SANDERS UNIFIED SCHOOL DISTRICT
URANIUM TREATMENT FACILITY
PWS # 04-01-022
SFB NO. 001BRG

BID DOCUMENTS

December 2016

EXPIRATION DATE: 09/30/18

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SANDERS UNIFIED SCHOOL DISTRICT
URANIUM TREATMENT FACILITY
SPECIFICATIONS

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DIVISION 1

GENERAL REQUIREMENTS

SECTION 01040

ORDER OF CONSTRUCTION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
1. Order of construction activities to allow the OWNER normal operation of the existing facilities located on the Project site.

B. Related Sections include, but are not necessarily limited to:
1. Division 1.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

A. Milestone Dates - The construction duration to reach substantial completion shall not exceed 120 calendar days. CONTRACTOR shall also comply with the following interim dates of completion:

Task	**Interim Completion Date (days after notice to proceed)**
Submit Shop Drawings for All Components	21
Deliver Treatment Vessels to Job Site and Install Building	75
Complete Installation of Equipment and Process Piping	90
Complete Electrical and Instrumentation and Control Wiring	100
Initiate Startup of Water Treatment Facility	110
Initiate Commissioning of Water Treatment Facility	120

1. CONTRACTOR shall include sufficient and complete overhead costs in base Bid for a 120 calendar day construction duration to reach substantial completion. No change orders or claims for extended overhead will be considered unless the actual duration to reach substantial completion exceeds 240 calendar days:
    a. No credit or refund will be given to CONTRACTOR if the work is substantially completed sooner than 120 calendar days.

B. Tie-ins shall be coordinated with the OWNER and shall be scheduled as to minimize the disruption of services:
1. For pipe tie-ins, the CONTRACTOR shall have 4 hours maximum for each of the tie-ins.
2. At no time shall CONTRACTOR or his employees modify operation of the existing facilities or start construction modifications without approval of the OWNER.
3. CONTRACTOR shall plan his work to allow OWNER access to existing facilities to perform maintenance and repair work.
4. Operation of existing valves shall only be performed by OWNER's personnel.

C. The following is a suggested construction sequence for the project which the CONTRACTOR should consider in developing his overall plan of construction. This is not intended to release the CONTRACTOR from the responsibility to coordinate the work in any manner which shall insure project completion within the time allowed:

1. Prepare site.
2. Install foundation and slab.
3. Install and pressure test yard piping.
4. Construct building.
5. Relocate vessels from Red Mesa.
6. Install treatment vessel on slab and chlorination tanks and equipment.
7. Install process vessels equipment and piping.
8. Install electrical and instrumentation and controls wiring.
9. Disinfect piping and equipment.
10. Conduct tie-ins from the existing facility to all new piping.
11. Conduct startup of treatment facility.
12. Work with ENGINEER to conduct commissioning. Conduct training of OWNER'S staff.
13. Complete sitework and punchlist items.
14. Clean facilities.

END OF SECTION

SECTION 01110

SUMMARY OF WORK

PART 1 - GENERAL

1.01 LOCATION AND DESCRIPTION OF WORK

A. The Work is located on the following sites:
   1. Sanders Unified School District Lower Tank Site, Sanders, AZ

B. The Contract Documents include the following:
   1. Volume 1 of 3: Division 0
   2. Volume 2 of 3: Divisions 1 Through 17 Specifications
   3. Volume 3 of 3: Drawings

C. The Contract Documents for the Work to be performed include the following, but are not limited to:
   1. Construction of the new uranium treatment facility and building equipment.

1.02 CONTRACT

A. The Work shall be constructed under one prime contract.

1.03 OTHER CONSTRUCTION CONTRACTS

A. Other construction contracts may be awarded by the OWNER that are in close proximity to or border on the Work of this Contract. CONTRACTOR shall coordinate work and safety issues with these ongoing projects.

1.04 WORK BY OWNER

A. OWNER will perform the following work:
   1. Operation of all existing wells, valves and equipment, unless specified otherwise.

1.05 SEQUENCE AND PROGRESS OF WORK

A. CONTRACTOR shall incorporate the requirements of Section 01111 - Schedule of Completion, and Section 01143 - Coordination with OWNER'S Operations, into the Construction Schedule. CONTRACTOR'S construction schedule may use a different sequence from that shown or specified, if techniques and methods known to CONTRACTOR will result in cost and time savings to the OWNER, still achieve the required objective and maintain the same or greater level of

treatment. The ENGINEER'S determination on the acceptability of any alternative sequence from that shown or specified shall be final.

1.06 CONTRACTOR'S USE OF PREMISES

A. CONTRACTOR shall coordinate use of the premises, for his storage and the operations of his workmen, with OWNER, ENGINEER and utility service companies.

B. The full use of the premises for storage, the operations of workmen and for all other construction activities will not be available to CONTRACTOR. CONTRACTOR must operate entirely within the space allowed to him.

C. CONTRACTOR shall be solely responsible for obtaining and paying all costs in connection with any additional work area, storage sites, access to the site or temporary right-of-way which may be required for proper completion of the Work.

D. It shall be understood that responsibility for protection and safe-keeping of equipment and materials on or near the site will be entirely that of CONTRACTOR and that no claim shall be made against the OWNER or his authorized representatives by reason of any act. It shall be further understood that should any occasion arise necessitating access to the sites occupied by these stored materials or equipment, the ENGINEER shall direct CONTRACTOR owning or responsible for the stored materials and equipment to immediately move the same. No materials or equipment may be placed upon the property of the OWNER, other than in the designated areas as shown on the Drawings, or as described in the specifications, unless the ENGINEER has agreed to the location contemplated by CONTRACTOR to be used for storage. All stored materials shall be labeled according to the appropriate contractor or subcontractor with the manufacturer's label as well. Appropriate material safety data sheets (e.g., MSDS) shall be provided.

E. CONTRACTOR shall be required to share use of the premises with other contractors whose services the OWNER has obtained or will obtain for construction of other facilities on the site.

1.07 SALVAGE OF EQUIPMENT AND MATERIALS

A. Existing equipment and materials removed, and not shown or specified to be reused as a part of the Work, shall become CONTRACTOR'S property, except the following items which shall remain OWNER'S property:
   1. As shown on Drawings.

B. Existing equipment and materials removed by CONTRACTOR shall not be reused in the Work, except where so specified or indicated.

C. CONTRACTOR shall carefully remove, in a manner to prevent damage, all equipment and materials specified or indicated to be salvaged and reused or to remain the property of OWNER. Store and protect salvaged items specified or indicated to be reused in the Work. Replace in kind or with new items any items damaged in removal, storage, or handling through carelessness or improper procedures.

D. CONTRACTOR may furnish and install new items, with ENGINEER'S approval, instead of those specified by OWNER or indicated to be salvaged and reused, in which case such removed items will become CONTRACTOR'S property.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01111

SCHEDULE OF COMPLETION

PART 1 - GENERAL

1.01 DESCRIPTION

A. CONTRACTOR shall commence the Work promptly upon the date established in the Notice to Proceed and shall pursue it to completion in accordance with the Agreement as described in this Section.

B. CONTRACTOR is advised that completion of certain activities is directly related to production capacities at SUSD Wells 1 and 2. CONTRACTOR shall be responsible for coordinating all shutdowns with the OWNER and the ENGINEER. CONTRACTOR shall, whenever possible, combine discrete shutdown when duration of the shutdowns or the work requirements allow such combining to occur in a work area. The intent of combining procedures is to minimize the impacts upon the well operations by limiting the number of shutdowns required.

C. CONTRACTOR shall not shut-off or disconnect any operating system of the wells unless approved by the ENGINEER, in writing. All equipment operations and shutdowns shall be executed by the OWNER, unless otherwise noted. OWNER shall have access to all areas of the well site throughout the construction period for operation and maintenance.

D. Liquidated damages for failure to Substantially Complete the work, are defined in the Agreement.

E. The contract time to substantial completion is 120 calendar days. All work under this contract shall be completed except warranty items, startup and commissioning wihin this time period.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01143

COORDINATION WITH OWNER'S OPERATIONS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The intent of this Section is to provide CONTRACTOR a sequence to perform the Work in such a manner that well pumping facilities are maintained operational throughout the construction period.

B. Except for the shutdown durations specified in this Section, CONTRACTOR'S means and methods shall be implemented such that the existing facility shall remain in continuous satisfactory operation during the entire construction period. Work shall be so scheduled and conducted by CONTRACTOR such that it shall not impede well operations or create potential hazards to operating equipment and Public Works Department operations personnel. In performing the Work shown and specified, CONTRACTOR shall plan and schedule the Work to meet both the constraints outlined in this Section and plant operating requirements.

C. Work not specifically covered in Section 01110 - Summary of Work; and Section 01111 - Schedule of Completion or in the following paragraphs may, in general, be done at anytime during normal work hours during the Contract period, subject to the operating requirements outlined in this Section. All references to days in this Section are consecutive calendar days.

D. CONTRACTOR has the option of providing additional temporary facilities that can eliminate a constraint provided it is done without additional cost to the OWNER, presents no safety hazards, and provided that all requirements of these Specifications are fulfilled.

E. CONTRACTOR shall be responsible for coordinating all shutdowns with the OWNER and ENGINEER. CONTRACTOR shall, whenever possible, combine discrete shutdown procedures identified in this Section or by CONTRACTOR into a single shutdown when the duration of the shutdowns or the Work requirements allow such combining to occur on a work area. The intent of combining procedures is to minimize the impacts upon facility operations by limiting the number of shutdowns required.

F. CONTRACTOR shall not shut-off or disconnect any operating system of the plant, unless approved by the ENGINEER, in writing. All equipment operations and shutdowns shall be executed by the OWNER, unless otherwise noted.

G. This Section of the Specifications contains several references to equipment, piping, material and appurtenances to be removed or reinstalled.

H. CONTRACTOR shall also refer to the Drawings, and other applicable Sections, for definition of the equipment, piping, material and appurtenances to be removed, turned over to the OWNER and stored on site, or to become the property of CONTRACTOR and removed from the site.

1.02 GENERAL CONSTRAINTS

A. Article 1.03, below, and Section 01111 - Schedule of Completion, specify the sequence and shutdown durations, where applicable, for plant units which are to be taken out of service. The operational status of new or existing units other than the designated units shall not be interrupted by CONTRACTOR during the specified time periods. New units may only be used after the specified testing is completed and the units are accepted for use by the ENGINEER, in writing.

B. The following constraints shall be applied to all equipment and appurtenant utility systems on the well sites.

1. Load limits on Access Roads: Existing and new underground facilities, such as electrical duct banks, pipelines, etc., in, under and crossing plant roads, have been designed for a maximum wheel load of HS20. CONTRACTOR shall not exceed this weight limit and shall provide means of protecting the underground facilities.
2. Access to Well and Treatment Plant Sites: An unobstructed traffic route through all gates shall be maintained at all times.
3. Safety Barriers: CONTRACTOR shall place safety barriers around unsafe areas located around operational areas accessible to OWNER Personnel.
4. Personnel Access: OWNER Personnel shall have access to all areas which remain in operation throughout the construction period.
5. Wells: The existing wells shall be kept in operation at all times, unless otherwise specified in Article 1.03, below.
6. Storm drainage: Storm drainage on the sites shall be operational at all times, unless otherwise specified in Article 1.03, below.
7. Power, Light and Communication Systems: Electric power, lighting service and communication systems shall be maintained in uninterrupted operation in all areas, unless otherwise specified in Article 1.03, below.
8. Dead End Valves or Pipe: CONTRACTOR shall provide blind flanges on all valves or pipes which dead-end a line on a temporary or permanent basis. Blind flanges shall be braced and blocked, as required or as directed by the ENGINEER in the field.
9. CONTRACTOR shall schedule all start-ups for Monday through Thursday. No start-ups will be allowed on Friday, Saturday, and Sunday.

1.03 SHUTDOWNS

A. General:

1. Shutdown shall be defined as taking the wells or treatment plant out of service in order to perform the specified Work. For each shutdown (mechanical, hydraulic, or electric), CONTRACTOR shall compile an

inventory of labor and materials required to perform tasks, an estimate of the time required, including time for the OWNER to take down and start-up the facility, and a written description of steps required to complete all tasks. The inventory, the estimate, and written procedures shall be submitted to the ENGINEER for review fourteen calendar days prior to the proposed start date of the shutdown. CONTRACTOR shall also request, in writing from the ENGINEER, approval for each shutdown a minimum of fourteen calendar days prior to the proposed shutdown date. No shutdown shall be initiated until the inventory of materials and labor is verified by the ENGINEER on site at least one week prior to the proposed start date.

2. The Work required herein and any other Work required by the ENGINEER which may interrupt the normal facility operations shall be accomplished at such times that will be convenient to the OWNER.
3. CONTRACTOR shall also have on hand and located in close proximity to the Work area, all tools, equipment, spare parts and materials, both temporary and permanent, necessary to complete each Work category without interruption. Adequate numbers of personnel shall be scheduled for each shutdown, so that the Work shall be accomplished within the specified time frame. Prefabrication of all piping and other assemblies shall be completed, to the greatest degree possible, prior to any shutdowns. The ENGINEER shall be satisfied that CONTRACTOR has complied with these requirements, to the fullest extent possible, before shutdowns will be authorized.
4. If CONTRACTOR'S procedures cause an unscheduled shutdown of the facilities, CONTRACTOR shall perform Work as necessary to immediately re-establish satisfactory operation. CONTRACTOR shall notify the ENGINEER, in writing, immediately of any unscheduled shutdown. CONTRACTOR shall permit OWNER'S personnel to work with CONTRACTOR'S personnel, as required, to maintain the facility in continuous satisfactory operation. Unscheduled shutdowns or interruptions of continued safe and satisfactory operation of the facilities that result in fines levied by the Maricopa County Department of Environmental Management shall be the responsibility of CONTRACTOR if it is demonstrated that CONTRACTOR was negligent in the Work or did not exercise proper precautions in the conduct of the Work.
5. The scheduled shutdowns during the period of CONTRACTOR'S Work shall not exceed seven calendar days at each well site. All Work requiring the wells to be out-of-service shall be performed during the scheduled shutdowns shown. It should be noted that OWNER staff shall continue to perform administrative, operation and maintenance functions during shutdowns.
6. Electrical Ductbank Installation: Shutdown and relocation of conflicting utilities alignments with electrical ductbank will only be allowed for certain types of pipelines. Any shutdown and relocations shall follow a strict time schedule in order to minimize impact to well operations.

B. Shutdowns of Electrical Systems: CONTRACTOR shall lock out and tag circuit breakers and switches operated by the OWNER and shall check cables and wires to be sure that they are de-energized to ground potential before Work begins. Upon completion of the Work, CONTRACTOR shall remove the locks and tags and notify the ENGINEER that the facilities are available for use.

1.04 OVERTIME

A. If overtime Work by CONTRACTOR is necessary to conform to the requirements of this Section shall be performed by CONTRACTOR, at no additional cost to the OWNER and shall be performed in accordance with the General Conditions. CONTRACTOR shall make no claims for extra compensation as a result thereof.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01291

SCHEDULE OF VALUES

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Schedule of Values is a detailed itemized list that establishes the value or cost of each detailed part of the Work. CONTRACTOR shall provide Schedule of Values AIA 701 & 702 or similar format. The Schedule of Values may be used as a basis for negotiations, concerning additional work or credits, which may arise during the construction. Quantities and unit prices shall be included in the schedule, when approved by or required by the ENGINEER.

B. The Schedule of Values itemized list of Work, for each major part of the Work and division of Work shall be grouped under the appropriate Technical Specification Sections.

1.02 PREPARATION

A. The Schedule of Values:
   1. Schedule of Values shall show breakdown of quantities, labor, materials, equipment, and other costs used in preparation of the Bid for each item in the Schedule of Values.
   2. Schedule of Values shall show all Work under the index areas listed.
   3. Costs shall be prepared for each Section of the Specifications. They shall be in sufficient detail to indicate separate amounts for each Section of the Specifications and subsections therein and also separate amounts for each site. Amounts shall be included for each type of Work specified, in a manner approved by the ENGINEER.
   4. CONTRACTOR shall include separate pay items for Mobilization and Demobilization, as specified in the Contract Documents.
   5. Fifteen percent of the total cost of each item is allotted to the cost of Shop Drawing preparation, Operation and Maintenance Manuals, Testing and Training. This amount will be released upon approval, by the ENGINEER, three percent is apportioned to Testing and four percent each to the remaining items.
   6. Use Table of Contents of the Specifications and the form included with Section 01330 - Submittals, as basis for Schedule of Values format and identify each item with number and title in the Table of Contents. Also, use each site as basis for schedule format. List sub-items of major products or systems, as appropriate or when requested by ENGINEER.
   7. When requested by ENGINEER, support values with data that will substantiate their correctness.

8. The sum of the individual values shown on the Schedule of Values shall equal the total Contract Price.
9. The CONTRACTOR'S overhead and profit shall be separate amounts.
10. Schedule of Values shall show the purchase and delivery costs for materials and equipment that CONTRACTOR anticipates he shall request payment for prior to their installation.
11. The Schedule of Values shall be prepared to a level of detail equal to or greater than required by the Supplementary Conditions.

1.03 SUBMITTALS

A. Submit two copies of the Schedule of Values to ENGINEER for review within 14 days after the Notice to Proceed.

B. Contractor shall revise and resubmit the Schedule of Values based on comments received from the OWNER and ENGINEER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01301

PRE-CONSTRUCTION CONFERENCE

PART 1 - GENERAL

1.01 DESCRIPTION

A. Date, Time and Location: Conference will be held after award of the Contract and before construction is started at the site. ENGINEER will fix the date, time and location of the meeting, in accordance with the General Conditions.

B. ENGINEER shall prepare agenda, preside at meeting, and prepare and distribute a transcript of proceedings to all parties.

C. CONTRACTOR shall provide data required, contribute appropriate items for discussion, and be prepared to discuss all items on agenda.

D. Unless previously submitted to ENGINEER, CONTRACTOR shall bring to the conference a preliminary schedule of each of the following:
   1. Progress Schedule.
   2. Shop Drawing and sample submittals log.

1.02 REQUIRED ATTENDANCE

A. Conference shall be attended by CONTRACTOR'S Project Manager, its superintendent and its major subcontractors and major equipment suppliers as CONTRACTOR deems appropriate.

B. OWNER'S representative.

C. ENGINEER.

D. Other utility company and regulatory representatives (if needed).

1.03 PURPOSE

A. The purpose of the Pre-construction conference is to designate responsible personnel and establish working relationships. Matters requiring coordination will be discussed and procedures for handling such matters will be established. A complete agenda will be furnished to CONTRACTOR prior to the Pre-construction conference date. However, CONTRACTOR should be prepared to discuss all of the following; but will not necessarily be limited to the following:
   1. Designation of responsible personnel.
   2. Subcontractors.
   3. Coordination with other contractors and projects.

4. Progress schedule.
5. Processing of Shop Drawing Submittals.
6. Schedule of Shop Drawing submittals.
7. Processing of Field Orders, Requests for Information and Clarification and Change Orders.
8. Requirements for copies of Contract Documents.
9. Insurance in force.
10. Schedule of values.
11. Processing and Schedule of Payments.
12. Use of premises.
13. CONTRACTOR responsibility for safety and first aid procedures.
14. Security.
15. Housekeeping.
16. Field Offices.
17. Maintaining Record Drawings.
18. Letter of Notice to Proceed.
19. Permits.
20. Emergency Telephone Numbers.
21. Operation and Maintenance Manuals.
22. Temporary Utilities.
23. Any other project related items.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01311

PROJECT COORDINATION

PART 1 - GENERAL

1.01 DESCRIPTION

A. As more fully set forth in of the General Conditions, CONTRACTOR shall be solely responsible for coordination of all of the Work. CONTRACTOR shall supervise, direct and cooperate fully with all subcontractors, manufacturers, fabricators, suppliers, distributors, installers, testing agencies and all others whose services, materials or equipment are required to ensure completion of the Work within the Contract Time.

B. As more fully set forth in of the General Conditions, CONTRACTOR shall cooperate with and coordinate the Work with the work of any other contractor, including the following; utility service companies or OWNER'S employees performing work at the site.

C. CONTRACTOR shall also coordinate the Work with the work of others to assure compliance with schedules.

D. CONTRACTOR shall attend and participate in all project coordination or progress meetings and report on the progress of all Work and compliance with schedules.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01312

PROGRESS MEETINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Date and Time:
   1. Regular Meetings: Every two weeks on a day and time agreeable to OWNER, ENGINEER and CONTRACTOR.
   2. Other Meetings, such as field site coordination meetings: As needed.

B. Place: ENGINEER’s premises, or other mutually agreed upon location.

C. ENGINEER will work with CONTRACTOR to prepare agenda with input from OWNER, and preside at meetings.

D. ENGINEER shall prepare draft transcripts for distribution to all parties.

E. CONTRACTOR shall provide data required and be prepared to discuss all items on agenda.

1.02 MINIMUM ATTENDANCE

A. CONTRACTOR:
   1. When needed for the discussion of a particular agenda item, CONTRACTOR shall require representatives of subcontractors or suppliers to attend a meeting.

B. ENGINEER.

C. OWNER'S representative, if required.

D. Others, as appropriate.

E. Representatives present for each party shall be authorized to act on their behalf.

1.03 AGENDA

A. Agenda will include, but will not necessarily be limited to, the following:
   1. Minutes of previous meeting.
   2. Progress since last meeting.
      a. CONTRACTOR’S work.
      b. Subcontractors’ work.
   3. Completion status.

4. Planned progress for next period.
5. Problems, conflicts and observations.
6. Status of Shop Drawings and RFIs.
7. Change Orders.
8. Pay Requests.
9. Quality Standards and Control.
10. Schedules, updated Project Schedules, including off-site fabrication and delivery schedules; corrective measures, if required.
11. Coordination between parties.
12. Permits.
13. Safety concerns.
14. Construction Photographs.
15. Record Drawings.
16. Warranty Requests.
17. Punch List Status.
18. Other business.
19. Next meeting date.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01323

CONSTRUCTION PHOTOGRAPHS

PART 1 - GENERAL

1.01 DESCRIPTION

A. CONTRACTOR shall retain a professional photographer or an acceptable person, as determined by the ENGINEER, to perform the services specified below.

B. Obtain ENGINEER'S approval of the photographer selected prior to taking first photographs. Submit qualifications and experience record of photographer to ENGINEER.

1.02 DIGITAL PHOTOGRAPHS

A. Photographs shall be taken as needed, with a minimum of five photographs per site per week (during periods of activity). After construction is completed, provide a minimum of 10 photos per site.

B. Provide high quality digital photographs on CDs. The file format shall be .jpg, .gif, or tiff.

C. Provide interior and exterior photographs of each buried structure prior to burial. Provide a minimum of four internal views and four external views of each structure. One view shall be provided of each wall, detail, floor and top of structure.

D. Place the following information on the front of each print:
   1. Date photograph was taken.
   2. Description of view shown in photograph.

1.03 PRE-CONSTRUCTION PHOTOGRAPHS

A. General
   1. It is CONTRACTOR'S responsibility to take a sufficient number of Pre-construction photographs, so as to resolve any disputes which may arise regarding the considerations prior to and subsequent to construction.
   2. If a dispute arises where no Pre-construction photographs were taken, the disputed area shall be restored to the extent directed by the ENGINEER and to the complete satisfaction of the ENGINEER.
   3. CONTRACTOR must furnish one set of the Pre-construction photographs on CD to the ENGINEER, and must make others available for review in settling any disputes.

4. Pre-construction photographs taken by CONTRACTOR will not be considered as part of the required number of construction photographs required in Paragraph 1.02, above.
5. A high quality video of the sites in DVD format shall be made and submitted by the CONTRACTOR, to be coordinated and witnessed by the ENGINEER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01330

SUBMITTALS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Submittal of documents described in the General Conditions, Supplementary Conditions and hereinafter are required prior to, during and at the end of the construction period. The submittals shall conform to the requirements described in this Section and all referenced Sections or Articles.

1.02 PROCEDURE

A. Submittal within 14 days after the Notice to Proceed: Location of information concerning each submittal is referenced and a copy of each required form is included in Section 01331 - Reference Forms.
   1. Schedule of Values: Prepare and submit in accordance with Section 01291 - Schedule of Values.
   2. Submittal Schedule: Prepare and submit schedule of all Shop Drawings in accordance with Section 01332 - Shop Drawing Procedures.

B. Submit the following items within ten days after the Notice to Proceed. Location of information concerning each submittal is referenced and a copy of each required form is included in Section 01331 - Reference Forms.

C. Submit the following items at the Pre-construction Conference: Refer to Sections 01332 - Shop Drawing Procedures.

D. Submittals Prior to Beginning the Work: Refer to the General Conditions and Supplementary Conditions of the Contract Documents.

E. Submittals During Construction: During progress of the construction, provide the following submittals in a timely manner to prevent any delay in the Work schedule:
   1. Shop Drawings, Product Data and Samples: Submit Shop Drawings, product data and samples in accordance with Section 01332 - Shop Drawing Procedures, and as required in various Sections of the Contract Documents.
   2. Progress Payments: Submit applications for partial payments as specified in the General Conditions.
   3. Request for Information: Submit a Request for Information, included in Section 01331 - Reference Forms, when any of the following are required: an interpretation of the Specifications; additional details; information not shown on the Drawings or in the Specifications; or clarification of

discrepancies is needed. CONTRACTOR shall retain one copy and submit three copies to the ENGINEER for response.

4. Change Orders: Forms shown in Section 01331 - Reference Forms. A proposal for a Change Order may be submitted by CONTRACTOR in accordance with the General Conditions. The Change Order Proposal included in Section 01331 - Reference Forms, must be in writing and must include sufficient information to assess the need for a change in the Work, the Contract time or the Contract amount. Whenever the ENGINEER determines the need for a Change Order, CONTRACTOR will receive a Request for Change Order Proposal Form included in Section 01331 - Reference Forms. Upon receipt of a Request for Change Order Proposal Form or when CONTRACTOR determines the need for a Change Order, CONTRACTOR shall prepare and submit three copies of a Change Order Proposal. The Change Order Proposal must be approved by CONTRACTOR, ENGINEER, and OWNER. When a Change Order Proposal has been accepted, a Work Change Directive shall be submitted. Each Work Change Directive shall include a Change Order Pricing Sheet, included in Section 01331 - Reference Forms. After the Work Change Directive has been accepted by the OWNER, a Change Order included in Section 01331 - Reference Forms, will be prepared and executed. CONTRACTOR is not authorized to begin work on a Change Order until it is fully executed. Any Work done by CONTRACTOR prior to execution of a Change Order is entirely at his own risk.
5. CONTRACTOR'S Daily Report: Shown in Section 01331 - Reference Forms: Submit four copies of CONTRACTOR'S Daily Report. CONTRACTOR and each subcontractor shall prepare and submit a daily report on forms shown in Section 01331 - Reference Forms. The report shall contain, as a minimum, information on the location and description of the Work being performed, size, quantity and description of materials and equipment installed or delivered, coordination or scheduling concerns, requests for clarifications, and any discrepancies noted in the Contract Documents or on the as-built conditions. The report shall also contain CONTRACTOR'S daily workforce count by craft, general weather conditions, any Work performed other than during established working hours, and any other pertinent items relative to the Work, and as required by ENGINEER. The report is due to the ENGINEER by 9:00 a.m. on the following Work day and shall be signed by a responsible member of CONTRACTOR'S staff.
6. Submittal Schedule: Shown in Section 01331 - Reference Forms. Submit an updated Shop Drawing, Product Data and Sample Submittal Schedule with each Progress Payment Request. Three updated Submittal Schedules shall be submitted with each month's Progress Payment Request.
7. Construction Photographs: Submit Construction Photographs with each month's Progress Payment Request as specified in Section 01323 - Construction Photographs.

8. Operation and Maintenance Manuals and Lesson Plans: Submit Equipment Operation and Maintenance Manuals for approval, by the ENGINEER, within 30 days after approval of Equipment Shop Drawing.

F. Submittal at Substantial Completion: Submit all Operations and Maintenance Data for each item of Work commissioned into operation.

G. Submittal At Project Closeout: With a written Notice of Completion, submit the following items in the proper form as a condition of Final Acceptance of the Work:
   1. Project Record Documents: Submit in accordance with Section 01782 - Record Documents.
   2. Guarantees, Warranties and Bonds: Submit as required in the General Conditions and listed in various Sections of the Specifications.
   3. Operations and Maintenance Data: Submit all remaining product data and manuals as specified in various Sections of the Specifications.
   4. Survey notes.
   5. Construction photographs of all completed Work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED

END OF SECTION

SECTION 01331

REFERENCE FORMS

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section contains the required forms for CONTRACTOR's use in documenting testing Work and other Work required under this Contract. This Section supplements but does not supercede specific testing requirements found elsewhere in the Contract Documents.

B. The forms listed below are included in this Section are referenced from other Sections in the Contract Documents. Forms will include, but will not necessarily be limited to the following:

	Form No.	Title
1.	01330-B	Shop Drawings, Product Data, and Sample Transmittal Schedule.
2.	01330-D	Application for Payment.
3.	01330-E	MBE/WBE Utilization Form.
4.	01330-H	Work Change Directive.
5.	01330-M	Contractor's Daily Construction Report.
6.	01332-A	Submittal Transmittal Form.
7.	01752-A	Equipment Test Report Form.
8.	01781-A	Operations and Maintenance Transmittal Form.
9.	01781-B	Equipment Information Form.
10.	01781-C	Manufacturer's Installation Certificate Form.
11.	11000-A	Motor Data Form.
12.	11005-A	Unit Responsibility Certification Form
13.	15142-A	Request for Bacteriological Samples.
14.	16000-A	Wire and Cable Resistance Test Data Form.
15.	16000-B	Installed Motor Test Data Form.
16.	16000-C	Dry Transformer Test Data Form.
17.	16000-D	Motor Control Center Test Form.
18.	16000-H	Low Voltage Switchgear Test Form.
19.	16000-M	Conduit and Wire Termination Sheet.
20.	17007-G	Field Switch Calibration Test Data Form.
21.	17007-H	Transmitter Calibration Test Data Form.
22.	17007-I	Miscellaneous Instrument Calibration Test Data Form.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

REQUEST FOR INFORMATION

Project Name:

Contractor _____	RFI#_____
Requested By _____	Directed to _____
Subject _____	Date Received _____
Spec. Section _____	Date Transmitted _____
Drawing References _____	Date Reply Received _____
Date Reply Needed _____	Date Reply Transmitted _____

INFORMATION NEEDED:

Date:_____ Signature: _____

REPLY:

Date:_____ Signature:_____

CONTRACTOR'S DAILY CONSTRUCTION REPORT

Project Name:

Contractor's Name _____ Report No. _____ Date: _____

CONTRACTORS WORK FORCE:	SUBCONTRACTORS WORK FORCE:	EQUIPMENT ON SITE:
Administrative		In Use / Not in Use
Supervisors	Mechanical	Cranes
Carpenters	Electrical	Loaders
Iron Workers	Instrumentation	Dozers
Operators	Sitework	Scrapers
Finishers	Masonry	Compactors
Welders	Roofing	Compressors
Electricians	Rebar	Welders
Laborers	Foundation	Graders
_____	Painting	Trucks
_____	_____	Backhoe
_____	_____	___
	_____	

Work Performed:

Material and Equipment Delivered:

Remarks:

_____
(Authorized Signature)

FIELD ORDER

Date: _____

Contractor:_____

Project Name:

Field Order No.: _____

By:_____ By_____
Owner's Authorized Signature Contractor's Receipt Acknowledged

Date:_____ Date:_____

AIA® Document G701™ – 2001

Change Order

PROJECT: *(Name and address)*

CHANGE ORDER NUMBER:

DATE:

OWNER ☐
ARCHITECT ☐
CONTRACTOR ☐
FIELD ☐
OTHER ☐

TO CONTRACTOR: *(Name and address)*

ARCHITECT'S PROJECT NUMBER:

CONTRACT DATE:

CONTRACT FOR:

The Contract is changed as follows:
(Include, where applicable, any undisputed amount attributable to previously executed Construction Change Directives.)

The original (Contract Sum) (Guaranteed Maximum Price) was	$
The net change by previously authorized Change Orders	$
The (Contract Sum) (Guaranteed Maximum Price) prior to this Change Order was	$
The (Contract Sum) (Guaranteed Maximum Price) will be (increased) (decreased) (unchanged) by this Change Order in the amount of	$
The new (Contract Sum) (Guaranteed Maximum Price), including this Change Order, will be	$
The Contract Time will be (increased) (decreased) (unchanged) by	( ) days.
The date of Substantial Completion as of the date of this Change Order, therefore, is	

NOTE: This Change Order does not include changes in the Contract Sum, Contract Time or Guaranteed Maximum Price that have been authorized by Construction Change Directive until the cost and time have been agreed upon by both the Owner and Contractor, in which case a Change Order is executed to supersede the Construction Change Directive.

NOT VALID UNTIL SIGNED BY THE ARCHITECT, CONTRACTOR AND OWNER.

ARCHITECT *(Firm name)*	CONTRACTOR *(Firm name)*	OWNER *(Firm name)*
ADDRESS	ADDRESS	ADDRESS
BY *(Signature)*	BY *(Signature)*	BY *(Signature)*
(Typed name)	*(Typed name)*	*(Typed name)*
DATE	DATE	DATE

CAUTION: You should sign an original AIA Contract Document, on which this text appears in RED. An original assures that changes will not be obscured.

