

b. Front of each medium-voltage transformer.

c. Front and rear of each freestanding low-voltage switchgear or switchboard section.

d. Front of each low-voltage transformer, panelboard, motor control center, enclosed circuit breaker, safety switch, and motor starter enclosure.

e. Cover of each pull box containing exposed low-voltage or medium-voltage conductors.

3.08 FLOOR MARKINGS

1. Interior Locations: Install floor marking tape on the floor at the locations listed below to indicate clear working space required by the NEC. Thoroughly prepare floor surface to receive tape. Outline working space with tape then infill with diagonal tape stripes placed 6 inches on center.

a. Front and rear of each medium-voltage switchgear.

b. Front of each medium-voltage transformer.

c. Front and rear of each low-voltage switchgear or switchboard section.

d. Front of each low-voltage transformer, switchboard, panelboard, motor control center, enclosed circuit breaker, safety switch, and motor starter enclosure.

3.09 UNDERGROUND CONDUIT AND DUCT IDENTIFICATION

A. General: Provide warning tape for all exterior underground conduit.

B. Location: In continuous length along center line of trench, 12 inches below finished grade.

END OF SECTION

SECTION 16111

CONDUIT

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Conduit, conduit couplings, connections, adapters, fittings, clamps, hangers and appurtenant hardware.

1.02 RELATED WORK

A. Specification Section 16010: Basic Electrical Requirements

B. Specification Section 16123: Low-Voltage Wire and Cable.

C. Specification Section 16130: Boxes.

1.03 REFERENCES

A. ANSI C80.1 - Rigid steel conduit, zinc-coated

B. ANSI C80.3 - Electrical Metallic Tubing - zinc coated.

C. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.

D. ANSI/NFPA 70 - National Electrical Code.

E. FS WW-C-566 - Specification for flexible metal conduit.

F. NECA "Standard of Installation".

G. NEMA RN 1 - Polyvinyl Chloride (PVC) externally-coated galvanized rigid steel conduit and electrical metallic tubing.

H. NEMA TC 2 - Electrical plastic tubing (EPT) and conduit (EPC-40 and EPC-80).

I. NEMA TC 3 - PVC fittings for use with rigid PVC conduit and tubing.

J. SSPC-SP1 – Surface Preparation Standards and Specifications (Solvent cleaning).

1.04 DEFINITIONS

A. See Section 16010 for the definitions of Dry Interior Locations, Wet Interior Locations, Exterior Locations, and Corrosive Atmosphere Locations, and Classified Locations.

REGULATORY REQUIREMENTS

B. Conform to requirements of ANSI/NFPA 70.

C. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

1.05 QUALITY ASSURANCE

A. Comply with NFPA 70 "National Electrical Code" and ANSI C2 "National Electrical Safety Code" for components and installation.

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
   1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.
   2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver conduits to site with ends capped. Store nonmetallic conduits with supports to prevent warping, and deforming, and cover to protect from UV degradation.

B. All conduits with visible damage, corrosion or discoloration from UV exposure will be rejected.

PART 2 PRODUCTS

2.01 GENERAL

A. Application: See conduit schedule in PART 3 for the application of the following types of conduits to this Project. It should be noted that not all conduit types specified in PART 2 of this Specification will necessarily be used on this Project.

2.02 ELECTRICAL METALLIC TUBING (EMT)

A. Type: ANSI C80.3; galvanized tubing.

B. Fittings and Conduit Bodies: ANSI/NEMA FB1; compression type, steel or malleable steel.

C. Grounding Bushings: ANSI/NEMA FB1; insulated lay-in grounding type, steel or malleable steel.

D. Listing: UL 797 listed.

2.03 RIGID METALLIC CONDUIT (RMC)

A. Conduit: ANSI C80.1; Rigid Galvanized Steel Conduit.

B. Conduit: ANSI C80.5; Rigid Aluminum Conduit.

C. Fittings and Conduit Bodies: ANSI/NEMA FB 1; threaded type, steel or malleable iron. Compression, setscrew, and crimp type fittings and conduit bodies are not acceptable.

D. Grounding Bushings: ANSI/NEMA FB 1; insulated lay-in grounding type, steel or malleable iron.

E. Listing: UL 6 listed.

2.04 POLYVINYL-CHLORIDE COATED RIGID METAL CONDUIT (PVC-RMC)

A. Conduit: NEMA RN 1; rigid steel conduit with external 40 mil PVC coating and internal galvanized surface.

B. Fittings and Conduit Bodies: ANSI/NEMA FB 1; NEMA Type TC 3; threaded type, steel or malleable iron with external PVC coating to match conduit. Compression, setscrew, and crimp type fittings and conduit bodies are not acceptable.

C. Ground Bushings: ANSI/NEMA FB 1; insulated lay-in grounding type, steel or malleable iron.

D. Listing: UL listed.

2.05 RIGID NONMETALLIC CONDUIT (RNMC)

A. RNMC of polyvinyl chloride:
   1. Per NEC 347, UL 651 and NEMA TC2 for EPC 40.
   2. UL-listed for use with 90 degree Celsius conductors.

3. Ultraviolet resistant, Schedule 40 polyvinyl chloride (except Schedule 80 where called for on Drawings).
4. Joints: glued, except provide bell-and-spigot expansion joint with "O" rings where required for expansion/contraction.
5. Fittings and cement: by conduit manufacturer.
6. Manufacturer / Product: Carlon Plus 40/Plus 80 or equal.

B. RNMC of Fiberglass-Reinforced Epoxy:
1. Per NEMA TC-14 2002 and ASTM D-2105.
2. UL-listed for use with 90 degree Celsius conductors.
3. Ultraviolet-resistant, fiberglass-reinforced epoxy.
4. Minimum trade size allowed: 2".
5. Wall thickness:
   a. 0.066 for 2" through 3½" conduit.
   b. 0.096 for 4" through 6" conduit.
6. Joints: Bell-and-spigot with triple seal method; provide expansion joint where required for expansion/contraction.
7. Fittings: By conduit manufacturer.
8. Product: United Fiberglass or equal.

2.06 FLEXIBLE METAL CONDUIT (FMC)

A. Conduit: FS WW-C-556, flexible steel conduit.

B. Fittings and Conduit Bodies: ANSI/NEMA FB 1, steel or malleable iron.

C. Listing: UL listed.

2.07 LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT (LFMC)

A. Per NEC 351 and UL 360.

B. Aluminum with a sheath rated for use with 90 degree Celsius conductors.

2.08 FLEXIBLE EXPLOSION PROOF CONDUIT (XPFC)

A. Braided steel or copper alloy with inner insulating sleeve.

B. Fittings: Threaded.

C. Product: Crouse Hinds Series EC or equal.

2.09 COUPLINGS

A. ENMT: Glued on fitting same as used for coupling RNMC.

B. EMT:
   1. Steel, not die cast.
   2. Concrete tight and rain tight compression type.
   3. Set screw or indenter type will not be acceptable.

C. LFMC, FMC: Not allowed.

D. Other conduits: As required by NEC and recommended by manufacturer.

2.10 CONNECTORS

A. EMT:
   1. Steel, not die cast.
   2. Concrete tight and rain tight compression type.
   3. Set screw or indenter type will not be acceptable.

B. FMC:
   1. Steel squeeze type.
   2. Appleton 7484 or equal.

C. LFMC: Liquid tight steel, insulated throat.
   1. Steel squeeze type.
   2. Appleton ST/STB or equal.

2.11 CONDUIT SEALING FITTINGS

A. Equipment provided for use in classified areas shall be suitable for the Material Classification Group as defined by NFPA 70, of the hazardous materials present.

B. Galvanized steel, aluminum when connected to aluminum conduit.

C. UL 1203.

2.12 CONDUIT SUPPORTS:

A. In accordance with Section 16190.

2.13 CORROSION PROTECTION TAPE

A. Manufacturer's Reference: 3M "Scotchrap 51" tape and 3M "Scotchrap" Pipe Primer.

B. Type: Pressure-sensitive PVC-base corrosion protection tape, 20 mils thick, used in conjunction with compatible rubber base primer.

PART 3 EXECUTION

3.01 DRAWINGS

A. Conduit Runs:
1. Conduit runs are not fully detailed on the Drawings and do not necessarily call out all specific junction boxes, fittings, or connection types that may be required.
2. Conduits are shown in spatial schematic location only relative to other structures. Contractor shall evaluate final route as necessary for final installation in compliance with NEC requirements and as approved by Engineer prior to installation.
3. In addition to conduits shown:
   a. Install as implied by circuiting, and as required for a complete system.
   b. Install as called for on the One Line Diagram.

3.02 SCHEDULE

A. Above Grade Installation:
1. Size: Per the Drawings, Conduit Schedule, and other sections of these Specifications. Minimum ¾ inch, unless otherwise noted.
2. Dry Interior Locations or housing Closed Water Processes:
   a. Lighting, Receptacle, HVAC Control, and Access Alarm Circuits: Rigid Metal Conduit (RMC) and fittings.
   b. Conduit in joist space: Electrical Metallic Tubing (EMT) and fittings.
   c. Conduit concealed in CMU Block Wall: Schedule 40 Non-Metallic Conduit (PVC) and fittings.
   d. All Other Applications and Locations Not Mentioned Above: Rigid Metal Conduit (RMC) and Fittings.
3. Exterior Locations / Wet Interior Locations / Corrosive Atmosphere Interior or Corrosive Atmosphere Exterior Locations / Hazardous Locations:
   a. Lighting, Receptacle, HVAC Control, and Access Alarm Circuits: PVC Jacketed Rigid Metal Conduit (PVC-RMC) and fittings.
   b. All Other Applications and Locations Not Mentioned Above: PVC Jacketed Rigid Metal Conduit (PVC-RMC) and Fittings.
4. CMU Block Wall / Exposed Trusses Building Type Installation Procedure:
   a. Lighting, Receptacle, and Intrusion Alarm Circuits: Conceal conduit in CMU block wall for attachment to outlet boxes associated with receptacles, light switches, wall-mounted light fixtures, and intrusion switches. Conduit for light fixtures

supported from roof trusses shall be run exposed within and supported from the webs of the trusses.

b. All Other Applications and Locations Not Mentioned Above: Route conduit exposed on interior CMU walls.

5. Hollow Stud Wall / Suspended Ceiling Building Type Installation Procedure:
   a. Lighting, Receptacle, and Intrusion Alarm Circuits: Conceal conduit in stud wall for attachment to outlet boxes associated with receptacles, light switches, wall-mounted light fixtures, and intrusion switches. Conduit for light fixtures supported from suspended ceiling shall be run concealed within ceiling and supported from the webs of the joists.
   b. All Other Applications and Locations Not Mentioned Above: Route conduit concealed within interior of stud walls.
6. Metal Building with Exposed Frame Wall / Rafter Building Type Installation Procedure:
   a. Lighting, Receptacle, and Intrusion Alarm Circuits: Conduit shall be run exposed for attachment to outlet boxes associated with receptacles, light switches, wall-mounted light fixtures, and intrusion switches. Conduit for light fixtures supported from roof joists shall be run exposed within and supported from the rafters with appropriate anchored supports.
   b. All Other Applications and Locations Not Mentioned Above: Route conduit exposed on interior wall frame horizontal and vertical members with appropriate anchored supports.
7. Metal Building with concealed Frame Wall and exposed Rafter Building Type Installation Procedure:
   a. Lighting, Receptacle, and Intrusion Alarm Circuits: Conceal conduit in stud or framed wall surface for attachment to outlet boxes associated with receptacles, light switches, wall-mounted light fixtures, and intrusion switches. Conduit for light fixtures supported from roof joists shall be run exposed within and supported from the rafters with appropriate anchored supports.
   b. All Other Applications and Locations Not Mentioned Above: Route conduit concealed within interior stud walls.
8. Pre-Cast or Cast-in-Place Concrete Wall Basin/Vault Structure above maximum water level Installation Procedure:
   a. Power, Control, Lighting, Receptacle Circuits: Route PVC-RNMC conduit embedded and anchored to concrete reinforcement. Install PVC-RMC conduit for all vertical or horizontal elbows beyond 15 degrees, and all concrete entrances/exits exposed for attachment to NEMA 4X rated boxes associated with receptacles, motor starters/disconnects, submersible cord/conduit connections, and switches.

b. All Other Applications and Locations on exterior wall surface (and as identified in Drawings): Route RMC mounted on stainless steel metal framing channels anchored to concrete walls.

9. Liquidtight Flexible Metal Conduit: Use for connection to motor, motor operated valves, dry-type transformer, mechanical equipment, instrumentation, and devices which produce vibration. Restrict maximum length to 36 inches.