AIA® Document G714™ – 2007

Construction Change Directive

PROJECT: *(Name and address)*

DIRECTIVE NUMBER:

DATE:

CONTRACT FOR:

TO CONTRACTOR: *(Name and address)*

CONTRACT DATED:

ARCHITECT'S PROJECT NUMBER:

OWNER ☐
ARCHITECT ☐
CONSULTANT ☐
CONTRACTOR ☐
FIELD ☐
OTHER ☐

You are hereby directed to make the following change(s) in this Contract:
(Describe briefly any proposed changes or list any attached information in the alternative.)

PROPOSED ADJUSTMENTS

1. The proposed basis of adjustment to the Contract Sum or Guaranteed Maximum Price:

   ☐ Lump Sum (increase) (decrease) of $

   ☐ Unit Price of $ per

   ☐ As provided in Section 7.3.3 of AIA Document A201™–2007

   ☐ As follows:

2. The Contract Time is proposed to (be adjusted) (remain unchanged). The proposed adjustment, if any, is (an increase of days) (a decrease of days).

When signed by the Owner and Architect and received by the Contractor, this document becomes effective IMMEDIATELY as a Construction Change Directive (CCD), and the Contractor shall proceed with the change(s) described above.

Contractor signature indicates agreement with the proposed adjustments in Contract Sum and Contract Time set forth in this CCD.

ARCHITECT *(Firm name)*	OWNER *(Firm name)*	CONTRACTOR *(Firm name)*
ADDRESS	ADDRESS	ADDRESS
BY *(Signature)*	BY *(Signature)*	BY *(Signature)*
(Typed name)	*(Typed name)*	*(Typed name)*
DATE	DATE	DATE

CAUTION: You should sign an original AIA Contract Document, on which this text appears in RED. An original assures that changes will not be obscured.

SECTION 01340

TECHNICAL SUBMITTALS
SHOP DRAWINGS, PROJECT DATA & SAMPLES, OPERATION AND MAINTENANCE MANUALS, EQUIPMENT RECORD SHEETS

PART 1 GENERAL

1.01 SUMMARY

A. General:
   1. Section Addresses:
      a. Mechanics of shop drawing and operation and maintenance manual submittal and review process.

B. Related Sections include but are not necessarily limited to:
   1. Division 1 - General Requirements.
   2. Sections in Divisions 2 through 17 identifying submittal requirements.

1.02 SUBMITTALS: GENERAL

A. Transmit all technical submittals electronically to:

Sriram Barigeda (or other designated representative)
Sriram@ncseng.com

For those items that require hard copies, send to following address:
NCS Engineers
202 E. Earll Drive, Suite 110
Phoenix, AZ 85012

B. Utilize one copy of "Contractor's Shop Drawing Transmittal" (Exhibit A-01340) Form to transmit all shop drawings, Operation and Maintenance Manuals, and samples. Transmittals will not be received from or returned to subcontractors.

C. Provide submittal information defining specific equipment or materials utilized on the project. Generalized product information not clearly defining specific equipment or materials to be provided will be rejected.

D. Calculations required in individual specification sections will be received for information purposes only and will be returned stamped "E". Engineer's Review Not Required" to acknowledge receipt.

E. Assure submittals meet the following schedule:
   1. Shop drawings:
      a. Submittal and approval prior to that portion of work being installed and prior to 50 overall percent completion.
      b. ENGINEER will attempt to return all submittals to CONTRACTOR within 10 days of receipt.
   1. Operation and Maintenance Manuals and Data Record Sheets:
      a. Initial submittal within 45 days after date shop drawings are approved.

F. Final payment on the project shall not be made until final approved copies of all Operation and Maintenance Manuals have been received.

G. Provide CONTRACTOR's stamp of approval as indication of his checking and verification of dimensions and coordination with interrelated work.

H. Provide FINALS in one binder and three electronic copies. Including, warranty and last pay application.

1.03 SUBMITTALS: SHOP DRAWINGS

A. Transmittal Mechanics:
   1. Utilize one copy of "Contractor's Transmittal" Form.
   2. Number transmittals consecutively beginning with 1.
   3. Assure resubmitted items retain the original number but with an added suffix letter starting with "A".
   4. Assure only one specification section is covered by one letter of transmittal.
   5. Provide breakout of each transmittal component on the "Contractor's Transmittal" Form. Each component thus defined shall receive specific action by the ENGINEER. Define manufacturer, item, tag number, and Drawing/Specification reference, as applicable.
   6. Do not change the scope of any re-submittal from the original transmittals' scope. If some components of the original transmittals are approved and others are not, the CONTRACTOR shall not resubmit the approved components in subsequent re-submittal packages, unless requested to do so by ENGINEER. Provide a summary sheet containing all components of the original transmittal at the front of each re-submittal. Indicate each component as either "approved", outstanding", or "submitted for action". Items previously approved shall be referenced to the transmittal in which approval was received. "Outstanding" items are defined as items unapproved and not yet resubmitted for action. "Submitted for action" shall indicate items which are included for review in the transmittal.
   7. Provide submittal in pdf format and transmit to ENGINEER via email for review.
   8. Provide clear space (3 inch square) for ENGINEER stamping of each component.

9. ENGINEER will return reviewed submittal in pdf format via email.

B. Transmittal Contents:

1. Coordinate and identify shop drawing contents so that all items can be easily verified by the ENGINEER.
2. Identify equipment or material use, tag number, drawing detail reference, weight, and other project specific information.
3. Provide sufficient information together with technical cuts and technical data to allow an evaluation to be made to determine that the item submitted is in compliance with the Contract Documents.
4. Submit items like equipment brochures, cuts of fixtures, product data sheets or catalog sheets on 8½ x 11 inch pages. Indicate exact item or model and all proposed options.
5. Larger sheets (11"x17" or 24"x36") should be folded into smaller sections to and sent by hard copy, if needed.
6. Include legible scale details, sizes, dimensions, performance characteristics, capacities, test data, anchoring details, installation instructions, storage and handling instructions, color charts, layout drawings, parts catalogs, rough-in diagrams, wiring diagrams, controls weights and other pertinent data. Arrange data and performance information in format similar to that provided in Contract Documents. Provide, at minimum, the detail provided in the Contract Documents.
7. If proposed equipment or materials deviate from the Specifications or Drawings in any way, clearly note the deviation and justify the said deviation in detail in a separate letter immediately following transmittal sheet. If explanation is not given, shop drawings will be returned without action.
8. Provide copy of applicable specification section annotated in red to indicate that all requirements have been met with the shop drawing.

1.04 SUBMITTALS: SAMPLES

A. Identify sample as to: manufacturer, item, use, type, project designation, tag number, specification section or drawing detail reference, color, range, texture, finish and other pertinent data.

B. Include application specific brochures, and installation instructions.

C. Provide CONTRACTOR's stamp of approval on samples as indication of his checking and verification of dimensions and coordination with interrelated work.

D. Resubmit samples of rejected items.

E. Approved samples submitted or constructed, constitute criteria for judging completed work. Finished work or items not equal to samples will be rejected.

F. Samples may be retained for comparison purposes and the CONTRACTOR shall remove samples when directed. CONTRACTOR shall include in bid all costs of furnishing and removing samples.

1.05 SUBMITTALS: OPERATION AND MAINTENANCE MANUALS

A. Transmittal Mechanics:
   1. See Paragraph 1.02 and 1.03.
   2. Provide transmittal form for Operation and Maintenance Manual with original number of the shop drawing approved item plus a suffix "O-M".
   3. Submit one copy until approval is received.
   4. Provide complete electronic copies of the entire O&M manual in PDF format. The entire O&M manual information for each specification section shall be included in a single PDF. Each PDF shall be appropriately labeled. This is required for all O&M manuals associated with this Project.
   5. Deficient submittals will be returned along with transmittal form which will be marked to indicate deficient areas.
   6. Identify resubmittals with the original number plus a suffix letter starting with "A."
   7. Submit Final Operation and Maintenance Manuals (4 copies) printed on 8-½" x 11" inch size high quality paper with standard three-hole punching and bound in stiff metal hinged binder constructed as a three-post style. Provide binders with titles. Tab each section of manuals for easy reference with plastic-coated dividers. Provide index for each manual.
   8. Reduce drawings or diagrams bound in manuals to an 8½" x 11" inch or 11" x 17" inch size. However, where reduction is not practical to ensure readability, fold large drawings separately and place in vinyl envelopes which are bound into the binder. Identify vinyl envelopes with drawing numbers.

B. Transmittal Content:
   1. Submission of Operation and Maintenance Manuals is applicable to but not necessarily limited to:
      a. Equipment such as meters, valves, pumps and feed system controls, electrical panels, and instrumentation.
      b. Equipment used with electrical motor loads (pumps).
      c. Specialized equipment including valves and instrumentation and control system components for process systems such as meters, recorders, and transmitters.
      d. Valves and actuators.
   2. Prepare operation and maintenance manuals which include, but are not necessarily limited to the following detailed information, as applicable:
      a. Equipment function, normal operating characteristics, limited operations.
      b. Assembly, disassembly, installation, alignment, tolerances, adjustment, and checking instructions.
      c. Operating instructions for start-up, routine and normal operation, regulation and control, shutdown, and emergency conditions.
      d. Lubrication and maintenance instructions (including schedules).

e. Guide to “troubleshooting”.
f. Parts list (including material of construction) and predicted life of parts subject to wear.
g. Outline, cross-section, and assembly (exploded view) drawings; engineering data; and electrical diagrams, including elementary diagrams, wiring diagrams, connection diagrams, word description of wiring diagrams and interconnection diagrams.
h. Test data and performance curves.
i. A list of recommended spare parts with a price list.
j. Copies of installation instructions, parts lists or other documents packed with equipment when delivered.
k. Tag numbers relating the equipment back to the Contract Documents.
l. Safety instructions.
m. ISO identification numbers for bearings.
n. List of specialty tools required and availability.
o. List weight of overall assemblies and individual weights of major individual components.
p. List of vendors and who to contact for warranty work.
q. List of fastener grades.
r. Copy of warranty, if applicable.
s. For all training sessions, provide training agenda and sign in sheet with final O&M manuals.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 SUBMITTALS: APPROVAL OR REJECTION

A. Items within Transmittals will be reviewed for overall design intent and will receive one of the following Actions:

A - NO EXCEPTIONS TAKEN
B - FURNISH AS NOTED
C - REVISE AND RESUBMIT
D - REJECTED
E - ENGINEER’S REVIEW NOT REQUIRED

B. Transmittals received will be initially reviewed to ascertain inclusion of CONTRACTOR’s approval stamp. Drawings not stamped by the CONTRACTOR or stamped with a stamp containing language other than that specified in Paragraph 1.02 G will not be reviewed for technical content and will be returned without any action.

C. Transmittals returned with disposition "A" or "B" are considered ready for fabrication and installation. If for any reason a transmittal that has an "A" or "B" disposition is resubmitted, it must be accompanied by a letter defining the changes that have been made and the reason for the resubmittal. The CONTRACTOR shall assure that previously approved documents are destroyed when they are superseded by a resubmittal as such.

D. Transmittals with disposition "A" or "B" combined with Action "C" (Revise and Resubmit) or "D" (Rejected), will be individually analyzed giving consideration as follows:

1. The portion of the transmittal given "C" or "D" will not be distributed (unless previously agreed to otherwise at the Preconstruction Conference). One copy or the one transparency of the "C" or "D" drawings will be marked up and returned to the CONTRACTOR. It shall be the CONTRACTOR's responsibility to ensure that these items are corrected and resubmitted.
2. Items marked "A" or "B" will be fully distributed.
3. If a portion of the items or system proposed are acceptable, however, the major part of the individual drawings or documents are incomplete or require revision, the entire submittal may be given "C" or "D" action. This is at the sole discretion of the ENGINEER. In this case, some drawings may contain relatively few or no comments or the statement, "Resubmit to maintain a complete package." Distribution to the OWNER, CONTRACTOR, and ENGINEER will not be made (unless previously agreed to otherwise).

E. Failure to include any specific information specified under the submittal paragraphs of the specifications shall result in the transmittal being returned to the CONTRACTOR unapproved.

F. In addition to calculations stamped and returned "E. Engineer's Review Not Required", other transmittals such as submittals which the Engineer considers as "Not Required" and submittal information in a transmittal which have been reviewed and approved in a prior transmittal, will be returned with action "E. Engineer's Review Not Required."

END OF SECTION

SECTION 01416

SPECIAL INSPECTIONS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The following types of Work will be subject to Special Inspections and will be performed by the ENGINEER or the Resident Project Representative as a third party, or by such other special inspector as the OWNER may employ:
   1. High-Strength Bolting: During all bolt installations and tightening operations.
      a. Exceptions:
         1) The special inspector need not be present during the entire installation and tightening operation, provided he has:
            a) Inspected the surfaces and bolt type for conformance to plans and specifications prior to start of bolting, and "will, upon completion of all bolting, verify the minimum specified bolt tension for ten percent of the bolts for each connection, with a minimum of two bolts per connection".
         2) In bearing-type connections when threads are not required by design to be excluded from the shear plane, inspection prior to or during installation will not be required.
   2. Concrete foundations and slabs.
   3. Reinforcing Steel.
   4. Structural Welding.
   5. Epoxy Anchors.
   6. Electrical Inspections.

B. CONTRACTOR shall coordinate with OWNER and ENGINEER to determine special inspection items and schedule special inspections.

1.02 SPECIAL INSPECTOR

A. The special inspector shall be a qualified person who shall demonstrate his competence to the satisfaction of the regulatory authorities for inspection of the particular type of construction or operation requiring special inspection.

1.03 DUTIES AND RESPONSIBILITIES OF SPECIAL INSPECTOR

A. The special inspector shall observe the Work assigned to be certain it conforms to the Contract Documents.

B. The special inspector shall furnish inspection reports to the regulatory authorities, the ENGINEER and other designated persons. All discrepancies shall be brought to the immediate attention of CONTRACTOR for correction, then, if uncorrected, to the ENGINEER and regulatory authorities.

C. The special inspector shall submit a final signed report stating whether the Work requiring special inspection was, to the best of his knowledge, in conformance with the Contract Documents and the applicable workmanship provision of these codes.

1.04 PERIODIC SPECIAL INSPECTIONS

A. Some inspections may be made on a periodic basis and satisfy the requirements of continuous inspection, provided this periodic scheduled inspection is performed as outlined in the Contract Documents and approved by the regulatory authorities.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01452

TESTING LABORATORY SERVICES FURNISHED BY CONTRACTOR

PART 1 - GENERAL

1.01 DESCRIPTION

A. OWNER shall employ and pay for an independent third party testing laboratory to perform the specified services. Laboratory selected shall be subject to approval by the ENGINEER.

B. ENGINEER or their agent shall perform sampling for the third party tester lab.

C. Inspection, sampling and testing shall be as specified in the individual Sections. These include but are not limited to:
   1. Section 02315 - Structural Excavation and Backfill
   2. Section 03300 - Grout.

1.02 QUALIFICATIONS OF LABORATORY

A. Where applicable, meet "Recommended Requirements for Independent Laboratory Qualification," latest edition, published by American Council of Independent Laboratories and the basic requirements of ASTM E 329, "Standards of Recommended Practice for Inspection and Testing Agencies for Concrete and Steel as Used in Construction." Laboratory shall be authorized to operate in the State of Arizona.

B. Submit five copies of report of inspection of facilities made by Materials Reference Laboratory of National Bureau of Standards, for the most recent tour of inspection, with memorandum of remedies of any deficiencies reported by inspection.

C. Testing Equipment:
   1. Calibrated, at maximum 12-month intervals by devices of accuracy traceable to either National Bureau of Standards or accepted values of natural physical constants.
   2. Submit copy of certificate of calibration made by an accredited calibration agency.

1.03 THIRD PARTY LABORATORY DUTIES

A. Cooperate with ENGINEER and provide qualified personnel promptly on notice.

B. Perform specified inspections, sampling and testing of materials and methods of construction; comply with applicable standards; and ascertain compliance with requirements of Contract Documents.

C. Promptly notify ENGINEER and CONTRACTOR of any irregularities or deficiencies of Work that are observed during performance of services.

D. Promptly submit electronic reports of inspections and tests to ENGINEER, including:
   1. Date issued.
   2. Project title and number.
   3. Testing laboratory name and address.
   4. Name and signature of inspector.
   5. Date of inspection or sampling.
   6. Record of temperature and weather.
   7. Date of test.
   8. Identification of product and Specification Section.
   9. Location in Work.
   10. Type of inspection or test.
   11. Results of tests and observations regarding compliance with Contract Documents.

E. Perform additional tests and services as required to ensure compliance with the Contract Documents.

1.04 CONTRACTOR'S COORDINATION WITH LABORATORY

A. Cooperate with laboratory personnel, and provide access to Work and to manufacturer's operations.

B. Provide to laboratory representative samples of materials to be tested, in quantities required by the laboratory for testing.

C. Furnish labor and facilities:
   1. To provide access to Work to be tested.
   2. To obtain and handle samples at the site.
   3. To facilitate inspections and tests.
   4. For laboratory's exclusive use for storage and curing of test samples.
   5. Forms for preparing concrete test beams and cylinders.

D. Notify laboratory and ENGINEER sufficiently in advance of operations to allow for assignment of personnel and scheduling of tests.

E. Arrange with laboratory and pay for, additional samples and tests required for CONTRACTOR'S convenience.

1.05 PRODUCT TEST REPORTS

A. Furnish copies of product test reports where required by the Specifications or requested by ENGINEER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01561

SECURITY

PART 1 - GENERAL

1.01 DESCRIPTION

A. CONTRACTOR shall safely guard all Work, materials, equipment and property from loss, theft, damage and vandalism. CONTRACTOR'S duty to safely guard property shall include the OWNER'S property and other private property from injury or loss in connection with the performance of the Work.

B. CONTRACTOR shall employ watchmen as required to provide the required security and prevent unauthorized entry.

C. CONTRACTOR shall make no claim against the OWNER for damage resulting from trespass.

D. CONTRACTOR shall be responsible for security and shall make good all damage to property of OWNER and others arising from failure to provide adequate security.

E. If existing fencing or barriers are breached or removed for purposes of construction, CONTRACTOR shall provide and maintain temporary security fencing equal to the existing in a manner satisfactory to the ENGINEER and OWNER.

F. Security measures taken by CONTRACTOR shall be at least equal to those usually provided by OWNER to protect his existing facilities during normal operation.

G. Maintain security program throughout the Work until OWNER'S acceptance and occupancy precludes need for CONTRACTOR'S security program.

H. CONTRACTOR shall comply with all aspects of OWNER's site specific Security Guard Protocol.

I. All costs for security as specified in this Section shall be borne by CONTRACTOR.

1.02 CONTRACTOR'S ACCESS TO THE SITE

A. Access to the well sites for CONTRACTOR'S employees, material, tools and equipment shall be from the existing well site entrances only.

B. CONTRACTOR shall ensure that each of his employees, representatives, material men, suppliers and other acting for CONTRACTOR, shall be subject to the following regulations:

1. CONTRACTOR'S subcontractor's, suppliers and manufacturer's employee's shall not park anywhere other than CONTRACTOR Employee's Parking Area. The Area shall be designated by the ENGINEER. CONTRACTOR shall prepare and maintain this area, as required.
2. All CONTRACTOR employees shall wear a laminated photograph identification and badge bearing CONTRACTOR'S name, employee's name, employee's signature and employee number at all times when the employee is on the site. Badge and Background Check Data form shall be completed by CONTRACTOR and approved by OWNER prior to CONTRACTOR personnel entering the site.
3. CONTRACTOR shall turn over the identification badge to the OWNER upon the individual's completion of the participation on the project or project completion.
4. OWNER reserves all rights to the approval of all CONTRACTOR, subcontractor, suppliers and manufacturers employees receiving an identification badge.
5. All work vehicles, including those belonging to CONTRACTOR, his employees and subcontractors, material men and suppliers entering the plant site shall conform to all security and safety regulations in force at the site, and in addition, must display a vehicle tag in the windshield while on the plant site. The vehicle tag shall be 3-inches by 5-inches permanently mounted to the windshield (lower left hand corner). The vehicle tag shall be green and identify CONTRACTOR, subcontractor, etc.
6. Personal vehicles shall not be allowed outside CONTRACTOR'S Employee Parking Area.
7. Delivery vehicles shall access the site from the entrance road stated in Paragraph 1.02 A. above.
8. Access to the well sites from any other entrance is strictly prohibited. Violators shall be banned from the site.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01770

CLOSEOUT PROCEDURES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Contract closeout requirements including:
   1. Final cleaning.
   2. Disinfection of systems.
   3. Preparation and submittal of closeout documents.
   4. Final completion certification.

1.02 FINAL CLEANING

A. Perform final cleaning prior to inspections for acceptance of the Work:
   1. Clean grease, mastic, adhesives, dust, dirt, stains, fingerprints, paint, blemishes, sealants, plaster, concrete, and other foreign materials from sight-exposed surfaces, and fixtures and equipment.
   2. Remove non-permanent protection and labels.
   3. Clean light fixtures and replace burned-out or dim lamps.

1.03 WASTE DISPOSAL

A. Arrange for and dispose of surplus materials, waste products, and debris off-site.

B. Do not create unsightly or unsanitary nuisances during disposal operations.

1.04 TOUCH-UP AND REPAIR

A. Touch-up or repair finished surfaces on structures, equipment, fixtures, and installations that have been damaged prior to inspection for acceptance of the Work.

B. Refinish or replace entire surfaces which cannot be touched-up or repaired satisfactorily.

1.05 CLOSEOUT DOCUMENTS

A. Submit following Closeout Submittals upon completion of the Work and at least 7 days prior to submitting Application for Final Payment:
   1. Evidence of compliance with requirements of governing authorities.
   2. Project Record Documents - Record Drawings shall be prepared for all the Work included in the Contract. On a weekly basis, CONTRACTOR shall review with the ENGINEER a full size annotated copy of the Record

Drawings that include changes from the previous week's Record Drawing submittal. Annotations shall include redlined "clouds" of only those changes from the previous week's submittal. The redlined Drawings shall show the actual in-place installation of the items installed under this Contract. The redlined Drawings shall show the Work in plan and sections as required for clarity with reference dimensions and elevations for complete Record Drawings.

3. Operation and Maintenance Manuals.
4. Warranties and Bonds.
5. Evidence of Payment and Release of Liens as outlined in Conditions of the Contract.
6. Release of claims as outlined in Conditions of the Contract.
7. Red-Line as-builts.
8. Dimensions on as-builts shall be shown from permanent location, concrete pads, structural monuments, or fixed monuments.

1.06 EVIDENCE OF COMPLIANCE WITH REQUIREMENTS OF GOVERNING AUTHORITIES

A. Submit the following:
   1. Certificate of Inspection as required.
   2. Certificate of Occupancy.

1.07 WARRANTIES AND BONDS

A. Provide executed Warranty, CONTRACTOR shall provide a two-year Warranty on all labor equipment and materials on this Contract or Guaranty Form if required by Contract Documents.

B. Provide specified additional warranties, guarantees, and bonds from manufacturers and suppliers on everything.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01783

SPARE PARTS AND MAINTENANCE MATERIALS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Spare parts and materials required to be supplied (as listed in the individual equipment specification sections in these Contract Documents) shall be furnished in manufacturer's unopened cartons, boxes, crates or other protective covering suitable for preventing corrosion or deterioration for the maximum length of storage which may be normally anticipated. They shall be clearly marked and identified as to the name of manufacturer or supplier, applicable equipment, part number, description and location in the equipment. All parts shall be protected and packaged for a shelf life of at least ten years.

B. During construction, store parts in buildings or trailers with floor, roof and closed sides and in accordance with manufacturers' recommendations. Protect from weather, condensation and humidity.

C. Parts and materials shall be delivered to the OWNER upon Substantial Completion of the Work or start-up. CONTRACTOR shall then place them in permanent storage rooms or areas approved by the OWNER. The turnover procedures shall be developed by the ENGINEER.

D. Provide a letter of transmittal and spare parts receiver form including the following:
   1. Date of letter and transfer of parts and material.
   2. Contract title and number.
   3. CONTRACTOR'S name and address.
   4. Transmittal should list applicable specification sections for each set of spare parts supplied.
   5. Spare Parts Receiver Form.

E. CONTRACTOR shall be fully responsible for loss or damage to parts and materials until they are transmitted to the OWNER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

SPARE PARTS RECEIVER

SPECIFICATION SECTION 01783

CONTRACTOR PLEASE FILL OUT:

MANUFACTURER:_____

ITEM DESCRIPTION:_____

COST:_____

MANUFACTURER PART NUMBER:_____

SUPPLIER:_____

CROSS REFERENCE NUMBER:_____

VENDOR INFORMATION:_____

VENDOR ORDER PART NUMBER:_____

PART TO BE USED ON
WHAT EQUIPMENT:_____

_____

EQUIPMENT NUMBER:_____

SPECIFICATION SECTION:_____

****

CITY PERSONNEL FILL IN:

BIN NUMBER:_____

AIMS NUMBER:_____

LOCATION IN STORES:_____

RECEIVED BY:_____

END OF SECTION

SECTION 01810

COMMISSIONING

PART 1 - GENERAL

1.01 SUMMARY

A. This Section Includes: Responsibility of the OWNER, ENGINEER and CONTRACTOR during the Commissioning Phase of the Project.

B. Work under this Section shall not start until the Work under Section 01111 - Schedule of Completion; Section 01143 - Coordination with OWNER'S Operation; Section 01751 - Starting and Placing Equipment in Operation; Section 01752 - Equipment and System Start-Up and Performance Testing; Section 01781 - Operation and Maintenance Data; Section 01782 - Record Documents; Special Tests and personnel training as defined under the individual technical specifications - Divisions 0 to 17 has been completed; and Notice of Substantial Completion for the Work as defined in the Supplementary Conditions has been completed and issued by the ENGINEER. Spare parts shall also be on-site and accepted prior to Commissioning.

1.02 REFERENCES

A. Related Sections: CONTRACTOR shall coordinate the requirements of the Work in this Section along with the requirements of the Sections listed below, which includes, but is not necessarily limited to, Work that is directly related to this Section.
   1. Division 1 - General Requirements.
   2. Division 11 - Equipment.
   3. Division 13 - Special Construction.
   4. Division 15 - Mechanical.
   5. Division 16 - Electrical.
   6. Division 17 - Instrumentation.

1.03 DEFINITIONS

A. Commissioning: The sequential process in which a newly constructed facility is put into successful operation.

B. Successful Operation: The resultant operation of all the processes and related controls in a manner that is consistent with the Contract Documents.

C. Manual Operational Mode: This operational mode represents the lowest level of control philosophy utilized in the plant instrumentation and control system. For all practical purposes, it means that an operational control decision requiring equipment

or process monitoring or control will require an individual to physically go to the local control for the associated task in order to operate the facility. In the manual operational mode, the focus will be on verifying that the equipment and processes function correctly, independent of the instrumentation system and control system.

D. Semi-Automatic Operational Mode: The highest level of control philosophy utilized in the plant instrumentation and control system.

1.04 SUBMITTALS

A. OWNER'S Personnel Training Schedule and Plan: Submit detailed plan and schedule for training OWNER'S personnel in accordance with training requirements of individual equipment in Divisions 2 through 17.

1.05 REQUIREMENTS

A. The commissioning process for the Project will consist of the following:

Commissioning Phases		
Work/Work Area	**Commissioning Requirements**	**Commissioning Duration (Calendar Days)**
Entire Facility	All instruments in manual (local) and semi automatic modes of operation	14

B. During the course of the Commissioning Process, the ENGINEER and OWNER will evaluate design related issues and recommend design modifications which shall be implemented by CONTRACTOR through the Change Order process.

1.06 RESPONSIBILITIES

A. Responsibilities listed do not relieve CONTRACTOR from all other responsibilities and duties associated with project closeout as defined in Division 0 and Division 1, General Requirements of the Specifications.

B. CONTRACTOR'S Responsibilities During the Commission Process:
   1. CONTRACTOR shall provide all staff, labor, materials, equipment and appurtenances required for carrying out CONTRACTOR'S commissioning duties described below.
   2. All Change Order work resulting from the evaluation of design-related issues by the ENGINEER and OWNER.
   3. All preventive and unscheduled maintenance of all equipment and facilities. This shall include, but not be limited to the following:
      a. Providing all lubricants.

b. Lubrication of all equipment in accordance with Manufacturer's recommendations.
c. Perform all Manufacturer recommended preventive maintenance, including instrument calibrations.
d. Exercise all equipment not in use during Commissioning phase.
e. Repair all failed equipment.
f. Periodic check of all equipment alignment, vibration, and noise levels to ascertain conformance with Specifications.
g. Provide all parts required for equipment repair.
h. Provide all tools and miscellaneous equipment required for equipment repair.
i. Administration/logging/documentation of all preventive maintenance and repair work.
j. Cleanup associated with equipment failure and repair.

4. Warranty related issues/items.
5. Other contractual requirements including, but not limited to, incomplete Work list.

C. OWNER'S Responsibilities During the Commissioning Process:
1. Provide all chemicals required for facility operations, including scheduling and securing of chemical deliveries to the facility and respective storage tanks.
2. Perform all laboratory analysis required for UTF operations.
3. Assisting ENGINEER in the evaluation of design related issues and recommendations of modifications to be implemented by CONTRACTOR through the change order process.

D. ENGINEER'S Responsibilities During Commissioning Process:
1. Provide staff for Commissioning Phases.
2. Assist OWNER with Operation of facilities.
3. Provide OWNER with systems training of the Commissioning Process.
4. Provide liaison and coordination between CONTRACTOR and OWNER'S activities.
5. Administer Change Order work performed by CONTRACTOR.
6. Develop commissioning protocol, coordinate with regulatory agencies, and develop a commissioning test report.

E. Based upon the data compiled during the commissioning period, modifications may be required. The ENGINEER and OWNER may issue a request for proposal to modify the Work, to change design or process related issues. CONTRACTOR shall respond to the request. Appropriate cost and time adjustment will be made to address the proposed change.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

A. Final completion of the project will not be granted until satisfactory completion of the commissioning period.

END OF SECTION

DIVISION 2

SITEWORK

SECTION 02100

SITE PREPARATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: clearing, grubbing, and stripping project site.

1.02 DEFINITIONS

A. Clearing: Consists of removal of natural obstructions, fences, lumber, walls, stumps, brush, weeds, rubbish, trees, boulders, utility lines, and any other items which shall interfere with construction operations or are designated for removal.

B. Grubbing: Grubbing shall consist of the removal and disposal of wood or root matter below the ground surface remaining after clearing and shall include stumps, trunks, roots, or root systems.

C. Stripping: Stripping shall include the removal and disposal of all organic sod, topsoil, grass and grass roots, and other objectionable material remaining after clearing and grubbing from the areas designated to be stripped.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements: Verify and comply with applicable regulations regarding those governing noise, dust, nuisance, drainage and runoff, fire protection, and disposal.

B. Pre-Construction Conference: Meet with OWNER to discuss order and method of work.

1.04 PROJECT CONDITIONS

A. Environmental Requirements:
   1. For suspected hazardous materials found, comply with current applicable laws and consult OWNER for direction.

B. Existing Conditions:
   1. Verify character and amount of clay, sand, gravel, quicksand, water, rock, hardpan, and other material involved and work to be performed.

1.05 SEQUENCING AND SCHEDULING

A. Clearing and Grubbing: Perform clearing and grubbing in advance of grading operations.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Examine site and verify existing conditions before beginning work.

3.02 PREPARATION

A. Protect existing improvements from damage by site preparation work.

3.03 INSTALLATION

A. Clearing:
   1. All exposed surfaces should be free of mounds and depressions which could prevent uniform compaction.
   2. Do not incorporate organic material from clearing and grubbing operations in fills and backfills.
   3. Contractor's Construction Facilities: Fill or remove pits, fill, and other earthwork required for erection of facilities, upon completion of the work, and level to meet existing contours of adjacent ground.

B. Grubbing:
   1. Totally remove stumps and roots within area impacted by construction.
   2. Backfill and compact cavities left below subgrade elevation by removal of stumps or roots to density of adjacent undisturbed soil.

C. Stripping:
   1. Remove soil material containing sod, grass, or other vegetation to depth of 6 inches from areas to receive fill or pavement and from area within 5 feet outside foundation walls.
   2. Deposit stripped material in accordance with following requirements:
      a. At locations as requested by ENGINEER.

END OF SECTION

SECTION 02200

EARTHWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
1. Loosening, excavating, filling, grading, borrow, hauling, preparing subgrade, compacting in final location, wetting and drying, and operations pertaining to structures.
2. Backfilling and compacting around structures.
3. CONTRACTOR shall include a unit lineal foot price in bid for hard dig of exterior pipelines, if necessary (as shown on Bid Tab).

1.02 REFERENCES

A. Associated General Contractors (AGC):
1. Manual of Accident Prevention in Construction (Section 9).

B. American Society for Testing and Materials (ASTM):
1. ASTM C 117 - Test Method for Material Finer than Number 200 Sieve in Mineral Aggregate by Washing.
2. C 131 - Test Method for Resistance to Degradation of Small-Size Course Aggregate by Abrasion and Impact in the Los Angeles Machine.
3. C 136 - Method for Sieve analysis of Fine and Course Aggregates.
4. D 698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.
5. D1556-Test Method for Density of Soil in Place by the Sand Cone Method.
6. D 2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
7. D 2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
8. D 3017 - Standard Test Method for Moisture Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
9. D 4318 - Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

C. Institute of Makers of Explosives (IOMOE).

D. Occupational Safety and Health Act (OSHA).

E. American Association of State Highway & Transportation Officials (AASHTO).

1.03 DEFINITIONS

A. Excavation: Consists of satisfactory loosening, removing, loading, transporting, depositing, and compacting in final location materials, wet and dry, necessary to be removed for purposes of construction, or as required for ditches, grading, roads, structures, and such other purposes as are indicated on the Drawings.