B. Below Grade Installation:

1. Size: Per the Drawings, Conduit Schedule, and other sections of this Specifications. Minimum ¾ inch, unless otherwise noted.
2. Buried Type: Schedule 40 non-metallic conduit (PVC), unless otherwise noted, and concrete encased where noted, except under concrete slabs.
3. Wet Interior Locations / Corrosive Atmosphere Interior Area:
   a. Power, Control, Lighting, Receptacle, HVAC Control, and Access Alarm Circuits: PVC Jacketed Rigid Metal Conduit (PVC-RMC) and fittings.
   b. All Other Applications and Locations Not Mentioned Above: PVC Jacketed Rigid Metal Conduit (PVC-RMC) and Fittings.
4. Damp Interior Locations:
   a. Lighting, Receptacle, HVAC Control, and Access Alarm Circuits: Rigid Metal Conduit (RMC) and fittings.
   b. All Other Applications and Locations Not Mentioned Above: Rigid Metal Conduit (RMC) and Fittings.
5. Pre-Cast or Cast-in-Place Concrete Wall / Roof Vault Structure with Dry Interior Process Piping Installation Procedure:
   a. Power, Control, Lighting, Receptacle, and Intrusion Alarm Circuits: Route PVC Jacketed Rigid Metal Conduit (PVC-RMC) and fittings conduit exposed for attachment to NEMA 6P rated boxes associated with receptacles, light switches, wall-mounted light fixtures, cord/conduit connections, and intrusion switches. Conduit for light fixtures supported from roof beams shall be run exposed within and supported from beam attachments. Provide conduit sleeves and compressed flexible annular sealing systems.
   b. All Other Applications and Locations Not Mentioned Above: Route conduit exposed and attached to interior concrete wall surface.
6. Cast-in-Place Concrete Wall / Roof Building Type with Partially/Fully Submerged Interior Installation Procedure:
   a. Lighting, Receptacle, and Intrusion Alarm Circuits: Not allowed.
   b. Power and Control Circuits: PVC Jacketed Rigid Metal Conduit (PVC-RMC) and Fittings with cord connections and conduit seal-offs.
   c. All Other Applications and Locations Not Mentioned Above: Route conduit exposed and attached to interior concrete wall surface.

d. Liquidtight Flexible Metal Conduit: Use for connection to motor, motor operated valves, dry-type transformer, mechanical equipment, instrumentation, and devices which produce vibration. Restrict maximum length to 36 inches.

3.03 INSTALLATION – GENERAL

A. Install conduit in accordance with NECA "Standard of Installation".

B. Where indicated on the Drawings, and where necessary to terminate conductors, tap-off, or redirect multiple conduit runs, provide appropriately designed junction boxes. Provide pull boxes to limit the number of directional changes of conduit to a total of not more than 270 cumulative degrees in any run between pull-boxes. Conduit runs between pull-boxes shall be limited to 400 feet maximum, less 100 feet for each 90-degree change in direction. Provide pull boxes, if necessary to meet these requirements, in accordance with Specification Section 16130: Boxes.

C. Maintain minimum 6 inch clearance between conduit and piping for above grade installations, 12 inches clearance for below grade installations, unless otherwise noted.

D. Maintain minimum 12 inch clearance between conduit and surfaces with temperature exceeding 104 degrees F (40 degrees C).

E. Support linear runs of conduit as scheduled below. In addition, support conduit within one foot of elbow, bend, change of direction, and terminations using framing channel specified in Section 16190. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.
   1. Rigid Metal Conduit and Fittings (RMC): 8’-0” maximum.
   2. Electrical Metallic Tubing (EMT):
      a. 1/2" Diameter: 6’-0” maximum.
      b. 3/4" Diameter and Larger: 8’-0” maximum.
   3. PVC Coated Rigid Metal Conduit and Fittings (PVC-RMC): 8’-0” maximum.
   4. Non-Metallic Conduit and Fittings (PVC):
      a. 1/2" to 1” Diameter: 3’-0” maximum.
      b. 1-1/4” to 2” Diameter: 5’-0” maximum.
      c. 2-1/2” Diameter and Larger: 6’-0” maximum.

F. Use grounding bushings on conduit terminations.

G. Use conduit hubs to fasten conduit to sheet metal enclosures. Conduit connections shall maintain the integrity of the NEMA rating of the enclosure they enter.

H. Provide pull wire/rope per Specification Section 16123: Low-Voltage Wire and Cable in each empty conduit.

I. Join nonmetallic conduit (PVC) using cement recommended by conduit manufacturer

J. Conduit bends in all but EMT:
   1. Factory-made or made with a conduit bending machine recommended by the conduit manufacturer. Handmade bends will not be acceptable.
   2. All bends shall be made with a bender that is not capable of reducing the size of the conduit while being bent, and shall leave no marks or scars on conduit.
   3. Where a conduit bank changes plane while changing direction, it is acceptable to use factory 90-degree elbows for the largest conduit in the bank. All conduits smaller than the largest conduit shall use the same radius as the largest conduit.
   4. Where a conduit bank stays in the same plane and changes direction, all conduits shall have the same radius center point/concentric bends (exception: where the bank of conduits is less than five the conduits can have the same radius provided there are no concentric bends in the area).
   5. Where a conduit bank offsets from one plane to another plane all bends shall match in bend angle, distance between bends and placement of bends.
   6. Where a conduit bank offsets on the same plane, the center of the bend shall line up on all adjacent bends while the distance between conduits is maintained the same throughout.

K. Make bends in EMT with a hand bender that fully supports the side walls.

L. Conduit Routing:
   1. All conduit shall be concealed in finished areas and where indicated on the Drawings.
   2. In many places, such as at motors and surface mounted wiring devices in process rooms and electrical rooms, the end of a run may be an exposed vertical riser even though the symbol used for the conduit run denotes concealed. Clarify routing with Engineer prior to installation of exposed conduits.
   3. For exposed conduit to be installed in unfinished building areas, such as metal buildings with no framed walls, install conduit either parallel with or perpendicular to structural members of the building or structure, except where allowed otherwise by the Engineer.
   4. Roof Penetrations:
      a. The only conduit that may be run on a roof is conduit that serves equipment on that roof.
      b. Locate sealed roof penetrations so no horizontal runs of conduit are required on the roof.

M. Sleeve wall Conduit Penetrations:
   1. Sleeve floor penetrations where through intermediate floors of a building and in other places indicated on the Drawings.

2. Material: Rigid metal conduit (RMC) or steel pipe securely fastened in place.
3. Set sleeves in masonry walls during construction.
4. Set sleeves in concrete before placement.
5. Extend floor sleeves 2 inches up except where shown otherwise on the Drawings.
6. Waterproof construction sleeves: Flanged type.
7. Exterior building wall sleeves:
    a. Install conduit in center of sleeve.
    b. Pack interior and exterior annular space around conduit with plastic backer rod sized to fit annular space in compression as recommended by backing manufacturer.
    c. Seal interior and exterior of joint with acrylic polymer sealant: DAP, subsidiary of Plough, Inc or equal.
8. Openings required after footings, walls, floors or ceilings constructed shall be provided and grouted at no additional expense to Owner.

N. Trip Hazard Locations:
1. Conduit shall not be installed on slabs, walkpaths, decks, sidewalks or floors where it may create a trip hazard. The Engineer shall be the sole judge as to "trip hazard".
2. Conduits may be installed on concrete surfaces only with written permission from the Engineer.

O. Conduits installed under floor slabs shall lie completely under the slab with no part of the horizontal run of the conduit embedded within the slab.

P. Conduit embedded in structural concrete:
1. Where shown on the Drawings.
2. No conduit shall be embedded in the walls of tanks or basins below the high water elevation, except when absolutely necessary and where specifically shown on the Drawings.
3. Set before concrete is poured.
4. Route in direct line, with bends as large a radius as practical.
5. Anchor all conduits to concrete reinforcing to prevent damage during concrete installation. Do not interfere with concrete reinforcing.

Q. Expansion joints: Where conduit spans building expansion joints or in long duct runs, use expansion fittings and bonding jumpers.

R. Drainage:
1. Avoid pockets in conduit runs.
2. Provide suitable drainage fittings in junction boxes at low spots in exposed conduit.
3. Weep holes not permitted.

S. Field Cuts and Threads:

1. Cut ends of conduit square with hand or power saw and ream to remove burrs and sharp edges.
2. Do not use wheel cutter.
3. Threads cut on job shall have same effective length, thread dimensions and taper as factory-cut threads.
4. Carefully remove burrs from threads and paint conduit threads with one coat of zinc chromate to male threads.

T. Conduit ends:
1. Cap spare conduit.
2. Open conduit ends terminating in trenches, panels or enclosures: plug space around cables with commercial duct sealing compound.
3. Cap conduit ends during construction to prevent entrance of foreign material.

U. Cleaning: clean and swab inside by mechanical means to remove foreign materials and moisture before wires or cables are installed.

V. Install PVC-RMC in strict accordance with the manufacturer's instructions. Use strap type wrenches. Pipe wrenches are not acceptable. PVC boot shall cover all threads. Leave no metallic threads uncovered. Use touch-up compound as recommended by the manufacturer to cover gouges and bare metal after installation.

3.04 INSTALLATION – ABOVE GRADE CONDUIT

A. Route conduit parallel and perpendicular to walls.

B. Route conduit to maintain headroom and present neat appearance.

C. Route conduit through roof using flashing and sealants.

D. Support conduit using straps, lay-in adjustable hangers, clevis hangers, and split hangers.

E. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.

F. Support surface mounted conduit routed along walls on framing channel with conduit straps or clamps.

G. Group related conduit in parallel runs where practical. Use conduit rack constructed of channel with conduit straps or clamps. Provide junction box with drain fitting at conduit low point, if necessary.

H. Avoid moisture traps where possible. Provide junction box with drain fitting at conduit low point, if necessary.

I. Seal conduit which passes through exterior wall penetrations using suitable sealants.

J. Stub up and cap spare conduit 6 inches above finish floor where required on Drawings. Install pull wire in conduit and thread cap over pull wire to secure pull wire in place.

K. Supports:
1. Hangers, supports or fastenings:
   a. Provide at each elbow and at end of every straight run terminating in box or cabinet.
   b. Rigid fastenings spaced maximum of 7 feet horizontal, 8 feet vertical.
   c. Adjustable supports spaced maximum of 7 feet.
2. Clamps: Comply with Section 16190.
3. One hole straps are to be installed with hole below conduit in horizontal runs.
4. Trapeze hanger:
   a. Use to support horizontal runs only.
   b. Install U-bolts at end of each run and at each elbow.
   c. Install clamps every third intermediate hanger for each conduit.
   d. Hangers are not detailed but must be adequate to support combined weight of conduit, conductors and hangers.
   e. Material:
      i. Aluminum unistrut with stainless steel fittings.
      ii. As specified in Section 16190 or equal.

L. CMU Wall Concealment: Coordinate and install conduits concealed in CMU block wall prior to insulation and bond grout installation for attachment to cast-in-place boxes.

3.05 INSTALLATION - BELOW GRADE CONDUIT

A. Route conduit from point-to-point, unless otherwise noted.

B. Install top of conduit minimum 24 inches below finish grade for circuits 600 volts and less, unless otherwise noted. Install top of conduit minimum 42 inches below finish grade for medium voltage circuits, unless otherwise noted.

C. Provide minimum separation between conduits as noted below:
1. 3” for 2” and larger conduit.
2. 2” for 1-1/2” and smaller conduit.
3. Regardless of conduit size, provide 3” side-to-side clearance for conduit containing alternating current power circuits and conduit containing direct current control or instrumentation wiring for parallel conduit in multiple conduit runs.

D. Stagger joints in multiple conduit runs 6 inches minimum horizontally.

E. Join nonmetallic conduit (PVC) using cement recommended by conduit manufacturer.

F. Use factory made chairs/separators to support and separate conduit.

G. Anchor conduit to prevent movement during concrete placement or earth back fill.

H. If concrete encasement is specified on drawings, provide minimum 4 inches, 3000 psi concrete encasement on all sides of conduit, except under concrete slabs, where conduit does not have to be concrete encased.

I. Use PVC-coated rigid metal elbows and conduit (PVC-RMC) or rigid metal elbows and conduit (RMC) with corrosion protection tape for bends greater than or equal to 15 degrees and vertical risers in underground non-metallic conduit (PVC) runs.