B. Backfill Adjacent to Structures: Backfill within volume delimited by exterior surfaces of structures, surface of undisturbed soil in excavation around structures, and finish grade around structure.

C. In-Place Density of Compacted Backfill: Density determined in accordance with ASTM D 698, and with ASTM D 2922 and ASTM D 3017.

D. Maximum Density: Is density obtained in laboratory when tested in accordance with ASTM D 698.

E. Definitions Related to Compaction of Coarse Fill:
   1. One Pass: Defined as one movement of roller over area being compacted.
   2. Measurement Of Pass Width: Measure width of pass between centers of outside tires or outside edge of roller wheel.

1.04 SYSTEM DESCRIPTION

A. Performance Requirements:
   1. Where mud or other soft or unstable material is encountered, remove such material and refill and compact space with approved backfill material which shall be compacted with no perceptible movement under roller.
   2. Responsibility for Compacted Fills:
      a. Assume responsibility for accomplishing specified compaction for backfill, fill, and other earthwork.
      b. Perform confirmation tests to verify and confirm that work has complied, and is complying at all times, with requirements specified in this Section concerning initial compaction demonstration, and field quality control testing.
   3. Borrow Area:
      a. No borrow area has been indicated on the Drawings.
      b. Where borrow material is required, provide such material from source selected by the CONTRACTOR, but not necessarily from within project site.
      c. Use of imported borrow shall not cause additional cost to the Contract.

1.05 SUBMITTALS

A. Property owner's Permission Agreements: Submit copy of property owner's agreements to allow dumping surplus material on their private property.

B. Product Data: Submit material source, gradation, and testing data for all imported materials.

1.06 QUALITY ASSURANCE

A. Initial Compaction Demonstration:
   1. Adequacy of Compaction Equipment and Procedures: Demonstrate adequacy of compaction equipment and procedures before exceeding any of following amounts of earthwork quantities:
      a. 200 linear feet of trench backfill.
      b. 10 cubic yards of structural backfill.
      c. 100 cubic yards of embankment work.
      d. 50 cubic yards of base material.
   2. Compaction Sequence Requirements: Until specified degree of compaction on previously specified amounts of earthwork is achieved, do not perform additional earthwork of the same kind.

1.07 SEQUENCING AND SCHEDULING

A. Schedule earthwork operations to meet requirements as provided in this Section for excavation and uses of excavated material.

B. If necessary, stockpile excavated material in order to use it in specified locations.

C. Excavation and Filling: Perform excavation and filling, during construction, in manner and sequence that provides drainage at all times.

PART 2 PRODUCTS

2.01 MATERIALS

A. Water For Compacting Fills: Use water from source OWNER. Contractor shall not transfer water from the job site.

B. Fill and Backfill Materials:
   1. General:
      a. Provide sand, aggregate base course, gravel, Class 2 permeable, drain rock, select material, and native material, where required for fill and backfill.

b. Obtain material for fills from cut sections or from borrow source.
c. Provide material having maximum particle size not exceeding 4 inches and that is free from frozen material, leaves, grass, roots, stumps, and other vegetable matter.
d. Materials derived from processing demolished or removed asphalt concrete are not acceptable.

2. Class 2 Permeable:
a. Consist of hard, durable particles of stone or gravel, screened or crushed to the specified size and gradation.
b. Provide free from frozen material, organic matter, lumps or balls of clay, and other deleterious matter.
c. Durability Index: Percentage of wear not greater than 40 percent when tested in accordance with ASTM C 131.
d. Sand Equivalent: Not less than 75 when tested in accordance with ASTM D 2419.
e. Conform to size and grade within the limits as follow when tested in accordance with ASTM C 136:

Sieve Size (Square Openings)	Percent by Weight Passing Sieve
1 inch	100
3/4 inch	90-100
3/8 inch	40-100
Number 4	25-40
Number 8	18-33
Number 30	5-15
Number 50	0-7
Number 200	0-3

4. Drain Rock:
a. Consist of hard, durable particles of stone or gravel, screened or crushed to specified size and gradation.
b. Free from frozen material vegetable matter, lumps or balls of clay, or other deleterious matter.
c. Crush or waste coarse material and waste fine material as required to meet gradation requirements.
d. Durability Index: Percentage of wear not greater than 40 percent when tested in accordance with ASTM C 131.

e. Conform to size and grade within the limits as follows when tested in accordance with AASHTO T-27 or ASTM C 136:

Sieve Size (Square Openings)	Percent By Weight Passing Sieve
2 inch	100
1-1/2 inch	95-100
3/4 inch	50-100
3/8 inch	15-55
Number 4	0-25
Number 8	0-5
Number 200	0-2

5. Gravel:
   a. Consist of hard, durable particles or fragments of stone or gravel, screened or crushed to specified sizes and gradations.
   b. Free from frozen material vegetable matter, lumps or balls of clay, alkali, adobe, or other deleterious matter.
   c. When sampled and tested in accordance with specified test methods, material shall comply with following requirements:
      1) Durability Index: Percentage of wear not greater than 40 percent after 500 revolutions when tested in accordance with ASTM C 131.
      2) Plasticity Index: Not greater than 5 when tested in accordance with ASTM D 4318.
      3) Liquid Limit: Not greater than 25 percent when tested in accordance with ASTM D 4318.
   d. Conform to sizes and grade within the limits as follows when tested in accordance with ASTM C 136 and ASTM C 117.

Sieve Size (Square Openings)	Percent By Weight	
	Type A	Type B
3 inch	100	–
1-1/2 inch	–	100
Number 4	30 - 75	30 - 70
Number 8	20 - 60	20 - 60
Number 30	10 - 40	10 - 40
Number 200	0 - 12	0 - 12

6. Native Material:
    a. Clean onsite native soil with a maximum dimension of 4 inches, and passing 1 inch sieve.
    b. Percent of material by weight passing Number 200 sieve shall not exceed 30 when tested in accordance with ASTM C 136.
7. Sand:
    a. Clean, coarse, natural sand.
    b. Nonplastic when tested in accordance with ASTM D 4318.
    c. 100 percent shall pass a ½ inch screen.
    d. No more than 20 percent shall pass a Number 200 screen.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:
1. Character and Amount of Material:
    a. Verify character and amount of rock, gravel, sand, silt, water, and other inorganic or organic materials to be encountered in work to be performed.
    b. Determine gradation and shrinkage of excavation and fill material, and suitability of material for use intended in work to be performed.
    c. Determine quantity of material, and cost thereof, required for construction of excavations and fills, whether from on site excavations, borrow areas, or imported materials.
    d. Include wasting of excess material, if required, in cost of work to be performed under this Contract.

3.02 PREPARATION

A. Surface Preparation:
1. Preparing Ground Surfaces for Fill or Concrete:
    a. After clearing is completed, scarify entire areas which underlie fill sections or structures to a depth of 8 inches and until surface is free of ruts, hummocks, west zones, and other features which would prevent uniform compaction by equipment to be used.
    b. Recompact areas to density specified in Sub-paragraph 3.03.C.1, titled “Compacted Fills” before placing of fill material or concrete.
    c. Where cemented rock, cobbles, or boulders compose a large portion of foundation material underlying structures, slabs, or paved areas, it may not be advisable to scarify the top 8 inches prior to compaction. If the CONTRACTOR deems it advisable not to scarify existing natural ground, then moisten the native soil and compact it as specified in Sub-paragraph 3.03C.2, titled “Compaction of Coarse Fill.”

3.03 APPLICATION

A. General:
   1. The CONTRACTOR shall assume responsibility and expense of disposing of excavated materials which are not required or unsuitable for fill and backfill in lawful manner.
   2. Do not dump surplus material on private property unless written permission agreement is furnished by owner of property. Submit copies of such agreements.
   3. Obtain material required for fills in excess of that produced by excavation from borrow areas as specified herein.
   4. Rocks, Broken Concrete, or Other Solid Materials Larger Than 4 Inches in Greatest Dimension: Do not place in fill areas but remove from project site at no additional cost to the Contract.
   5. Stabilization of Subgrade: Provide materials used or perform work to stabilize subgrade so it can withstand loads which may be placed upon it by CONTRACTOR's equipment at no additional cost to Contract.
   6. Engineered fill under structure foundations and slabs on grade shall consist of native material that is conditioned and compacted as specified in this Section.
   7. Backfill around all structures that require hydrostatic testing shall not be completed until after hydrostatic testing is completed, and the structures have passed the hydrostatic test.
   8. Undermining footings/slabs after they have been cast-in place is prohibited.

B. Excavation:
   1. Excavations for Structures:
      a. The building and slabs on grade shall be over excavated to a uniform depth of two feet below the foundation or two feet below the existing ground surface, which ever depth is greater. The over excavation shall extend five feet beyond the footprint of the building and slab on grade. The over excavated areas shall be filled with engineered fill. Include trenching for adjacent piping and all work incidental thereto.
      b. Where soil of Unsuitable Bearing Value is Encountered: The CONTRACTOR may direct in writing that excavation be carried to elevations above or below those indicated on the Drawings.
      c. Unless directed by the ENGINEER, excavations shall not be carried below elevations indicated on the Drawings.
      d. Where excavations are made below elevations required for the foundation, adjust elevations of excavations in accordance with requirements following:
         1) Under Slabs: Restore to proper elevation in accordance with procedure specified for backfill in this Section.
         2) Under Footings: Select one of the following:
            a) Increase heights of walls or footings.

b) Refill space with Class C concrete, as specified in Section 03300, at no additional cost to the Contract.

c) Excavation Width: Extend excavations at least 24 inches clear from walls and footings to allow for placing and removal of forms, installation of services, and inspection. Undercutting of slopes will not be permitted.

e. Bottom of Excavations For Structures: Consist of native material with top 8 inches compacted to 95 percent of maximum density and graded to conform to outside limits of structures as indicated on the Drawings, except where otherwise indicated on the Drawings or specified.

f. Difficulty of Excavation: No extra compensation will be made for removal of rock or any other material due to difficulty of excavation.

g. Location of Structures on Different Substrates: Where structure will be located partially on fill and partially on undisturbed or natural material, over-excavate entire area to depth of 12 inches below the structure and re-compact to 95 percent maximum density.

2. Excavation of Ditches and Gutters:

a. Cutting: Cut ditches and gutters accurately to cross sections and grades indicated on the Drawings.

b. Excavation: Take care not to excavate ditches and gutters below grades indicated on the Drawings.

c. Over Excavation: Back fill excessive ditch and gutter excavation to grade with suitable thoroughly compacted material to form adequate gutter paving.

d. Depositing Of Material Adjacent To Ditches: Do not deposit any material within three feet of edge of ditch unless otherwise indicated on the Drawings.

3. Necessary Over Excavation:

a. General:

1) Where it becomes necessary to excavate beyond normal lines of excavation in order to remove boulders or other interfering objects, backfill voids remaining after removal as specified below in "Backfilling Of Voids", or as acceptable to the ENGINEER.

2) With ENGINEER's approval, perform necessary excavation beyond normal lines as specified in Subparagraph above and backfill such voids. Cost of such work shall be considered as included in price bid for the work.

3) Backfilling of Voids:

a) Fill voids with suitable material acceptable to the OWNER, placed in manner and to same uniform density as surrounding material.

C. Compaction:

1. Compacted Fills:

a. Lines and Grades:

1) Construct fills, embankments, and backfills, designated herein as fills, at locations and to lines and grades indicated on the Drawings.

2) Borrow sources are not available within project site. Where required, CONTRACTOR shall provide necessary imported fill material from outside sources.

b. Compacted Fill Shape and Sections: Provide completed fill that corresponds to shape of typical sections indicated on the Drawings or that meets requirements for particular case.

c. Preparation of Areas Designated to Receive Fill Material: Scarify to minimum depth of 8 inches, unless otherwise indicated on the Drawings, and recompact to density of fill material as specified in following Article.

d. Fills and Backfills and Upper 6 Inches in Cuts: Compact to percentage of maximum density as follows:

1) Backfill Adjacent to Structures: 95 percent.

2) Under Present and Future Structures: 98 percent.

3) Under Roadways (aggregate base course, and dirt), Parking, Curbs and Sidewalks: 95 percent.

4) Aggregate Base Below Pavement 100 percent.

5) Onsite or Imported Fill Below Exterior Slabs on Grade: 95 percent.

6) Aggregate Base other than Below Pavement: 95 percent.

7) Landscaped Areas: 90 percent unless otherwise noted.

8) Compacted Embankments: 95 percent.

9) Spoil Areas Indicated on the Drawings: No minimum required.

e. Placing Compacted Fills:

1) Placement: Place loose material in successive layers that do not exceed 8 inches before compaction.

2) Moisture Content: Bring each layer to optimum moisture content for maximum density before compaction by rolling.

3) Defective Compacted Fills:

a) Remove and replace any placed material that does not have correct moisture content.

b) Remove and replace fills with suitable material when any one of the following 2 conditions exist as they shall serve as sufficient evidence, without further testing, that moisture content is not correct:

(1) Soft, spongy or stringy material causing areas that "pump" when heavy loads pass over.

(2) Dry material that will not "ball".

f. Mechanical Spreading and Rolling Layers of Fills:
1) Spreading: Spread each layer uniformly by use of road machine or other accepted device.
2) Rolling: Roll with acceptable tamping roller, heavy pneumatic roller, or power roller until thoroughly compacted to not less than specified density.
3) Fill Required to be Compacted That is Inaccessible to Rollers: Compact with pneumatic, vibrating, or other tamping equipment.
4) Use of Other Equipment: Use of trucks, carryalls, scrapers, tractors, or other heaving hauling equipment is not considered as rolling in lieu of rollers, but distributed traffic of such hauling equipment over fill in such manner as to make use of compaction by use of rollers.

2. Compaction of Coarse Fill:
a. When Materials Are Coarsely Graded Such That Performance of Field Density Tests Are Impossible:
1) Placement and Compaction: Place material in lifts so as to obtain compacted thickness of 6 inches and roll with pneumatic roller or power roller.
2) Moisture Content: Provide moisture content of fraction of material passing 3/4 inch sieve within plus or minus 2.0 percent of optimum moisture as determined in accordance with ASTM D 1557.

3.04 FIELD QUALITY CONTROL

A. Tests:
1. Confirmation Tests:
a. CONTRACTOR's Responsibilities:
1) Accomplish specified compaction for backfill, fill, and other earthwork.
2) Control operations by confirmation tests to verify and confirm that compaction work complies, and is complying at all times, with requirements specified in this Section concerning compaction, control, and testing.
3) Copies of Confirmation Test Reports: Submit promptly to the OWNER and ENGINEER.
b. Frequency of Confirmation Testing:
1) Perform testing not less than as follows:
a) For Structural Fill and Backfill: One every 30 cubic yards, or each day's production which ever is more frequent.
b) In Embankment or Fill: One every 200 cubic yards.
c) Base Material: One every 50 cubic yards.

d) Subgrade of Structures, Footings, Structural Slabs in cut situation: once per foundation area.

2. Retesting:
   a. Costs of Retesting: Costs of retesting required to confirm and verify that remedial work has brought compaction within specified requirements shall be borne by the CONTRACTOR.
   b. CONTRACTOR's Confirmation Tests During Performance of Remedial Work:
      1) Performance: Perform tests in manner acceptable to the ENGINEER.
      2) Frequency: Double amount specified for initial confirmation tests.

B. Tolerances:
   1. Finish Grading of Excavations, Backfill and Fills:
      a. Perform fine grading under concrete structures such that finished surfaces are never above established grade or approved cross section and are never more than 0.10 feet below.
      b. Provide finish surface areas outside of structures that are not more than 0.10 feet above or below established grade or accepted cross section.
   2. Of Areas Which are not Under Structures, Concrete, Asphalt, Roads, Pavements, Walks, Dikes and Similar Type Items:
      a. Provide finish graded surfaces of either undisturbed natural soil, or cohesive material not less than 6 inches deep.
      b. Intent of preceding is to avoid sandy or gravelly areas.
   3. Finished Grading Surfaces:
      a. Reasonably smooth, compacted, and free from irregular surface changes.
      b. Provide degree of finish that is ordinarily obtainable from blade grader operations, except as otherwise specified.
      c. Uniformly grade areas which are not under concrete.
      d. Finish gutters and ditches so that they drain readily.

3.05 ADJUSTING

A. Finish Grades of Excavations, Backfilling and Fill:
   1. Repair and reestablish grades to required elevations and slopes due to any settlement or washing way that may occur from action of the elements prior to final acceptance.

3.06 PROTECTION

A. Finish Grades of Excavations, Backfilling and Fill:
   1. Protect newly graded areas from action of the elements.

3.07 DISPOSAL OF EXCAVATED MATERIAL

A. Unusable material or excavated material in excess of that needed for backfill or fill offsite shall become the property of the CONTRACTOR and shall be removed from the project site and legally disposed of at no cost to the OWNER.

END OF SECTION

SECTION 02223

TRENCHING, BACKFILLING AND COMPACTING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Trench excavation, fine grading, pipe bedding, backfilling, and compaction for the following, including requirements for ditch crossings:
   1. Pipe and electrical conduits.
   2. Manholes, valves, or other accessories.
   3. Piping and appurtenances.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. C 117 - Standard Test Method for Material Finer Than Number 200 Sieve in Mineral Aggregate by Washing.
   2. C 131 - Standard Test method for resistance to degradation of small size coarse aggregate by abrasion and impact in the Los Angeles machine.
   3. C 136 - Standard Test Method for Sieve analysis of fine and coarse aggregate.
   4. D 1556 - Standard Test Method for Density of Soil in Place by the Sand-Cone Method.
   5. D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.
   6. D 2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
   7. D 4318 - Standard Test Method for liquid limit, plastic limit, and plasticity index of soils.

1.03 SUBMITTALS

A. Products Data: For all proposed bedding and backfill materials.
   1. Material source.
   2. Gradation.
   3. Testing data.

PART 2 PRODUCTS

2.01 MATERIALS

A. General:
1. Provide material having maximum particle size not exceeding 4 inches and that is free of frozen material, leaves, grass, roots, stumps, and other vegetable matter.
2. Materials derived from processing demolished or removed asphalt concrete are not acceptable.

B. Gravel:
1. Consist of hard, durable particles or fragments of stone or gravel, screened or crushed to specified sizes and gradations.
2. Free from frozen material, vegetable matter, lumps or balls of clay, alkali, adobe, or other deleterious matter.
3. When sampled and tested in accordance with specified test methods, material shall comply with following requirements:
   a. Durability Index: Percentage of wear not greater than 40 percent after 500 revolutions when tested in accordance with ASTM C 131.
   b. Plasticity Index: Not greater than 5 when tested in accordance with ASTM D 4318.
   c. Liquid Limit: Not greater than 25 percent when tested in accordance with ASTM D 4318.
4. Conform to sizes and grade within limits as follows when tested in accordance with ASTM C 136 and ASTM C 117.

Sieve Size (Square Openings)	Percent By Weight	
	Type A	Type B
3 inch	100	–
1-1/2 inch	–	100
Number 4	30 - 75	30 - 70
Number 8	20 - 60	20 - 60
Number 30	10 - 40	10 - 40
Number 200	0 - 12	0 - 12

C. Native Material:
1. Sound, earthen material passing the 1 inch sieve.
2. Percent of material passing the Number 200 sieve by weight shall not exceed 30 when tested in accordance with ASTM C 136.

D. Sand:
1. Clean, coarse, natural sand.

2. Nonplastic when tested in accordance with ASTM D 4318.
3. 100 percent shall pass a ½ inch screen.
4. No more than 20 percent shall pass a Number 200 screen.

E. Select Material: Sound earthen material for which the sum of the plasticity index when tested in accordance with ASTM D 4318 and the percent of material by weight passing the Number 200 sieve shall not exceed 23 when tested in accordance with ASTM C 136.

PART 3 EXECUTION

3.01 PREPARATION

A. General:
1. Before laying pipes or electrical conduits in fill, place fill and compact it to not less than 2 feet above top of pipe or conduit.
2. After placing and compacting fill, excavate through fill and fine grade as required in this Section.

B. Protection: Stabilize excavation.

3.02 INSTALLATION

A. Trench Excavation:
1. General Requirements:
a. If, because of soil conditions, safety requirements or other reasons, trench width at top of pipe is increased beyond width specified in this Section, upgrade laying conditions or install stronger pipe designed in conformance with Specifications for increased trench width, without additional cost.
b. Pipe And Electrical Conduits:
1) Lay pipe in open trench.
2) Where shown on Drawings, lay electric conduits in concrete encased duct banks with a warning ribbon located 1'-0" above the top of the duct bank. Do not use any rebar and dye. NEC approved chairs shall be placed every 5' throughout the length of the duct bank to provide support and separation of conduits.
3) If bottom of excavation is found to consist of rock or any material that by reason of its hardness cannot be excavated to provide uniform bearing surface, as determined by ENGINEER, remove such rock or other material to a depth of not less than 4 inches below bottom of pipe and refill to grade with aggregate base course material or sand placed at uniform density, with minimum possible compaction, at no additional cost.

4) If bottom of excavation is found to consist of soft or unstable material which is incapable of properly supporting pipe, remove such material to a depth and for the length required, as determined by the OWNER, and then refill trench to grade with aggregate base course or sand, compacted to 95 percent of maximum density.

5) Where indicated on the Drawings, and where fill conditions dictate, cradle pipe in concrete.

6) Minimum Clear Width of Trench for Pipe 4 Inches in Diameter and Over (Measured At Top Of Pipe): Not less than outside diameter of pipe plus 18 inches.

7) Maximum Clear Width of Trench for Pipe (Measured at Top of Pipe):

a) For Pipe Sizes up to and Including 24 Inches: Not exceed outside diameter of pipe plus 24 inches.

b) For Pipe Sizes Over 24 Inches: Not exceed outside diameter of pipe plus 36 inches.

c. For Manholes, valves, or other accessories:

1) Provide excavations sufficient to leave at least 12 inches clear between their outer surfaces and embankment or shoring which may be used to hold banks and protect them.

2) Do not backfill with earth under manholes, vaults, tanks, or valves.

3) Fill any unauthorized excess excavation below elevation indicated on the Drawings for foundation of any structure with aggregate base material or concrete at no additional cost.

4) Backfilling of Manhole Excavation: Conform to backfilling requirements as specified for trenches in this Section.

d. Potable Water Pipe and Appurtenances:

1) Lay in trench separate from those used for sewers.

2) Unless otherwise specified or indicated on the Drawings, lay in trenches having cover of not less than 4 feet below surface of ground and located at distance of not less than 10 feet from any parallel sewer trench.

e. At Road Crossings or Existing Driveways:

1) Make provision for trench crossing at these points, either by means of backfills, tunnels, or temporary bridges.

B. Trench Fine Grading:

1. For Pipes 16 Inches in Nominal Diameter and Under:

a. Unless otherwise specified, accurately grade bottom of trench to provide uniform bearing and support for each section of pipe, on undisturbed soil at every point along pipe's entire length, except for portions of pipe where it is necessary to excavate for bells and for proper sealing of pipe joints.

2. For Pipe over 16 Inches in Diameter:
    a. Overexcavate bottom of trench by at least 4 inches, or 1/12 outside diameter of pipe, whichever is greater.
    b. Fill overcut with bedding material specified herein, and fine graded as specified above.
    c. Place bedding material at uniform density, with minimum possible compaction.
    d. Where trench excavation is below grade of bedding material, restore trench bottom to proper grade by backfilling and compacting backfill to 95 percent of maximum density, at no additional cost. Use bedding material as specified in this Section.
3. Bell or Coupling Holes:
    a. Dig holes after trench bottom has been graded.
    b. Provide holes of sufficient width to provide ample room for grouting, banding, or welding.
    c. Excavate holes only as necessary in making joints and to ensure that pipe rests upon prepared trench bottom and not supported by any portion of the joint.
4. Depressions for Joints, Other Than Bell-and-Spigot:
    a. Make in accordance with recommendations of joint manufacturer for particular joint used.

C. Pipe Bedding:
1. After Pipe Laid:
    a. Place bedding material under and around pipe to level even with spring line of pipe, and compact to 90 percent of maximum density. Depth of bedding under pipe shall be 4 inches.
    b. Fill section of trench from spring line to 12 inches above top of pipe with bedding material and mechanically compact to 90 percent of maximum density.
2. Pipe Displacement:
    a. Take necessary precautions in placement and compaction of bedding material to prevent displacement of piping.
    b. In event there is movement, re-excavate, re-lay, and backfill the pipe.
3. Consolidation:
    a. Use mechanical means.

D. Trench Backfill:
1. Place and compact backfill in accordance with following requirements:
    a. From 12 inches above top of pipe to natural surface level.
    b. Finish grade indicated on the Drawings as follows:
        1) Backfill For Trench Cuts Across Roadways, Paved Streets, Site Access Roads, and Site Road: Backfill trench to underside of specified pavement replacement with aggregate base course material compacted to 95 percent of maximum density.

c. Trench Backfill for Trench Cuts in Areas Outside the Improved Section of Roadways and within open spaces: Backfill trench from 12 inches above top of pipe to finish grade with native material compacted to 90 percent of maximum density.

d. Trench Backfill through Earth Slopes or Embankments Supporting Structures, through Structural Fill, or Adjacent to and/or Under Structures: Backfill trench from 12 inches above top of pipe to finish grade with ABC material or approved select material compacted to 95 percent of maximum density.

e. The more stringent compaction requirements for trench backfill between the specifications and the geotechnical report shall be used.

f. No backfill shall be placed until ENGINEER has inspected.

E. Compacting Native Material:

1. Assure that native material, when used as previously specified, is capable of being compacted to degree specified.

2. If native material cannot be compacted to density as previously specified, remove and dispose of material whether it has been placed in trench as backfill or not, and utilize other backfill material from another source acceptable to the ENGINEER.

F. Excess Material:

1. Remove excess excavated material from the project site.

3.03 FIELD QUALITY CONTROL

A. Tests:

1. Confirmation Tests:

a. CONTRACTOR's Responsibilities:

1) Accomplish specified compaction of trench backfill.

2) Control operations by confirmation tests to verify and confirm that compaction work complies, and is complying at all times, with requirements specified in this Section concerning compaction, control, and testing.

3) Copies of Confirmation Test Reports: Submit promptly to the OWNER and ENGINEER.

b. Frequency of Confirmation Testing:

1) Perform testing not less than as follows:

a) For Trenches: At each location include tests for each type or class of backfill from bedding to finish grade.

b) In Open Fields: Two every 500 linear feet.

c) Along Dirt or Gravel Road or off Traveled Right-of-Way: Two every 500 linear feet.

d) Crossing Paved Roads: Two locations along each crossing.

e) Under Pavement Cuts or Within 2 Feet of Pavement Edges: One location every 200 linear feet.

f) Under structures and slabs: minimum of one, and one

every 50 linear feet.

2. Retesting:
   a. Costs of Retesting: Costs of retesting required to confirm and verify that remedial work has brought compaction within specified requirements shall be borne by the CONTRACTOR.
   b. CONTRACTOR's Confirmation Tests During Performance of Remedial Work.
      1. Performance: Perform tests in manner acceptable to the ENGINEER.
      2. Frequency: Double amount specified for initial confirmation tests.
3. Water Testing Pipe:
   a. After bedding the pipe, contractor shall water pressure and leak test pipe.
   b. If pipe does not pass test, locate leaks, repair and retest, repeating until pipe section under test passes, then backfill.

B. As-builts:
   1. CONTRACTOR shall survey the entire line prior to backfill.

3.04 SCHEDULES

A. Bedding Materials:
   1. For Pipe Less Than 16 Inch Nominal Size: Other than plastic pipe, except as otherwise specified, use native sand or aggregate base course.
   2. For Polyvinyl Chloride or Other Plastic Pipe Less Than 2 Inches in Diameter: Sand or select material.
   3. For polyvinyl chloride pipe larger than 2 inches in diameter: aggregate base course.
   4. For pipe greater than 16 inch nominal size: Except as otherwise specified, use aggregate base course.

END OF SECTION

DIVISION 3

CONCRETE

SECTION 03100

CONCRETE WORK

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Concrete formwork.

B. Related Sections:
1. Section 03600 - Grout.

1.02 REFERENCES

A. American Concrete Institute (ACI):
1. 117 - Standard Tolerances for Concrete Construction and Materials.

1.03 SYSTEM DESCRIPTION

A. Design Requirements:
1. Design concrete forms, falsework, and shoring in accordance with local, state, and federal regulations.
2. Design forms and ties to withstand concrete pressures without bulging, spreading, or lifting of forms.

B. Performance Requirements:
1. Construct forms so that finished concrete conforms to shapes, lines, grades, and dimensions indicated on the Drawings.
2. It is intended that surface of concrete after stripping presents smooth, hard, and dense finish that requires minimum amount of finishing.
3. Provide sufficient number of forms so that the work may be performed rapidly and present uniform appearance in form patterns and finish.
4. Use forms that are clean and free from dirt, debris, concrete, and similar type items. Coat with acceptable form release oil if required, prior to use or reuse.

1.04 QUALITY ASSURANCE

A. Qualifications of Formwork Manufacturers: Use only forming systems manufactured by manufacturers having minimum 5 years experience, except as otherwise specified.

B. Regulatory Requirements: Install work of this Section in accordance with local, state, and federal regulations.

1.05 PROJECT CONDITIONS

A. Requirements Due to Weather Condition:
1. Removal of Formwork: Do not remove forms from concrete which has been placed when outside ambient air temperature is below 50 degrees Fahrenheit until concrete has attained specified strength as determined by test cylinders stored in field under equivalent conditions as concrete structure.

PART 2 PRODUCTS

2.01 MATERIALS

A. Form Ties:
1. General:
a. Provide form ties for forming system selected that are manufactured by recognized manufacturer of concrete forming equipment.
b. Do not use wire ties or wood spreaders of any form.
c. Provide ties of type that accurately tie, lock, and spread forms.
d. Provide form ties of such design that when forms are removed they locate no metal or other material within 1-1/2 inches of the surface of the concrete.
e. Do not allow holes in forms for ties to allow leakage during placement of concrete.
2. Cone-Snap or Flat Bar Form Ties:
a. Cone-snap ties shall form a cone shaped depression in the concrete with a minimum diameter of 1 inch at the surface of the concrete and 1-1/2 inches deep.
b. Provide neoprene waterseal washer which is located near the center of the concrete.
3. Taper Ties:
a. Neoprene Plugs for Taper Tie Holes: Size so that after they are driven, plugs are located in center third of wall thickness.
b. Drypack Mortar for Filling Taper Tie Holes:
1) Consist of mix of one part of Portland Cement to one part of plaster sand.
2) Amount of water to be added to cement-sand mix is to be such that mortar can be driven into holes and be properly compacted.
3) Admixtures or additives: Are not to be used in drypack mortar.

B. Built-Up Plywood Forms:
1. Built-up plywood forms may be substituted for prefabricated forming system following minimum requirements:
a. Size and Material:
1) Full size 4 by 8 feet plywood sheets, except where smaller pieces are able to cover entire area.

2) Sheet Construction: 5-ply plywood sheets, 3/4 inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.

b. Wales: Minimum 2 by 4 inch lumber.

c. Studding And Wales: Contain no loose knots and be free of warps, cups, and bows.

C. Steel or Steel Framed Forms:

1. Steel Forms: Provide forms that are:
   a. Rigidly constructed and capable of being braced for minimum deflection of finish surface.
   b. Capable of providing finish surfaces that are flat without bows, cups, or dents.
2. Steel Framed Plywood Forms:
   a. Provide forms that are rigidly constructed and capable of being braced.
   b. Plywood Paneling: 5-ply, 5/8 inch nominal or 3/4 inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.

D. Incidentals:

1. External Angles:
   a. Where not otherwise indicated on the Drawings, provide with 3/4 inch bevel, formed by utilizing true dimensioned wood or solid plastic chamfer strip on walkways, slabs, walls, beams, columns, and openings.
   b. Provide 1/4 inch bevel formed by utilizing true dimensioned wood or solid plastic chamfer strip on walkways, walls, and slabs at expansion, contraction, and construction joints.
2. Keyways: Steel, plastic, or lumber treated with form coating, applied according to label directions.
3. Inserts: Dovetail Anchors or Ties.
4. Pipe Sleeves: Refer to Drawings for type, location, and sizes. All sleeves shall be made of cast iron, unless noted otherwise.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:
1. Do not place any concrete until all forms have been thoroughly checked for alignment, level, strength, and to assure accurate location of all mechanical and electrical inserts or other embedded items.

3.02 INSTALLATION

A. Forms and Accessories:
1. Vertical Forms:
a. Remain in place minimum of 24 hours after concrete is placed.
b. If, after 24 hours, concrete has sufficient strength and hardness to resist surface or other damage, forms may be removed.
2. Other Forms Supporting Concrete And Shoring: Remain in place as follows:
a. Sides of Footings: 24 hours minimum.
b. Vertical Sides of Beams, Girders, And Similar Members: 48 hours minimum.
c. Slabs, Beams, and Girders: Until concrete strength reaches specified strength or until shoring is installed.
d. Shoring for Slabs, Beams, and Girders: Shore until concrete strength reaches specified strength.
e. Wall Bracing: Until concrete strength of beams and slabs laterally supporting wall reaches specified strength.

B. Form Ties:
1. Cone-Snap Rod and Bar Ties: Tie forms together at not more than 2 foot centers vertically and horizontally. After forms are removed from wall, fill tie holes as follows:
a. Remove form ties from surfaces.
b. Roughen cone shaped tie holes by heavy sandblasting before repair.
c. Dry pack cone shaped tie holes with drypack mortar as specified in Section 03600.
2. Taper Ties:
a. Neoprene Plug in Taper Tie Holes: After forms and taper ties are removed from wall, plug tie holes with neoprene plug as follows:
1) Heavy sandblast and then clean tie holes.
2) After cleaning, drive neoprene plug into each of taper tie holes with steel rod. Final location of neoprene plug shall be in center third of wall thickness. Bond neoprene plug to concrete with epoxy.
3) Locate steel rod in cylindrical recess, made in plug, during driving:

a) At no time are plugs to be driven on flat area outside cylindrical recess.

b. Dry Pack of Taper Tie Holes: After installing plugs in tie holes:

1) Coat tie hole surface with epoxy bonding agent and fill with drypack mortar as specified in Section 03600.

a) Drypack Mortar: Place in holes in layers with thickness no exceeding tie hole diameter and heavily compact each layer.

b) Drypack the outside of the hole no sooner than 7 days after the inside of the hole has been dry packed.

c) Wall surfaces in area of drypacked tie holes: On the water side of water containing structures and the outside of below grade walls:

(1) Cover with minimum of 10 mils of epoxy gel.

(2) Provide epoxy gel coating on wall surfaces that extend minimum of 2 inches past drypack mortar filled tie holes.

(3) Provide finish surfaces that are free from sand streaks or other voids.

3. For water retaining structures, use taper ties. No other type of tie will be allowed.

C. Built-Up Plywood Forms:

1. Studding:

a. Spaced at 16 inches or 24 inches on center.

b. Closer spacing may be required depending upon strength requirements of the forms, in order to prevent any bulging surfaces on faces of finished concrete work.

c. Install studs perpendicular to grain of exterior plys of plywood sheets.

2. Wales: Form wales of double lumber material minimum size as specified in this Section.

3. Number of Form Reuses: Depends upon durability of surface coating of overlay used, and ability to maintain forms in condition such that they are capable of producing flat, smooth, hard, dense finish on concrete when stripped.

D. Steel or Steel Framed Forms:

1. Steel Forms:

a. Adequately brace forms for minimum deflection of finish surface.

2. Steel Framed Plywood Forms:

a. Rigidly construct and brace with joints fitting closely and smoothly.

b. Number of Form Reuses: Depends upon durability of surface coating or overlay used.

3. Built-Up Plywood Forms: As specified in this Section may be used in conjunction with steel forms or steel framed plywood forms for special forming conditions such as corbels and forming around items which will project through forms.

E. Bracing and Alignment of Forms:
   1. Line and Grade: Limit deviations to tolerances which will permit proper installation of structural embedded items or mechanical and electrical equipment and piping.
   2. Formwork:
      a. Securely brace, support, tie down, or otherwise hold in place to prevent any movement.
      b. Make adequate provisions for uplift pressure, lateral pressure on forms, and defection of forms.
   3. When Second Lift is Placed on Hardened Concrete: Take special precautions in formwork at top of old lift and bottom of new lift to prevent:
      a. Spreading and vertical or horizontal displacement of forms.
      b. Grout "bleeding" on finish concrete surfaces.
   4. Pipe Stubs, Anchor Bolts, and Other Embedded Items: Set in forms where required.
   5. Cracks, Openings, or Offsets At Joints in Formwork: Close those that are 1/16 inch or larger by tightening forms of by filling with acceptable crack filler.

F. Incidentals:
   1. Keyways: Construct keyways as indicated on the Drawings.
   2. Reentrant Angles: May be left square.
   3. Level Strips: Install level strips at top of wall concrete placements to maintain true line at horizontal construction joints.
   4. Inserts:
      a. Encase pipes, anchor bolts, steps, reglets, castings, and other inserts, as indicated on the Drawings or as required, in concrete.
      b. Use dovetail anchors or ties in conjunction with slots or inserts for various materials as specified under other sections of these Specifications and as may be necessary for required work.

G. Pipe and Conduit:
   1. Install pipe and conduit in structures as indicated on the Drawings, and seal with materials as specified in Section 07900, unless otherwise specified.

H. Tolerances:
   1. Finish concrete shall conform to shapes, lines, grades, and dimensions indicated on the Drawings.
   2. The maximum deviation from true line and grade shall not exceed tolerances listed below at time of acceptance of project.
   3. General: Comply with ACI 117, paragraphs 2.0 through 2.2 and paragraphs 4.0 through 4.5, except as modified in following:
      a. Slabs:
         1) Slope: Uniformly sloped to drain when slope is indicated on the Drawings.

2) Slabs Indicated to be Level: Have maximum deviation of 1/8 inch in 10 feet without any apparent changes in grade.

b. Inserts: Set inserts to tolerances require for proper installation and operation of equipment or systems to which insert pertains.

c. Maximum Tolerances: As follows:

Item	Inches
Sleeves and Inserts	Plus 1/8 Minus 1/8
Projected Ends of Anchor Bolts	Plus 1/4 Minus 0.0
Anchor Bolt Setting	Plus 1/16 Minus 1/16

END OF SECTION

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Concrete reinforcement.

B. Related Sections:
1. Section 03100 - Concrete Formwork.

1.02 REFERENCES

A. American Concrete Institute (ACI):
1. SP-66-ACI - Detailing Manual.
2. 315 - Details and Details of Concrete Reinforcement.
3. 318 - Building Code Requirements for Reinforced Concrete.

B. American Society for Testing and Materials (ASTM):
1. A 143 - Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure, for Detecting Embrittlement.
2. A 185 - Standard Specification for Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement.
3. A615 - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Deformed and Plain Billet-Steel Bars.
4. A 767 - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
5. ASTM E8 - Standard Test Methods for Tensile Testing of Metalic Materials.
6. ASTM A 706 - Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.

C. American Welding Society (AWS):
1. D1.4 - Structural Welding Code - Reinforcing Steel.

1.03 SYSTEM DESCRIPTION

A. The Drawings contain general notes concerning amount of reinforcement and placing, details for reinforcement at wall corners and intersections, and details of extra reinforcement around openings in concrete.

1.04 SUBMITTALS

A. Shop Drawings:
   1. Shop Drawings on Reinforcing Steel:
      a. Submit to the ENGINEER reinforcing steel detail drawings in accordance with Contract Documents.
      b. Changes to Reinforcing Steel Contract Drawing Requirements:
         1) Indicate in separate letter submitted with shop drawings any changes of requirements indicated on the drawings for reinforcing steel.
         2) Such changes will not be acceptable unless the ENGINEER has accepted such changes in writing.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing And Shipping:
   1. Deliver bars bundled and tagged with identifying tags.

B. Acceptance At Site:
   1. Reinforcing Bars: Deliver reinforcing bars accompanied by manufacturer's guarantee of grade.

C. Storage:
   1. All rebar shall be stored on dunnage.

1.06 SEQUENCING AND SCHEDULING

A. Bar Supports: Do not place concrete until samples and attached data of bar supports has been accepted by the ENGINEER.

PART 2 PRODUCTS

2.01 MATERIALS

A. Reinforcement:
   1. General: Provide reinforcing steel that is new material, of quality specified, free from excessive rust or scale or any defects affecting its usefulness.

B. Reinforcing Bars:
   1. Reinforcing Bars to be Embedded in Concrete or Masonry: Grade 60 deformed bars conforming to ASTM A 615 except as specified in the next subparagraph.
   2. Reinforcement resisting earthquake-induced flexural and axial forces in concrete frame members and in concrete wall boundary members shall comply with low alloy ASTM A 706. ASTM A 615 Grade 60 reinforcement may be used in these members if the following requirements are met:

a. The actual yield strength based on mill tests does not exceed the specified yield strength by more than 18,000 pounds per square inch (retest shall not exceed this value by more than an additional 3,000 pounds per square inch).
b. The ratio of the actual ultimate tensile stress to the actual tensile yield strength is not less than 1.25.

3. Hot-Dip Galvanized Reinforcing Bars:
   a. When reinforcing bars are indicated on the Drawings to be hot-dip galvanized, perform such galvanizing in accordance with ASTM A 767 and ATM A 143.
   b. Galvanizing: Galvanize bars in conformance with Class 1 coating and perform galvanizing after fabrication and shearing.
4. Thread Bars:
   a. Provide thread bars having continuous rolled-in patter of thread-like deformations along entire length.
   b. Provide hex nuts and couplers for the thread bars that develop 125 percent of yield strength of bar.
   c. Thread Bars:
      1) Conform to ASTM A 615 Grade 60.
   d. Do not substitute cut threads on regular reinforcing bars for thread bars.

C. Bar Supports:
1. Reinforcement Support Chairs:
   a. Hot-dip galvanized steel. Provide hot-dip galvanized steel with plastic tips at surfaces which will be exposed to view. Use unless otherwise indicated on the Drawings.
   b. Stainless Steel where indicated on the Drawings.
   c. Provide concrete adobe blocks to support rebar associated with building foundation slabs.
   d. Other suitable material approved by ENGINEER.

D. Tie Wires: Annealed Steel.

2.02 FABRICATION

A. Shop Assembly:
1. Cut and bend bars in accordance with provisions of ACI 315 and ACI 318.
2. Bend bars cold.
3. Provide bars free from defects and kinks and from bends not indicated on the Drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Conditions:
   1. Reinforcing Bars:
      a. Verify that bars are new stock free from rust scale, loose mill scale, excessive rust, dirt, oil, and other coatings which adversely affect bonding capacity when placed in the work.

3.02 PREPARATION

A. Surface Preparation:
   1. Reinforcing Bars: Thin coating of red rust resulting from short exposure will not be considered objectionable. Thoroughly clean any bars having rust scale, lose mill scale, or thick rust coat.
   2. Cleaning of Reinforcement Materials: Remove concrete of other deleterious coatings from dowels and other projecting bars by wire brushing or sandblasting before bars are embedded in subsequent concrete placement.

3.03 INSTALLATION

A. Reinforcing Bars:
   1. No field bending of bars will be allowed on bars larger than #4.
   2. Welding:
      a. Weld reinforcing bars where indicted on the Drawings or acceptable to the ENGINEER.
      b. Perform welding in accordance with AWS D1.4.

B. Placing Reinforcing Bars:
   1. Accurately place bars and adequately secure them in position.
   2. Overlap bars at splices as specified or indicated on the Drawings.
   3. Unless specifically otherwise indicated on the Drawings, install bars at lap splices in contact with each other and fasten bars together with tie wire.
   4. If lap splice length for bars in concrete is not specified or indicated on the Drawings, bars shall be lap spliced in accordance with ACI 318.
   5. Bar Supports:
      a. Provide in sufficient number to prevent sagging and to support loads during construction, but in no case less than quantities and at locations as indicated in ACI 315.
      b. Support reinforcing for concrete places on ground by standard manufactured chairs, with steel plates for resting on ground.
      c. Do not use brick, broken concrete masonry units, spalls, rocks, or similar material for supporting reinforcing steel.
   6. If not indicated on the Drawings, provide protective concrete cover in accordance with ACI 318.

C. Tying of Bar Reinforcement:
   1. Fasten bars securely in place with wire ties.
   2. Tie bars sufficiently often to prevent shifting.
   3. There shall be at least 3 ties in each bar length (does not apply to dowel lap splices or to bars shorter than 4 feet, unless necessary for rigidity).
   4. Tie slab bars at every intersection around periphery of slab.
   5. Tie wall bar and slab bar intersections other than around periphery at not less than every fourth intersection, but at not greater than following maximum spacing:

Bar Size	Slab Bars Spacing (Inches)	Wall Bars Spacing (Inches)
Bars Number 5 and Smaller	60	48
Bars Number 6 through Number 9	96	60
Bars Number 10 and Number 11	120	96

   6. After tying wire ties, bend ends of wire ties in towards the center of the concrete section. Wire ties shall conform to the cover requirements of the reinforcing bars.

D. Lap Splices of Reinforcing Bars:
   1. Where bars are to be lapped spliced at joints in concrete, ensure bars project from concrete first placed, minimum length equal to lap splice length indicated on the Drawings.
   2. Where lap splice length is not indicated on the Drawings, then provide lap splice length as specified in ACI 318 and this Division.

E. Welded Wire Fabric Reinforcement:
   1. Install necessary wiring, spacing chairs, or supports to keep welded wire fabric in place while concrete is being placed.
   2. Bend fabric as indicated on the Drawings or required to fit work.
   3. Unroll or otherwise straighten fabric to make perfectly flat sheet before placing in the Work.
   4. Lap splice welded wire fabric as indicated on the Drawings.
   5. If lap splice length is not shown on the Drawings, splice fabric in accordance with ACI 318.

END OF SECTION

SECTION 03301

EPOXIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Epoxy.
   2. Epoxy gel.
   3. Epoxy bonding agent.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. D 638 - Test Method for Tensile Properties of Plastics.
   2. D 695 - Test Method for Compressive Properties of Rigid Plastics.
   3. D 790 - Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

1.03 SYSTEM DESCRIPTION

A. Performance Requirements:
   1. Provide epoxy materials that are new and use them within shelf life limitations set forth by manufacturer.
   2. Perform and conduct work of this Section in neat orderly manner.

1.04 SUBMITTALS

A. Not Used.

PART 2 PRODUCTS

2.01 MATERIALS

A. Epoxy: Water-insensitive two-part type low viscosity epoxy adhesive material containing 100 percent solids and meeting or exceeding following characteristics when tested in accordance with standards specified: Manufacturers: One of the following or equal:
   1. Master Builders, Inc., Concressive Standard LVI.
   2. Sika Chemical Corp.'s, Sikadur 35 Hi-Mod LV.

Physical Characteristic	Test Method	Required Results
Tensile Strength	ASTM D 638	8,000 pounds per square inch at 14 days and 77 deg. F cure.
Flexure Strength	ASTM D 790	11,000 pounds per square inch at 14 days and 77 deg. F cure.
Compressive Strength	ASTM D 695	16,000 pounds per square inch at 24 hours and 77 deg. F cure.
Bond Strength	N/A	Concrete shall fail before failure of epoxy.
Gel Time in 5-Mil Film	N/A	Four hours maximum at 77 deg. F
Elongation	ASTM D 638	1 percent minimum at 14 days and 77 deg. F

B. Epoxy Gel: Manufactures: One of the following or pre-approved equal:
   1. Sika Chemical Corp.'s, Sikadur 31 Hi-Mod Gel.

C. Epoxy Bonding Agent: Manufacturers: One of the following or pre-approved equal:
   1. Master Builders, Inc., Concressive 1001 Liquid LPL.
   2. Sika Chemical Corp.'s, Sikadur 32 Hi-Mod.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install and cure epoxy materials in accordance with manufacturer's installation instructions.

B. Epoxy:
   1. Apply in accordance with manufacturer's installation instructions.

C. Epoxy Gel:
   1. Apply in accordance with manufacturer's installation instructions.
   2. Use for vertical or overhead work, or where high viscosity epoxy is required.
   3. Epoxy gel used for vertical or overhead work may be used for horizontal work.

D. Epoxy Bonding Agent:
   1. Apply in accordance with manufacturer's installation instructions.
   2. Bonding agent will not be required for filling form tie hole or for normal finishing and patching of similar sizes small defects.

END OF SECTION

DIVISION 5

METALS

SECTION 05052

ANCHOR BOLTS, TOGGLE BOLTS AND CONCRETE INSERTS

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown on the Drawings, specified, and required to furnish and install anchor bolts, toggle bolts and concrete inserts.

B. This Section includes all anchor bolts, toggles and inserts required for the Work, but not specified under other Sections.

C. The types of Work using the anchor bolts, toggles and inserts include, but are not limited to the following:
   1. Hangers and brackets.
   2. Equipment.
   3. Piping.
   4. Electrical and Plumbing Work.
   5. Metal and plastic fabrications.
   6. Structural members and accessories.

D. Related Sections: CONTRACTOR shall coordinate the requirements of the Work in this Section along with the requirements of the Sections listed below which includes, but is not necessary limited to, Work that is directly related to this Section.

1.02 QUALITY ASSURANCE

A. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown and specified.
   1. ASTM A 36 - Specification for Carbon Structural Steel.
   2. ASTM A 123 - Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   3. ASTM A 153 - Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   4. ASTM A 307 - Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   5. ASTM A 484 - Specification for General Requirements for Stainless and Heat-Resisting Steel Bars, Billets and Forgings.
   6. ASTM A 536 - Specification for Ductile Iron Castings.
   7. ASTM B 633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel.

8. ASTM F 593 - Stainless Steel Bolts; Hex Cap Screws, and Studs.
9. Federal Specification FF-S-325 for Concrete Expansion Anchors.
10. Federal Specifications WW-H-171E for Malleable Iron.
11. ICBO, International Conference of Building Officials.
12. International Building Code

B. Inserts shall be ICBO, UL or FM approved.

C. Toggle Bolts: Federal Specification FF-B-588C - Type I, Class A, Style 1.

1.03 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Copies of manufacturer's specifications, load tables, dimension diagrams and installation instructions for the devices.
2. Copies of ICBO, UL or FM Reports certifying load carrying capacities and installation requirements for the anchorage devices.

PART 2 PRODUCTS

2.01 DESIGN CRITERIA

A. When the size, length or load carrying capacity of an anchor bolt, toggle bolt, or concrete insert is not shown on the Drawings, provide the following:
1. For anchor bolts (cast-in-place), provide the size, length and capacity required to carry the design load based on the values and requirements given in the International Building Code.
2. For concrete anchors (epoxy adhesive types), stud type expansion anchors, and concrete inserts, provide the size, length, type, and capacity required to carry the design load based on the values and requirements given in the ICBO Evaluation Report, or similar certifications by UL or FM, for the anchor to be used. Alternately the capacity may be based on independent testing lab capacities for tension and shear strength using a minimum safety factor of four. Consideration of reduced capacity due to spacing and edge distance shall be made.

B. Determine design loads as follows:
1. For equipment anchors, use the design load recommended by the equipment manufacturer.
2. For pipe hangers and supports, use the total weight of: pipe, fittings, and water contained in pipe, plus the full weight of valves and accessories located between the hanger or support in question.
3. Allowances for vibration shall be included.

4. Concrete anchors shall develop ultimate shear and pull-out loads of not less than the following values in 4,000 psi concrete:

Bolt Diameter (Inches)	Min. Shear (Pounds)	Min. Pull-Out Load (Pounds)
½	5,000	7,600
5/8	8,000	12,000
3/4	11,500	17,000
7/8	15,700	20,400
1	20,500	28,400

2.02 APPLICATION

A. In masonry, only anchor bolts shall be used.

B. Anchor Bolts (cast-in-place):
1. Shall be used where indicated and may be used where concrete anchors are indicated.
2. Where an anchor bolt is indicated, only a cast-in-place anchor bolt shall be used, unless another anchor type is accepted by the ENGINEER.
3. Provide anchor bolts as shown on the Drawings or as required to secure structural steel to concrete or masonry.

C. Epoxy Adhesive Anchors:
1. Use where subject to vibration or where buried or submerged.
2. Use for pipe supports.
3. Use in concrete.
4. Shall not be used for pipe hangers.

D. Concrete Inserts:
1. Use only where indicated on the Drawings.
2. Use for pipe hangers and supports for the pipe size and loading recommended by the insert manufacturer.

E. Toggle Bolts:
1. Use for fastening brackets and other elements onto masonry units.

F. Stud Type Expansion Anchors:
1. Use only when indicted on the Drawings.

2.03 MATERIALS

A. Anchor Bolts:
1. Provide carbon steel bolts complying with ASTM A 307 - headed or non-headed type where indicated.

2. In buried or submerged locations, provide stainless steel bolts complete with washers complying with ASTM F 593 - AISI Type 316 and with nitronic 60 stainless steel nuts and locknuts.
3. For equipment, provide anchor bolts, which meet the equipment manufacturer's recommendations for size, material, and strength.
4. Provide anchor bolts as shown on the Drawings or as required to secure structural steel to concrete or masonry.
5. Locate and accurately set the anchor bolts using templates or other devices as required.
6. Protect threads and shank from damage during installation of equipment and structural steel.
7. Comply with manufacturer's required embedment length and necessary anchor bolt projection.

B. Epoxy Adhesive Anchors:
1. Provide stainless steel adhesive anchors complying with ASTM F 593 - AISI Type 316 with nitronic 60 stainless steel nuts and locknuts.
2. In buried or submerged locations, provide stainless steel adhesive anchors complying with ASTM F 593 - AISI Type 316 with nitronic 60 stainless steel nuts and locknuts.
3. Anchors shall be of the size required for the concrete strength specified.
4. Adhesive anchors shall consist of threaded rods or bolts anchored with an adhesive system into hardened concrete or grout-filled masonry. The adhesive system shall use a two-component adhesive mix and shall be injected with a static mixing nozzle following manufacturer's instructions. The embedment depth of the rod/bolt shall provide a minimum allowable bond strength that is equal to the allowable tensile capacity of the rod/bolt, unless noted otherwise on the Drawings.
5. Product and Manufacturer: Provide one of the following:
   a. RE 500 Epoxy Injection Adhesive Anchor System, as manufactured by Hilti.
   b. Or equal.

C. Concrete Inserts:
1. For piping, grating and floor plate, provide malleable iron inserts. Comply with Federal Specification WW-H-171E (Type 18). Provide those recommended by the manufacturer for the required loading.
2. Finish shall be black.
3. Product and Manufacturer: Provide inserts by one of the following:
   a. Figure 282, as manufactured by ITT Grinnell.
   b. No. 380, as manufactured by Hohmann and Barnard, Incorporated.
   c. Or equal.

D. Toggle Bolts:
1. Provide spring-wing toggle bolts, with two-piece wings.
2. Provide carbon steel bolts with zinc coating in accordance with Federal Specification FF-S-325.
3. Product and Manufacturer: Provide toggle bolts by one of the following:

a. The Rawlplug Company, Incorporated.
b. Haydon Bolts, Incorporated.
c. Or equal.

E. Stud Type Expansion Anchors:
1. Product and manufacturer
a. Kwik-Bolt 3.
b. Or equal.

F. Powder activated fasteners and other types of bolts and fasteners not specified herein shall not be used.

PART 3 EXECUTION

3.01 INSPECTION

A. CONTRACTOR shall examine areas and conditions under which anchor bolts, toggle bolts and concrete insert Work is to be installed.

3.02 INSTALLATION

A. Assure that embedded items are protected from damage and are not filled in with concrete.

B. Use concrete inserts for pipe hangers and supports for the pipe size and loading recommended by the insert manufacturer.

C. Use toggle bolts for fastening brackets and other elements onto masonry units.

D. For the epoxy adhesive anchors and adhesive material, CONTRACTOR shall comply with the manufacturer's installation instructions on the hole diameter and depth required to fully develop the tensile strength of the adhesive anchor or reinforcing bar. Contractor shall properly clean out the hole utilizing a wire brush and compressed air to remove all loose material from the hole, prior to installing adhesive capsules or material.

3.03 CLEANING

A. After embedding concrete is placed, remove protection and clean bolts and inserts.

END OF SECTION

DIVISION 7

THERMAL AND MOISTURE PROTECTION

SECTION 07920

CAULKING AND SEALANTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope:
1. Provide all labor, materials, tools, equipment and incidentals as shown on the Drawings, specified and required to furnish and install caulking and sealants.
2. Extent of each type of caulking and sealant is shown on the Drawings and includes the following:
a. All joints between concrete members and masonry.
b. All concrete to concrete joints.
c. All metal to metal joints.
d. All joints between masonry and metal.
e. All expansion joints in masonry and concrete.
f. All control joints.
g. All joints between reglets and flashing.
h. All sound-sealed and air-sealed joints.
i. As an exposed-to-view finish on the exposed face of all fire-rated sealants.
j. On both sides of all terminations of all construction systems, specified to receive caulking and sealants, where construction system remains exposed-to-view in the finished Work.
k. All isolation joints between equipment and other items.
l. All joints where construction systems are discontinuous or inherently non-watertight.
m. All locations whether or not shown on the Drawings, required to render the building watertight, except where a construction system is specified or shown as not relying upon the use of sealants in order to achieve weather and watertightness.
3. Types of products required include the following:
a. Two-component, urethane based, non-sag, elastomeric sealant.
b. Two-component, urethane based, self-leveling, elastomeric sealant.
c. Polyethylene backer rods.
d. Miscellaneous materials and accessories.

B. Coordination:
1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the caulking and sealants.
2. Coordinate the final selection of caulking and sealants to be compatible with all caulking and sealant substrates specified.

1.02 QUALITY ASSURANCE

A. Installer Qualifications: Engage a single installer regularly engaged in caulking and sealant installation and with successful experience in the application of the types of materials required, and who agrees to employ only tradesmen with specific skill and successful experience in this type of Work.

B. Job Mock-ups:
   1. Prior to the installation of caulking and sealant Work, but after ENGINEER'S approval of samples, install sample of each type of caulking and sealant in areas selected by ENGINEER to show a representative installation of the caulking and sealants. Obtain ENGINEER'S acceptance of visual qualities of the mock-ups before start of caulking and sealant Work. Retain and protect mock-ups during construction as a standard for judging completed caulking and sealant Work. Do not alter mock-ups.
   2. Caulking and sealant Work that does not meet the standard approved on the sample areas shall be stopped, removed and replaced with new material.

C. Source Quality Control: Obtain materials from only manufacturers who will, if required:
   1. Send a qualified technical representative to the site, for the purpose of advising installer of proper procedures and precautions for the use of the materials.
   2. Test caulking and sealants for compatibility with the substrates specified for conformance to FS-TT-S-0027, and recommend remedial procedures as required.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ASTM C 510, Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants.
   2. ASTM C 661, Test Method for Identation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
   3. ASTM C 793, Test Method for Effects of Accelerated Weathering on Elastomeric Joint Sealants.
   4. ASTM C 794, Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
   5. Federal Specification, FS TT-S-00227, Sealing Compound: Elastomeric Type, Multi-component for Caulking, Sealing, and Glazing in Buildings and Other Structures.

E. Compatibility: Before purchase of each specified sealant, investigate its compatibility with the joint surfaces, joint fillers and other materials in the joint system. Provide only materials (manufacturer's recommended variation of the specified materials) which are known to be fully compatible with the actual installation condition, as verified by manufacturer's published data or certification and as shown on approved Shop Drawings.

1.03 SUBMITTALS

A. Samples: Submit for approval the following:
   1. Each type of actual cured material samples of each caulking and sealant specified, 3-inches long, in each of the manufacturer's standard colors.
   2. Each size and type of sealant backer rod, 3-inches long, as recommended by the caulking and sealant manufacturer.
   3. Bond breaker tape as recommended by the manufacturer.
   4. Samples will be reviewed by ENGINEER for color and texture only. Compliance with other requirements is the responsibility of CONTRACTOR.
   5. Refer to and comply with the requirements of Section 01333, Samples.

B. Shop Drawings: Submit for approval the following:
   1. Copies of manufacturer's specifications, recommendations and installation instructions for each type of sealant, caulking compound and associated miscellaneous material required. Include manufacturer's published data, indicating that each material complies with the requirements and is intended for the applications shown.
   2. Pre-Installation Meeting report as specified in Paragraph 1.05.A., below.

C. Test Reports: Submit for approval the following:
   1. Compatibility tests for substrates, based on adhesion-in-peel standard test procedures and FS TT-S-0027.
   2. Certified laboratory test reports indicating conformance with the requirements.

D. Guarantee: Submit for approval the following:
   1. Copies of written guarantee agreeing to repair or replace sealants which fail to perform as specified. Refer to paragraph 1.06.A of this Section.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver materials in caulking and sealant manufacturer's original unopened, undamaged containers, indicating compliance with approved Shop Drawings and approved Sample color selections.
   2. Include the following information on the label:
      a. Name of material and supplier.
      b. Formula or specification number, lot number, color and date of manufacture.
      c. Mixing instructions, shelf life and curing time, when applicable.
   3. Failure to comply with these requirements shall be sufficient cause for rejection of the material in question, by ENGINEER. Immediately remove rejected materials from the site and do not offer them again for approval by ENGINEER. Supply new material conforming to the specified requirements, at no additional expense to OWNER.

B. Storage and Handling of Materials:
   1. Store materials so as to preclude the inclusion of foreign materials.
   2. Do not store or expose materials to temperature above 90°F or store in direct sunshine.
   3. Do not use materials which are outdated as indicated by shelf life.
   4. Store sealant tape in a manner which will not deform the tape.
   5. In cool or cold weather, store containers where temperature approximates 75°F for 16 hours before using.
   6. When high temperatures prevail, store mixed sealants in a cool place.
   7. Refer to and comply with the requirements of Section 01661 - Storage of Materials and Equipment.
   8. Handle materials carefully to prevent inclusion of foreign materials.
   9. Do not open containers or mix components until necessary preparatory Work and priming has been completed.

1.05 JOB CONDITIONS

A. Pre-Installation Meeting:
   1. Prior to the installation of the caulking and sealants and associated Work, schedule and meet at the job site with; the caulking and sealant installer, the calking and sealant manufacturer's technical representative, other trades involved in coordination with the caulking and sealant Work, the ENGINEER, and the OWNER. Record the discussions of the Pre-Installation Meeting and the decisions and agreements (or disagreements) and furnish a copy of the record to each party attending. Review foreseeable methods and procedures related to the caulking and sealant Work, including but not necessarily limited to the following:
      a. Review project requirements, including Drawings, Specifications and other Contract Documents.
      b. Review required submittals, both completed and yet to be completed.
      c. Review status of substrate and similar considerations.
      d. Review each major caulking and sealant application required.
      e. Review availability of materials, tradesmen, equipment and facilities needed to make progress and avoid delays.
   2. Reconvene the meeting at the earliest opportunity if additional information must be developed in order to conclude the subjects under consideration.

B. Environmental Conditions:
   1. Do not proceed with installation of caulking and sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.
   2. Proceed with the Work only when forecasted weather conditions are favorable for proper cure and development of high early bond strength.
   3. Wherever joint width is affected by ambient temperature variations, install elastomeric sealants only when temperatures are in the lower third of manufacturer's recommended installation temperature range, so that sealant

will not be subjected to excessive elongation and bond stress at subsequent low temperatures.

4. When high temperatures prevail avoid mixing sealants in direct sunlight.

C. Protection: Do not allow caulking and sealants to overflow or spill onto adjoining surfaces, or to migrate into the voids of adjoining surfaces including rough textured materials. Use masking tape or other precautionary devices to prevent staining of adjoining surfaces, by either the primer/sealer or the caulking and sealant materials.

1.06 GUARANTEE

A. Provide a written guarantee agreeing to repair or replace sealants which fail to perform as air-tight and watertight joints; or fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability; or appear to deteriorate in any other manner not clearly specified by submitted manufacturer's data, as an inherent quality of the material for the exposure indicated. Provide guarantee signed by installer and CONTRACTOR. Provide guarantee period of two years from Final Completion. Refer to paragraph 1.03.D.1 of this Section.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Exterior and Interior Horizontal and Vertical Joints; submerged and intermittently submerged:

1. Two-Component Polysulfide Sealant:

a. Polysulfide-based, 2-part elastomeric sealant complying with the following:

1) Thiokol's Building Trade Performance Specifications: Type II Class A (non-sag).

2) Adhesion-in-Peel, FS TT-S-00227E and ASTM C 794 (minimum 5 lbs.): Glass, minimum 21 lbs./linear inch; Aluminum, minimum 18 lbs/ linear inch; Concrete, minimum 21 lbs/linear inch.

3) Hardness (Standard Conditions), ASTM C 661: 15 to 50 (Shore A).

4) Stain and Color Change, FS TT-S-00227E and ASTM C 510: No discoloration or stain.

5) Accelerated Aging, ASTM C 793: No change in sealant characteristics after 250 hours in weatherometer.

6) Rheological Vertical Displacement at 120°F, FS TT-S-00227E: No sag.

b. Product and Manufacturer: Provide one of the following:

1) Sonnolastic Two-Part by Sonneborn Building Products, Division of Chemrex, Inc.

2) Lasto-Meric by Tremco.
3) Or equal.

B. Exterior and Interior Vertical Joints; non submerged:
1. Two-Component Urethane Sealant:
a Urethane-based, 2-part elastomeric sealant complying with the following:
1) FS TT-S-00227E: Type II (non-sag) Class A.
2) Adhesion-in-Peel, FS TT-S-00227E and ASTM C 794: (Minimum 5 lbs/linear inch with no adhesion failure): 28 lbs.
3) Hardness (Standard Conditions), ASTM C 661: 15 to 50 (Shore A).
4) Stain and color change, FS TT-S-00227E and ASTM C 510: No discoloration or stain.
5) Accelerated Aging, ASTM C 793: No change in sealant characteristics after 250 hours in weatherometer.
6) Rheological Vertical Displacement at 120°F, FS TT-S-00227E: No sag.
b. Product and Manufacturer: Provide one of the following:
1) Sonolastic NP 2 by Sonneborn Building Products, Division of Chemrex, Inc.
2) Dymeric by Tremco.
3) Or equal.

C. Exterior and Interior Horizontal Joints; non submerged:
1. Two-Component Polyurethane Sealant:
a. Polyurethane-based, 2-part elastomeric sealant complying with the following:
1) FS TT-S-00227E, Type I (self-leveling) Class A.
2) Water Immersion Bond, FS TT-S-00227E: Elongation of 25 percent with no adhesive failure.
3) Hardness (Standard Conditions), ASTM C 661: 35 to 45.
4) Stain and Color Change, FS TT-S-00227E and ASTM C 510: No discoloration or stain.
5) Accelerated Aging, ASTM C 793: No change in sealant characteristics after 250 hours in weatherometer.
b. Product and Manufacturer: Provide one of the following:
1) SL_2 Sealant by Sonneborn Building Products, Division of Chemrex, Inc.
2) THC/900 by Tremco.
3) Or equal.