J. Apply an application of half-lapped corrosion protection tape where rigid metal conduit (RMC) is in contact with earth. Prepare pipe with primer prior to application of tape. Follow manufacturer's application instructions.

K. Patch concrete and asphalt cut during construction for installation of conduit to match existing in-kind.

L. Use conduit seals to comply with NEC Article 300. Where indicated, use a conduit seal with drain. For all other applications, use a standard conduit seal. Use a non-hardening sealing compound to seal conduit seals, as required to comply with NEC Article 300.

M. Use conduit seals on conduit leaving a classified area to comply with NEC Article 500. Use sealing cement and fiber filler to seal conduit seals, as required to comply with NEC Article 500. Do not install cement and filler until end of project following approval of Owner.

N. Trenching Requirements:
   1. Coordinate installation of underground conduits with other outside and building construction work.
   2. Do not back-fill underground conduits until they have been inspected.
   3. Warning Tapes: Bury warning tapes 12 inches below finish grade for all underground conduit runs.
   4. Where existing roadways, sidewalks, curbing, etc. are encountered, remove those sections as needed during construction and replace with new sections after back filling to match original conditions.
   5. Excavations shall be carefully made to avoid unknown underground utilities or utilities which are in a location different from that expected or shown on the Drawings.

6. Grade trenches and place select material to provide uniform trench bottom for conduit support.

O. Raceways utilized for fiber optic cable shall be installed in the following manner:
1. For conduits that are underground all deflections greater than 30 degrees within a 10-foot span shall be in rigid galvanized conduit, and the radius for all defections shall be not less than 36 inches.
2. Where the conduit run is less than 20 feet, standard radius 90 degree sweeping elbows can be used.
3. Fiber optic cable shall not pass through any condulets that incorporate a 90-degree change of direction.
4. Conduits shall enter any cabinet in a manner that will allow for a logical and professional installation of the fiber optic cable in the cabinet.
5. Where fiber is installed other than underground or outdoors, it shall be installed in "lay in wireway". Wherever possible, lay the fiber cables in, do not pull into place.

3.06 CONDUIT TERMINATIONS

A. General: Review requirements of Drawings and other sections of the Specifications regarding constraints on location of termination of conduit to enclosures.

B. Method of Termination for RGS Conduit:
1. Dry Interior Locations: For conduit terminating to an enclosure that does not have an integral threaded hub, terminate using double bonding locknuts.
2. Wet Interior and Exterior Locations: For conduit terminating to an enclosure that does not have an integral threaded hub, terminate conduit use a threaded conduit hub fitting (Myers hub). Use threaded conduit hub fitting regardless of location of termination on enclosure (top, sides, and bottom.)

C. Bushings:
1. Use insulated throat grounding bushings with lay-in style grounding lug on conduit terminations, except where conduit terminates in a threaded conduit hub fitting or threaded hub integral to an enclosure.
2. For conduit required to terminate in a threaded conduit hub fitting, use Myers-type conduit hub with insulated throat and interior bushing with integral grounding lug or screw.

D. Caps: Use conduit caps to protect installed conduit against entrance of dirt and moisture.

3.07 HAZARDOUS (CLASSIFIED) AREAS

A. Conduit sealing fittings shall be installed:
   1. Within 18 inches of an enclosure.
   2. When entering or leaving a Class 1 hazardous area.

3.08 GENERAL CONDUIT APPLICATIONS

A. Electrical Metallic Tubing (EMT): EMT may be used in hollow metal or wood walls and hollow building ceiling spaces of finished locations for conductors of lighting, receptacle, and alarm circuits only.

B. Rigid Metallic Conduit (RMC):
   1. Not permitted underground or concrete embedded unless protected with corrosion protection tape.
   2. Not permitted in corrosive atmospheres as defined by Engineer.
   3. On aluminum handrails, use aluminum RMC supported by aluminum or stainless-steel hardware.
   4. Steel RMC may not be used in place of PVC RMC or aluminum RMC where these types are specifically denoted on Drawings.
   5. Do not cast aluminum RMC in concrete or use it for sleeves.
   6. Aluminum RMC: Not permitted in contact with earth or concrete.

C. Rigid Non-Metallic Conduit (RNMC): May not be used where exposed to direct sunlight.

D. FMC:
   1. Use FMC for the final connection to luminaires in lay in type ceilings.
   2. Not all such FMC runs are shown on the Drawings.
   3. No other usage of FMC is allowed unless specifically called for on the Drawings.

E. LFMC:
   1. Use LFMC for the final connection to:
      a. Equipment that may vibrate.
      b. Equipment or instrumentation cases or boxes.
      c. Industrial type luminaires that might be temporarily moved or disconnected for maintenance or calibration.
      d. Not all such LFMC runs are shown on the Drawings.

F. Type of Conduit:
   1. The Drawings show the type of conduit required for certain runs.
   2. Where the type is not shown, any type listed in "SCHEDULE" may be used, subject to NEC restrictions and the above requirements.

3.09 SIZE

A. General:

1. The Drawings show the minimum size required for certain conduit runs.
2. Where size is not shown, comply with this specification section as a minimum.

B. If a conduit size has to be increased because a motor or other equipment furnished by the Contractor requires more power (and therefore larger wire and conduit than shown) than the specified motor or equipment, the larger conduit shall be installed at no additional cost to the Owner.

C. Minimum size requirements:
1. As required by NEC, but larger if shown on the Drawings or required below.
2. Exterior pole lighting circuits: 3/4 inch.
3. 120/208/240V receptacle circuits: 3/4 inch minimum.
4. 120/208/240V individual branch circuits: 3/4 inch.
5. 208 or 240V feeders: 3/4 inch.
6. 480V circuits: 3/4 inch.
7. 120V control circuits:
   a. 3/4 inch minimum.
   b. 3/4 inch for ten to twenty 14 AWG.
   c. 1 inch minimum for more than twenty 14 AWG.
   d. All others: Size by NEC for conductor number.
8. Shielded or coaxial cable: 3/4 inch.
9. Circuits of special systems: As shown on Drawings or as required in the specification section for the respective system.

END OF SECTION

SECTION 16123

LOW-VOLTAGE WIRE AND CABLE

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish, install, connect and test all wire and cable operating at 600 volts or less.

B. Furnish wire and cable for all systems except:
   1. Where supplied as part of an equipment or system.
   2. Where specifically stated otherwise in other parts of the specifications or on the Drawings.

1.02 RELATED WORK

A. Section 01340: Shop Drawings, Product Data, and Samples.

B. Section 16075: Electrical Identification.

1.03 REFERENCES

1. ANSI/NFPA 70 - National Electrical Code.
2. NEMA WC 5 - Thermoplastic-insulated wire and cable for the transmission and distribution of electrical energy.
3. UL 83 - Thermoplastic-Insulated Wires and Cables.

1.04 REGULATORY REQUIREMENTS

1. Conform to requirements of ANSI/NFPA 70.
2. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

1.05 SUBMITTALS FOR RELEASE

1. Submit in accordance with Specification Section 16010: General Electrical Requirements.
2. Catalog Data: Include data for power and lighting wire, control wire and cable, and ground wire.

PART 2 PRODUCTS

2.01 GENERAL

A. Conductors: Copper only.

B. Color Coding and Marking: Conform with Specification Section 16075: Electrical Identification.

2.02 600V POWER AND GENERAL PURPOSE WIRE

A. General:
1. Conductors: Copper only.
2. Color Coding: Conform with Section 16195.

B. Power and Lighting Wire: NEMA WC 5, UL 83, Type THWN/THHN, minimum #12 AWG, unless otherwise noted.
1. #12 AWG and #10 AWG: Solid or Class B stranded conductor.
2. #8 AWG or larger: Class B stranded conductor.

C. Control and Instrumentation Wire: NEMA WC 5, UL 83, Type THWN/THHN, #14 AWG stranded conductor, unless otherwise noted.

D. Fixture Wires: Factory installed by fixture manufacturer and labeled for application.

E. Ground Wire:
a. Main Ground, Bonding and Raceway Conductor:
b. #12 AWG and #10 AWG: Solid or Class B stranded conductor; thermoplastic insulated, NEMA WC 5, UL 83, 600 V, Type THWN/THHN. Green solid color compound throughout conductor length.
c. #8 AWG: Class B stranded conductor; thermoplastic insulated, NEMA WC 5, UL 83, 600 V, Type THWN/THHN. Green solid color compound throughout conductor length.
d. #6 AWG and larger: Class B stranded conductor; bare.
2. Ground Counterpoise Conductor: Class B solid or stranded conductor; bare. For required type and size, see Section 16170.
3. Internal Perimeter Ground Conductor (Halo): Class B solid or stranded conductor; bare. For required type and size, see Section 16170.

F. Manufacturer:
1. Southwire Inc. or equal.

2.03 CONTROL WIRE AND CABLE:

A. Single Conductors: NEMA WC 5, UL 83, Type THWN/THHN, 14 AWG stranded conductor, UL Listed, unless otherwise noted.

B. Two 16 AWG stranded 19 x 29 tinned copper conductors, PVC insulated with overall aluminum polyester foil shield; 100 percent shield coverage; stranded 18 AWG tinned copper stranded drain wire; overall PVC jacket; color coded black and clear and numbered at one-inch intervals. Manufacturer's reference; Belden #8719.

C. RS-485 Cable: Category 5e Ethernet cable with appropriate connectors.

D. UL Listed.

2.04 DATA NETWORK CABLE

A. Per TIA 568.C.2, NEMA WC-63.1 Category 5e.

B. Four pair, 24 AWG insulated solid bare copper.

C. Shielded unless otherwise indicated.

D. Jacket: Low Smoke FR-PVC, polyester rip cord installed under jacket.

E. UL Listed.

2.05 TRAY CABLE (TC)

A. Per NEC 340, 318, 501, 725 and 760.

B. UL Listed:
1. Type TC.
2. Suitable for direct burial in sizes 14 AWG and larger.

C. Flame, moisture and sunlight resistant; meet IEEE 383 flame test at 210,000 BTU.

D. Ratings:
1. 600V.
2. 90° C dry locations; 75° C wet locations.

E. Construction:
1. Conductor: stranded soft annealed copper.
2. Insulation: PVC with 5 mil nylon jacket.
3. Jacket: PVC.

F. Conductor Identification:
1. 8 AWG and larger: ICEA Method 4.

2. 10 AWG and smaller: ICEA Table K 2, Methods 1 and 4.

G. Manufacturer:
1. Southwire Inc. “TC”
2. or equal.

H. Sometimes referred to on Drawings as "TC".

2.06 DIRECT BURIAL SIGNAL CABLE

A. 12 each: 22 AWG solid copper conductors, each insulated with color-coded, high-molecular-weight polyethylene.

B. Conductors twisted into six pairs with staggered pair lay.

C. Core air space filled with PE/PJ compound.

D. 0.006" alloy 194 copper shield (97.5% copper, 2.35% iron, 0.12% zinc, 0.03% phosphorus).

E. Black, weather-resistant, extruded polyethylene jacket.

F. Ratings:
1. Comply with REA PE 39 requirements.
2. 60° C to +80° C.
3. 300 working volts.
4. Resist acid, alkali, moisture and fungus.
5. Suitable for direct burial.

G. UL Listed.

2.07 SPECIAL CABLES

A. As supplied by equipment suppliers or as required on the Drawings.

2.08 CABLE LUBRICANT

A. Water based polymer solution with minimal, non flammable residue.

B. Residue shall not hinder future cable removal or pulls such as can happen with certain wax emulsion lubricants.

C. Guaranteed by the manufacturer to be non-damaging to the physical and electrical properties of the conductor insulation.

D. Manufacturer:

1. American Polywater Corporation Polywater J.
2. Engineer-approved equivalent.

2.09 CONNECTORS

A. Wire sizes 18 through 8 AWG: Insulated twist-on, spring grip with steel inner shell. 3M Scotchlok types R, Y, G or B.

B. Wire sizes 6 AWG through 1000 kCMIL: Parallel, Tee-tap and Multi-tap connectors with 90 degrees C 600 Volt insulating plastic cover. Ilsco Series GTA, GTT, PT and GT.

C. Split bolt connectors and taped connectors: Prohibited except as authorized in writing by the Owner, or as specifically included on Drawings.

2.10 CRIMP-ON TERMINALS

A. Ring Tongue Terminal: Heavy duty, funnel entry design, vinyl insulated, tin-plated copper ring tongue terminal used to connect wire to terminations with screw connections. UL Listed.

B. Male Adapter Terminal: Heavy duty, funnel entry design, vinyl insulated, tin-plated copper male adapter terminal used to connect wire to terminal blocks with pressure-type block lug connections. UL Listed.