D. Provide colors selected by ENGINEER from caulking and sealant manufacturer's standard and custom color charts. "Or equal" manufacturers shall provide the same generic products and colors as available from manufacturers specified.

E. Miscellaneous Materials:

1. Joint Cleaner: As recommended by the caulking and sealant manufacturer.
2. Joint Primer and Sealer: As recommended by the caulking and sealant manufacturer.
3. Bond Breaker Type: Polyethylene tape or other plastic tape as recommended by the caulking and sealant manufacturer, to be applied to sealant-contact surfaces where bond to the substrate or joint filler must be avoided for proper performance of caulking and sealant. Provide self-adhesive tape, wherever applicable.
4. Sealant Backer Rod: Compressible rod stock polyethylene foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable nonabsorptive material as recommended for compatibility with caulking and sealant by the caulking and sealant manufacturer. Provide size and shape of rod which will control the joint depth for sealant placement, break bond of sealant at bottom of joint, form optimum shape of sealant bead on back side, and provide a highly compressible backer to minimize the possibility of sealant extrusion when joint is compressed.
5. Low Temperature Catalyst: As recommended by the calking and sealant manufacturer.

2.02 MIXING

A. Comply with sealant manufacturer's written instructions for mixing two-component sealants.

B. Thoroughly mix components before use.

C. Add entire contents of activator can to base container. Do not mix partial units.

D. Mix contents for a minimum of five minutes or as recommended by the sealant manufacturer, until color and consistency are uniform.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine joint surfaces, substrates, backing, and anchorage of units forming sealant rabbet, and the conditions under which the caulking and sealant Work is to be performed, and notify ENGINEER, in writing, of any conditions detrimental to the proper and timely completion of the Work and performance of the sealants. Do not proceed with the calking and sealant Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.02 JOINT SURFACE PREPARATION

A. Clean joint surfaces immediately before installation of sealant compound. Remove dirt, weakly adhering coatings, moisture and other substances which would interfere with bonds of sealant compound as recommended by sealant manufacturer's written instructions as shown on approved Shop Drawings.

B. Etch concrete and masonry joint surfaces to remove excess alkalinity, unless sealant manufacturer's written instructions, as shown on approved Shop Drawings, indicate that alkalinity does not interfere with sealant bond and performance.
   1. Etch with five percent solution of muriatic acid.
   2. Neutralize with dilute ammonia solution.
   3. Rinse thoroughly with water and allow to dry before sealant installation.

C. If necessary, clean porous materials such as concrete and masonry by grinding, sand blasting or mechanical abrading. Blow out joints with oil-free compressed air, or by vacuuming joints prior to application of primer or sealant.

D. Roughen joint surfaces on vitreous coated and similar non-porous materials, wherever sealant manufacturer's data indicates lower bond strength than for porous surfaces. Rub with fine abrasive cloth or steel wool to produce a dull sheen.

3.03 INSTALLATION

A. Comply with sealant manufacturer's written instructions, except where more stringent requirements are shown on the Drawings or specified and except where manufacturer's technical representative directs otherwise; but only as approved by ENGINEER.

B. Prime or seal the joint surfaces as shown on approved Shop Drawings. Do not allow primer or sealer to spill or migrate onto adjoining surfaces. Allow primer to dry prior to application of sealants.

C. Apply masking tape before installation of primer, in continuous strips in alignment with the joint edge to produce sharp, clean interface with adjoining materials. Remove tape immediately after joints have been sealed and tooled as directed.

D. Do not install sealants without backer rods or bond breaker tape.

E. Roll the back-up rod stock into the joint to avoid lengthwise stretching. Do not twist, braid, puncture or prime backer-rods.

F. Employ only proven installation techniques, which will ensure that sealants will be deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of the joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface, slightly below adjoining

surfaces. Where horizontal joints are between a horizontal surface and a vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.

G. Install sealants to depths as recommended by the sealant manufacturer, but within the following general limitations, measured at the center (thin) section of the bead.
   1. For horizontal joints in sidewalks, pavements and similar locations sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75 percent of joint width, but not more than 5/8-inch deep or less than 3/8-inch deep.
   2. For vertical joints subjected to normal movement and sealed with elastomeric sealants, but not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but not more than 1/2-inch deep or less than 1/4-inch deep.

H. Remove excess and spillage of compounds promptly as the Work progresses.

I. Cure caulking and sealant compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability.

3.04 FIELD QUALITY CONTROL

A. Where questions of compatibility of sealants and substrate arise, the sealant manufacturer shall test the substrate in question for compatibility with the specified sealant and report his findings, along with recommendations, to ENGINEER.

B. Do not proceed with installation of elastomeric sealants over joint surfaces which have been painted, lacquered, waterproofed or treated with water repellent or other treatment or coating unless a laboratory test for durability (adhesion), in compliance with FS TT-S-00227 has successfully demonstrated that sealant bond is not impaired by the coating or treatment. If laboratory test has not been performed, or shows bond interference, remove coating or treatment from joint surfaces before installing sealant.

C. After nominal cure of exterior joint sealants which are exposed to the weather, test for water leaks. Flood the joint exposure with water directed from a 3/4-inch diameter garden hose, without nozzle, held perpendicular to wall face, 2 feet - 0 inch from joint and connected to a water system with 30 psi minimum normal water pressure. Move stream of water along joint at an approximate rate of 20 feet per minute.

D. Test approximately five percent of total joint system, in locations which are typical of every joint condition, and which can be inspected easily for leakage on opposite face. Conduct test in the presence of ENGINEER, who will determine the actual percentage of joints to be tested and the actual period of exposure to water from the hose, based upon the extent of observed leakage, or lack thereof.

E. Where nature of observed leakage indicates the possibility of inadequate joint bond strength, ENGINEER may direct that additional testing be performed at a time when joints are fully cured, and before Substantial Completion of the Work.

3.05 ADJUSTMENT AND CLEANING

A. Repair sealant installation at leaks or, if leakage is excessive, replace sealant installation.

B. Clean adjacent surfaces of sealant and soiling resulting from the Work. Use solvent or cleaning agent recommended by the sealant manufacturer. Leave all finish Work in a neat and clean condition.

C. Protect the sealants during the construction period so that they will be without deterioration, soiling, or damage at the time of Final Completion.

END OF SECTION

DIVISION 9

FINISHES

SECTION 09800

SPECIAL COATINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Field applied high performance coatings. All exposed surfaces of equipment, piping, supports shall be field finished, unless specifically stated otherwise.

B. See Drawings.

1.02 REFERENCES

A. NSF International (NSF):
1. 61 - Drinking Water System Components - Health Effects.

B. American National Standards Institute (ANSI):
1. A159.1 - Surface Preparation Specifications.

C. American Society for Testing and Materials (ASTM):
1. D 16 - Terminology Relating for Paint, Related Coatings, Materials, and Applications.
2. D 4417, Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel.
3. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

D. American Water Works Association (AWWA):
1. C652 Disinfection of Water Storage Facilities.
2. D102 - Coating Steel Water Storage Tanks.

E. The Society for Protective Coatings (SSPC):
1. SP 1 - Solvent Cleaning.
2. SP 2 - Hand Tool Cleaning.
3. SP 3 - Power Tool Cleaning.
4. SP 6 - Commercial Blast Cleaning.
5. SP 7 - Brush-off Blast Cleaning.
6. SP 10 - Near White Metal Blast Cleaning.
7. SP 11 - Power Tool Cleaning to Bare Metal.
8. Steel Structures Painting Manual, Volumes 1 and 2.
9. VIS 1 - Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning.

10. VIS 3 - Guide and Reference Photographs for Steel Surfaces Prepared by Hand and Power Tool Cleaning.
11. PA1 - Shop, Field, and Maintenance Painting of Steel, latest revision.
12. PA2 Level 3- Procedure for Determining Conformance to Dry Coating Thickness Requirements.
13. PA10-Guide to Safety and Health Requirements.
14. Guide 6-Guide for Containing Surface Preparation Debris Generated During Paint Removal Operations.
15. Guide 12-Guide for Illumination of Industrial Painting Projects.

F. National Association of Corrosion Engineers (NACE International)
1. SP0188-Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
2. Publication 6D-173-A Manual for Painter Safety.

1.03 DEFINITIONS

A. Submerged Metal: Steel or iron surfaces below tops of channel or structure walls which will contain water even when above expected water level.

B. Dry Film Thickness (DFT): Thickness of fully cured coating, measured in mils (1/1000 inch).

C. Wet Film Thickness (WFT): Thickness of freshly applied coating, measured in mils (1/1000 inch).

D. Volatile Organic Compound (VOC): Content of air polluting hydrocarbons in uncured coating products measured in units of grams per liter or pounds per gallon.

E. Rust Spot: Rusted surface with area smaller than 0.05 SQ.FT.

F. Installer or Applicator: Installer or applicator is the person actually installing or applying the product in the field at the Project site. Installer or applicator are synonymous. Installer or Applicator may be the CONTRACTOR.

G. Inaccessible Areas: Areas of the finished structure that, by virtue of the configuration of the completed structure, cannot be accessed to perform surface preparation or coating application (with or without the use of scaffolding, rigging, or staging).

H. Holiday: A void, crack, thin spot, foreign inclusion, or contamination in the coating film that significantly lowers the dielectric strength of the coating. May also be identified as a pinhole.

I. The term “coating” and “lining” as used herein are considered interchangeable and mean coating systems materials, including any applicable resinous primers and finish coats that function to provide protection of steel substrates.

J. Touch-Up Coating: The application of a coating on areas of coated surfaces to repair marks, scratches, and areas where the coating has deteriorated to restore the coating film to an unbroken condition.

K. Shop Coat: One or more coats applied in a shop or plant prior to shipment to the site, where the field or finishing coat is applied.

1.04 PERFORMANCE REQUIREMENTS

A. Coating materials for metal surfaces shall be especially adapted for steel vessels used for potable water purposes.

B. Coating materials that come into contact with potable water shall be certified to NSF Standard 61.

1.05 SUBMITTALS

A. Product Data: Include description of physical properties of coatings including solids content and ingredient analysis, VOC content, temperature resistance, typical exposures and limitations, and manufacturer’s standard color chips.

B. Certificates: Provide certificate stating that the used coating systems meet the Section 09800 requirements.

C. Manufacturer’s Instructions: Submit in accordance with requirements for Product Data. Include:
1. Special requirements for transportation and storage.
2. Mixing instructions.
3. Shelf life.
4. Pot life of material.
5. Precautions for applications free of defects.
6. Surface preparation.
7. Method of application.
8. Recommended number of coats.
9. Recommended thickness of each coat.
10. Recommended total thickness.
11. Drying time of each coat, including prime coat.
12. Required prime coat.
13. Compatible and non-compatible prime coats.
14. Recommended thinners, when recommended.
15. Limits of ambient conditions during and after application.

16. Time allowed between coats.
17. Required protection from sun, wind and other conditions.
18. Touch-up requirements and limitations.
19. Material Safety Data Sheet.

1.06 QUALITY ASSURANCE

A. Qualifications of CONTRACTOR and Applicator:
   1. Minimum of five years of continuous experience in applying specified products or similar type products under the conditions similar to those of the Work.
   2. CONTRACTOR is completely responsible to insure that applicator personnel are completely trained and experienced in the proper use of all specified/submitted coating and lining materials, surface preparation and application equipment being used for the project.

B. Regulatory Requirements: Comply with requirements regarding the following:
   1. Volatile organic compound limitations.
   2. Coatings containing lead compounds.
   3. NSF certification of coatings for use in potable water supply systems.
   4. Abrasives and abrasive blast cleaning techniques, and disposal.

C. Compatibility of Coatings: Use products by same manufacturer for prime coats, intermediate coats, and finish coats on same surface, unless specified otherwise.

D. If any requirements of this specification conflict with a referenced standard, the more stringent requirement shall apply.

E. Do not use or retain contaminated, outdated, or diluted materials for coating operations. Do not use materials from previously opened containers.

F. Use only products of the approved manufacturer. Use products of one manufacturer in any one resurfacing system with compatible materials. Provide same material product for touch up as for original material.

G. Make available all locations and phases of the work for access by the ENGINEER or other personnel designated by the ENGINEER. The CONTRACTOR shall provide ventilation and egress to safely access the coating work areas for inspection.

H. Pre-Application Meetings:
   1. Pre-application meetings shall take place at the job-site a minimum 1 week before the application of any coating or lining work proceeding. Attendance is required of all principal decision making parties directly affecting work of this Section, including CONTRACTOR, ENGINEER, OWNER, Trades Persons of other work in and around the coatings work, Coating Applicator,

Coating Manufacturer's Technical Representative, and ENGINEER'S Coating Inspector.

I. Coating Application Log:

1. Coating Application Log shall be maintained on a daily basis for all areas where the Work is being performed. The Coating Application Logs shall be turned over to the ENGINEER at the end of each week (during surface preparation and coating application) of the work was performed. The log shall include the following:
   a. Date.
   b. Time.
   c. Weather condition (at work location).
   d. Air temperature (at work location).
   e. Surface temperature (at work location).
   f. Dew point (at work location).
   g. Humidity (at work location).
   h. Wind direction, wind speed, and surface temperature a minimum of three (3) times per day for each day the CONTRACTOR is on site completing the work. The CONTRACTOR shall also record the interior metal surface temperatures on sides of vessel that are shaded and not shaded from the sun.
   i. Material temperature Before (Separately) and Mixed (Combined).
   j. Location/area square footage of area coated.
   k. Description of work performed.
   l. Materials used, colors and batch numbers, quantity of materials used (not including waste).
   m. Application/surface preparation equipment and personnel.
   n. WFT/surface profile measurements.
   o. Comments, quality control procedures.
   p. Signature/title.

1.07 PROJECT CONDITIONS

A. Proceed with surface preparation and coating application only when air and surface temperatures are above the manufacturers' recommended minimum surface temperature and below the manufacturer's recommended maximum. Coating shall not be applied to dusty, wet, or damp surfaces, and shall not be applied in rain, snow, fog or mist, or when relative humidity exceeds 85 percent. No coating shall be applied when it is expected that the relative humidity will exceed 85 percent or when the air temperature will drop below 40 degrees Fahrenheit within 8 hours after the application of the coating. If working conditions are questionable, the ENGINEER shall make the decision and the CONTRACTOR shall accept ENGINEER'S interpretation as final and binding.

B. For interior surfaces, provide adequate continuous ventilation and sufficient heating facilities to maintain minimum 45 degrees Fahrenheit for 24 hours before, during, and 48 hours after application of finishes.

C. Provide fans, heating devices, dehumidification or other means recommended by coating manufacturer to prevent formation of condensate or dew on surface or substrate, intermediate coats, and within curing time following application of last coat.

D. No surface preparation or coating application work shall be done under unfavorable weather conditions, unless the work is adequately protected, and then only with the specific approval of the ENGINEER and inspection.

E. Before coating is started in any area, all surfaces to be coated and floors shall be cleaned of all dust using commercial vacuum cleaning equipment equipped with high-efficiency particulate air filters (HEPA filters) and dust containment systems. Just blowing down surface is not acceptable.

1.08 MAINTENANCE

A. Extra Materials: Provide minimum 1 gallon of each type and color of coating applied.
   1. When manufacturer packages material in gallon cans, deliver unopened labeled cans as comes from factory.
   2. When manufacturer does not package material in gallon cans, deliver material in new gallon containers, properly sealed and identified with typed labels indicating brand, type, and color.

1.09 PRODUCTS DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products in accordance with Section 01651.

B. Remove unspecified and unapproved paints from Project site immediately.

C. Deliver containers with labels identifying the manufacturer's name, brand name, product type, batch number, date of manufacturer, expiration date or shelf life, color, and mixing and reducing instructions.

D. Store coatings in well ventilated facility that provides protection from the sun weather, and fire hazards. Maintain ambient storage temperature between 45 and 90 degrees Fahrenheit, unless otherwise recommended by the manufacturer.

E. Take precautions to prevent fire and spontaneous combustion.

1.10 PROTECTION

A. Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being painted and in particular, surfaces within storage and preparation area.

D. Place cotton waste, cloths and material which may constitute fire hazard in closed metal containers and remove daily from site.

E. Remove electrical plates, surface hardware, fittings and fastenings, prior to coating operations. Carefully store, clean and replace on completion of coating in each area. Do not use solvent or degreasers to clean hardware that may remove permanent lacquer finish.

PART 2 PRODUCTS

2 .01 MATERIALS

A. General:
1. P = prime coat. I = intermediate coat. F = finish coat. Finish color to be selected by OWNER.
2. All coatings and products for each coating system shall be the product of a single coating manufacturer.
3. All materials brought to the jobsite shall be subject to inspection by ENGINEER.
4. Only full kits of approved coating shall be mixed. No partial kits will be saved or mixed at a later time.
5. All coating materials used must not contain more than 3.5 LBS/GAL VOC as applied (in a thinned state).
6. Coating thicknesses specified are minimum dry mil thicknesses.

B. Acceptable Manufacturers
1. Following are acceptable coating manufacturers:
a. Tnemec Coatings.
b. Carboline
c. Or pre-approved “Or Equal”.

C. Coating Systems (not all system number used):
1. System No. 3 - Polyamide Epoxy: For all assembled galvanized steel items; and all plastic including PVC, FRP, and CPVC surfaces. Exposed PVC and CPVC piping shall be painted.
a. Items may include PVC, FRP and CPVC piping.

P1 = Series 66 (gray), 1 coat, 3-5 mils DFT.
*F1 = Series 66 (white), 1 coat, 4-6 mils DFT.
F1E = Series 73 (beige), 1 coat, 2.5 - 3.5 mils DFT.

PART 3 EXECUTION

3.01 GENERAL PREPARATION

A. Prepare surfaces in accordance with coating manufacturer's instructions, unless more stringent requirements follow.

B. Protect following surfaces from abrasive blasting in accordance with Paragraph 1.10, by masking, or other means:
   1. Surfaces to be assembled against gaskets.
   2. Aluminum ladders, handrails and platforms.
   3. Field instruments like pressure gauges, pressure sensors, flow meters, electrical panels, etc.

C. Protect installed equipment, and adjacent coated equipment from abrasive blasting to prevent damage caused by entering sand or dust.

3.02 GENERAL PROTECTION

A. Protect adjacent surfaces not to be coated with drop cloths and other coverings.

B. Mask off surfaces of items not to be coated or remove items from area.

3.03 GENERAL APPLICATION REQUIREMENTS

A. Apply coatings in accordance with the coating manufacturer's most current written instructions.

B. Verify metal surface preparation immediately before applying coating in accordance with the specified cleanliness standard for that area.

C. Allow surfaces to dry, except where coating manufacturer requires surface wetting before coating.

D. Apply minimum number of specified coats.

E. Apply coats to thicknesses specified.

F. Apply additional coats when necessary to achieve specified thicknesses, especially at edges and corners.

G. Coat surfaces without runs, drops, ridges, waves, holiday, laps, or brush marks.

H. Remove spatter and droppings after completion of coating.

I. When multiple coats of same material are specified, tint prime coat and intermediate

coats with suitable pigment to distinguish each coat.

J. Dust coatings between coats: Lightly sand and dust surfaces to receive high gloss finishes, unless instructed otherwise by coating manufacturer.

M. Spray Application:
1. When using spray application, apply coating to thickness not greater than that suggested in coating manufacturer's instructions.
2. Use airless spray method, unless air spray method is required by coating manufacturer's instruction or these Specifications.
3. Conduct spray coating under controlled conditions. Protect adjacent construction and property from coating mist or spray.

N. Drying and Recoating:
1. Limit drying time to that required by coating manufacturer's instructions.
2. Do not allow excessive drying time or exposure which may impair bond between coats.
3. Recoat within time limits recommended by coating manufacturer.
4. When time limits are exceeded, re-prepare surface according to the coating manufacturer's most current written recommendations before applying another coat.
5. When limitations on time between abrasive blasting and coating cannot be met before attachment of components to surfaces which cannot be abrasive blasted, coat components before attachment.
6. Ensure primer and intermediate coats of coating are unscarred and completely integral at time of application of each succeeding coat.
7. Touch up suction spots between coats and apply additional coats where required to produce finished surface of solid, even color, free of defects.
8. Check for discontinuities on steel immersion surfaces using holiday detector (NACE SP0-188). Any discontinuities located shall be corrected in according to with the coating manufacturer's most current written recommendations/guidelines. All corrected discontinuities shall be re-tested according to (NACE SP0-188) until compliant.
9. Sand and recoat scratched, contaminated, or otherwise damaged coating surfaces so damages are invisible to naked eye.

O. DFT readings shall be recorded in accordance with SSPC PA2- Level 3.

3.04 FIELD QUALITY CONTROL

A. Inspection will be performed by the ENGINEER prior to and following the abrasive blasting and following each coat. Strip and remove defective coats, prepare surfaces and recoat. Successive coats shall only be applied following approval of previous coat or surface preparation.

B. Control and check dry film thicknesses and integrity of coatings.

C. Measure dry film thickness with calibrated thickness gauge.

D. Dry film thickness reading equipment to be used must be certified and still within certification during the inspection process.
   1. Ferrous and Non-Ferrous substrates - Type 1 or Type 2 dry film thickness gauges, manufactured by Elcometer, Delfelsko or equal.

3.05 SCHEDULES OF ITEMS NOT REQUIRING COATING

A. Galvanized pipe trays and cable trays.

B. Aluminum handrails, platform and ladder.

C. Fiberglass vessels

D. Nameplates.

E. Caution signs

F. Serial number tags.

G. Control Panels and Instruments.

3.06 CLEANING

A. As work proceeds and upon completion, promptly remove coating where spilled, splashed, or spattered.

B. Adjacent painted surfaces shall be protected from discoloration, scratching or other damage. Any touch-up painting required to damaged areas prior to project completion and acceptance belongs to CONTRACTOR.

C. After the vessel interior surface is inspected and approved by the OWNER or ENGINEER, the final sterilization of said interior shall be done by the CONTRACTOR at no cost to the OWNER.

D. The CONTRACTOR shall, at all times, keep the premises free from accumulations of waste material or rubbish caused by his employees or work. All unneeded construction equipment shall be removed from the site and all damages repaired expeditiously so that the adjacent property is inconvenienced as little as possible.

E. On or before the completion of work, the CONTRACTOR shall, unless otherwise directed in writing, remove all temporary works, tools and machinery or other construction equipment placed by him. He shall remove all rubbish from any

grounds that he has occupied and shall leave all of the premises and adjacent property affected by the operation in a neat and restored condition satisfactory to the ENGINEER.

3.07 DISINFECTION

A. CONTRACTOR shall be responsible for vessel disinfection. Disinfection shall conform to all applicable requirements of AWWA C652, and as specified below.

B. After the vessel has been coated and interior surface has been thoroughly and properly cured, the inside of the vessel shall be thoroughly cleaned. Interior of the vessel shall be disinfected by spraying all surfaces, including lateral piping, shell and roof manways, with a 200 ppm available chlorine solution. Solution shall remain in contact with surfaces for a minimum of 30 minutes. Technique shall be such that a sterile vessel will result. After spray disinfection, the vessel shall be filled to completely. Following this procedure and subject to satisfactory bacterial testing and acceptable aesthetic quality, the water shall be delivered to the distribution system.

C. The OWNER shall take a bacteria test of the water after disinfecting. If the water is considered not safe after testing, additional disinfecting and testing shall be performed by the CONTRACTOR at his expense until the vessel is tested safe for use as part of a potable water supply system.

D. The OWNER shall take a taste and odor test of the water after disinfecting to detect the presence of any volatile organic compounds (VOC's) imparted by the coating. If the water is not considered safe or acceptable after testing, further work shall be performed by the CONTRACTOR at his expense until the vessel is tested safe and acceptable for use as part of a potable water supply system.

E. Water for initial disinfection and filling and for any additional disinfection during the initial disinfection procedure to obtain satisfactory bacteriological samples, will be furnished by the OWNER. CONTRACTOR shall be responsible for all disinfection chemical required.

F. If the vessel must be emptied, re-sprayed, flushed and refilled to obtain satisfactory bacteriological samples, the OWNER will furnish additional water for the Work at the expense of CONTRACTOR. Additional disinfection chemical required costs shall belong to CONTRACTOR.

G. Supply all necessary pumps, hoses and other required equipment each time the vessel needs to be emptied.

3.08 FIRST ANNIVERSARY INSPECTION

A. Interior and exterior surfaces of the vessel shall be inspected by OWNER, ENGINEER and CONTRACTOR approximately 12 months after the coating work

has been completed. Inspection, remedial work, if required, and report shall all be provided as required by AWWA D 102, Section 5.2.

B. OWNER will conduct the vessel interior inspection.

C. If any vessel interior coating remedial work has to be performed, CONTRACTOR shall be responsible for all costs associated with the coating remedial work and disinfection of the vessel.

END OF SECTION

SECTION 09900

PAINTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Field applied paint and related materials for normal exposures.

B. Related Sections:
   1. Section 09800 - Special Coatings

1.02 DEFINITIONS

A. Paints: Manufacturer's best ready-mixed coatings, except when field catalyzed, with fully ground pigments having soft paste consistency and capable of being readily and uniformly dispersed to complete homogenous mixtures, having good flowing and brushing properties, and capable of drying or curing free of streaks or sags.

B. Volatile Organic Compound (VOC): Content of air polluting hydrocarbons in uncured coating products measured in units of grams per liter or pounds per gallon.

1.03 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01332. Include schedule of where and for what use coating materials are proposed in accordance with requirements for Product Data.

B. Product Data: Submit in accordance with Section 01332. Include description of physical properties of coatings including solids content and ingredient analysis, VOC content, temperature resistance, typical exposures and limitations, and manufacturer's standard color chips.

C. Samples: Submit in accordance with Section 01333. Include 8 inch square draw-downs or brush-outs of topcoat finish when requested. Identify each sample as to finish, formula, color name and number and sheen name and gloss units.

D. Manufacturer's Instructions: Submit in accordance with requirements for Product Data. Include:
   1. Special requirements for transportation and storage.
   2. Mixing instructions.
   3. Shelf life.
   4. Pot life of material.

5. Precautions for applications free of defects.
6. Surface preparation.
7. Method of application.
8. Recommended number of coats.
9. Recommended thickness of each coat.
10. Recommended total thickness.
11. Drying time of each coat, including prime coat.
12. Required prime coat.
13. Compatible and non-compatible prime coats.
14. Recommended thinners, when recommended.
15. Limits of ambient conditions during and after application.
16. Time allowed between coats.
17. Required protection from sun, wind and other conditions.
18. Touch-up requirements and limitations.
19. Material Safety Data Sheet.

1.04 QUALITY ASSURANCE

A. Products: First line or best grade.

B. Materials for Each Paint System: By single manufacturer.

C. Applicator Qualifications: Applicator of products similar to specified products with minimum 3 years experience.

D. Regulatory Requirements: Comply with by using paints that do not exceed governing agency's VOC limits or do not contain lead.

E. Field Sample: Paint one complete surface of each color scheme to show colors, finish texture, materials and workmanship. Obtain approval before painting other surfaces.

1.05 PRODUCTS DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle products in accordance with Section 01651.

B. Remove unspecified and unapproved paints from Project site immediately.

C. Deliver containers with labels identifying the manufacturer's name, brand name, product type, batch number, date of manufacturer, expiration date or shelf life, color, and mixing and reducing instructions.

D. Store coatings in well ventilated facility that provides protection from the sun weather, and fire hazards. Maintain ambient storage temperature between 45 and 90 degrees Fahrenheit, unless otherwise recommended by the manufacturer.

E. Take precautions to prevent fire and spontaneous combustion.

1.06 ENVIRONMENTAL CONDITIONS

A. Do not paint or coat:
   1. Under dusty conditions.
   2. When light on surfaces measures less than 15 foot-candles.
   3. When ambient or surface temperature is less than 45 degrees Fahrenheit.
   4. When relative humidity is higher than 85 percent.
   5. When surface temperature is less than 5 degrees Fahrenheit above dew point.
   6. When surface temperature exceeds the manufacturer's recommendation.
   7. When ambient temperature exceeds 90 degrees Fahrenheit, unless manufacturer allows a higher temperature.
   8. Apply clear finishes at minimum 65 degrees Fahrenheit.

B. Provide fans, heating devices, or other means recommended by coating manufacturer to prevent formation of condensate or dew on surface or substrate, coating between coats and within curing time following application of last coat.

C. Provide adequate continuous ventilation and sufficient heating facilities to maintain minimum 45 degrees Fahrenheit for 24 hours before, during, and 48 hours after application of finishes.

1.07 PROTECTION

A. Protect adjacent surfaces from paint and damage. Repair damage resulting from inadequate or unsuitable protection.

B. Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from fouling surfaces not being painted and in particular, surfaces within storage and preparation area.

C. Place cotton waste, cloths and material which may constitute fire hazard in closed metal containers and remove daily from site.

D. Remove electrical plates, surface hardware, fittings and fastenings, prior to painting operations. Carefully store, clean and replace on completion of painting in each area. Do not use solvent or degreasers to clean hardware that may remove permanent lacquer finish.

1.08 EXTRA MATERIALS

A. Extra Materials: Include minimum 1 gallon of each type and color of coating applied.
   1. When manufacturer packages material in gallon cans, deliver unopened labeled cans as comes from factory.
   2. When manufacturer does not package material in gallon cans, deliver material in new gallon containers, properly sealed and identified with typed labels indicating brand, type and color.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Paints: One of the following or equal:
   1. Carboline: Carbonline, St. Louis, MO.
   2. Cook: Sherwin-Williams, St. Louis, Mo.
   3. Devoe: Devoe Coatings, Louisville, KY.
   4. Dunn Edwards: Dun Edwards Paints, Los Angeles, CA.
   5. Frazee: Frazee/Deer-O-Paints, City of Commerce, CA.
   6. Fuller: Fuller O'Brien Paints, San Francisco, CA.
   7. Kop-Coat: Carboline, St. Louis, MO.
   8. Pittsburgh: Pittsburgh Paints.
   9. Porter: Porter International, Louisville, KY.
   10. P & L: Pratt & Lambert.
   11. S-W: Sherwin-Williams Co., Cleveland, OH.
   12. Sinclair: Sinclair Paints.
   13. Tnemec: Tnemec Co., Kansas City, MO.

B. Submit requests for substitutions in accordance with Section 01631.
   1. Include certified ingredient analyses.
   2. Provide colors that match existing finish of storage tank on site.

2.02 ARCHITECTURAL FINISHES

Exterior Materials	**Primer or First Coat**	**Second Coat**	**Third Coat**	**Fourth Coat**
Galv. Metal Alkyd Gloss	Galva-Etch GE-123	Versaprime 42-44	Syn-Lustro 10 Series	Syn-Lustro 10-Series
Ferrous Metal Alkyd Gloss	Corrobar 43-5	Syn-Lustro 10 Series	Syn-Lustro 10 Series	Syn-Lustro 10 Series

PART 3 - EXECUTION

3.01 INSPECTION

A. Thoroughly examine surfaces scheduled to be painted before starting work.

B. Start painting when unsatisfactory conditions have been corrected.

3.02 PREPARATION OF SURFACES

A. Prepare surfaces in accordance with paint manufacturer's instructions or when none, the following.

B. Canvas and Cotton Insulation Coverings: Remove dirt, grease and oil.

C. Concrete: Remove dirt, loose mortar, scale, powder and other foreign matter. Remove oil and grease with solution of tri-sodium phosphate. Remove stains caused by weathering of corroding metals with solution of sodium metasilicate. Rinse well and allow to thoroughly dry. Spot prime exposed metal with alkyd primer.

3.03 APPLICATIONS

A. Apply each coat at proper consistency.

B. Tint each coat of paint slightly darker than preceding coat.

C. Sand lightly between coats to achieve required finish.

D. Do not apply finishes on surfaces that are not sufficiently dry.

E. Allow each coat of finish to dry before following coat is applied, unless directed otherwise by manufacturer.

3.04 CLEANING

A. As work proceeds and upon completion, promptly remove paint where spilled splashed or spattered.

B. During progress of work keep premises free from unnecessary accumulation of tools, equipment, surplus materials and debris.

C. Upon completion of work leave premises neat and clean.

END OF SECTION

DIVISION 11

EQUIPMENT

SECTION 11002

EQUIPMENT IDENTIFICATION TAG SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals, as shown on the Drawings, specified and required to furnish and install an equipment identification tag system.
   2. The extent of the equipment identification tag system is specified herein and shown on the Drawings.
   3. The type of equipment identification tag system includes, but is not necessarily limited to, the following:
      a. Equipment identification tags.
      b. Miscellaneous mechanical fasteners.

B. Related Sections: CONTRACTOR shall coordinate the requirements of the Work in this Section along with the requirements of the Sections listed below which includes, but is not necessarily limited to, Work that is directly related to this Section.
   1. Division 11 - Equipment.
   2. Division 15 - Mechanical.
   3. Division 16 - Electrical.
   4. Division 17 - Instrumentation and Controls.

C. Equipment Identification Tags:
   1. Equipment Identification Tags shall be made of brass and contain device numbers and name descriptions.
      a. Tag numbers shall consist of up to seven digits.
      b. Device descriptions shall consist of three to four lines with a maximum of 55 letters.
   2. Device numbers and name descriptions shall be furnished by the OWNER during construction.
   3. CONTRACTOR shall provide sufficient number of equipment tags to label all equipment requiring identification.

1.02 QUALITY ASSURANCE

A. Source Quality Control: Provide equipment identification tags by a single manufacturer.

1.03 SUBMITTALS

A. Samples: Submit for approval samples for color and finish of materials and accessories required for the equipment identification tag system. ENGINEER'S review of samples will be for color and texture only. Compliance with all other requirements is the exclusive responsibility of CONTRACTOR.

B. Shop Drawings: Submit for approval the following:
   1. List of all devices including tag number with device and signal name description.
   2. Anchorage and accessory items.
   3. Samples of actual equipment identification tags for five devices.

PART 2 - PRODUCTS

2.01 EQUIPMENT IDENTIFICATION TAGS

A. Tags shall be 1-inch by 3-inches with two 1/8-inch holes centered on each end of the tag. Tags shall be made from aluminum 0.020-inch thick and coated with black enamel paint.

B. Each tag shall be engraved with the equipment identification number and description as shown on the Drawings or as specified. The engraving print shall be 1/4-inch Gothic.

C. Each tag shall be attached with fasteners of nylon coated, 48-mil, stainless steel wire as manufactured by Brady, Catalog Number 23310 or equal and brass double ferrule wire clamps, as manufactured by Brady Catalog Number 23312 or equal, to secure the stainless steel wire.

PART 3 - EXECUTION

3.01 INSPECTION

A. CONTRACTOR and his installer shall examine the substrates and conditions under which the equipment identification tags are to be installed and notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.02 INSTALLATION

A. Install equipment identification tags and components at the locations shown on the Drawings or, if not shown, as directed by ENGINEER; securely mount with concealed theft-resistant fasteners.

B. Install level, plumb, and at the proper height. Repair or replace damaged units as directed by ENGINEER.

END OF SECTION

SECTION 11005

EQUIPMENT: GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes
   1. Requirement of this Section apply to all equipment provided on the Project, including that found in Divisions 11, 13, 15 and 16, even if not specifically referenced as a related section in those Specifications.

B. Related sections include, but are not necessarily limited to:
   1. Division 1 - General Requirements.
   2. Section 09800 - Special Coatings.
   3. Section 10400 - Identification, Stenciling and Tagging Systems.
   4. Individual equipment specifications in Divisions 11 through 15.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society for Testing and Materials (ASTM):
      a. A307, Standard Specification Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
      b. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   2. Institute of Electrical and Electronics Engineers (IEEE):
      a. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment.
      b. ICS 6, Enclosures for Industrial Control and System.
      c. MG1, Motors and Generators.
   4. NSF International:
      a. 61 - Drinking Water System Components

B. Unit Responsibility:
   1. Where indicated in these documents, equipment systems made up of two or more components shall be manufactured and assembled as a unit by the responsible manufacturer. The responsible manufacturer shall select all components of the system to assure compatibility, ease of construction and efficient maintenance. The responsible manufacturer shall coordinate selection and design of all system components, such that all equipment

furnished under the specification for the equipment system, including equipment specified elsewhere, but referenced in the specification, is compatible and operates properly to achieve the performance requirements specified. Unless otherwise specified, the responsible manufacturer shall be the manufacturer of the driven equipment. This requirement for unit responsibility shall in no way relieve CONTRACTOR of his responsibility to the OWNER for performance of all systems.

2. CONTRACTOR shall assure that all equipment systems provided for the Project are products for which unit responsibility has been accepted by the responsible manufacturer. Where the detailed specification requires CONTRACTOR to furnish a certificate from the Unit Responsibility Manufacturer, such certificates shall be provided prior to Shop Drawing review. No other submittal material will be processed until a Certificate of Unit Responsibility has been received and has been found to be satisfactory. Failure to provide acceptable proof that the unit responsibility requirement has been satisfied will result in withholding approval of progress payments for the subject equipment even though the equipment may have been installed in the Work.

1.03 DEFINITIONS

A. Product: Manufactured materials and equipment.

B. Equipment: One or more assemblies capable of performing a complete function. Mechanical, electrical, instrumentation or other devices requiring an electrical, pneumatic, electronic or hydraulic connection. Not limited to items listed under "Equipment" article within Specifications.

1.04 SUBMITTALS

A. Shop Drawings:
   1. General for all equipment:
      a. See Section 01332 - Shop Drawing Procedures.
      b. Acknowledgement that products submitted comply with the requirements of the standards referenced.
      c. Manufacturer's delivery, storage, and handling instructions.
      d. Equipment identification utilizing tagging system and name utilized in Drawings.
      e. Equipment installation details:
         1) Location of anchorage.
         2) Type, size, and materials of construction of anchorage.
         3) Anchorage setting templates.
         4) Manufacturer's installation instructions.
      f. Equipment area classification rating.
      g. Shipping and operating weight.

h. Equipment physical characteristics:
    1) Dimensions (both horizontal and vertical).
    2) Materials of construction and construction details.
i. Equipment factory primer and painting and coating data.
j. Manufacturer's recommended spare parts list.
k. Piping and duct connection size, type and location.

2. Mechanical and Process Equipment
    a. Operating characteristics:
        1) Technical information including applicable performance curves showing specified equipment capacity, rangeability, and efficiencies.
        2) Brake horsepower requirements.
        3) Copies of equipment data plates.
    b. Piping and duct connection size, type, and location.
    c. Equipment bearing life certification.
    d. Field noise testing reports if such testing is specified in specific equipment sections.
    e. Equipment foundation data:
        1) Equipment center of gravity.
        2) Criteria for designing vibration, special or unbalanced forces resulting from equipment operation.

3. Electrical and control equipment:
    a. Electric motor information:
        1) Nameplate data.
        2) Service factor on motors ½ HP and above.
        3) Motor enclosure type.
        4) NEMA frame size, if applicable.
        5) NEMA design code, if applicable.
        6) Insulation type.
        7) Efficiency and power factor at full load, $^{3}/_{4}$ load, ½ load and $^{1}/_{4}$ load.
    b. Control panels:
        1) Panel construction.
        2) Point-to-point wiring diagrams.
        3) Scaled panel face and subpanel layout.
        4) Technical product data on panel components.
        5) Panel and subpanel dimensions and weights.
        6) Panel access openings.
        7) Nameplate test.
        8) Panel anchorage.
    c. Motor tests reports.
    d. Certification that equipment has been installed properly, has been initially started up and is ready for operation.

e. Certification prior to Project closeout that electrical panel drawings for manufacturer-supplied control panels truly represent panel wiring including any field-make modifications.

B. Operations and Maintenance Manuals:
1. Section 01781.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
1. Motors: US Motors or preapproved equal.

2.02 MANUFACTURED UNITS

A. Electric Motors:
1. Provide motors designed and applied in compliance with NEMA, IEEE, and the NEC for specific duty imposed by driven equipment.
2. Where used in conjunction with adjustable speed drives, provide motors fully compatible with the variable speed controllers. These motors shall be inverter duty.
3. Where frequent starting applications are specified, design for frequent starting duty equivalent to duty service required by driven equipment.
4. Rate for continuous duty at 50 Deg C ambient. Design in accordance with NEMA standards for Class F insulation with Class B temperature rise above 50 Deg C ambient on continuous operation or intermittent duty at nameplate horsepower.
5. Design for full or reduced voltage starting, as appropriate.
6. Design bearing life based upon actual operating load conditions imposed by driven equivalent.
7. Size for altitude of Project.
8. Size so that, under maximum continuous load imposed by driven equipment, motor nameplate horsepower for continuous operation is minimum of 15 percent more than driven load.
9. Provide encapsulated windings in wet/corrosive and for outdoor applications.
   a. Provide encapsulation using a silicone or epoxy seal after the windings have been dried to less than 1 percent moisture.
10. Furnish with clamp-type grounding terminals inside motor conduit box.
11. Furnish with oversized external conduit boxes.
12. Furnish with stainless steel nameplates with information to include all data as required by paragraph 430-7 of the National Electric Code, NFPA 70.
13. Totally Enclosed, Fan-Cooled (TEFC) unless specified otherwise.

2.03 ACCESSORIES

A. Guards:
   1. Provide each piece of equipment having exposed moving parts with full length, easily removable guards, meeting OSHA requirements.
   2. Interior Applications:
      a. Construct from expanded galvanized steel rolled to conform to shaft or coupling surface.
      b. Utilize non-flattened type 16 GA galvanized steel with nominal ½ IN spacing.
      c. Connect to equipment frame with hot-dip galvanized bolts and wing nuts.
   3. External Applications:
      a. Construct from 16 GA stainless steel or aluminum.
      b. Construct to preclude entrance of rain, snow, or moisture.
      c. Roll to conform to shaft or coupling surface.
      d. Connect to equipment frame with stainless steel bolts and wing nuts.

B. Anchorage:
   1. Cast-in-place anchorage:
      a. Provide ASTM F593, Type 316 stainless steel anchorage for exposed equipment.
      b. For continuously submerged anchorage, utilize ASTM A307 anchorage. For intermittently submerged applications, use 316 stainless steel.
      c. Configuration and number of anchor bolts shall be per manufacturer's recommendations.
      d. Provide two nuts for each bolt.
   2. Drilled anchorage:
      a. Epoxy grout per Section 03600.
      b. Threaded rods same as cast-in-place.

C. Data Plate:
   1. Attach a stainless steel data plate to each piece of rotary or reciprocating equipment. Permanently stamp information on data plate including manufacturer's name, equipment operating parameters, serial number and speed.

2.04 FABRICATION

A. Design, fabricate, and assemble equipment in accordance with best modern engineering and shop practices.

B. Manufacture individual parts to standard sizes and gages so that repair parts, furnished at any time, can be installed in field.

C. Furnish like parts of duplicate units to be interchangeable.

D. Assure that equipment has not been in service at any time prior to delivery, except as required by tests.

E. Furnish equipment which require periodic internal inspection or adjustment with access panels which will not require disassembly of guards, dismantling of piping or equipment or similar major efforts. Quick opening but sound, securable access ports or windows shall be provided for inspection of chains, belts, or similar items.

F. Provide common, lipped base plate mounting for equipment and equipment motor where said mounting is a manufacturer's standard option. Provide drain connection for tubing.

G. Machine the mounting feet of rotating equipment.

H. Shop or Factory Finishes shall be in accordance with Section 09800.

PART 3 - EXECUTION

3.01 ERECTION/INSTALLATION/APPLICATION

A. Install equipment as shown on Drawings and in accordance with manufacturer's directions.

B. Utilize templates for anchorage placement for slab mounted equipment.

C. For equipment having drainage requirements such as seal water, provide 3/4-inch PVC or clear plastic tubing from equipment base to nearest floor or equipment drain. Route clear of major traffic areas and as approved by OWNER.

D. Extend all non-accessible grease fittings using stainless steel tubing to a location which allows easy access of fittings.

E. Construct subbases, either concrete, steel or cast iron, level in both directions. Particular care shall be taken at hold-down bolt locations so these areas are flat and level.

F. Machine Base:

1. Mount machine bases of rotating equipment on subbases in manner that they are level in both directions according to machined surfaces on base. Use machinist level for this procedure.

2. Level machine bases on subbases and align couplings between driver and driven unit using steel blocks and shims.
    a. Size blocks and shims to provide solid support at each anchor bolt location. Area size of blocks and shims shall be approximately 1-1/2 times area support surface at each anchor bolt point.
    b. Provide blocks and shims at each anchor bolt. Blocks and shims shall be square shape with "U" cut out to allow blocks and shims to be centered on anchor bolts.
    c. After all leveling and alignment has been completed and before grouting, tighten anchor bolts to proper torque value.
    d. Do not use nuts below the machine base on anchor bolts for base leveling.

G. Grouting:
1. After machine base has been shimmed, leveled, couplings aligned and anchor bolts tightened to correct torque value, a dam or formwork shall be placed around base to contain grouting. Dam or formwork shall extend at least ½ IN above the top of leveling shims and blocks.
2. Grouting mixture shall be non-shrink grout per Division 3 requirements.
3. When the grout has sufficiently hardened, remove dam or framework and finish the exposed grout surface to fine, smooth surface. Cover exposed grout surfaces with wet burlap and keep covering sufficiently wet to prevent too rapid evaporation of water from the grout. When the grout has fully hardened (after a minimum of 7 days) tighten all anchor bolts and recheck driver-driven unit for proper alignment.

H. Identification of Equipment and Hazard Warning Signs:
1. Identify equipment and install hazard warning signs in accordance with Section 10400.

I. Field coat in accordance with Section 09800.

3.02 WIRING CONNECTIONS AND TERMINATION

A. Clean wires before installing lugs and connectors.

B. Coat connection with oxidation eliminating compound for aluminum wire.

C. Terminate motor circuit conductors with copper lugs bolted to motor leads.

D. Tape uninsulated conductors and connectors with electrical tape, 150 percent of insulation value of conductor.

E. Connections to carry full ampacity of conductors without temperature rise.

F. Terminate spare conductors with electrical tape.

3.03 FIELD QUALITY CONTROL

A. Furnish equipment manufacturer services as specified in the individual equipment specifications.

B. Inspect wire and connections for physical damage and proper connection.

C. Check rotation of motor before connection to driven equipment, before couplings are bolted or belts installed. Before motor is started to check rotation, determine that motor is lubricated.

END OF SECTION

SECTION 11337

RATE OF FLOW CONTROL VALVE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Hydraulic Rate of Flow Controller
   1. Provide one flow control valves as shown on Drawings.
   2. The Supplier shall furnish all labor, materials, tools, equipment, and services for all valve equipment as specified herein or as required for a complete functioning system.
   3. All valve equipment shall be furnished by single manufacturer who shall be responsible for proper operation and interfacing of the equipment, testing and startup (provide unit system responsibility).
   4. Although such work may not be specifically indicated, the manufacturer of the valve equipment shall furnish all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

1.02 RELATED SECTIONS

A. Section 01330 - Submittals

B. Section 09800 - Special Coatings

C. Section 11005 - Equipment: General Requirements

D. Division 17 - Instrumentation and Controls

1.03 QUALITY ASSURANCE

A. Source Quality Control
   1. The manufacturer shall use only equipment which is compatible in function, arrangement, reliability, and accuracy and will perform in the modes of operation outlined herein. The Supplier shall require all equipment listed in this Specification to be furnished or coordinated through a single valve equipment manufacturer.

B. Reference Standards

1. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
    a. Occupational Safety and Health Act
    b. Joint Industrial Council (JIC)
    c. Instrumentation, Systems, and Automation Society
    d. National Sanitation Foundation (NSF) 61 - Drinking Water System Components.
    e. American Society of Mechanical Engineers
    f. American Society of Testing Materials
    g. American National Standards Institute, Inc.

1.04 SYSTEM DESCRIPTION

A. The Rate of Flow Control Valve shall maintain a specified flow rate based on an input signal (set point) from the arsenic treatment facility programmable logic controller.

1.05 SUBMITTALS

A. The equipment manufacturer shall:

1. Submit shop drawings showing the layout of all equipment furnished, dimensional data, fabrication assembly, and the piping configuration.
2. Submit operation and maintenance manuals incorporating all major equipment furnished under these Specifications. Also, submit copies of all approved shop drawings.
3. Submit a cavitation chart that shows flow rate, percentage of valve opening, Cv factor, system velocity, and if there will be cavitation damage.
4. Provide data on range, accuracy and repeatability as applicable for all major equipment furnished under these Specifications.
5. Submit data on capacity, weight, and material of each item of equipment.

1.06 WARRANTY

A. Provide a written warranty that the equipment furnished and installed under these Specifications will be free of defects in material and workmanship and operate without problems for a period of at least 3 years from date of shipment, provided the valve is installed and used in accordance with all applicable instructions.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Cla-Val Co.

1. The main valve shall be a Cla-Val Co. Model No. 631-01 Rate of Flow Control Valve.
2. Electronic Valve Controller Model VC-22D.
3.

2.02 MAIN VALVE

A. Number of units: 1

B. General:
1. The valve shall be electronically operated, diaphragm, globe pattern.
2. The valve shall consist of three major components: the body with seat installed, the cover with bearing installed, and the diaphragm assembly.
3. 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.
4. Flow range is 20-80 gpm

C. Features:
1. Valve body and cover shall be of ductile iron.
2. The valve shall contain a resilient, synthetic rubber disc forming a tight seal against a single removable seat insert. The disc guide shall permit smooth transition of flow and shall hold the disc firmly in place. The disc retainer shall be of a sturdy one-piece design capable of withstanding opening and closing shocks. It must have straight edge sides and a radius at the top edge to prevent excessive diaphragm wear as the diaphragm flexes across this surface.
3. The diaphragm assembly containing a non-magnetic 303 stainless steel stem of sufficient diameter to withstand high hydraulic pressures shall be fully guided at both ends. The seat shall be a solid, one-piece design for a positive, drip-tight shut off.
4. The stem shall be drilled and tapped in the cover end to receive and affix such accessories as may be deemed necessary. 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.
5. The main valve seat and the stem bearing in the valve cover shall be removable for ease of maintenance. To insure proper alignment of the valve stem, the valve body and cover shall be machined with a locating lip. Cover bearing, disc retainer, and seat shall be made of the same material. All necessary repairs and/or modifications other than replacement of the main valve body shall be possible without removing the valve from the pipeline.

D. Materials
1. Valve Size: See Drawings
2. Main Valve Body and Cover: Ductile Iron
3. Main Valve Trim: Bronze

4. Pressure Rating: 100-150 psi
5. Temperature Range: 180 Degrees F Maximum
6. Rubber Material: Buna-N
7. Exterior Coating: According to Section 09800, System 1.

2.03 ELECTRONIC VALVE CONTROLLER

A. Number of units: 1

B. General:
1. The controllers shall provide control of the valve using remote set-points from ATF PLC.
2. Local manual set-point and emergency manual control shall also be provided.
3. The electronic controller shall provide outputs to the ATF PLC as indicated below.

C. Features:
1. The valve will be normally set for a flow rate that will be controlled either manually or by the PLC. This flow rate varies. The maximum flow rate through the valve will be as shown in the Equipment Schedule.
2. The controller will provide proper signals to modulate and maintain the valve at the desired flow rate. A display of current feedback status and set-point in scaleable engineering units shall be provided as an integral part of the controller. Control of the valve will be at the local controller.
3. When the feedback signal deviates from the set-point, the appropriate opening or closing solenoid on the valve will pulse. As the feedback signal approaches the set-point, this on/off pulse time will gradually lessen to smoothly modulate the valve to the set-point. The total cycle time between each pulse shall be programmable between 1 and 60 seconds. A programmable time proportional output feature shall also function to aid in tuning valve response. When the feedback signal is within a programmable deadband zone, the opening and closing solenoids will not activate and the valve will maintain position.
4. The controller has 6 analog inputs and 4 analog outputs.
5. The controllers shall be solid-state construction with an internal chassis capable of being removed for inspection and repair. All program memory including set-point and timing parameters shall be protected by an internal lithium battery rated for 10 year life.
6. Two solenoid valves will be used for Rate of Flow Control.
7. The material must be able to withstand pHs as low as 6.5.
8. A standard aluminum mounting bracket is included with the controller.
9. The controller is a flame retardant UL rated PC/ABS plastic enclosure.

D. Electronic Valve Controller Input
1. Utilizing an isolated, 4-20 mA analog signal, the flow rate will be transmitted

to the Rate of Flow Electronic Valve Controller (Model VC-22D) from ATF PLC.

2. The desired flow rate set-point will be input manually or electronically from the PLC into the electronic valve controller.

E. Electronic Valve Controller Outputs

1. The controller will send a General Equipment Fault output (contact closure) signal to the ATF PLC.

F. Controller Specifications

1. Control Parameters:
   a. Proportional Bands: 1 to 200% adjustable in 1% increments independently for opening and closing.
   b. Deadband: Adjustable 0.00 to 25.5% of span.
   c. Cycle Time: 1 to 60 seconds in 1 sec. increments.
   d. Temperature: 5 C to 55 C (40 F to 130 F)
   e. Humidity: 90% RH, non-condensing.
   f. Power Input: 13.5 watts max. at 120 VAC, 50/60 Hz.
   g. Memory Protection: Internal lithium battery rated for 10 year life.
   h. Electronics Enclosure: NEMA 4X (vented back).

2.04 CONTROL VALVE PILOT SYSTEM

A. Number of units: 1

B. General:

1. The hydraulic control valve pilot system shall consist of two solenoids that alternately apply or relieve pressure to the diaphragm chamber to position the main valve. Solenoids shall be designed such that electrical or control failure of the solenoids result in the main valve closing.
2. Solenoids shall be 120 volt AC with NEMA type 4X enclosure.
3. Pilot system will be pressure rated to 200 psi for temperatures between 0 and 150 degrees F.
4. A manual system to by-pass the solenoids shall also be provided.

PART 3 - EXECUTION

3.01 START-UP AND TEST

A. All equipment shall be operationally-tested by the Supplier at the job site following installation of the equipment, controls, valves and piping. Should the tests indicate any malfunction, the Supplier shall make all necessary repairs and/or adjustments. Tests and adjustments shall be repeated until, the installation is complete and the equipment is functioning properly and accurately, and is ready for permanent continuous operation.

3.02 MANUFACTURER'S SERVICES

A. The Supplier shall provide the services of a qualified, factory trained representative of the manufacturer to check and approve the installation before it is placed in service, supervise initial operation, and testing in the presence of the ENGINEER. The Supplier's representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

B. The Supplier shall provide the services of a qualified, factory trained representative of the manufacturer to instruct the OWNER's personnel in operation and maintenance of the equipment. Four (4) hours of training will be provided. The 4 hours may not be consecutive if more than one training session is necessary.

END OF SECTION

DIVISION 13

SPECIAL CONSTRUCTIONS

SECTION 13122
PREFABRICATED TREATMENT BUILDING

PART 1 - GENERAL

A. SCOPE

This specification includes two prefabricated building system designed, supplied, and installed by a single BUILDING SUPPLIER (SUPPLIER). The buildings shall be supplied FOB to Sanders, AZ to one site located in at the Sanders unified School District: Lower Tank Site, near the intersection of I-40 and US Route 191. Approximately 50 ft. x 50 ft. staging area at the site will be provided. The scope of work under this contract includes supply and installation of one building with painted metal finish, structural framing of walls and roof trusses, supply and installation of all exterior doors, interior gypsum finish of all walls, insulation of all exterior walls, ceiling and roof, finish and painting of walls and doors, complete design of all exterior walls, roof and column structural framing, and documentation sufficient for permitting of the building through the Apache County Plan Review Department.

Work performed by others includes treatment facilities, electrical wiring and fixtures, equipment, concrete slab, utilities, site work, and grading. Items hung from the purlins/main frames will include lighting fixtures. BUILDING SUPPLIER shall work with OWNER, ENGINEER, and other CONTRACTORS in completing the project. CONTRACTOR shall coordinate scheduling with BUILDING SUPPLIER of concrete slab, electrical work, and HVAC to facilitate building construction.

Submittals of the detailed building drawings shall be made within four weeks of receiving a NOTICE TO PROCEED and purchase order from the OWNER. Building shall be erected within 10 weeks after approval of drawing submittals, contingent on completion of slab and related site work by OWNER and other contractors.

Any deviation from these specifications must be stated as an exception in response to the bid, and may be grounds for disqualification.

B. RELATED SECTIONS

1. Section 01340 - Technical Submittals
2. Section 01651 - Transportation and Handling of Materials and Equipment

1.2 QUALITY ASSURANCE

A. The structural steel members must be fabricated in accordance with Metal Building Manufacturers Association (MBMA) Metal Building System manual and the AISC

Specification for Structural Steel Buildings. An alternate system using wood trusses and framing system may is acceptable, if manufacturer is preapproved by the OWNER, and appropriate referenced design standards are provided.

B. The company manufacturing the products specified in this section shall have a minimum of five years experience in the manufacture of similar prefabricated building systems.

C. REFERENCE STANDARDS

1. AISI - *Specification for the Design of Cold-Formed Steel Structural* Members - 1996 Edition with 1999 Addendum.
2. AISC - *Specification for Structural Steel Buildings - Allowable Stress Design and Plastic Design,* 1989.
3. AISC - Steel Design Guide Series 3 - Serviceability Design Considerations for Low-Rise Buildings, 1990.
4. ASTM A36 - Specification for Carbon Structural Steel, 2000.
5. ASTM A123 - Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products, 2000.
6. ASTM A153 - Specification for Zinc Coating (Hot Dip) on Iron and steel Hardware, 2000.
7. ASTM A307 - Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength, 2000.
8. ASTM A325 - Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength, 2000.
9. ASTM A463 - Specification for Steel Sheet, Aluminum-Coated, by the Hot-Dip Process, 2000.
10. ASTM A475 - Specification for Zinc-Coated Steel Wire Strand.
11. ASTM A490 - Specification for Heat Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength, 2000.
12. ASTM A500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes, 1999.
13. ASTM A501 - Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing, 1999.
14. ASTM A529 - Specification for High-Strength Carbon-Manganese Steel of Structural Quality, 2000.
15. ASTM A572 - Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel, 2000.
16. ASTM A653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanized) by the Hot-Dip Process, 2000.
17. ASTM A792 - Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process, 1999.
18. ASTM A1011 - Specification for Steel Sheet and Strip Hot Rolled Carbon, Structural High Strength Low-Alloy and High Strength Low-Alloy with Improved Formability, 2000.
19. ASTM C665 - Specification for Mineral-Fiber Blanket Thermal Insulation for

Light Frame Construction and Manufactured Housing, 1998.

20. ASTM D1494 - Test Method for Diffused Light Transmission Factor of Reinforced Plastic panels, 1997.
21. ASTM E1514 - Specification for Structural Standing Seam Steel Roof panel Systems, 1998.
22. ASTM E1592 - Test method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference, 1998.
23. ASTM E1646 - Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference, 1995.
24. ASTM E1680 - Test Method of Rate of Air Leakage through Exterior metal Roof Panel Systems, 1995.
25. AWS A2.4 - Standard Welding Symbols, 1998.
26. AWS D1.1 - Structural Welding Code - Steel , 2000.
27. AWS D1.3 - Structural Welding Code - Sheet Steel, 1998.
28. MBMA Metal Building Systems Manual, 2002.
29. NAIMA 202 - Standard for Flexible Fiberglass Insulation Systems in Metal Buildings, 2000.
30. SJI (Steel Joist Institute) - Standard Specifications, Load Tables and Weight Tables for Steel Joists and Joist Girders, 40th Edition, 1994.
31. SSPC (Society for Protective Coatings) - SP-2 - Specification for Hand Tool Cleaning, 1995 (Part of Steel Structures Painting Manual, Vol. Two)
32. SSPC - Paint 15 – Steel Joist Shop Primer; Society for Protective Coatings; 1999 (Part of Steel Structures Painting Manual, Vol. Two)
33. SSPC – Paint 20 – Zinc-Rich Primers (Type I, “Inorganic”, and Type II, “Organic”); Society for Protective Coatings; 1991 (Part of Steel Structures Painting Manual, Vol. Two).
34. UL 580 - Tests for Uplift Resistance of Roof Assemblies, 1994.

1.3 SYSTEM DESCRIPTION

A. The BUILDING SUPPLIER will provide a Prefabricated Building System that is designed to enclose the facilities shown on the attached plan drawings. The clear height to the bottom of the roof trusses from the floor shall be 12'-0". The building shall include pre-engineered columns, rafters, purlins, and girts. The design of the foundation for the metal building described in this specification will be supplied by the CONTRACTOR. BUILDING SUPPLIER shall supply all trim, fasteners, and closures necessary to complete the building.

B. The exterior dimensions of the buildings shall be
1. SUSD uranium Treatment Building: 15' x 15'.

C. The building shall include one 6'x8'double door (24 gauge) with locking mechanism. The door shall include a factory powder coat finish with a color to be selected by OWNER (beige, tan or similar).

D. Doors shall be self framing, self flashing, steel doors with lever and dead bolt locks, hinges, and thresholds with sweeps. Exterior doors shall be Steel Clad insulated (Plyco series 92) with 2 x 6 Series 3068 frame.

F. All four exterior faces of the building shall have a painted metal synthetic finish. The finish shall include final paint at a color to be selected by OWNER. Provide example finish and texture to ENGINEER for approval. Exterior wall sheet shall be a minimum of 10 gage thickness.

I. There will be no equipment located on the roof of the building. The only loads on the interior purlins and trusses will be normal electric lighting fixtures.

J. Building design loads are per Apache County standards and are non reducible. The roof snow load is 10 PSF.

K. Soffit panels are not required to be vented if there is no overhang. Other than piping and electrical conduit slab penetrations, There will be no equipment or other items within the building space prior to its erection.

L. Buildings shall be equipped with two 48" x 48" roof hatches as shown on the drawings. The hatches shall be at the location shown on the drawings and include a chain operator such that they can be opened from the interior of the building from a location six feet below the roof elevation. The hatches shall be watertight. BUILDING SUPPLIER shall provide flashing (to ensure a weather tight seal) and wood framing structural supports for the hatch.

1.4 SUBMITTALS

A. The construction drawings and design calculations for the building shall be signed and sealed by a Structural Engineer Registered in the State of Arizona. This information is required within four weeks of contract award. Plan and elevation drawings of all four exterior sides of the building are required.

B. Shop or erection drawings indicating assembly dimensions, locations of structural members, connections, attachments, openings, cambers, loads, wall and roof system dimensions, general construction details, anchorages and methods of anchorages, framing anchor bolt settings, sizes and locations from the datum must be submitted for approval by the ENGINEER.

C. Field welded connections with AWS A2.4 welding symbols, indicating net weld length must be submitted for approval

D. All building submittals shall be presented in accordance with Section 01340.

E. Provide installation procedures and coordination considerations.

1.5 DESIGN REQUIREMENTS

A. The building shall be designed by the BUILDING SUPPLIER as a complete system. Members and connections not indicated on the drawings shall be the responsibility of the BUILDING SUPPLIER. All components of the system shall be supplied or specified by the same BUILDING SUPPLIER.

B. Design Code: The design load application shall be in accordance with the International Building Code, 2015. 20 PSF roof LL, 90 PH wind load, 10 PSF snow load, exposure C, 10 psf.

C The Seismic Loads to be used in the building design shall be as follows: le=1.25, use group 2, Ss=0.60, Sl=0.15, SDs=0.53, Sdl=0.22

1.7 WARRANTY

A. The BUILDING SUPPLIER shall provide a material and workmanship warranty that includes 10 years for all exterior panels, all structural members, and roofing, and all other components. The warranty shall include all components that are supplied by the BUILDING SUPPLIER.

1.8 ADMINISTRATION

A. All nomenclature shall conform to MBMA Metal Building Systems Manual or equivalent wood frame standards.

B. BUILDING SUPPLIER shall coordinate with OWNER, ENGINEER and other construction contractors and equipment suppliers that will be providing services at the site during the same period.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURES

A. Cleary Building Corporation
B. Garvin Construction
C. Bunger Steel
D. Anthem Steel Buildings
E. Other preapproved equal (approved prior to bid submission)

2.2 PERFORMANCE AND DESIGN

A. FRAMING

1. This section includes buildings with a clear span rigid frame, without interior intermediate columns. Truss systems may be used as approved by the

ENGINEER.

2. The bay spacing and minimum clearances shall be as shown on the drawings.

3. The roof slope shall be a minimum of 4 in 12 or as needed to meet snow load criteria.

4. The primary framing may be manufactured of rigid frame of rafter beams and columns, with or without braced end frames, end wall columns and canopy beams as proposed by the BUILDING SUPPLIER and approved by the ENGINEER.

5. Secondary framing shall be detailed in the submittal and approved by the ENGINEER.

6. Horizontal loads not resisted by the main frame may be resisted by the use of lateral bracing in the side wall, end wall and roof. The method of bracing must be approved by the ENGINEER.

7. Details of the wall and roof system, including preformed steel panels, insulation, liners and accessory components shall be included in the submittal for approval by the ENGINEER. Roof and wall sheets shall be 10 gage minimum.

8. Accessories including skylights, doors, windows, louvers and ventilators shall be included in the submittal for approval by the ENGINEER.

B. MATERIALS - ROOF SYSTEM

1. The sheet steel stock used in the roofing system shall be galvanized, zinc coated or aluminized as required by the BUILDING SUPPLIER's design.

2. The exterior roof insulation shall be of the glass fiber type, faced with a reinforced material having a flame spread classification of 25 or less. The minimum R value shall be 11 for areas with interior ceilings. The minimum R value shall be 30 for the building, where no interior ceilings are present.

3. The roofing supplied maybe standing seam or through fastened type with a UL rating of 90.

4. Exterior and interior surfaces of the roof panel shall be pre-coated. Coating weight shall be a minimum of 0.32 oz. of aluminum-zinc alloy per square foot of coated sheet equivalent to about 0.75 mil thickness on each side. The color selected shall be from the BUILDING SUPPLIER's standard colors and specified at the time of submittal for approval.

C. MATERIALS - WALL SYSTEMS

1. The sheet steel stock used in the wall system shall be galvanized, zinc coated or aluminized as required by the BUILDING SUPPLIER's design.

2. The exterior wall insulation shall be of the glass fiber type, faced with a reinforced material having a flame spread classification of 25 or less and a minimum R value of 30.

3. All Material, closures, fasteners and Sealants shall be of the BUILDING SUPPLIER's standard type.

4. Exterior surfaces of the wall panel shall be pre-coated. All exterior and interior surfaces of the galvanized steel wall covering and exterior trim shall receive a factory, roller applied, paint coating having an exterior coating thickness of 0.8 to 1.2 mils of dry film thickness. The color selected shall be from the BUILDING SUPPLIER's standard colors and specified at the time of submittal approval.