2.11 PULL ROPE

A. Two ply polypropylene with 210 pounds tensile strength.

2.12 WIRE CLEANER

A. Non-flammable, non-conductive, non-corrosive, non-staining and low toxicity cleaner. CRC "Cable Clean".

PART 3 EXECUTION

3.01 GENERAL WIRING METHODS

A. Run wiring in raceways, unless otherwise indicated on Drawings.

B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work which will injure conductors has been completed.

C. Do not install conductors in raceways until concrete and plaster work is complete.

D. Completely and thoroughly swab raceway system before installing conductors.

E. Pull all conductors into a raceway at the same time.

F. Do not exceed manufacturer's maximum pulling tension.

G. Use wire pulling lubricant for pulling building wire 4 AWG and larger.

H. Clean exposed conductors in equipment and enclosures when wire pulling lubricant has been used.

I. Use separate conduit for each function (AC power, DC power, analog signals, digital signals, and communication signals).

J. Neatly train and lace wiring inside boxes, enclosures and equipment, and panelboards. Lace no more than six current carrying conductors 12 AWG and 10 AWG sizes. Lace larger sizes with no more than three conductors.

3.02 BUILDING WIRING

A. Place an equal number of conductors for each phase of a circuit in same raceway or cable.

B. Make conductor lengths for parallel circuits equal.

C. For branch circuits, provide number of phase and neutral conductors required to implement circuiting, unless otherwise noted.

D. Splice building wire only in accessible junction and outlet boxes and wireways. Do not splice in panelboards, cabinets, control panels and enclosures.

3.03 CONTROL AND INSTRUMENTATION WIRING

A. Install control and instrument wire and cable in continuous lengths from field devices, or terminal blocks of intermediate junction boxes where so indicated on the Drawings or Interconnection Wiring List, to terminal blocks in Control Panels and Terminal Boards. Except for installations where new cable must be spliced into an existing instrument loop or where otherwise indicated on the Drawings, do not splice instrument cable unless specifically approved.

B. Terminate shielded cables at terminal block only, unless otherwise indicated.

3.04 CABLE INSTALLATION

A. Bending radii: not less than permitted by ICEA or as recommended by cable manufacturer.

B. Cable in trenches, (such as under the MCC's) handhold and manholes:
   1. Except for individual THWN grounding conductors, all conductors shall be TC or PLTC.
   2. Maintain separation between AC and DC cables.

C. Cable Pulling:
   1. Reels: firmly mount on portable stand and secure against displacement.
   2. Use pulling grips.
   3. Pulling tension shall not exceed manufacturer's recommendations.
   4. Lubricate as recommended by the lubricant manufacturer to minimize mechanical stress that may lead to future cable faults.

D. Splicing:
   1. General:
      a. Permissible only in boxes, enclosures, or similar accessible, protected locations.
      b. Splicing in conduit bodies not permitted.
      c. Splicing in underground handholds and manholes not allowed unless specifically allowed in other Sections of this specification or on the Drawings, or proposed by the Contractor and allowed by the Engineer.
      d. Splices shall be made in strict accordance with manufacturer's instructions.
   2. 480V Circuits:
      a. Splicing allowed at motors: Section 16124 2.03.
      b. Other splicing allowed only where specifically shown on Drawings, or by approval of Engineer.
         i. If allowed: see Section 16124 2.01 and 2.02.
   3. 277V Lighting Circuits:
      a. If allowed on Drawings: Section 16124 2.01 and 2.02.
      b. Otherwise, use terminal boards, same as required for control circuits below.
   4. 120/208/240V lighting and power circuits: Section 16124 2.01 and 2.02.
   5. Control circuits:
      a. No splicing allowed without specific approval of Engineer.
      b. If splicing approved, provide enclosure as approved by Engineer and terminal blocks (Section 16124).
      c. Mark wiring as in Section 16123 3.02.
      d. Mark terminal boards as in Section 16124.
   6. Instrument wiring:
      a. No splicing allowed without specific approval of Engineer.

b. If splicing approved, provide enclosure as approved by Engineer and terminal blocks (Section 16124).
c. Mark wiring as in Section 16075.
d. Mark terminal boards as in Section 16124.

3.05 WIRING CONNECTIONS AND TERMINATIONS

A. Use only approved wire connectors.

B. Thoroughly clean wires before installing lugs and connectors.

C. Install crimp-on ring tongue terminals on all control wiring connected to terminations with screw connections. Use ratcheting crimp tool.

D. Install crimp-on male adapter terminals on all control wiring connected to terminal blocks with pressure-type block lug connections. Use ratcheting crimp tool.

E. Make splices, taps and terminations to carry full capacity of conductors.

F. Terminate spare conductors with insulated wire connectors.

G. Install wire connectors in accordance with manufacturer’s instructions. Use tools and accessories recommended.

H. Shielded Control Wire Termination:
1. Open Ground Termination at Field Device: Pull cable shield and drain wire back one inch over outside jacket of cable. Cover shield and drain wire completely with heat shrink cable marker. Do not terminate drain wire.
2. Open Ground Termination at Terminal Block: Pull cable shield back one inch over outside jacket of cable. Cover shield completely with heat shrink cable marker. Terminate drain wire on terminal block.

3.06 PULL ROPE INSTALLATION

A. Install pull ropes in empty conduits and ducts.

B. Leave at least 12 inches slack each end of run, unless more is indicated on Drawings.

3.07 FIELD QUALITY CONTROL

A. Torque test conductor connections and terminations to manufacturer's recommended values.

B. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.

3.08 SCHEDULE

A. Wire and cable required under this Section for this project:
1. Section 2.01 - 2.03.

END OF SECTION

SECTION 16124

WIRE CONNECTORS AND ACCESSORIES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Wire connectors and splice kits, terminal blocks, wiring duct and cable pedestal.

1.02 SUBMITTALS FOR RELEASE

A. Section 16010: General Electrical Requirements.

B. Complete manufacturer's catalog cuts.

PART 2 PRODUCTS

2.01 600V WIRE NUTS

A. For splices on conductors 8 AWG and smaller.

B. Color-coded outer shell; steel inner shell.

C. Expandable spring type; removable by twisting in reverse.

D. UL listed and CSA certified for:
   1. 600V maximum building wire.
   2. 1000V maximum fixture wire.
   3. 105° C maximum temperature rating.

E. PVC insulated.

F. Manufacturer:
   1. Ideal Industries Wing Nuts or equal.

G. Use only for wire types and combinations recommended by the manufacturer.

H. For splices in locations defined in 2.02C below, wire nuts are not acceptable.

2.02 BUTT CONNECTORS

A. For splices on 120/240/480V circuit conductors 10 AWG and larger (except at motors).

B. Non-insulated, brazed seam, compression type.

C. Insulation method for butt splices that may become submerged, such as in manholes, handholes, underground pull boxes, wet wells and in other places noted on the Drawings:
   1. Tubular, prestretched EPDM rubber cold shrink insulators which are supplied on a removable, collapsible core for easy installation.
   2. Manufacturer:
      a. 3M PST or equal.

D. Insulation method for other butt splices.
   1. Same as 2.02C.
   2. Cover with half lapped Scotch 33+, then with Scotch 5300 Series in-line kit or equal.

2.03 MOTOR LEAD CONNECTORS

A. Solid wire: 600V wire nuts, paragraph 2.01.

B. Stranded wire:
   1. Install non-insulated ring terminal compression lugs on each conductor, then bolt together.
   2. Insulate with Scotch 5300 Series pigtail kits or equal.

2.04 TAP CONNECTORS

A. For gutter taps.

B. Use only where called for on Drawings.

C. Compression type:
   1. Hydraulically compressed.
   2. Figure C or Figure 3 type.
   3. Specifically selected for the proper AWG:
      a. Brundy "Crimpit" or equal.

D. Insulation:
   1. Scotch 85-XX Multi-Mold splicing kit or equal.

2.05 DIRECT BURY SPLICE KIT

A. Use for splices in 24 VAC sprinkler controller conductors located in underground boxes or direct buried, and where called for on the Drawings.

B. Gel-filled polypropylene insulator tube with locking fingers for wire nuts and strain relief cover.

C. Manufacturer:
   1. 3M DBY or equal.

2.06 POURED POLYURETHANE SPLICING KIT

A. Use for:
   1. Splicing of direct burial signal cable (Section 16123).
   2. Where called for on the Drawings.
   3. For other applications where called for on the Drawings.
   4. Where proposed in writing by the Contractor and approved by the Engineer.

B. Snap-together, two-piece translucent plastic mold body.

C. Connections:
   1. Stranded wire: insulated, compression-type butt connectors.
   2. Solid wire: solder and heat-shrink sleeves.

D. Spacer web to keep splice bundle away from mold body and allow a minimum of ¼" of sealing compound to flow readily between the splices and the body.

E. Jumper wire for shield.

F. Two-part, low-viscosity polyurethane sealing compounder.

G. Manufacturer:
   1. 3M Scotchcast series 72-N with Scotchcast 2104 compound or equal.

2.07 RE-ENTERABLE POURED URETHANE SPLICING KITS

A. Use for:
   1. Splicing of direct burial signal cable (Section 16123).
   2. Where called for on the Drawings.
   3. Other applications where called for on the Drawings.
   4. Where proposed in writing by the Contractor and approved by the Engineer.

B. Two-piece, transparent, PVC-mold body.

C. End caps with graduated openings for two cables per end.

D. Connections:
   1. Stranded wire:
      a. Insulated compression-type butt connectors.
      b. Wye connectors for taps.
   2. Solid wire: solder and heat-shrink sleeves.

E. Spacer web to keep splice bundle away from mold body and allow a minimum of ¼" of sealing compound to flow readily between the splices and the body.

F. Strain relief bar and shield connector kit.

2.08 HEAVY DUTY TERMINAL BLOCKS

A. Voltage rating: 600V UL.

B. Material: nylon with elevated marking strip.

C. Spacing: ½" center-to-center.

D. Contacts:
   1. Electrical grade copper alloy.
   2. Tubular clamp type.

E. Wire range: #18 to #6 AWG.

F. Maximum service temperature: 125 degrees Celsius.

G. Manufacturer:
   1. Square D or equal.

2.09 ULTRA HEAVY-DUTY TERMINAL BLOCKS

A. Voltage rating: 600V UL.

B. Material: phenolic with painted marking area.

C. Spacing: 1.19" center-to-center.

D. Contacts:
   1. Electrical grade copper alloy.
   2. Tubular screw type.
   3. 270A.

E. Wire range: 6 AWG to 250 MCM.

F. Maximum service temperature: 150°C.

G. Manufacturer:
1. Square D or equal.

2.10 WIRING DUCT

A. UL-rated as self-extinguishing with a continuous-use temperature of 55°C.

B. Rectangular cross-section with rounded returns on tops of fingers.

C. Cover: easy-on/easy-off, with rounded shoulder to easily grip the duct.

D. Manufacturer:
1. Panduit Inc or equal.

2.11 DIN RAIL-MOUNTED CONTROL TERMINAL BLOCKS

A. General:
1. Thermoplastic insulator housing with marker channels, funnel wire guides and flexible universal mounting foot for DIN1 asymmetrical and DIN3 symmetrical rails.
2. Compression clamp terminal connections with recessed, captive, self-locking screws.

B. Terminal blocks, 600V rating:
1. DC digital and analog signals: 6mm spacing (0.238") for 22-12 AWG wire.
   a. DC positive or supply: grey body, Entrelec M4/6, or Engineer approved equal.
   b. DC negative or return: blue body, Entrelec M4/6N, or Engineer approved equal.
2. DC shield and drain wire: 6mm spacing.
   a. Terminals insulated from ground: yellow body, Entrelec M4/6, or Engineer approved equal.
   b. Terminals grounded to rail: yellow body with green stripe, Entrelec M4/6P, or Engineer approved equal.
3. AC signal or power: 8mm spacing (0.315"), for 22-8 AWG wire.
   a. AC hot or switched supply: grey body, Entrelec M6/8, or Engineer approved equal.
   b. AC neutral or return: blue body, Entrelec M6/8N, or Engineer approved equal.
4. AC foreign voltage where circuits remain live after opening of control voltage disconnect switch: 8mm spacing (0.315"), orange body, Entrelec M6/8, or Engineer approved equal.
5. AC equipment ground, terminals grounded to rail: 8mm spacing (0.315"), yellow body with green stripe, Entrelec M6/8P, or Engineer approved equal.