5. Along the perimeter of the building, the interior of the wall shall be finished with ½" water resistant gypsum to cover the insulation. The drywall shall include a textured finish and be painted. Consult ENGINEER for final color in wall interior. Along the interior of the ceiling the roof trusses shall remain exposed.

6. As an alternative to the exterior system specified above, an integrated prefabricated wall panel system using urethane foam insulation and metal interior and exterior finishes can be provided (AO 300GS or equal). All other requirements listed in these specifications for metal thickness and R-value shall be maintained. The interior finished listed above is not required if the alternative system is used.

D. MATERIALS - TRIM

1. Flashings, internal and external corners, closure pieces, etc. shall be of the same material and finish as the adjacent material and profiled to suit the system.

E. MATERIALS - DOORS, FRAMES, WINDOWS ROOF OPENINGS AND TRANSLUCENT PANELS

1. Windows, translucent panels and roof openings, as well as both personnel and overhead doors shall be as described herein.

F. MATERIALS - ACCESSORIES

1. Supply to wall louvers (12" x 12" each) that are the same material and finish as the adjacent material and located as shown on the plans. The louvers shall be designed by the BUILDING SUPPLIER to meet the wind load specified in IBC, 2015.

2. Curbs for skylights, hatches, etc. shall be compatible with the steel roof panel and sealed against water penetration in accordance with the BUILDING SUPPLIER's instructions. Curbs shall accommodate the expansion and contraction movement of the roof.

3. Doors and frames shall be factory painted with one coat of baked on primer. All doors shall be preassembled in their frames and hardware installed and tested prior to shipment. Final painting of doors shall be done in the field with color to match the wall.

4. Provide 350-400 CFM exhaust fan as shown on drawings.

2.3 FABRICATION

A. PRIMARY FRAMING

1. Framing Members - Clean blast as needed and prepare to provide an even surface, free from debris and impurities. Coat with the BUILDING SUPPLIER's standard primer.

2. Hot rolled members shall be fabricated in accordance with AISC Specification for pipe, tube and rolled structural shapes and primed.

3. Built up members shall be fabricated in accordance with the MBMA Metal Building Systems Manual, Common Industry Practices

B. FABRICATION - SECONDARY

1. Framing Members - Clean blast as needed and prepare to provide an even surface, free from debris and impurities. Coat with the BUILDING SUPPLIER's standard primer.

2. Cold formed structural shapes shall be fabricated in accordance with the MBMA Metal Building Systems Manual, Common Industry Practices.

PART 3 - EXECUTION

3.1 EXECUTION

A Before commencing with the erection of the Metal building, the BUILDING SUPPLIER must verify that the site conditions are suitable for the safe erection of the building.

B The BUILDING SUPPLIER must verify that the foundation, floor slab, mechanical and electrical utilities and placed anchors are in the correct position and squared.

3.2 ERECTION - FRAMING

1. Erect the framing in accordance with the BUILDING SUPPLIER's directions.

2. Templates must be used for the accurate setting of anchor bolts. Level bearing plates with wedges or shims and grout.

3. Erect the building frame true and level with vertical members plumb and bracing properly installed. Maintain structurally stability at all times during the erection process.

4. Ream holes requiring enlargement to admit bolts. Burned holes for bolted connections are not permitted without written approval of the BUILDING SUPPLIER. Burned holes must be reamed.

5 Tighten bolts and nuts, using the proper procedure, in accordance with the BUILDING SUPPLIER's directions. Snug tight, turn-of-the-nut tightening, calibrated wrench tightening, tension control bolts or direct tension indicator washers may be used to ensure correct tightening.

6. The erector shall furnish temporary guys and bracing where needed for squaring, plumbing and securing the structural framing against loads, such as wind loads acting on exposed framing and seismic forces, as well as loads due to erection and erection operation, but not including loads resulting from the performance of work by others. Bracing furnished by the BUILDING SUPPLIER for the metal building system cannot be assumed adequate during erection and are not to be used to pull frames into plumb condition. The temporary guys, braces, falsework and cribbing are the property of the erector and the erector shall remove them immediately upon completion of erection.

7. Field cutting or modification of the structural members without written approval of the building BUILDING SUPPLIER is not permitted.

8. The erector shall prime welds, abrasions and surfaces not shop primed or galvanized that need touch-up.

3.3 ERECTION - WALL AND ROOFING SYSTEMS

1. Install all wall and roofing systems in accordance with the manufacturer's directions.

2. Exercise care when cutting prefinished material to ensure cuttings do not remain on the finished surface.

3. Fasten cladding system to structural supports, using proper fasteners, aligned level and plumb.

4. Set purlins and girts at right angle and bolt to appropriate clips. Attach to clips as required to satisfy design loads and as shown on the plans.

5. Place screw down roof panels at right angle to purlins and girts. Attach and plumbwall panels as shown on th plans. Maintain consistent module coverage for the entire length of the wall. Pre drill panels. Lap panel ends on the roof and wall according to the manufacturer's directions. Apply butyl roof panel side and end lap sealant between panel ends and side laps to provide water tight installation per manufacturer's directions.

6. Place Standing Seam Roof panels at right angle to purlins. Attach with sliding concealed clip where expansion and contraction must be accounted for. Lap panel ends as determined by the BUILDING SUPPLIER's standard and panel notch. Place end caps above purlin with back up plate and cinch strap so panel end-lap fasteners do not penetrate purlin.

3.4 ERECTION - TRANSLUCENT PANEL (NOT APPLICABLE)

3.5 ERECTION - ACCESSORIES

1. Install all personnel and overhead doors and frames according to the manufacturer's directions.

2. All floor and wall accessories must be installed weathertight.

3.6 TOLERANCES

1. All work shall be performed by experienced workmen in a workmanlike manner to published tolerances and according to Common Industry Practices.

END OF SECTION.

SECTION 13201

HIGH DENSITY POLYETHYLENE (HDPE) TANK

PART 1 GENERAL

1.01 DESCRIPTION

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals required to furnish and install (HDPE) backwash water syorage tank and appurtenances as shown on the Drawings and as specified.

B. Related Sections: CONTRACTOR shall coordinate the requirements of the Work in this Section along with the requirements of the Sections listed below which includes, but is not necessarily limited to, Work that is directly related to this Section.
1. Section 01330 - Submittals.
2. Section 01651 - Transportation and Handling of Materials and Equipment.
3. Division 15, Applicable Sections on Piping and Installation, Pipe Supports, Fittings, Valves and Accessories.

1.02 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
1. Manufacturer shall have a minimum of ten years prior experience in construction of crosslink polyethylene tanks in similar applications and shall be able to show evidence of previous installations in the past 36 months or provide a list of customers using tanks for the same application.

B. Source Quality Control:
1. Each tank shall be inspected for defects in accordance with the requirements of ASTM D1998.
2. Hydrostatic Test of Each Tank at Factory:
a. Each tank shall be factory tested by filling with water to overflow prior to being placed in service. Blind flange or plug all outlets as required for testing.
b. All materials, labor and equipment for above tests and retests shall be furnished by CONTRACTOR. This will not, however, relieve CONTRACTOR from repairing leaks that may appear when the tanks are field tested. Upon arrival at the site, the tanks shall be retested with water. Any leaks shall be repaired immediately by CONTRACTOR and tanks shall be retested. Above procedure shall be repeated until tanks are 100 percent leak free.

C. Materials Testing:

1. The material employed in items fabricated of crosslink polyethylene shall be capable of withstanding maximum calculated stresses that may occur during fabrication, installation and continuous operation, with allowance for an adequate safety factor. To confirm materials properties, tests shall be conducted by an independent, qualified testing laboratory on representative material samples in accordance with specified reference standards.

D. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified.

1. ANSI B16.5 - Pipe Flanges and Flanged Fittings.
2. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.
3. ASTM D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
4. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
5. ASTM D883 - Standard Terminology Relating to Plastics.
6. ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.
7. ASTM D1525 - Standard Test Method for Vicat Softening Temperature of Plastics.
8. ASTM D1693 - Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
9. ASTM D1998 - Standard Specification for Polyethylene Upright Storage Tank: Section 11.3: Low Temperature Impact Test and Section 11.4: Oxylene-Insoluble Fraction (Gel Test).

E. Products used in the Work of this Section shall be produced by manufacturers regularly engaged in the production of such items and have a successful history of product acceptability, as interpreted by ENGINEER.

F. Tanks shall be manufactured by a firm with a nationally accepted quality standard ISO 9001: 2015

1.03 SUBMITTALS

A. Shop Drawings: Submit for approval the following:

1. CONTRACTOR shall submit as provided in this Section, shop drawings, details of construction and erection for each tank as listed below. Equipment will not be accepted and installation will not be allowed until such review has been completed:
    a. Dimensions of storage and secondary containment tanks, fittings and attachments, with bolt and gasket material.
    b. Details of inlet and molded outlet fittings, manways, flexible connections, and vents.

c. Wall thickness calculations per ASTM D 1998 using 300-psi design hoop stress @ 100 degrees F.
d. Locations of fittings and attachments and size of manway openings.
e. Resin used and a complete manufacturer specification of the resin used.
f. Empty weight of tanks.
g. Electrical heat tracing and panel, and installation details.
h. Insulation data.
i. Statement that fabrication is in accordance with these Specifications.
j. Certificate of Compliance from the tank manufacturer stating:
    1) All fittings, etc. have been installed by the tank manufacturer.
    2) Hydrostatic tests have been performed by the manufacturer and all fittings were installed prior to the tests.
    3) That materials and resin used are suitable for intended service.
    4) Details on packaging.
    5) Instructions for handling, storage and installation of tanks.

2. Operation and Maintenance Manuals.

1.04 WARRANTY

A. The warranty shall be provided by the manufacturer for a period of one year from being placed into service.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. CONTRACTOR shall be responsible for the safe transportation to the job site, including any freight cost and necessary permits, handling, and open air storage of the tanks and other materials specified in this Section.

B. Tanks delivered to the job site shall be inspected by CONTRACTOR for damage, unloaded and stored with a minimum of handling. Comply with manufacturer's recommendations for handling and storing tanks. Tanks shall be shipped empty, all interior components shall be shipped separately.

C. In general, tanks shall be:
1. Checked and tied down to prevent being blown by wind.
2. Vented to allow for temperature changes that may affect their integrity.
    a. Provided with opening protection to exclude foreign matter.
3. Large sub-assemblies should be supported during unloading to prevent excessive deflection and overstressing.
4. Equipment and materials shall be stored so as to keep free from damages and deterioration.

D. Tanks shall be protected, by padding or bracing, from banding or ropes used in shipment. No chains are to be used to secure any tanks in transportation.

E. Tanks shall be clearly marked for any precautions in handling and transportation.

F. Trip recorders shall be used when shipping large vessels by rail.

G. After manufacture and before shipping, MANUFACTURER shall check tanks against shop drawings to confirm tanks are correctly manufactured.

1.06 EQUIPMENT INSPECTION

A. Prior to field hydrotesting of any vessel, vessel shall be checked for, which will include but not be limited to, the following:
   1. Vessel size, dimensions and fabrication tolerances.
   2. Proper nozzle and appurtenance placement in accordance with fabrication drawings.
   3. Minimum design thicknesses.

B. Prior to final inspection, all surfaces shall be made clean by brushing, wiping, or with a compressed-air blast to remove all loose foreign materials.

C. CONTRACTOR shall inspect each piece of equipment upon arrival at construction site to inspect for damage incurred in transit. Any damage shall be immediately repaired by respective equipment fabricator's personnel (not a sales representative).

PART 2 PRODUCTS

2.01 GENERAL

A. CONTRACTOR shall use the manufacturer’s name and model or catalog number to establish the standard of quality and general configuration desired.

B. CONTRACTOR shall make sure that like items of materials, equipment are provided by the same manufacturer.

2.02 MATERIALS

A. Plastic:
   1. The tanks shall be molded from High Density Polyethylene (HDPE).

B. Fillers and Pigments:

1. The plastic shall not contain any fillers. All plastic shall contain a minimum of 0.25 percent UV stabilizer and maximum of 0.60 percent. Pigments may be added as desired by the OWNER or as designated by the manufacturer, not to exceed 0.5 percent of dry blend.

2.03 HIGH DENSITY POLYETHYLENE DOUBLE CONTAINMENT TANKS

A. The high density polyethylene tanks shall be designed for the following:

Location	Service	Tank Dimensions	Tank Volume (gal)
Backwash Tank	Ion Exchange backwash water (well water with solids) and no chemicals	Vertical Closed Top-See Drawings	2,000

B. Acceptable Manufacturers:

1. Polyprocessing Company
2. Snyder
3. Or Approved equal

C. The tank color shall be Natural crosslink color.

D. The nominal properties of the material are as follows based on molded parts:

Property	ASTM Specification	Value
Density	D1505	0.938-0.944 g/cc
ESCR Condition A 10% Igepal 100% Igepal	D1693	>1,000 hours
Tensile Strength Ultimate 2 in/min Type IV Spec	D638	2,830 psi
Elongation at Break 2 in/min.	D638	700 percent
Vicat Softening Temperature	D1525	248 degrees F
Heat Distortion Temperature	D648	150 degrees F 66 degrees C
Brittleness Temperature	D746	<-180 degrees F
Flexular Modulus	D790	86,780 psi

2.04 VERTICAL STORAGE TANKS

A. The tanks shall be vertical, cylindrical, flat bottom, dome top, and seamless in construction.

B. The assembly consists of one cylindrical, closed top inner primary tank and one cylindrical, top containment outer tank.

C. The tank(s) are designed for above-ground, vertical installation and are designed to store approved chemicals at atmospheric pressures.

D. The assembly shall be designed to prevent rainwater and debris from entering the containment tank.

E. Where indicated, tanks shall be provided with ancillary mechanical fittings and accessories. Tanks shall be marked to identify the manufacturer, date of manufacture and serial numbers must be permanently embossed into the tank.

F. The tank diameter shall be measured externally. Tolerance on the outside diameter including out of roundness shall be plus or minus three percent. Measurement shall be taken in a horizontal position.

G. The tank wall thickness shall be of uniform thickness from tank dome top to bottom knuckle radius. A stratified wall thickness is unacceptable. Ultrasonic thickness testing shall be provided to document this construction.

J. All cut out edges, such as manway openings, nozzle openings, shall be trimmed to have smooth edges.

K. Fittings:

1. Fitting shall be CPVC, gasket shall be EPDM and bolt material shall be Titanium or a material that is compatible with the product being stored. Threaded fittings shall use American Standard Pipe Threads. If tanks are insulated, fittings shall be installed at the factory prior to application of the insulation.
2. Double flange fittings shall be constructed of virgin polyethylene. Bolts will be welded to a common backing ring and encapsulated with polyethylene preventing fluid contact with the metal material. Flange will have one full face gasket to provide a sealing surface against the flange and tank surface. Bolt holes shall straddle the principal centerline of the tank.
3. Bolted flange bulkhead fittings shall be constructed with one 150-lb flange installed inside the tank and one flange ring installed outside the tank. The flange will be socket or threaded according to specific connection requirements. The head of the bolts shall be encapsulated with polyethylene preventing fluid contact with the metal material. Encapsulated heads shall

have a gasket to provide a sealing surface against the flange. Bolt holes shall straddle the principal centerline of the tank.

4. Down Pipes and Fill Pipes: Down pipes and fill pipes shall be supported at 6-ft max intervals. Down pipes and fill pipes shall be CPVC or material compatible with the chemical stored.
5. U-Vents: Each tank must be vented for the material and flow and withdrawal rates expected. Vents should comply with OSHA 1910.106(F)(iii)(2)(IV)(9). U-vents shall be sized by the tank manufacturer and be furnished complete with insect screen if required (Insect screen lessens the tank capacity by 1/3) in accordance with the venting schedule listed above.
6. Flange Adapters: Adapters may be used to adapt threaded or socket fitting components to 150-lb flange connections. Adapters shall be of material compatible with the chemical stored.
7. Flexible hose connections are required on the lower sidewall for transition through secondary containment tank. Connection shall include ultra high molecular weight hose, two King nipples (barbed); and mechanically attached corrosion resistant bands securing the hose to the nipples.

2.05 ACCESSORIES

A. Manways:
   1. The manways shall be 17-inch diameter or greater.
   2. The tank manufacturer shall provide lockable manways.

B. Side Wall Fittings:
   1. Outlet pipe shall have integrally molded type fitting. Universal ball dome fittings with flange adapters shall be used for fill, level sensor, and level switch connectors. Flexi-joint flexible connections shall be used as needed. Materials options for flange fittings are CPVC. Gasket material options are Viton and EPDM based on the compatibility of the specific chemical being used. All bolts used must be encapsulated with a compatible elastomer. Bolt material can be 316 SS, Titanium or Hastelloy 316 SS. The following table indicates the chemical stored, resin used, fitting material, gasket material and bolt material based on the chemical stored.

C. Tank Connections:
   1. To the extent feasible, all fittings located on the side of the tank shall be integrally molded type.
   2. All nozzles located on the tank roof shall be self-aligning type.
   3. CONTRACTOR shall be responsible for all coordination ad costs between instrument supplier and tank supplier to ensure that flange openings are suitable and compatible for installation of level sensors and probes.

D. Seismic Restraint and Hold Down System:
   1. Metal components to be galvanized, stainless steel, or painted clips, edge softeners, and tension ring with stainless steel and clamps.

2.06 SYSTEM DESCRIPTION

A. All openings shall be covered to prevent the entrance of dirt and debris during shipping.

B. Instructions shall be provided for unloading and installation of tanks. Provide lifting lugs as needed.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the high-density polyethylene tanks in accordance with the Drawings and the manufacturer's instructions.

B. All sidewall connections shall be installed with flexible type connections as per the Manufacturers recommendations. Flexible connections must be designed to absorb a minimum of ½" of expansion from the tank.

C. The CONTRACTOR shall make all piping connections to tanks as shown on the Drawings. These connections along with the storage tank connections must be tested with water after installation and prior to chemical introduction.

D. Tanks and support members shall be clamped using 1/4" 304 SS cable and clamps to loop around the grating of the bars to secure the tank intoin their final position according to the manufacturer's recommendations. See Drawings.

E. Provide SS clamps cable, nuts, and supports. Installation will be inspected by manufacturer to verify system flexible connections, venting and fittings are properly installed. In addition to on-sight inspection tank system(s) to be reviewed using tank manual check list as supplied by manufacture as listed below.

F. Manufacturer to provide 1 hour training session to prepare operators to service and maintain the tank system. Included in training session will be training manuals for the City's operation staff.

G. Manufacturer's trained technician to do an onsite inspection of installation. Inspection will verify chemical application, plumbing connections, venting, and applicable ancillary equipment such as ladders, restraints, etc. A verification of proper installation certificate will be supplied when equipment passes installation checklist.

H. Tank manuals will consist of installation check lists, tank drawing(s) as built, fitting drawings referencing nozzle schedule on tank drawing, materials of construction, and recommended maintenance program.

3.02 FIELD TESTING

A. After installation, each tank(s) connecting plumbing shall be field tested by filling with water. The tank and fittings shall hold water without loss or evidence of weeping for a period of 24 hours prior to acceptance.

B. After testing, the tanks shall be thoroughly cleaned.

C. Should any defects become evident during inspection, testing or within the guarantee period, the CONTRACTOR in conjunction with the tank manufacturer shall repair or replace the defective items as approved by the ENGINEER.

END OF SECTION

SECTION 13334

MAGNETIC FLOW METERS

PART 1 GENERAL

1.01 SUMMARY OF SECTION

A. Provide a magnetic flowmeter as shown on the Drawings to monitor water flow rate (Tag No. FM6).

B. Related Sections include, but are not necessarily limited to:
1. Division 1 - General Requirements
2. Section 01330 - Submittals
3. Section 01651 - Transportation and Handling of Materials
4. Section 01781 - Operation and Maintenance Data
5. Section 11005 - Equipment: General
6. Division 16 - Electrical

1.02 REFERENCES

A. National Electrical Manufacturer's Association (NEMA).

B. ICS 6, Enclosures for Industrial Controls and Systems

1.03 SUBMITTALS

A. Shop Drawings
1. Product data sheets, including dimensions and material specifications
2. Documentation to demonstrate compliance with specifications
3. Manufacturers installation instructions
4. Flow ranges and levels of accuracy
5. Electrical power requirements and wiring diagrams
6. Provide manufacturer's certification that meter operates within specified ranges of accuracy for the given lengths of straight pipe runs upstream and downstream of flow meter.

B. Operations and Maintenance Manuals
1. See Section 11005 - Equipment, General Statement

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Endress Hauser (400 W)

B. Ultra-Mag

2.02 MATERIALS

A. Body: Carbon Steel

B. Liner: Polyurethane

C. Electrodes: Stainless steel

2.02 DESIGN/FABRICATION

A. Pulsed DC type sensor

B Provide integrally mounted flow transmitter with NEMA 6 enclosure.

C. Solid state circuitry with adjustable span, zero and output signal damping.

D. Power Supply: Transmitter shall operate on 120 VAC, 60 Hz.

E. Flow Rate Ranges: Units shall operate under flow conditions specified in Meter Schedule on Drawings with an accuracy of ±0.5% under all conditions

F. Outputs: Provide with amplifiers, noise suppression circuitry, signal converting circuitry to produce an isolated 4-20 mA signal and a totalizer pulse signal transmitted to the ATF PLC.

G. Include local LCD display calibrated for instantaneous and totalized display.

H. Flanged end connections rated for 150 psi.

I. Accessories:
   1. Provide all ancillary devices required for a complete installation including grounding rings, signal isolators, cables, and hardware.
   2. Meter body and electrical connections shall be suitable for outdoor use.

PART 3 EXECUTION

3.01 INSTALLATION

A. Installation: As per drawings and manufacturer's installation instructions.

B. Project Conditions
   1. Environmental Requirements: The instrument selected shall be suitable for the following conditions:
      a. Humidity: 0–50% relative humidity.
      b. Ambient temperature limit: 60 to 100 °F with local display.

C. Manufacturer's Representative will provide two hours of training per site.

END OF SECTION

DIVISION 15

MECHANICAL

SECTION 15050

BASIC PROCESS PIPING MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Basic piping materials and methods.

1.02 REFERENCES

A. American Society of Testing and Materials (ASTM):
   1. A 106 - Specification for Seamless Carbon Steel Pipe for High Temperature Service.
   2. D 2240 - Test Method for Rubber Property - Durometer Hardness.
   3. A-536 - Specification for Ductile Iron Casting.

B. National Sanitation Foundation (NSF) 61.

C. AWWA C-111 - Standard for Rubber Gasketed Joints for Ductile Iron Pressure Pipe and Fittings.

D. Refer to Section 09800 for coating requirements for exterior of exterior piping.

1.03 DEFINITIONS

A. Exposed Piping: Piping within buildings, vaults, tunnels, or other structures without regard to elevation of piping, or exposed piping outside buildings and structures.

B. Buried Piping: Piping actually buried in soil or cast in concrete.

C. Wet Wall: Wall with water on at least one side.

1.04 INTENT OF DRAWINGS AND SPECIFICATIONS

A. Except in details, piping is indicated diagrammatically. Sizes and locations are indicated on the Drawings. Not every offset and fitting, or structural difficulty that may be encountered has been indicated on the Drawings.

B. Perform minor modifications to piping alignment where necessary to avoid structural, mechanical, or other type of obstructions that cannot be removed or changed:
   1. Modifications are intended to be of minor scope, not involving a change to the design concept or a change to the Contract Price or Contract Time.

1.05 SYSTEM DESCRIPTION

A. Performance Requirements:
   1. Restraining Piping:
      a. Restrain piping as follows:
         1) When piping is underground, use mechanical restraints throughout. All buried piping shall be restrained.
         2) When piping is aboveground or under water, use mechanical or structural restraints.
      b. Provide restraints with ample size to withstand thrust forces resulting from test pressures.
   2. Connections to Existing Piping:
      a. Expose existing piping to which connections are to be made with sufficient time to permit, where necessary, field adjustments in line, grade, or fittings:
         1) Protect domestic water supplies from contamination:
            a) Make connections between domestic water supply and other water systems in accordance with requirements of public health authorities.
            b) Provide devices approved by owner of domestic water supply system to prevent flow from other sources into the domestic supply system.
      b. Make connections to existing piping and valves after sections of new piping to be connected have been tested and found satisfactory.
      c. Provide sleeves, flanges, nipples, couplings, adapters, and other fittings needed to install or attach new fittings to existing piping and to make connections to existing piping.
   3. Connections to In-Service Piping:
      a. Shutdown in-service piping in accordance with Section 01040:
         1) Establish procedures and timing in a conference attended by CONTRACTOR, ENGINEER, and OWNER of the in-service piping.
   4. Connections of Dissimilar Metals:
      a. Connect ferrous and nonferrous metal piping, tubing, and fittings with dielectric couplings especially designed for the prevention of chemical reactions between dissimilar metals.
      b. Nonferrous metals include aluminum, copper, and copper alloys.
      c. For flanged piping with dissimilar metals, use an insulated coupling or insulating gasket.
   5. All pipe tapping saddles are to be of bronze construction, unless noted otherwise on the Drawings.

PART 2 PRODUCTS

2.01 ESCUTCHEONS

A. Manufacturers: One of the following or pre-approved equal:
   1. Dearborn Brass Company, Model Number 5358.
   2. Keeney Manufacturing Company, Model Number 102 or Number 105.
   3. Beaton and Corbin, Model Number 1 or Number 13.

B. Material: Chrome plated steel plate.

2.02 LINK SEAL

A. Manufacturers: One of the following or pre-approved equal:
   1. Calpico, Inc.
   2. Thunderline Corporation.

B. Characteristics:
   1. Modular mechanical type, consisting of interlocking neoprene or synthetic rubber links shapes to continuously fill the annular space between the pipe and wall opening.
   2. Assemble links solely with stainless steel bolts and nuts to form a continuous rubber belt around the pipe.
   3. Provide a stainless steel pressure plate under each bolt head and nut. Isolate pressure plate from contact with wall sleeve.
   4. The link seals used in the chemical storage containment areas shall be corrosion resistant to the chemicals contained in the chemical storage tanks.

2.03 COUPLINGS

A. Ductile Iron Couplings:
   1. Provide ductile iron couplings for use in connection of smooth end joints of ductile iron, steel or other types of pipe.
   2. General Requirements.
      a. Sleeve or center rings shall be of nominal O.D. size, range and length specified. Sleeve shall be of Ductile Iron ASTM A536. Ends shall have a smooth inside taper to provide uniform gasket seal. Sleeve shall be given a shop coat of oil-modified urethane, corrosion-resistant paint.
      b. Follower flanges or end rings shall be of the thickness determined by the coupling size, and shall be of ductile iron, ASTM-536. Flanges shall be identified by a color coded shop coat finish as described in Item 2a.
      c. Gaskets shall be compression-type, formed with Virgin Styrene Butadiene Rubber (SBR), compounded with ingredients to produce

permanence and resistance to set after installation. O.D. range shall be imprinted on the gasket in permanent ink (minimum).

d. Bolts and nuts shall be of high-strength, low-alloy steel, with nominal coarse thread, and hex nuts with black finish. Dimensions and minimum stress values shall be in accordance with AWWA/ANSIC111/A21.11.

e. Where specification states a cast transition or reducing coupling in place of a straight coupling, the sleeve and follower flange shall be of the same manufacturer and compatible for the specific use intended.

f. Quality control procedures shall be employed to ensure that the sleeve, follower flanges, and gaskets are properly fabricated and free of any visible defects. Coupling shall have pressure rating of 150 psi.

3. Manufacture: EBAA Iron Inc., Romac Industries Inc., or Pre-approved equal.

B. Expansion Joint (Flexible Bellows Coupling):

1. Manufacturer:General Rubber or Pre-approved equal.

2. Performance and Design:

a. Provide single and double arch expansion joints, as shown on the drawings, complete with restraining rods to prevent over-expansion. Provide flanged spool with single or multiple arches, designed to provide motion capability as specified. Rubber expansion joints shall be rated for 250°F and 150 psi.

3. Materials:

a. Tube - Provide single, seamless, leakproof tube made of synthetic rubber that extends through the bore to the outside edges of both flanges.

b. Body - Fabric reinforcement shall be used as the flexible and supporting member between the tube and the cover. Fabrics of high strength synthetic fibers shall be used. All Fabrics plies shall be impregnated with rubber or synthetic compounds to permit flexibility between the fabric plies to reduce service strain.

c. Cover - The exterior surface of the joint shall be formed from synthetic rubber to protect the body from outside damage. Utilize special polymers to resist sunlight.

d. Integral Flanges - Constructed of resilient rubber, and smooth finish, the full-faced flanges form a tight seal against the pipe flange without the need of gaskets. Provide standard AWWA flanges as specified in Section 15062.

e. Provide restraining rods attached to flanges for thrust protection.

4. Execution:

a. Install expansion joint as shown on the Drawings and in accordance with the manufacturer's recommendations.

C. Flanged Coupling Adapter:
   1. Description: One end of adapter shall be flanged and the other end shall have a sleeve type flexible coupling.
   2. Pressure and Service: Same as connected piping.
   3. Material: Cast iron or steel.
   4. Bolts and Nuts: Type 316 stainless steel.
   5. Harnessing:
      a. Harness adapters to restrain pressure piping. Test pressures for pressure pipelines shall conform to the requirements of Section 15050, Piping Systems.
      b. For adapters 12-inch diameter and less, provide 1/2-inch minimum stainless steel anchor studs installed in a pressure tight anchor boss. Provide number of studs required to restrain test pressure and service conditions. Harness shall be as designed and recommended by manufacturer; however, the following minimum anchor studs shall be provided, unless otherwise approved by ENGINEER:
         1) 6-inch diameter and less: Two.
         2) 8-inch diameter and less: Four.
         3) 10-inch diameter and less: Six.
         4) 12-inch diameter and less: Eight.
      c. For adapters larger than 12-inch diameter, provide split-ring harness clamps with a minimum of four Type 316 stainless steel bolts. Harness assembly shall be as designed and recommended by manufacturer. Dimensions, sizes spacings and materials shall be suitable for service and conditions encountered and shall be approved by ENGINEER.
      d. Harness couplings to restrain pressure piping.
      e. Test pressures for pressure pipe lines shall conform to the requirements of Section 15050, Piping Systems.
      f. Harnessing shall conform to the details shown on the Drawings.
   6. Product and Manufacturer: Provide one of the following:
      a. Smith-Blaire, Model 912.
      b. Romac Industries Inc., FC400/FCA501/RFCA.
      c. Ford FFCA.

2.04 CONTROLLED LOW STRENGTH MATERIAL

A. Controlled low strength material shall consist of portland cement coarse and fine aggregate, and water.

B. Cement content shall be 0.5 sack of cement per yard.

C. The material shall have slump of 7 inches ± dye inch.

D. Compressive strength at 28 days shall be 70 psi ± 30 psi.

2.05 BURIED PIPING

A. All buried piping shall also be provided with an identification tape (non detectible) placed 3 feet above the crown of the pipe. The tape shall be an inert polyethylene-plastic impervious to alkalis, acids, chemical reagents, and solvents likely to be encountered in the soil. The tape shall be a minimum of 4.0 mils thick and not less than 3" wide. The color of the tape and the text will be selected by OWNER. Lettering shall be minimum 1 ½" high. The OWNER will select text for each pipe run using manufacturer's normally available stock.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verification of Existing Conditions:
   1. Locate and expose existing structures, piping, conduits, and other facilities and obstructions which may affect construction of underground piping before starting excavation for new underground piping and appurtenances.
   2. Verify sizes, elevations, locations, and other relevant features of existing facilities and obstructions. Determine conflicts for the construction of the new underground piping and appurtenances.
   3. Make piping location and grade adjustments to resolve conflicts between new piping and existing facilities and obstructions.

3.02 WALL AND SLAB PENETRATIONS

A. Provide sleeves for piping penetrations through masonry and concrete walls, floors, ceilings, roofs, pilasters, columns, piers, and beams unless specified or otherwise indicated on the Drawings.

B. For piping 1 inch in nominal diameter and larger, provide sleeves with minimum inside diameters of 1 inch plus outside diameter of piping. For piping smaller than 1 inch in nominal diameter, provide sleeve of minimum twice the outside diameter of piping:
   1. Arrange sleeves and adjacent joints so piping can be pulled out of sleeves and replaced without disturbing the structure.
   2. Cut ends of sleeves flush with surfaces of concrete, masonry, or plaster.
   3. Conceal ends of sleeves with escutcheons where piping runs through floors, walls, or ceilings of finished spaces within buildings.
   4. Seal spaces between pipes and sleeves.

C. Cast couplings or wall pieces in walls for penetrations of buried rigid piping including cast iron, ductile iron, reinforced concrete, and vitrified clay through structures:

1. Provide couplings or wall pieces with mechanical push-ons, or similar flexible joints at outside of walls.
2. Provide additional similar joints in piping at transition points between trenches and structure excavations.
3. For steel piping, single joints may be used in lieu of two joints. Locate single joints outside within 2 feet from outside faces of walls.

D. Link Seal: Use 2 link seals where seal is used to seal at wet wall sleeves. Mount one seal on the inside face of the wall and the other on the outside face of the wall. Coordinate the inside diameter of the wall sleeve with the size of the seal to provide watertight sealing.

E. Where not indicated on the Drawings, penetrations for conditions other than those specified under the preceding subparagraphs shall be one of the three types specified in such subparagraphs found by OWNER to be the most suitable for the particular conditions.