C. Switch terminal blocks:
   1. DC: 6mm spacing (0.238"), short hinged blade, grey body, orange blade, Entrelec M4/6SN, or Engineer approved equal.
   2. AC: 8mm spacing (0.315"), long hinged blade, grey body, grey blade, Entrelec M6/8SNB, or Engineer approved equal.

D. Fuse-holder terminal blocks:
   1. DC or AC: fused switch style, for 6.35mm x 32mm (¼" x 1¼") fuses, 13mm (0.512") spacing, with blown fuse indicator for appropriate voltage per paragraph E2 below, Entrelec M10/13TSFL, or Engineer approved equal.
   2. Blown fuse indicators: one of a, b or c below, as appropriate for the voltage at the terminals.
      a. For 24 VDC.
      b. For 48 VDC.
      c. For 120-277 VAC.

E. Accessories:
   1. Mounting rails: bichromated, zinced steel.
   2. Either a or b below, or as specified on the Drawings.
      a. DIN1 asymmetrical.
      b. DIN3 symmetrical.
   3. End sections for blocks: required on the open extremity of each size and style of terminal block, Entrelec FEM series, or Engineer approved equal.
   4. Circuit separator: required between blocks of different voltages, power and control, AC and DC, Entrelec SCM series, or Engineer approved equal.
   5. End stops for rails: required at the extremities of each series of terminal blocks, Entrelec BAM series, or Engineer approved equal.
   6. Jumpers: required for jumpering between blocks; either a or b below, or as specified on the Drawings.
      a. Comb type: Entrelec PC with EIP insulating tips, or Engineer approved equal.
      b. Bar type: Entrelec BJ series with appropriate parts and insulators, or Engineer approved equal.
   7. Protecting covers: required for AC power circuit terminal blocks, Entrelec EPD61 and VSPD61 screws, or Engineer approved equal.

F. Markers: required for every terminal block and board.
   1. Terminal block:
      a. Side mount, preprinted vertical or horizontal to match board alignment, Entrelec RC, RB or RS, or Engineer approved equal.
      b. Coordinate abbreviations of text with Engineer if descriptor exceeds available space.
   2. Terminal board: end stop marker holder, Entrelec PEB series, or Engineer approved equal.

G. Test devices and plugs: provide during testing and leave with the project spares the following items:
   1. Screw head test receptacle for 6mm blocks (if used): four each, Entrelec DCJ (yellow), or Engineer approved equal.
   2. Screw head test receptacle for 8mm blocks (if used): four each, Entrelec DCO (orange), or Engineer approved equal.
   3. Test plugs for the above receptacles: eight each, Entrelec FC2, or Engineer approved equal.

PART 3 EXECUTION

3.01 MARKING OF TERMINAL BOARDS AND TERMINALS

A. Terminal Boards:
   1. Engraved Micarta nameplate with ½" letters.
   2. Adjacent to each row or column of terminals.
   3. Text: as shown on Drawings or submittals.

B. Terminal Points:
   1. Mark each terminal to be wired.
   2. Mark other terminals if so shown on Drawings.
   3. Text: as shown on Drawings or submittals; if not shown, then match wire number.

3.02 INSTALLATION, ORIENTATION AND CONNECTION OF DIN RAIL TERMINALS

A. Mount switch and fuse-holder terminal blocks so the blades will fall open, with the hinge at the bottom if blocks are mounted vertically (horizontal rail).

B. Connect switch and fuse-holder terminal blocks so the blade is de-energized, i.e. with voltage on the non-hinged side and return or neutral on the hinged side.

C. Install DIN rails with empty space for one future block for each 10 installed, except that no rail shall have fewer than four empty spaces for the largest block used.

D. DIN rails shall be attached every 6".

E. Other devices such as relays, surge protectors, power terminals and interface modules may occupy the same rail as terminal blocks.

END OF SECTION

SECTION 16130

BOXES

PART 1 .GENERAL

1.01 SCOPE OF WORK

A. Requirements for outlet boxes, pull and junction boxes, as required for a complete conduit system.

1.02 RELATED WORK SPECIFED ELSEWHERE

A. Specification Section 16010: Basic Electrical Requirements.

B. Specification Section 16160: Cabinets and Enclosures.

1.03 REFERENCES

A. ANSI/NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

B. ANSI/NEMA 0S 2 - Nonmetallic Outlet Boxes, Devices Boxes, Covers, and Supports.

C. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.

1.04 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

1.05 SUBMITTALS FOR RELEASE

1. Catalog Data: Submit catalog literature and data sheets for precast underground pull boxes as specified in this section.

1.06 DEFINITIONS

A. See Section 16010 for the definitions of Wet Interior Locations, Dry Interior Locations, Exterior Locations, Corrosive Atmosphere Locations, and Classified Locations.

PART 2 PRODUCTS

2.01 GENERAL

A. Application: See box schedule in Part 3 for the application of the following types of boxes to this project. It should be noted that not all box types specified in Part 2 of this section will necessarily by used on this project.

2.02 OUTLET BOXES

A. Sheet Metal Boxes:
   1. Surface/Free Standing: ANSI/NEMA OS 1, galvanized steel sheet metal box; rated for weight of equipment supported; include 1/2 inch male fixture studs where required; grounding terminal.
   2. Flush Mounted: ANSI/NEMA OS 1; galvanized steel sheet metal box with grounding terminal and square corners and straight sides for flush mounting in CMU block wall.

B. Cast Boxes:
   1. ANSI/NEMA FB 1:
      a. Type "FD" cast ferroalloy, threaded hubs, grounding terminal.
      b. Type “FS”, “FD”, “WAG” or similar, cast aluminum (Weathertight).

C. PVC Boxes: ANSI/NEMA OS 2 PVC boxes; grey color.

D. Stainless Steel Boxes: NEMA 4X, IP65/IP66, 316 stainless steel.

E. Submersible Screw Cover Box:
   1. Construction: Submersible, hot compression molded fiberglass reinforced thermoset polyester, with seamless gasket and captive 304 stainless steel screws.
   2. Listings: UL listed for 4X, 6P.
   3. Manufacturer’s Reference: Crouse-Hinds FSJS.

F. NEMA 7/9 Screw Cover Box:
   1. Construction: Copper-free aluminum body. Rated for explosion proof, dust-ignition proof, raintight, water tight, wet locations.

2. Cover: Copper-free aluminum cover.
3. Listings: UL listed for Class 1, Division 1 and 2, UL 886.
4. Manufacturer's Reference: Crouse-Hinds.

2.03 PRECAST UNDERGROUND PULL BOXES

A. Construction: One piece constructed box. Aggregate of sand and gravel bound with polymer and reinforced with continuous woven glass strands. Inner surface of heavy gel polyester resin backed by double layer of heavy weave fiberglass. Designed with non-settling shoulders positioned to maintain grade and facilitate back filling.

B. Loading: Heavy vehicular traffic rated; designed to meet ANSI Tier 22 loading of 22,500 pounds. One piece locking cover, skid resistant surface. Logo as required for the application.

C. Size: 36-3/4" x 23-3/4" x 24"D exterior dimensions, unless otherwise indicated.

PART 3 EXECUTION

3.01 GENERAL

A. Provide electrical boxes for equipment shown on the Drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.

B. Electrical box locations shown on the Drawings are approximate unless dimensioned.

C. Locate boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for boxes. Grout area between boxes and masonry unit to fill any gaps.

D. Provide knockout closures for unused openings.

E. Support boxes independently of conduit except for Cast Boxes that are connected to two rigid metal conduits, both supported within 12 inches of box and for boxes attached to conduit stub-ups that are within 12 inches of finished floor.

F. Use multiple-gang boxes where more than one device is mounted together; do not use section boxes. Provide barriers to separate wiring of different voltage systems.

G. Align adjacent wall mount outlet boxes for switches, thermostats, and similar devices with each other.

H. Ensure that boxes installed in exterior locations are accessible.

3.02 OUTLET BOX SCHEDULE

A. Dry Interior Locations:
   1. Flush Mounted Sheet Metal Box: Use for attachment to conduit concealed within the CMU wall.
   2. All Other Applications and Locations Not Mentioned Above: Cast Boxes.

B. Exterior Locations: Cast Boxes.

C. Wet Interior Locations: PVC Boxes.

D. Corrosive Interior Atmosphere Locations: PVC Boxes.

E. Corrosive Exterior Locations: Stainless Steel Box.

F. Hazardous Locations: NEMA 7/9 Screw Cover Box.

G. Underground Vault Housing Water Conveyance Equipment: Submersible Screw Cover Box.

3.03 PULL AND JUNCTION BOX SCHEDULE

A. For pull and junction boxes with dimensions that do not exceed standard outlet boxes, use Outlet Boxes described in Part 2.

B. For pull and junction boxes with dimensions that exceed standard outlet boxes, use Enclosures specified in Section 16160.
   1. Dry Interior Locations: NEMA 1 Screw Cover Enclosure.
   2. Exterior Locations: NEMA 3R Screw Cover Enclosure.
   3. Wet Interior Locations: NEMA 4X Polycarbonate Screw Cover Enclosure.
   4. Corrosive Interior Atmosphere Locations: NEMA 4X Polycarbonate Screw Cover Enclosure.
   5. Corrosive Exterior Locations: NEMA 4X Stainless Steel Hinged Cover Enclosure Type 2.
   6. Hazardous Locations: NEMA 7,9 Explosion Proof Hinged Cover Enclosure.

3.04 UNDERGROUND PULLBOX INSTALLATION

A. Install pullbox per manufacturer’s recommendations.

B. Set pullbox on 6” deep gravel (1” or smaller gravel size). Line vertical sides and top of gravel area with 30 pound felt paper before placement of gravel.

C. Use solid concrete building blocks evenly spaced around base of box for leveling.

D. Construct top of pullbox flush with adjacent finish grade.

E. Construct 6” wide by 8” deep concrete curb with #4 rebar ring around perimeter of pullbox to reduce settling. Use 3000 psi concrete.

F. Grout and trim conduit into pullbox.

G. Install bollards around pullbox, if indicated on the Drawings.

END OF SECTION

SECTION 16141

WIRING DEVICES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Requirements for wall switches, receptacles, device cover plates, and power distribution blocks.

1.02 RELATED WORK

A. Section 16010: General Electrical Requirements.

1.03 REFERENCES

A. FS W-C-596 - Electrical Power Connector, Plug, Receptacle, and Cable Outlet.

B. FS W-S-896 E - Switch, Toggle.

C. NEMA WD 1 - General-purpose Wiring Devices.

D. NEMA WD 6 - Wiring Device Configurations.

E. UL 498 - Attachment Plugs and Receptacles.

F. UL 943 - Ground-Fault Circuit-Interrupters.

1.04 DEFINITIONS

A. See Section 16010 for the definitions of Wet Interior Locations, Dry Interior Locations, Exterior Locations, Corrosive Atmosphere Locations, and Classified Locations.

1.05 SUBMITTALS FOR RELEASE

A. Catalog Data: Provide data for wiring devices listed in Part 2.

PART 2 PRODUCTS

2.01 GENERAL

A. Application: Not all devices specified in Part 2 of this section will necessarily be used on this project. Use devices as necessary to meet the requirements of the Drawings and other sections of the Specifications.

B. All wall switches and general purpose receptacles used on this project shall be of the same manufacturer.

2.02 WALL SWITCHES

A. Type: NEMA WD 1, FS W-S-896E, two position, specification-grade toggle switch; ivory handle.

B. Rating: 20 Amperes at 120-277 volts AC.

2.03 RECEPTACLES

A. Standard Duplex Receptacle: NEMA WD 1, FS W-C-596, heavy duty specification-grade, self-grounding with grounding terminal on receptacle body. Configuration: NEMA WD 6; Type 5-20R.

B. GFCI Duplex Receptacle: UL 498, UL 943 heavy duty specification-grade, self-grounding with grounding terminal on receptacle body. Configuration: NEMA WD 6; Type 5-20R.

C. 2-pole Receptacle: Single locking receptacle, UL 498. Configuration: NEMA WD 6; Type L6-20R.

D. Color:
1. Brown in process areas and outdoors.
2. Ivory in all other areas unless otherwise called for on Drawings.

E. Manufacturer's Reference: Hubbell or equal.

F. Other Receptacles: As indicated on the Drawings or elsewhere in these Specifications.

2.04 EMERGENCY GENERATOR RECEPTACLE AND PLUG:

A. Type: 600V, NEMA 4, heavy duty, circuit breaking, pin and sleeve receptacle and plug.

B. Amperage: As shown on Drawings.

C. Configuration: 3 wire, 4 pole, with spring door. Grounding pole is electrically connected to grounding conductor and metal receptacle housing.

D. Plug: Provide matching plug from same manufacturer as receptacle.

E. Receptacle Back Box: Angled back box from same manufacturer as receptacle. Hub size determined by application.

F. Housing: Cast aluminum.

G. Certification: UL listed.

H. Manufacturer's Reference: Crouse-Hinds Arktite.

2.05 DEVICE COVER PLATES

A. Dry Interior Locations: Type 302 specification-grade stainless steel. "Jumbo" size on flush mounted boxes, otherwise match box size.

B. Wet Interior or Exterior Locations:
   1. Weatherproof (WP) In-use Cover plate:
      a. Vertical mount:
         i. Deep, single, self-closing oversized metallic lid.
         ii. UL listed NEMA 3R with a cord connected.
         iii. Meet NEC 410-57.
         iv. Manufacturer: Taymac or equal.

C. Corrosive Atmosphere Locations: Gasketed polycarbonate with hinged gasketed device covers.

2.06 POWER DISTRIBUTION BLOCK

A. 600 V, enclosed power distribution block with IP-20 touch protection, meeting the following requirements:
   1. Primary Conductor Range: As required for application.
   2. Number of Ports Per Pole Primary: As required for application.
   3. Secondary Conductor Range: As required for application.
   4. Number of Ports Per Pole Secondary: As required for application.
   5. Ampere Rating Per Pole: As required for application.
   6. Connector: Copper, tin plated.
   7. Insulator Base: Glass filled polycarbonate.
   8. Terminal Screws: Aluminum, tin plated and steel, nickel plated.
   9. Connector Mounting Screw: Steel, zinc plated.

B. Agency Approvals:
   1. UL Recognized, UL 1059 Terminal Block Standard.
   2. CSA Certified, CSA C22.2.
   3. CE compliant to IEC 60947-7-1.

C. Manufacturer's Reference: ILSCO PDE series.

2.07 PRE-INSULATED CONNECTOR

A. 600 V, pre-insulated, multi-conductor connector, meeting the following requirements:
   1. Conductor Range: As required for application.
   2. Number of Ports: As required for application.
   3. Connector: Dual rated for use with copper and/or aluminum cables.
   4. Terminal Screws: Hex screw with removable access plugs.
   5. Cold Temperature Rating: -45°C.

B. Agency Approvals:
   1. UL Listed 486B wire connector (Dry locations).

C. Manufacturer's Reference: Polaris IPL series.

PART 3 EXECUTION

3.01 INSTALLATION

A. Wall Switch: Install wall switches 4'-0" above finish floor, "OFF" position down, unless otherwise noted.

B. Receptacle:
   1. Interior: Install receptacles 18" above finish floor, grounding pole on top, unless otherwise noted.
   2. Outdoor and Process Area:
      a. Mount outdoor and process area duplex receptacles in the horizontal position so that weatherproof covers fully protect the receptacle when the cover is open.
      b. Mount at 30" nominal above finished grade or floor unless otherwise shown on the Drawings

C. Emergency Generator Receptacle and Plug:
   1. Install receptacle as shown on Drawings and in accordance with manufacturer's recommendations.
   2. Deliver associated plug to Owner.

D. Power Distribution Block:
   1. Mount power distribution block where shown in Drawings in accordance with manufacturer's recommendations.
   2. Install distribution block manufacturer's safety plugs in unused taps.

END OF SECTION

SECTION 16160

CABINETS AND ENCLOSURES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Requirements for enclosures and enclosure accessories associated with Division 16 work.

1.02 REFERENCES

A. NEMA ICS 6 - Enclosures for Industrial Control Equipment and Systems.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

C. UL 50 – Enclosures for Electrical Equipment.

D. UL 508 – Industrial Control Equipment.

E. UL 870 - Wireways, Auxiliary Gutters, and Associated Fittings

1.03 SUBMITTALS FOR RELEASE

A. Catalog Data: Submit catalog literature and data sheets for the complete enclosure and interior components and accessories as specified in this section.

1.04 SUBMITTALS FOR CLOSEOUT

A. Spare Parts / Maintenance Materials: Provide four cans of manufacture recommended spray touch-up paint appropriate for field repair of each type of painted enclosure specified in this section.

1.05 DEFINITIONS

A. See Section 16010 for the definitions of Wet Interior Locations, Dry Interior Locations, Exterior Locations, Corrosive Atmosphere Locations, and Classified Locations.

PART 2 PRODUCTS

2.01 GENERAL

A. Application: Not all enclosures specified in Part 2 of this section will necessarily be used on this project. Use enclosures as necessary to meet the requirements of the Drawings and other sections of the Specifications.

2.02 NEMA 1 SCREW COVER ENCLOSURE

A. Construction: NEMA Type 1, UL 50 Type 1, steel, minimum 16 gauge. No knockouts.

B. Finish: ANSI 61 gray enamel polyester powder finish inside and outside over phosphatized surfaces.

C. Cover: Flat, removable cover fastened with removable, plated screws. Keyhole screw slots in cover.

D. Manufacturer’s Reference: Hoffman, Bulletin A90.

2.03 NEMA 3R SCREW COVER ENCLOSURE

A. Construction: NEMA Type 3R, UL 50 Type 3R, steel, minimum 16 gage. No knockouts. Drip shield top and seam-free sides, front, and back.

B. Finish: ANSI 61 gray enamel polyester powder finish inside and outside over phosphatized surfaces.

C. Cover: Slip on removable cover fastened with removable, plated screws along bottom edge. Provisions for padlocking.

D. Manufacturer’s Reference: Hoffman, Bulletin A90.

2.04 NEMA 3R HINGED COVER ENCLOSURE

A. Construction: NEMA 250; Type 3R steel.

B. Finish: ANSI 61 gray enamel finish over galvanized steel.

C. Covers:
1. Enclosures 12"W x 12"H or smaller: Continuous galvanized steel hinge, held closed by draw pull catch with provisions for padlocking.

2. Enclosures larger than 12"W x 12"H: Continuous galvanized steel hinge, held closed by captive screws with hasp and staple provided for padlocking.

D. Manufacturer's Reference: Hoffman Bulletin A-3/A-12.

2.05 NEMA 12 WIREWAY

A. General: Feed-through wireway with fittings and brackets to allow for specific wireway lengths and configurations.

B. Construction: NEMA Type 12, UL 870, steel, minimum 14 gauge. No knockouts. Smooth, rounded edges on sections and fittings. External screw clamps. Oil-resistant gasket and adhesive.

C. Finish: ANSI 61 gray polyester powder finish inside and outside over pretreated surfaces.

D. Cover: Hinged cover fastened with heavy butt hinges.

E. Manufacturer’s Reference: Hoffman, Bulletin F20.

2.06 NEMA 3R WIREWAY

A. Construction: NEMA Type 3R, UL 870, steel, minimum 16 gauge. No knockouts. Drip shield top and seam-free sides, front, and back.

B. Finish: ANSI 61 gray enamel polyester powder finish inside and outside over phosphatized surfaces.

C. Cover: Slip on removable cover fastened with captive plated screws along bottom edge.

D. Manufacturer’s Reference: Hoffman, Bulletin F40.

2.07 NEMA 4X WIREWAY

A. Construction: NEMA Type 4X, 304 stainless steel, minimum 14 gauge. No knockouts.

B. Finish: Natural stainless steel with a smooth brushed finish.

C. Cover: Removable butt hinged cover secured with screw clamps.

D. Accessories: Elbows, box connectors, cover plates, etc. as needed to complete configuration shown on Drawings.

E. Manufacturer’s Reference: Hammond 1487SS Series.

2.08 NEMA 4X POLYCARBONATE SCREW COVER ENCLOSURE

A. Construction: NEMA Type 4X, UL 508 Type 4X, impact-resistant polycarbonate.

B. Finish: Manufacturer’s standard light gray inside and outside.

C. Cover: Opaque, impact-resistant polycarbonate cover held in place with polyamide screws.

D. Manufacturer’s Reference: Hoffman, Bulletin Q41.

2.09 NEMA 12 HINGED COVER ENCLOSURE TYPE 1

A. Construction: Wall mount or pad mount, as indicated, NEMA Type 12, UL 508 Type 12, steel, minimum 14 gauge, with interior subpanel. No knockouts. Seams continuously welded and ground smooth. Body designed to prevent no more than 1/8” flex in any surface from one corner to another. One inch diameter cable loop welded to interior of enclosure near door hinge for attachment of cable from door to enclosure. Ground stud welded to interior sidewall of enclosure near door hinge.

B. Door: Door supported with continuous steel hinge, and 3-point latch and handle with padlock attachment. Continuous oil-resistant gasket attached with oil-resistant adhesive and held in place with steel retaining strips. Door stop to secure door in open position. Door designed to prevent no more than 1/8” deflection across surface from one corner to another. One inch diameter cable loop welded to interior of door near door hinge for attachment of cable from door to enclosure. Ground stud welded to interior of door near door hinge. Install bonding strap from ground stud of door to ground stud on enclosure.

C. Finish:

1. Enclosure Exterior: ANSI 61 gray enamel polyester powder finish over phosphatized surfaces.
2. Enclosure Interior: White enamel polyester powder finish over phosphatized surfaces.
3. Subpanel: Manufacturer’s standard white enamel polyester powder finish over phosphatized surfaces.

D. Options: Interior data/print pocket.

E. Accessories: Swing-out panel where required on Drawings.

F. Manufacturer’s Reference: Hoffman, Bulletin A12.

2.10 NEMA 12 HINGED COVER ENCLOSURE TYPE 2

A. Construction: Wall mount, as indicated, NEMA Type 12, UL 508A, steel, minimum 18 gauge, with interior subpanel. No knockouts. Seams continuously welded and ground smooth. One inch diameter cable loop welded to interior of enclosure near door hinge for attachment of cable from door to enclosure (Where required). Body grounding stud welded to interior sidewall of enclosure near door hinge.

B. Door: Solid or window-door supported with steel hinge pins, and quarter-turn slotted latch. Continuous seamless foam gasket. One inch diameter cable loop welded to interior of door near door hinge for attachment of cable from door to enclosure (Where required). Bonding provision on door (except window-door models). Install bonding strap from ground stud of door to ground stud on enclosure.

C. Finish:

1. Enclosure Exterior: ANSI 61 gray enamel polyester powder finish over phosphatized surfaces.
2. Enclosure Interior: White enamel polyester powder finish over phosphatized surfaces.
3. Subpanel: Manufacturer’s standard white enamel polyester powder finish over phosphatized surfaces.

D. Options: Interior data/print pocket.

E. Manufacturer’s Reference: Hoffman, Bulletin CW1.

2.11 NEMA TYPE 3R/12 HINGED COVER ENCLOSURE

A. Same as NEMA Type 12 Hinged Cover Enclosure Type 1 with the addition of a drip shield kit to achieve a NEMA 3R/12, UL 508 Type 3R12 rating.

2.12 NEMA 4X STAINLESS STEEL HINGED COVER ENCLOSURE TYPE 1

A. Construction: Wall mount, NEMA Type 4X, UL 508A, 316L stainless steel, minimum 14 gauge, with interior subpanel. No knockouts. Seams continuously welded and ground smooth. Ground stud welded to interior sidewall of enclosure near door hinge.

B. Door: Door supported with continuous stainless steel hinge, and screw-down door clamps with padlock attachment. Seamless foam-in-place gasket for water-tight seal. Bonding provisions on door interior near door hinge. Install bonding strap from door to ground stud on enclosure.

C. Subpanel: Manufacturer's standard white enamel polyester powder finish over phosphatized surfaces.

D. Accessories: Swing-out panel where required on Drawings.

E. Manufacturer's Reference: Hoffman, Bulletin A4S.

2.13 NEMA 4X STAINLESS STEEL HINGED COVER ENCLOSURE TYPE 2

A. Construction: Wall mount, NEMA Type 4X, UL 50/50E, 316L stainless steel, minimum 14 gauge, without interior subpanel. No knockouts. Seams continuously welded and ground smooth. Bonding provisions on interior sidewall of enclosure near door hinge.

B. Door: Door supported with continuous stainless steel hinge, and screw-down clamps. Seamless foam-in-place gasket for water-tight seal. Bonding provisions on door interior near door hinge. Install bonding strap from door to enclosure.

C. Manufacturer's Reference: Hoffman, Bulletin A51S.

2.14 NEMA 7,9 EXPLOSION PROOF HINGED COVER ENCLOSURE

A. Construction: Wall mount, NEMA Type 7,9, explosionproof, dust-ignitionproof, UL 698/1203, PTB 07 ATEX 1024, copper-free cast aluminum, with interior mounting pan if required for application. No knockouts. Bonding provisions on interior sidewall of enclosure near door hinge.

B. Door: Door supported with stainless steel hinges with stainless steel hardware, and stainless steel cover bolts. Seamless "O" ring gasket located inside bolt circle for water-tight seal. Install bonding strap from door to enclosure.

C. Manufacturer's Reference: Appleton AJBEW series.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install enclosures and trim plumb.

B. Anchor securely to framing channel mounted to wall or plywood backboard. Secure enclosure at each corner, minimum.

C. Make conduit penetrations to maintain enclosure's NEMA rating. Use conduit hubs to terminate conduits to enclosures, regardless of location of penetration into enclosure. Do not penetrate top of enclosures in exterior or wet interior locations.

END OF SECTION

SECTION 16190

SUPPORTING DEVICES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Provide all labor, materials and incidentals to install strut systems, supports and anchors.

1.02 DEFINITIONS

A. See Section 16010 for the definitions of Wet Interior Locations, Dry Interior Locations, Exterior Locations, Corrosive Atmosphere Locations, and Classified Locations.

PART 2 PRODUCTS

2.01 METAL FRAMING CHANNEL

A. Material: Hot-dipped galvanized or Type 316 stainless steel, as scheduled. Designed with inturned lips to allow special, spring-loaded nuts to be inserted anywhere along the channel
   1. Basic Unit Size: 1-5/8” x 1-5/8”. Use back-to-back channel and half-channel where required for special applications and where specifically indicated.
   2. Spring-loaded nut and bolt made of stainless steel and designed to provide positive locking in place when tightened.
   3. Material Thickness: 12 gauge.
   4. Nuts, Bolts, and Miscellaneous Hardware: Type 316 stainless steel.
   5. Manufacturer’s Reference: Unistrut or equal.

2.02 FIBERGLASS FRAMING CHANNEL

A. Material: Pultruded glass-reinforced polyester or vinyl ester resin.
   1. Strut and hanger rod construction: linear glass strands, continuous mat laminates and corrosion resistant polyester resins simultaneously pulltruded to form a uniform, rigid, thermoset shape.
   2. Fiberglass: self extinguishing with UL 94 V O classification.

3. Hanger rod washers: stamped from pulltruded flat stock.
4. Hanger rod square nuts: made from pulltruded flat stock.
5. Hanger rod hex nuts and stout nuts: injection molded.
6. rod beam clamps and pipe straps: steel with 15 mil PVC coating and SS bolts.
7. Single strut: 1.715 x 1.76 x 0.15 wall by length.
8. Back to back strut: 1.715 x 3.52 x 0.15 wall by length.
9. Manufacturer: Allied Electrical Group Cope-Glas Strut Support System or equal.

2.03 CONDUIT AND BOX SUPPORTS

A. Steel RMC, IMC, RNMC, and EMT:
   1. Support with:
      a. Stainless steel clamps.
      b. Threaded stainless steel rod and hangers.
      c. Strut system.
      d. By pipe hangers of aluminum or stainless steel specifically manufactured for the purpose.
   2. Flexible galvanized steel or copper perforated straps (plumber's tape) will not be acceptable.
   3. In non process indoor areas, clamps may be galvanized steel.

B. Steel pull and junction boxes: support with stainless steel bolts and anchors.

C. Aluminum conduit and boxes: support with stainless steel bolts and aluminum plates, clamps and hardware and/or aluminum unistrut.

D. NEMA 4X boxes: support with stainless steel bolts and anchors or strut.

2.04 ANCHORS IN MASONRY

A. Stainless steel Wejit bolts and hardware.

B. Stainless steel parabolts or equal expansion bolts.

C. Conical threaded steel inserts with a lead shield set in place with a drive punch using stainless steel bolts.

D. Lead shields with lag bolts will not be acceptable.

E. Toggle bolts may be used in hollow portions of masonry walls in non process indoor areas.

F. Manufacturer: Hilti Corporation or equal.

2.05 ANCHORS IN CONCRETE

A. Stainless steel bolts and hardware with chemical adhesive.

B. Manufacturer: Hilti Corporation or equal.

PART 3 EXECUTION

PART 4 FRAMING CHANNEL SCHEDULE

A. Dry Interior Locations: Metal Framing Channel – Hot-dipped Galvanized.

B. Exterior Locations: Metal Framing Channel – Type 316 Stainless Steel.

C. Wet Interior Locations: Metal Framing Channel – Type 316 Stainless Steel.

D. Corrosive Atmosphere Locations: Fiberglass Framing Channel. If exposed to sunlight, use Type 316 Stainless Steel.

E. Classified Locations: Fiberglass Framing Channel. If exposed to sunlight, use Type 316 Stainless Steel.

4.02 USAGE OF CHANNEL

A. Do not install fiberglass strut where exposed to sunlight.

B. Do not cast fiberglass or aluminum strut in concrete.

C. Follow manufacturer's recommendation as to maximum loading.

D. Do not exceed deflection stated in manufacturer's literature.

END OF SECTION

SECTION 16400

ELECTRICAL SERVICE

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Contractor shall coordinate a schedule with Local Electric Utility (LEU) for the installation of a new secondary metered, 480 Volt, single-phase, three-wire service.

1.02 RELATED WORK

A. LEU construction staff and subcontractor will provide that portion of the primary riser and feeder required by the Specifications, Drawings, or LEU policy.

B. Contractor shall include in the Bid and provide all secondary service conduits and conductors in accordance with LEU policy.

C. The Owner will pay LEU direct charges under a utility line extension agreement separate from this construction contract, which are related to LEU installed equipment such as the primary feeder extension.

D. Contractor shall include in the Bid and pay to LEU all additional charges they may require for their participation in outages or standby time related to system modifications during construction.

E. Payment of Charges:
   1. Contractor to apply for and sign a service contract with and pay Local Utility to provide a new service to the facility for billing purposes.
   2. Contractor to pay all monthly charges, demand charges and power consumption for the new service until Substantial Completion is granted.
   3. Upon Substantial Completion, Contractor shall arrange for an ownership transfer with LEU. The Owner will pay the charge to have the service transferred from the Contractor’s name to the Owner’s name and Owner shall begin payment of the monthly charges for the new service at that point.
   4. The Owner will continue to pay all monthly charges for the existing service until it is removed.

F. Work on new services is critical to construction phasing and is the sole responsibility of the Contractor for coordination.

G. Coordination with the LEU and Owner is the sole responsibility of the Contractor. Contractor is responsible for providing documentation to the LEU regarding easements, plats, property locations, and addressing.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 16452

GROUNDING

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Requirements for grounding and bonding of equipment and raceway.

1.02 RELATED SECTIONS

A. Section 16123 – Low-Voltage Wire and Cable.

1.03 SUBMITTALS FOR RELEASE

A. Catalog Data: Provide catalog data for the following:

1. Ground rods.

2. Ground plates.

3. Ground bus bars.

PART 2 – PRODUCTS

2.01 MATERIALS

A. Ground Wire: See Section 16123.

B. Ground Rods: Copper bonded steel ground rod, 5/8 inch diameter by 8 feet in length.

C. Ground Plates: Solid copper, two square foot minimum, 1/16 inch minimum thick, with #2/0 AWG stranded terminated welded pigtail.

1. Manufacturer’s Reference: Erico GPECEBH.

D. Ground Bus Bars: Solid copper or tinned copper (as required), ¼ inch thick, pre-punched bar with insulators, galvanized steel brackets, adapters, and hardware for wall and/or tower mounting.

1. Required Bonding Points:

a. Cabinet Ground Bus Bar: Size bus bar to accommodate required bonding points indicated on the Drawings plus an additional 5 available bonding points.

b. All other Ground Bus Bars: Size bus bar to accommodate required bonding points indicated on the Drawings plus an additional 20 available bonding points.

2. Manufacturer's Reference: Andrew UGBKIT.

PART 3 – EXECUTION

3.01 GENERAL

A. Ground Conductor:

1. Interior and Exterior Above Grade Bonding Jumper: #6 AWG stranded copper. Use jacketed conductors.

2. Below Grade:

a. Ground Counterpoise: #4/0 AWG bare copper.

b. Ground Radials: #1/0 AWG bare copper.

c. Jumpers from equipment and ground bus bars to ground counterpoise: #1/0 AWG bare copper.

3. Bonding to Galvanized Steel:

a. Use tinned copper conductors.

b. Do not let copper conductor come in contact with galvanized steel.

c. Do not install bare copper above galvanized steel where rain runoff from copper can come into contact with galvanized steel.

B. Ground Rods:

1. General: Install ground rod straight down if possible. An angle of up to 45° is allowed. If not possible, install ground rod in a horizontal trench, at least 30 inches deep, perpendicular to the building it is connected.

2. Burial Depth:

   a. Typical: 24 inches below finish grade.

   b. When Part of Ground Ring: Ground ring depth (typically 30 inches).

3. Spacing: Minimum 8 foot and maximum 16 foot.

C. Grounding Connections:

1. Below Grade Connections: Irreversible high-compression connector.

2. All Other Connections: Mechanical grounding connection.

3.02 EXTERIOR GROUNDING

A. Bond fences at corner post. Use flexible bonding conductor at gates.

3.03 OTHER GROUNDING

A. Power System Grounding: If a new electrical service entrance is provided on the project, bond the electrical service system neutral (grounded conductor) at the service entrance equipment in accordance with the National Electrical Code (NEC) and local utility company requirements.

B. Raceway Grounding: Provide a separate equipment grounding conductor in all raceway systems, excluding spare raceways, and unless noted otherwise. Terminate each end on a grounding terminal, lug, bus or bushing. Install bond wire from conduit grounding bushing to box or enclosure grounding terminal, lug or bus.

C. Equipment Grounding: Bond together equipment enclosures, metal raceway systems, conduit grounding hubs, and receptacle ground connections in accordance with the NEC.

END OF SECTION

SECTION 16476

DISCONNECT SWITCHES AND ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SCOPE OF WORK

A. This Section includes individually mounted switches and circuit breakers used for the following:
   1. Feeder and equipment disconnect switches.
   2. Feeder branch-circuit protection.
   3. Motor disconnect switches.

1.02 RELATED WORK

A. Section 16010: General Electrical Requirements

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

1.03 SUBMITTALS FOR RELEASE

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data for disconnect switches, circuit breakers, and accessories specified in this Section.

C. Product Data for switches, circuit breakers, and accessories specified in this Section. Include the following:
   1. Descriptive data, time-current curves, and short circuit interrupting capacity.
   2. Coordination charts and tables and related data.

D. Wiring diagrams detailing wiring for power and control systems and differentiating between manufacturer-installed and field-installed wiring.

E. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and Owners, and other information specified.

F. Field test reports indicating and interpreting test results.

G. Maintenance data for tripping devices to include in the operation and maintenance manual specified in Division 1.

1.04 QUALITY ASSURANCE

A. Testing Agency Qualifications: In addition to the requirements specified in Division 1 Section "Quality Control," an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be a full member company of the International Electrical Testing Association (NETA).
   1. Testing Agency's Field Supervisor: Person currently certified by NETA or the National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain disconnect switches and circuit breakers from one source and by a single manufacturer.

C. Comply with NFPA 70 for components and installation.

D. Listing and Labeling: Provide disconnect switches and circuit breakers specified in this Section that are listed and labeled.
   1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
   2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering disconnect switches and circuit breakers that may be incorporated into the Work include, but are not limited to, the following:
   1. Fusible Switches:
      a. Eaton Corp.; Cutler-Hammer Products.
      b. Schneider Electric.
   2. Molded-Case Circuit Breakers:
      a. Eaton Corp.; Cutler-Hammer Products.
      b. Schneider Electric.
   3. Combination Circuit Breaker and Ground Fault Trip:
      a. Eaton Corp.; Cutler-Hammer Products.
      b. Schneider Electric.

4. Molded-Case, Current-Limiting Circuit Breakers:
   a. Eaton Corp.; Cutler-Hammer Products.
   b. Schneider Electric.

2.02 DISCONNECT SWITCHES (SINGLE AND DOUBLE THROW SWITCHES)

A. Enclosed, Nonfusible Switch: NEMA KS 1, Type HD, with lockable handle.

B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable with 2 padlocks, and interlocked with cover in CLOSED position.

C. Enclosure: NEMA KS 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.
   1. Outdoor Locations: Type 3R or 4X as indicated on Drawings.
   2. Wet or Damp Indoor Locations: Type 4X.
   3. Hazardous Areas Indicated on Drawings: Type 7C.

2.03 ENCLOSED CIRCUIT BREAKERS

A. Enclosed, Molded-Case Circuit Breaker: NEMA AB 1, with lockable handle.

B. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting rating to meet available fault current.

C. Application Listing: Appropriate for application, including switching fluorescent lighting loads or heating, air-conditioning, and refrigerating equipment.

D. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.

E. Circuit Breakers, 400 A and Larger: Field-adjustable, short-time and continuous-current settings.

F. Current-Limiting Trips: Where indicated, let-through ratings less than NEMA FU 1, Class RK-5.

G. Current Limiters: Where indicated, integral fuse listed for circuit breaker.

H. Molded-Case Switch: Where indicated, molded-case circuit breaker without trip units.

I. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.
   1. Shunt Trip: Where indicated.

J. Accessories: As indicated.

K. Enclosure: NEMA AB 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.
   1. Outdoor Locations: Type 3R or 4X as indicated on Drawings.
   2. Wet or Damp Indoor Locations: Type 4.
   3. Hazardous Areas Indicated on Drawings: Type 7C.

L. Transient Voltage Surge Suppressors: IEEE C62.41, to meet requirements for category indicated.
   1. Exposure: Medium.
   2. Impulse sparkover voltage coordinated with system circuit voltage.
   3. Factory mounted with UL-recognized mounting device.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install disconnect switches and circuit breakers in locations as indicated, according to manufacturer's written instructions.

B. Install disconnect switches and circuit breakers level and plumb.

C. Install wiring between disconnect switches, circuit breakers, control, and indicated devices.

D. Connect disconnect switches and circuit breakers and components to wiring system and to ground as indicated and instructed by manufacturer.
   1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

E. Identify each disconnect switch and circuit breaker according to requirements specified in Section 16075 – Electrical Identification.

3.02 FIELD QUALITY CONTROL

A. Testing Agency: Provide the services of a qualified testing agency to perform specified field quality-control testing.

B. Testing: After installing disconnect switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for disconnect switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.

C. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.03 ADJUSTING

A. Set field-adjustable disconnect switches and circuit-breaker trip ranges as indicated.

3.04 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

END OF SECTION

SECTION 16477

FUSES

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Fuses.

B. Fuse blocks and holders.

1.02 SUBMITTALS FOR RELEASE

A. Section 16010.

B. Catalog cut-sheets.

C. Time current characteristic curves.

D. Current limitation curves.

E. Operating temperature characteristics.

F. Submit only for the types of fuses, blocks and holders required by the Drawings.

PART 2 PRODUCTS

2.01 CURRENT LIMITING, DUAL ELEMENT, TIME DELAY FUSES

A. Time delay: 10 seconds minimum at 5 x rated current.

B. Overload portion of dual element shall open at a temperature not greater than 300°F.

C. Interrupting rating: 200,000A RMS symmetrical.

D. U.L. Class RK 5.

E. 250VAC:
   1. Bussman Fusetron FRN R.
   2. Engineer-approved equivalent.

F. 600VAC:
   1. Bussman Fusetron FRS R.
   2. Engineer-approved equivalent.

2.02 FAST CURRENT LIMITING, DUAL ELEMENT, TIME DELAY FUSES

A. Time Delay: 10 seconds minimum at 5 x rated current.

B. Overload portion of dual element shall open at a temperature not greater than 300°F.

C. Interrupting rating: 200,000A RMS symmetrical.

D. U.L. Class RK 1.

E. 250VAC:
   1. Bussman Low Peak LPN RK.
   2. Engineer-approved equivalent.

F. 600VAC:
   1. Bussman Low Peak LPS RK.
   2. Engineer-approved equivalent.

2.03 HIGH AMPACITY, FAST CURRENT LIMITING, TIME DELAY FUSES

A. Open at 150% of rated current within four hours.

B. Time delay: four seconds minimum of 5 x rated current.

C. Interrupting rating: 200,000A RMS symmetrical.

D. U.L. Class L.

E. 600 VAC:
   1. Bussman Hi Cap KRP C.
   2. Engineer-approved equivalent.

2.04 CONTROL TRANSFORMER PRIMARY AND INSTRUMENT FUSES

A. Open at 135% of rated current within one hour.

B. Time delay: four seconds minimum at 3 x rated current.

C. Interrupting rating. 200,000A RMS symmetrical.

D. UL Class CC, with rejection feature.

E. 600 VAC:
   1. Bussman CC Tron FNQ R.
   2. Engineer-approved equivalent.

2.05 SMALL DIMENSION CONTROL CIRCUIT FUSES

A. Manufacturer:
   1. Bussman AGC, ABC, MDL, MDQ or MDX.
   2. Enginner-approved equivalent, to match current and voltage of circuit.

B. Use dual element fuses unless recommended otherwise by equipment manufacturer or shown as fast acting on the Drawings.

2.06 REJECTION FUSE BLOCKS FOR 2.01 AND 2.02 FUSES

A. Base: phenolic.

B. Box terminals.

C. Manufacturer:
   1. Bussman Class R Phenolic.
   2. Engineer-approved equivalent.

2.07 REJECTION FUSE BLOCKS FOR 2.04

A. Body: phenolic with mounting holes for bolting to panel and screw knob.

B. Combination 1/4" quick connect/solder terminals.

C. Manufacturer:
   1. Bussman HPF-RR.
   2. Engineer-approved equivalent.

2.08 FUSEHOLDERS FOR 2.05

A. Body: phenolic with bayonet knob.

B. Voltage rating: 250V.

C. Maximum fuse size: 20A.

D. Terminals: 1/4" right angle quick connect.

E. Manufacturer:
   1. Bussmann HTB-481.
   2. Engineer-approved equivalent.

2.09 FUSE CABINET

A. Bussmann SFC.

B. Engineer-approved equivalent.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 16478

SURGE PROTECTION DEVICES (SPD)

PART 1 GENERAL

1.01 SCOPE OF WORK

A. Furnish and install surge protection device (SPD) as shown on the Drawings and specified herein.

B. This Section is hereby made a part of all other applicable sections of Division 16 as fully as if repeated in each therein.

1.02 RELATED WORK

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

B. Section 16010: General Electrical Requirements.

1.03 SUBMITTALS FOR RELEASE

A. Submit the following in accordance with Section 16010:
   1. Product Data: Submit manufacturer's product data on SPD devices including electrical characteristics and ratings.
   2. Shop Drawings: Submit shop drawings showing wiring diagrams, physical dimensions, weight, and connection details.
   3. Certified Documentation of UL 1449 listing and clamping voltage and Life Cycle Testing.
   4. Documentation of Factory Testing.

1.04 QUALITY ASSURANCE

A. SPD devices shall be tested to and comply with the latest editions of the following standards:
   1. NFPA 70, 75 and 78
   2. UL Standard 1449 and 1283
   3. IEEE STD 142 and 518
   4. ANSI/IEEE C62.41 and C62.45
   5. FIPS PUB 94

6. NEMA
7. ANSI
8. MIL-STD 220A

B. The SPD shall be listed per UL 1449 as a complete system under the UL 1449 standard.

C. System shall be tested to meet ANSI/IEEE C62.41, tested per ANSI/IEEE C62.45. Category C3 - Biwave: 8 x 20 □ SEC at 10,000 Amperes; 1.2 x 50 □ SEC at 20,000 Volts.

D. The system shall be life cycle tested to 2,500 sequential ANSI/IEEE C62.41 Category C3 waveforms without failing or degrading the UL 1449 Surge Suppression Rating by more than 10%.

E. The system shall be tested to MIL-STD 220A for electrical line noise attenuation per 50 ohm insertion loss measurement method of RF Frequencies up to 100 MHZ.

F. Thoroughly factory test to UL Manufacturing and production-line tests, quality assurance tests, MCOV tests, and surge clamping voltage verification tests.

1.05 WARRANTY

A. Equipment shall be warranted for a minimum of 10 years.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
1. Square D Co.
2. Eaton Corp.; Cutler-Hammer Products.
3. or Engineer-Approved Equal.

B. Unit shall be manufactured in the USA by a qualified manufacturer of suppression filter systems equipment.

2.02 SURGE PROTECTION DEVICE (SPD)

A. Equipment is to be a multi-stage parallel protector. The equipment surge current capacity shall be based on an 8 x 20 microsecond waveform per ANSI/IEEE C62.41 Category C3 rating.

B. The system protection modules shall contain a high performance, balanced metal oxide varistor (MOV) array and filtering circuit.

C. Units shall be UL 1449 listed for SPD. However, each individual surge protection unit shall be considered on its own merit. Units which rely on other external or upstream units to achieve the required performance and UL 1449 listing are expressly excluded.

D. Maximum Continuous Operating Voltage (MCOV). The maximum continuous operating voltage (MCOV) of all suppression components utilized in the unit shall not be less than 115% of the facility's normal operating voltage.

E. Protection Modes: The SPD shall provide line-to-line (L-L), line-to-neutral (L-N), line-to-ground (L-G), and neutral-to-ground (N-G) protection.

F. Tested Single-Pulse Surge Current Capacity. Based on ANSI/IEEE C62.41 standard 8 x 20 microsecond current waveform, and in accordance with NEMA Publication No. LS-1-1992, the tested single pulse surge current capacity, in amps, of the unit shall be no less than as follows for service entrance switchboard and motor control center applications:

MODE OF PROTECTION	TESTED SINGLE PULSE SURGE CURRENT
L-L	320,000
L-N	160,000
L-G	160,000
N-G	160,000

G. Tested Single-Pulse Surge Current Capacity. Based on ANSI/IEEE C62.41 standard 8 x 20 microsecond current waveform, and in accordance with NEMA Publication No. LS-1-1992, the tested single pulse surge current capacity, in amps, of the unit shall be no less than as follows for panelboard distribution applications:

MODE OF PROTECTION	TESTED SINGLE PULSE SURGE CURRENT
L-L	160,000
L-N	80,000
L-G	80,000
N-G	80,000

H. High Frequency Extended Range Tracking Filter: The unit shall include a high-frequency extended range tracking filter and shall be UL 1283 Listed as an Electromagnetic Interference Filter. The filter shall reduce fast rise-time, high-frequency, error-producing transients and electrical line noise to harmless levels, thus eliminating disturbances which may lead to system upset. The filter shall provide minimum noise attenuation as follows:

ATTENUATION FREQUENCY	INSERTION LOSS (RATIO)	INSERTION LOSS (DB)
100 kHz	50-1	34
1 MHZ	350-1	51
10 MHZ	500-1	54
100 MHZ	250-1	48

*Note: Standardized insertion loss data obtained utilizing MIS-STD-E220A 50 ohm insertion loss methodology

I. The unit shall include solid-state, long-life, externally mounted LED visual status indicators that monitor the on-line status of each phase of the unit. Provide two (2) Form-C contacts for remote monitoring when suppressor module is inoperative, and two disturbance counters.

J. Performance Ratings: The system performance ratings shall be based on the UL 1449 listing ratings for IEEE C62.41 Category C3 equipment. The maximum UL 1449 voltage clamping rating for each of the specified protection modes shall not exceed:

System Voltage	L-N/L-G/N-G	L-L
208Y/120 VAC	400 VAC	800 VAC
480Y/277 VAC	800 VAC	1600 VAC

K. Field Connections: The unit shall include mechanical lugs for each phase, neutral and ground, if applicable. The lugs shall accommodate up to #2 AWG copper conductor with integral fused disconnect switch and up to 1/0 AWG copper conductor without integral fused disconnect switch.

L. Enclosure: Units shall be provided in a NEMA 4 type enclosure of 14 gauge steel or be integral to switchboard, motor control center or panelboard.

PART 3 EXECUTION

3.01 INSTALLATION

A. SPD devices shall be installed adjacent to or internally within switchboard, motor control center or panelboard in accordance with final submitted drawings and with manufacturer's written instructions.

B. Furnish and install a circuit breaker between the switchboard, motor control center or panelboard bus and the SPD.

C. Wiring from the bus to the SPD shall not exceed 6 feet length and shall avoid unnecessary bends.

D. All terminations shall be made with compression lugs.

3.02 FACTORY TESTING

A. Conduct manufacturer's standard factory tests per approved submittal data.

B. Submit formal report of factory tests within ten (10) days of factory tests, stating tests conducted, acceptable limits of such tests, actual test results, and original test data sheet with legible signatures of those conducting, witnessing, and approving such tests.

3.03 TESTS

A. Test SPD an accordance with manufacturer’s instructions.

END OF SECTION