3.03 EXPOSED PIPING

A. Install exposed piping in straight runs parallel to the axes of structures, unless indicated otherwise:
1. Install piping runs plumb and level, unless otherwise indicated on the Drawings.

B. Install exposed piping after installing equipment and after piping and fitting locations have been determined.

C. Support piping in accordance with Section 15141 and as shown on Drawings:
1. Do not transfer pipe loads and strain to equipment.

D. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, and other types of joints or means which are compatible with and suitable for the piping system, and necessary to allow ready assembly and disassembly of the piping.

E. Assemble piping without distortion or stresses caused by misalignment:
1. Match and properly orient flanges, unions, flexible couplings, and other connections.
2. Do not subject piping to bending or other undue stresses when fitting piping. Do not correct defective orientation or alignment by distorting flanged joints or subjecting flange bolts to bending or other undue stresses.

3. Flange bolts, union halves, flexible connectors, and other connection elements shall slip freely into place.
4. After piping assembly to fit when proper fit is not obtained.
5. Install eccentric reducers or increasers with the top horizontal for pump suction piping.

3.04 BURIED PIPING

A. Bury piping with minimum 4 foot cover without air traps, unless otherwise indicated on the Drawings.

B. Where 2 similar services run parallel to each other, piping for such services may be laid in the same trench. Lay piping with sufficient room for assembly and disassembly of joints, for thrust blocks, for other structures, and to meet separation requirements of public health authorities having jurisdiction.

C. Laying Piping:
1. Lay piping in finished trenches free from water or debris. Begin at the lowest point with bell ends up slope.
2. Place piping with top or bottom markings with markings in proper position.
3. Lay piping on an unyielding foundation with uniform bearing under the full length of barrels.
4. Where joints require external grouting, banding, or pointing, provide space under and immediately in front of the bell end of each section under and immediately in front of the bell end of each section laid with sufficient shape and size for grouting, banding, or pointing of joints.
5. At the end of each day's construction, plug open ends of piping temporarily to prevent entrance of debris or animals.

3.05 CLEANING

A. Piping Cleaning:
1. Upon completion of installation, clean piping interior of foreign matter and debris. Perform special cleaning when required by the Contract Documents.
2. Maintain pipe in clean condition during installation.
3. Before jointing piping, thoroughly clean and wipe joint contact surfaces and then properly dress and make joint.
4. Immediately prior to pressure testing, clean and remove grease, metal cuttings, dirt, or other foreign materials which may have entered the system.
5. At completion of work and prior to final acceptance, thoroughly clean work installed under these Specifications. Clean equipment, fixtures, pipe, valves, and fittings of grease, metal cuttings, and sludge which may have accumulated by operation of system, from testing, or from other causes. Repair any stoppage or discoloration or other damage to parts of building, its finish, or furnishings, due to failure to properly clean piping system, without cost to Owner.

6. Clean chlorine piping by pulling a cloth saturated with trichloroethylene or other suitable chlorinated solvent through each length of pipe. Disassemble valves and clean with suitable solvent. All surfaces which may come in contact with chlorine shall be thoroughly dry, and free of oil or grease before placing in service.

B. Cleaning Potable Water Piping:
   1. Flush and disinfect potable water piping in accordance with Section 15495.

3.06 FIELD QUALITY AND CONTROL

A. General:
   1. Upon completion of piping, but prior to application of insulation on exposed piping or covering concealed/buried piping, test all piping systems.
   2. Test all piping systems at 150 psi for 2 hours, unless otherwise indicated. Pressure shall stabilize within 2% of 150 psi.
   3. Isolate equipment which may be damaged by the specified pressure test conditions.
   4. Perform pressure test using calibrated pressure gauges and calibrated volumetric measuring equipment to determine leakage rates. Select each gauge so that the specified test pressure falls within the upper half of the gauge's range. Notify the OWNER 24 hrs prior to each test.
   5. Unless otherwise specified, completely assemble and test new piping systems prior to connection to existing pipe systems.
   6. Acknowledge satisfactory performance of tests and inspections in writing to OWNER prior to final acceptance.
   7. Provide all necessary equipment and perform all work required in connection with the tests and inspections.
   8. Bear the cost of all testing and inspecting, locating and remedying of leaks and any necessary retesting and re-examination.
   9. CONTRACTOR to dispose of testing water.

B. Pressure Testing Methods and Criteria:
   1. Types of pressure testing and inspection to be employed include hydrostatic pressure testing, and hydrostatic infiltration/exfiltration testing.
   2. Liquid systems:
      a. The following liquid piping systems shall have zero leakages at the specified test pressure throughout the specified duration:
         1) Exposed piping.
         2) Buried insulated piping and buried or exposed pressure piping.
   3. Hydrostatic pressure testing:
      a. All joints, including welds, are to be left exposed for examination during the test.

b. Provide temporary restraints for expansion joints for additional pressure load under test. Equipment in piping system with rated pressure lower than pipe test pressure shall be isolated by valves or blind flanges.

c. Do not paint or insulate exposed piping until successful performance of pressure test.

d. Test soil, waste and drain piping at completion of installation of each stack or section of piping by filling system with water to highest point and checking joints and fittings for leaks. Leaks must be eliminated before proceeding with work or concealing piping. Minimum test heights shall be 10 ft.

3.07 PIPING SCHEDULE

A. See Drawings.

END OF SECTION

SECTION 15075

PLASTIC PIPING AND TUBING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Plastic pipe, tubing, and fittings.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. B 16.12 - Cast Iron Screwed Drainage Fittings.

B. American Society for Testing and Materials (ASTM):
   1. D 648 - Test Method for Deflection Temperature of Plastics Under Flexural Load.
   2. D 1248 - Specification for Polyethylene Plastics Molding and Extrusion Materials.
   3. D 1784 - Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated by Poly (Vinyl Chloride) (CPVC) Compounds.
   4. D 1785 - Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
   5. D 1869 - Specification for Rubber Rings for Asbestos-Cement Pipe.
   6. D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications.
   7. D 2412 - Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
   8. D 2466 - Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings Schedule 40.
   9. D 2467 - Specification for Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings Schedule 80.
   10. D 2513 - Specification for Thermoplastic Gas Pressure Pipe Tubing and Fittings.
   11. D 2564 - Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
   12. D 2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
   13. D 2665 - Specification for Poly (Vinyl Chloride) (PVC) Plastic, Waste and Vent Pipe Fittings.
   14. D 2680 - Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Pipe.
   15. D 2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.

16. D 3034 - Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
17. D 3212 - Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
18. D 3261 - Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
19. D 3350 - Specification for Polyethylene Plastic Pipe and Fittings Material.
20. D 4101 - Specification for Propylene Plastic Injection and Extrusion Materials.
21. F 439 - Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
22. F 441 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
23. F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
24. F 483 - Method for Total Immersion Corrosion Test for Aircraft Chemicals Maintenance.
25. F 493 - Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
26. F 645 - Guide for Selection, Design and Installation of Thermoplastic Water Pressure Piping System.
27. F 679 - Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
28. F 714 - Specification for Polyethlene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

C. American Water Works Association (AWWA):
1. C 900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings.
2. C-115 - Standard for Flanged Ductile Iron Pipe with Grey Iron Threaded Flanges.

D. Code of Federal Regulations:
1. Title 49.

E. Plastic Pipe Institute (PPI):
1. PE 3408.

F. United States Department of Transportation:
1. Materials Transportation Bureau.

G. National Sanitation Foundation (NSF) 61.

1.03 ABBREVIATIONS

A. ABS: Acrylonitrile-Butadiene-Styrene.

B. CPVC: Chlorinated Polyvinyl Chloride.

C. DWV: Drain, waste, and vent.

D. ID: Inside diameter of piping or tubing.

E. NPS: Nominal pipe size followed by the size designation.

F. NS: Nominal size of piping or tubing.

G. PE: Polyethylene.

H. PP: Polypropylene.

I. PVC: Polyvinyl Chloride.

J. SDR: Standard dimension ratio.

1.04 SUBMITTALS

A. Product Data: Describe materials and installation equipment including fusion machine.

B. Manufacturer's Published Installation Instructions.

C. Certificates:
   1. Submit manufacturer's certificate attesting that plastic pipe, tubing, and fitting meet specified requirements.
   2. Copies of solvent cement manufacturer's report and certification in accordance with ASTM D 2564 for PVC piping, and ASTM F 493 for CPVC piping.

D. Qualifications of installation crew for PE piping, including qualifications of the fusion machine technician.

1.05 QUALITY ASSURANCE

A. Fusion Machine Technician Qualifications: 1 year experience in the installation of similar PE piping systems from the same manufacturer.

B. Provide pipe and tubing bearing NSF seal, except for drainage piping.

C. Mark plastic pipe with nominal size, type, class, schedule or pressure rating, and manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect piping materials from sunlight, scoring, and distortion.

B. Do not allow surface temperatures on pipe and fittings to exceed 120 degrees Fahrenheit.

C. Store and handle pipe and fittings as recommended by manufacturer in published instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Extruding and Molding Material: Virgin material containing no scrap, regrind, or rework material except where permitted in the referenced standards.

B. Fittings: Same material as the pipe and of equal or greater pressure rating, except the DWV fittings need not be pressure rated.

C. Unions 2-1/2 inches and smaller: Socket end screwed unions. Make unions 3 inches and larger with flange ends with 1/8 inch full face soft rubber gasket.

2.02 PVC PIPING, SCHEDULE TYPE

A. Materials:
   1. PVC schedule type piping: Designation PVC 1120 conforming to ASTM D 1785 and appendices thereto.
      a. Pipe and fittings: Extruded from Type I, Grade 1, Class 12454-B material in accordance with ASTM D 1784.
      b. PVC Schedule Type Piping: Schedule 80 unless otherwise indicated on the Drawings.
   2. Fitting:
      a. Supplied by pipe manufacturer.
      b. Pressure Fittings: In accordance with ASTM D 2466 or ASTM D 2467.
      c. DWV Fittings: In accordance with ASTM D 2665.
   3. Solvent Cement: In accordance with ASTM D 2564.

2.03 PVC PIPING, CLASS TYPE

A. Materials:
   1. PVC pipe, Class type: Pipe shall have outside diameters of ductile iron pipe sizes:
      a. ASTM D2241 PVC Pipe, Pressure rating 250 psi: SDR 17 and Uni-Bell Standard UNI-B-2-72.
      b. PVC Pipe, Class Type: AWWA C 900, Pressure Class 150 and SDR 18.
      c. Bell Section: At least as strong as the pipe barrel.

2. Fittings: Cast or ductile iron fittings as specified under Section 15062, sized for the dimensions of the pipe being used.
    a. Fittings for joining pipe 4 inches in diameter and larger: Flanged fitting to meet AWWA C115, and nitrite gaskets.
3. Gaskets: Meeting the requirements of ASTM D 1869 or ASTM F 477.

2.04 PVC EXPANSION JOINTS

A. Materials:
1. PVC schedule type expansion joints: Designation PVC 1120 conforming to ASTM D 1785 and appendices thereto.
2. Seals: EPDM or Viton.

B. Manufacturers:
1. Spears.
2. Or Pre-approved equal.

C. PVC expansion joints shall be provided every 50 ft for pipe run.

2.05 PE AND HDPE PIPING FOR DRAIN, WATER, AND VENT

A. General:
1. Pipe and fittings: High density polyethylene.
2. Dimensions of pipe and fittings: Based on controlled outside diameter in accordance with ASTM F 714.
    a. SDR: Equal to or less than 11.

B. Materials:
1. Manufacturers: One of the following or equal:
    a. DuPont, Sclairpipe.
    b. Polaris, Duratuff; or Pre-approved equal:
        1) Pipe, fittings, and adapters: Furnished by the same manufacturer, and compatible with components in the same system and with components of other systems to which connected.
2. Polyethylene: In accordance with ASTM D 1248, Type III, Class C, Category 5, Grade P34; listed by the Plastic Pipe Institute under the designation PE 3408; and have a minimum cell classification, in accordance with ASTM D 3350, of 345434C.
    a. Pipe and fittings: Manufactured from material with the same cell classification.

2.06 CPVC PIPE

A. CPVC pipe shall be Schedule 80, Class 23447-B, conforming to ASTM D 1784 and ASTM F 441.

B. All joints shall be solvent welded. At all valves, appurtenances and connections to equipment, CONTRACTOR shall provide unions for ease of disassembly. (THIS APPLIES TO ALL CPVC PIPING INSTALLED UNDER THIS PROJECT).

C. Provide flanged fittings at all valves and equipment with nitrile gaskets, unless shown otherwise on the Drawings. Provide type 316 stainless steel bolts and nuts.

D. Provide CVPC expansion joints for every 50 feet of pipe run. Confirm locations with ENGINEER in field.

2.07 SOURCE QUALITY CONTROL

A. PVC Piping, Schedule Type:
   1. Mark pipe and fittings in accordance with ASTM D 1785.

B. PVC Piping, Class Type:
   1. Test pipe to withstand, without failure, 150 psi, hydrostatic pressure .
   2. Test integral bell with the pipe.

C. CPVC Piping:
   1. Mark pipe and fittings in accordance with ASTM F 441.

2.08 DETECTABLE TAPE

A. Materials:
   1. 3.5 mil thick solid foil core encased in a protective plastic jacket.
   2. Resistant to alkalies, acids and other destructive elements commonly found in soil.
   3. Lamination shall have sufficient strength that the layers cannot be separated by hand.
   4. Total composite thickness shall be 4.3 mils minimum.
   5. Foil core to be visible to ensure continuity.
   6. Minimum tensile strength of 63 lbs in the machine direction and 68 lbs in the transverse direction per three (3) inch strip.
   7. Continuous warning message repeated every 16 to 36 inches shall be imprinted on the tape surface. Tape shall be colored.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Where not otherwise specified, install piping in accordance with ASTM F 645, or manufacturer's published instructions for installation of piping, as applicable to the particular type of piping.

2. Provide molded transition fittings for transitions from plastic to metal or IPS pipe. Do not thread plastic pipe.
3. Locate unions where indicated on the Drawings, and elsewhere where required for adequate access and assembly of the piping system.
4. Provide serrated nipples for transition from plastic pipe to rubber hose.
5. All buried plastic pipe shall have detectable tape applied along the entire length of pipe.
6. PVC expansion joints installed on PVC pipelines as conditions require.

B. Installation of PVC Piping, Schedule Type:
1. Exposed 4-inch and larger connections will be van stone style flanged as shown on the drawings. Spigot van stone style will be used to flange fittings. Socket van stone style will be used for piping flanges exposed less than 4" and smaller connections will be solvent welded.
2. Neoprene gaskets will be used for all water piping.
3. Solvent weld joints in accordance with ASTM D 2855.
4. Install piping in accordance with manufacturer's published instructions.

C. Installation of PVC Piping, Class Type:
1. Install piping in accordance with the Appendix of AWWA C900 complemented with manufacturer's published instructions.
2. For contraction and expansion at each joint, provide rubber ring and integral thickened bell as part of each joint.
3. Direct burial installation tie-ins will be done at the proper buried temperatures.

D. Installation of Polyethylene (PE) Tubing and Fittings:
1. Install small bore PE tubing in accordance with manufacturer's printed instructions, in neat straight lines, supported at close enough intervals to avoid sagging, and in continuous runs wherever possible.
2. Bundle tubing in groups of parallel tubes within protective sheath.
3. Tubes within protective sheath may be color coded, but protect tubing other than black outside the sheath by wrapping with black plastic electrician's tape.
4. Grade tubing connected to meters in one direction.

E. Installation of PE Piping for Drain, Waste, and Vent:
1. Install piping as recommended in manufacturer's published instructions.

3.02 FIELD QUALITY CONTROL

A. Clean and test piping as specified in Section 15050.

END OF SECTION

SECTION 15110

VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Basic requirement for valves:
   1. Requirements indicated on the Drawings and specified elsewhere in these Specifications take precedence over the requirements specified under this Section.
   2. Furnish and install valves required for proper piping and equipment operation and maintenance, in addition to the valves indicated on the Drawings, and specified.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   2. A126 - Gray Icon Casting for Valves, Flanges, and Pipe Fittings.
   3. A48 - Specifications for Gray Iron Castings.
   4. A536 - Ductile Iron Castings.

B. American Water Works Association (AWWA):
   1. C111 - Rubber-Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
   2. C504-00 - Rubber Seated Butterfly Valves.
   3. C508 - Swing Check Valves for Waterworks Service, 2 through 24 IN NPS.
   4. C-110 - Standard for Ductile Iron and Grey Iron Fittings.
   5. C-207 - Steel Pipe Flanges for Waterworks Service.

C. Steel Structures Painting Council (SSPC):
   1. SP-2 - Hand Tool Cleaning.
   2. SP-10 - Near-White Blast Cleaning.

D. American National Standards Institute (ANSI):
   1. B1.20.1, Pipe Threads, General Purpose.

E. NSF 61 - Drinking Water System Components.

1.03 DESIGN REQUIREMENTS

A. Pressure Rating: 150 psi.

B. Valve To Piping Connections:
   1. Valves 3 inch nominal size and larger: Flanged ends unless otherwise specified on the Drawings.
   2. Valves less than 3 inch nominal size: Screwed ends.

1.04 SUBMITTALS

A. Product Data: Submit detailed technical information relating to the valve including description of component parts, materials of construction, performance, dimensions, and weights.

B. Manufacturer's Published Instructions:
   1. Submit instructions for installation, operation, and maintenance of valves.
   2. Furnish bound sets of installation, operation, and maintenance instructions for each type of valve 3 inch nominal size and larger.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Valves: Manufactured by manufacturers whose valves have had successful operational experience in comparable service.

PART 2 PRODUCTS

2.01 MATERIALS

A. Underground Bolts: Low-alloy steel in accordance with AWWA C111.

B. Bronze And Brass Alloys: Use bronze and brass alloys with not more than 6 percent zinc and not more than 2 percent aluminum in the manufacturing of valve parts.

C. Interior Protective Coating:
   1. Epoxy coat interior non-working surfaces, except stainless steel surfaces.
   2. Coating Types:
      a. Powder Epoxies:
         1) Manufacturers: One of the following or equal:
            a) 3-M Company, ScotchKote 134; certified to NSF 61 for drinking water use.
            b) Michigan Chrome and Chemical Company, Micron 650 or 651.
            c) Or Pre-approved equal.

b. High Solids Polyamine Cured Epoxy:
1) Manufacturers: One of the following or equal:
a) Tnemec: Series 140N Pota Pox
b) Ameron: Amercoat 395
c) Carboline: Carboguard 891
d) DevoeL Bar Rust 223H
e) Or Pre-approved equal

3. Clean surfaces to meet SSPC-SP-10, near-white metal blast cleaning, with grit of size recommended by epoxy manufacturer.
4. Apply in accordance with manufacturer's published instructions:
a. High Solids Polyamine Cured Epoxy:
1) Not less than 2 coats to the specified thickness.
5. Coating Thickness: 12 mils except that:
a. Coating thickness in grooves for gaskets: 5 mils.
b. Do not coat seat grooves in valves with bonded seat.
6. Quality Control:
a. Coating Thickness: Measured with a nondestructive magnetic type thickness gauge.
b. Verify coating integrity with a holiday detector set at 1,800 volts.
c. Consider tests successful when coating thickness meets specified requirements and when no pin holes are found:
1) Correct defective coating disclosed by unsuccessful tests, and repeat test.
2) Repair pinholes in accordance with manufacturer's published recommendations.

D. Underground Valves:
1. Provide underground valves with flanged, mechanical, or other type of joint required for the type of pipe to which the valve is to be connected.
2. Coating and Wrapping:
a. Paint buried valves with 3 coats of asphalt varnish in accordance with AWWA C 504:
1) Protect coating from damage during handling and installation; repair coating where damaged.
b. After installation, wrap valves in polyethylene as specified for ductile iron piping in Section 15062:
1) Ascertain that polyethylene wrapping does not affect operation of valve.

E. Valve Boxes:
1. Furnish and install access to operators of buried valves through cast-iron valve boxes, as shown on Drawings:
a. Do not support boxes on valve, valve operator, or pipe.
b. Boxes: Fabricated of cast-iron; provided with cover, asphalt varnished or enameled. Adjust to grade, install centered around the

upper portions of the valve and valve operator.

c. Use seamless pipe inside valve box. If seam is required, use a sealed bell joint.

d. Minimum clear inside diameter of 6 inches.

e. Install per MAG Detail 391-1 Type A.

F. Valve Operators:

1. Open counterclockwise.

2. Provide valves located below operating level or deck with extensions for key operation or floor stands and handwheels.

3. Provide manually operated valves and gates located not more than 6 feet above the operating level with levers, tee handles, wrenches, or handwheels, as shown on Drawings.

a. Make the valve operator more conveniently accessible by rolling valves, located more than 5 feet but less than 6 feet above the operating level, toward the operating side.

b. Secure tee handles and wrenches to the valve head or stem, except where a handle or wrench so secured constitutes a hazard to personnel; in which case, stow handle or wrench immediately adjacent to the valve on or in a suitable hanger, bracket, or receptacle.

4. Fit valves located more than 6 feet above operating level with chain operated handles or valve wheels:

a. Chains: Sufficient length to reach approximately 4 feet above the operating level.

b. Where chains constitute a nuisance or hazard to operating personnel, provide hold-backs or other means for keeping the chains out of the way.

G. Air Release Valve:

1. Manufacturer: Vent-O-Mat, Series RBXb, APCO, or Pre-approved equal.

2. Orifice: 5/16".

3. Size: See Drawings.

4. Body: stainless steel.

5. Float: HDPE.

6. Seat: Buna-N (soft seat).

7. Float Guide: stainless steel.

8. O Ring Seat: EPDM rubber.

9. Other internal parts: stainless steel.

10. Pressure rating: 150 psi.

11. Provide isolation valve upstream of air release valve.

2.02 FABRICATION

A. Valves:

1. End connections:

a. Provide end connections for valves as required in Piping Schedule.
b. Assure end connections meet the following standards:
    1) Threaded: ANSI B1.20.1
    2) Flanged: AWWA C207.
    3) Bell and spigot or mechanical (gland) type: AWWA C111.

PART 3 EXECUTION

3.01 PREPARATION

A. Once flanged valves and flanged check valves are selected, determine face-to-face dimensions of valves.

B. Fabricate piping to lengths taking into account the dimensions of flanged valves and flanged check valves.

3.02 INSTALLATION

A. Prior to installation, valves that will be electrically actuated will have actuators mounted and tested by the valve manufacturer. Actuators will be shipped by the actuator manufacturer to the valve manufacturer for mounting and testing.

B. Provide incidental work and materials necessary for installation of valves including flange gaskets, flange bolts and nuts, valve boxes and covers, concrete bases, blocking, and protective coating.

C. Where needed, furnish and install additional valves for proper operation and maintenance of equipment and plant facilities under the following circumstances:
    1. Where such additional valves are required for operation and maintenance of the particular equipment furnished by CONTRACTOR.
    2. Where such additional valves are required as a result of a substitution or change initiated by CONTRACTOR.
    3. Install valves with their stems in vertical position above the pipe, except as follows:
        a. Butterfly valves, gate valves aboveground, globe valves, and angle valves may be installed with their stems in the horizontal position.

D. Install valves so that handles clear obstructions when the valves are operated from full open to fully closed.

E. Place top of valve boxes flush with finish grade or as otherwise indicated on the Drawings.

3.03 ADJUSTING

A. Make sure all adjustments to valves, operators and appurtenant equipment prior to Project Acceptance. Operate valve, open/close, at system pressures.

END OF SECTION

SECTION 15111

BALL VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: DIP ball valves, plastic body ball valves and instrument isolation ball valves.

1.02 REFERENCES

A. American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME):
   1. B16.5 – Pipe Flanges and Flanged Fittings.

B. American Petroleum Institute (API).

C. American Society for Testing and Materials (ASTM):
   1. A 351 – Specification for Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts.

D. American Water Works Association (AWWA):
   1. C 507 – Standard for Ball Valves 6 Inch Through 48 Inch.

E. National Sanitation Foundation (NSF) 61.

1.03 SYSTEM DESCRIPTION

A. General: Unless otherwise indicated on the Drawings use:
   1. Plastic body ball valves on plastic pipelines.
   2. Where valves are connected to electric actuators, the valve and actuator assembly shall be supplied by the same Supplier/Manufacturer.

PART 2 PRODUCTS

2.01 BALL VALVE TYPES

A. Full Port Ductile Iron (DI) Ball Valves:
   1. Manufacturers: One of the following or equal.
      a. Conbraco.
      b. Dezurik.
      c. Or pre-approved equal.

B. Plastic Ball Valves:
   1. Manufacturers: One of the following or equal.
      a. Asahi America.
      b. Spears.
      c. Hayward.
      d. Or pre-approved equal.

C. General:
   1. Type: Non-lubricated and capable of sealing in either flow direction.
   2. End Connections: for PVC valves - flanged or socket end connections, True union; for DI valves - flanged end connections.
   3. Operator Handle: Lever.
   4. Valves bodies requiring actuators shall have integrally mounted molded stem support and platform to assure proper alignment of the actuator to the valve.
   5. 150 psi pressure rated.

D. Materials:
   1. Body: Ductile iron body for DI valves; PVC/CPVC body for plastic valves.
   2. Ball: PVC/CPVC for plastic valves.
   3. Seats: FKM (Viton) or EPDM or PTEF.
   4. O-rings: FKM (Viton) or EPDM.
   5. All ball valves installed on chemical system lines shall be made of CPVC/PVC as shown on Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install each type of valve in accordance with manufacturers' printed instructions.

B. Schedule: All valves 3-inches and smaller are not shown on the Valve Schedule in the Drawings.

END OF SECTION

SECTION 15141

MECHANICAL - PROCESS PIPE SUPPORTS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Supports for pipe, fittings, valves, and appurtenances.

1.02 REFERENCES

A. American National Standard Institute or Manufacturer's Standardization Society (ANSI/MSS):
   1. SP 58 - Pipe and Supports, Design and Manufacture.
   2. SP 69 - Pipe Supports and Hangers, Selection and Applications.

1.03 SUBMITTALS

A. Shop Drawings: Include schedule, indicating where supports will be installed, and drawings of pipe support system components.

PART 2 PRODUCTS

2.01 PIPE SUPPORTS

A. Pipe Supports:
   1. 3-inch and larger: As indicated on the Drawings.
   2. 2-inch and smaller: Supplied by CONTRACTOR under constraints of these specifications. Locations for these supports are not specifically shown in drawings but are the responsibility of the CONTRACTOR.

2.02 MATERIALS

A. Materials: As indicated on the Drawings.

B. Materials Not Specifically Indicated on the drawings: Hot-dip galvanized steel with stainless fasteners.

PART 3 EXECUTION

3.01 INSTALLATION

A. Properly support, suspend or anchor exposed pipe, fittings, valves, and appurtenances to prevent sagging, over-stressing, or movement of piping and to prevent thrusts or loads on or against connected pumps, valves, meters and other equipment.

B. Carefully determine locations of inserts. Anchor to form work prior to placing concrete.

C. Do not use stud type powder actuated fasteners for securing metallic conduit or steel pipe larger than 1 inch to concrete, masonry, or wood.

D. Suspend pipe hangers from hanger rods. Secured with double nuts.

E. Install continuously threaded hanger rods only where indicated on the Drawings.

F. Use adjustable ring hangers; or adjustable clevis hangers, for 6-inch and smaller diameter pipe.

G. Use adjustable clevis hangers for pipe larger than 6 inches in diameter.

H. Secure pipes with galvanized double nutted U-bolts or suspend pipes from hanger rods and hangers.

I. Support Spacing (unless otherwise specified on drawings):
   1. Support 2-inch and smaller piping on horizontal and vertical runs at maximum 5 feet on center, unless otherwise specified.
   2. Support larger than 2-inch piping on horizontal and vertical runs at maximum 8 feet on center, unless otherwise specified.
   3. Support exposed polyvinyl chloride and other plastic pipes at maximum 5 feet on center, regardless of size.
   4. Support tubing, copper pipe and tubing, fiber-reinforced plastic pipe or duct, and rubber hose and tubing at intervals close enough to prevent sagging greater than 1/4 inch between supports.

J. Install Supports at the following Locations (unless otherwise shown on Drawings):
   1. Horizontal bends.
   2. Both sides of flexible pipe connections.
   3. Base of risers.
   4. Floor penetrations.
   5. Connections to pumps, blowers and other equipment.
   6. Valves and appurtenances.

K. Securely anchor plastic pipe, valves, and headers to prevent movement during operation of valves.

L. Anchor plastic pipe between expansion loops and direction changes to prevent axial movement through anchors.

M. Size hanger rods, supports, clamps, anchors, brackets, and guides in accordance with ANSI/MSS SP 58 and SP 69.

N. Do not use chains, plumbers' straps, wire, or similar devices for permanently suspending, supporting, or restraining pipes.

O. Support plumbing drainage and vents in accordance with Uniform Plumbing Code.

P. Supports, clamps, brackets, and portions of support system bearing against copper pipe: Copper plates, copper throughout, or isolated with neoprene or PVC tape.

Q. Where pipe is insulated, install over-sized supports and hangers.

R. Install insulation shield in accordance with ANSI/MSS SP 69, Type 40. Shield shall be galvanized steel unless specified elsewhere.

S. Install riser clamps at floor penetrations and where indicated on the Drawings.

T. Paint or Coat support system components as specified in Section 09800.

END OF SECTION

SECTION 15495

DISINFECTION OF PROCESS WATER PIPING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Disinfection of water lines and piping, bacteriological testing, and flushing at lines at completion of construction. This includes piping at water treatment facility site.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. AWWA C 651 - Disinfecting Water Mains.

B. Standard Methods for Examination of Water and Wastewater.

1.03 SUBMITTALS

A. Submit disinfection test plan which details procedure to be utilized to disinfect water lines including:
   1. Method and locations of disinfectant application.
   2. Locations of sampling points.
   3. Method of flushing and location of flushing ports.
   4. Method of dechlorination.
   5. Disposal location for dechlorinated water.

B. Submit disinfection reports and include the following:
   1. Date issued.
   2. Project name and location.
   3. Treatment subcontractor’s name, address, and phone number.
   4. Type and form of disinfectant used.
   5. Time and date of disinfectant injection start.
   6. Time and date of disinfectant injection completion.
   7. Test locations.
   8. Initial and 24-hour disinfectant residuals in part per million for each outlet tested.
   9. Time and date of flushing start.
   10. Time and date of flushing completion.
   11. Disinfectant residual after flushing in parts per million for each outlet tested.

C. OWNER will perform sampling and laboratory analyses for microbiological testing.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Protect against damage and contamination.

B. Maintain caution labels on hazardous materials.

C. Maintain storage room dry with temperatures as uniform as possible between 60 and 80 degrees Fahrenheit.

1.05 PROTECTION

A. Provide necessary signs, barricades, and notices to prevent persons from accidentally delivering water for potable use.

PART 2 PRODUCTS

2.01 MATERIALS

A. Disinfectant: Free chlorine in liquid form.

PART 3 EXECUTION

3.01 CLEANING WATER LINES

A. Prior to chlorination, remove by flushing or other means, soil, and debris from water lines.

3.02 INSPECTION

A. Verify that water line system is completed and cleaned.

B. Start disinfection of water lines when conditions are satisfactory.

3.03 SYSTEM TREATMENT

A. Perform disinfection of water lines in accordance with AWWA C 651 and as specified in this Section.

B. Starting at outlet closest to water source, bleed water from each outlet until water produces odor of disinfectant. Repeat process at each outlet throughout system.

C. Test for disinfectant residual at each of following locations and other locations in accordance with submitted disinfection test plan:

1. Ends of piping runs.
2. Remote outlets.

D. Maintain disinfectant in system for 24 hours.

E. When disinfectant residual is less than 25 parts per million after 24 hours, repeat system treatment.

3.04 FLUSHING

A. Remove disinfectant from water lines.

B. Flush water lines with potable water containing no more disinfectant residual than the active distribution system or 1.0 parts per million, which ever is greater.

C. Continue flushing until water at designated flushing ports contains disinfectant residual equal to concentrate specified above.

3.05 DISPOSAL OF CHLORINATED WATER

A. For on-site piping, dechlorinate and dispose water into backwash holding tank (on site).

3.06 MICROBIOLOGICAL TEST

A. Advise OWNER to take water samples no sooner than 24 hours after flushing system.

B. At the end of 24 hours and before the water main is placed in service, collect microbiological samples in accordance with the submitted disinfection test plan at each piping run.

C. When microbiological test proves water quality to be unacceptable, repeat disinfection treatment.

END OF SECTION

SECTION 15496

DISINFECTION OF TREATMENT VESSELS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Disinfection of the new treatment vessel (pressure vessel), bacteriological testing, flushing and disposal of disinfecting water at completion of treatment.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. AWWA C 653-97 - Disinfection of Water Treatment Plants

B. Standard Methods for Examination for Water and Wastewater.

C. OSHA Confined Space Requirements
   1. 29 CFR Part 1910.146

1.03 SUBMITTALS

A. Submit disinfection test plan which details procedure to be utilized to disinfect the adsorption contactor including:
   1. Method and locations of disinfectant application.
   2. Locations of sampling points.
   3. Method of dechlorination.
   4. Disposal location for dechlorinated water.
   5. MSDS for each chemical to be used.

B. Submit disinfection reports and include the following:
   1. Date issued.
   2. Project name and location.
   3. Type and form of disinfectant used.
   4. Time and date of disinfection start.
   5. Time and date of disinfection completion.
   6. Test locations.
   7. Initial and 24-hour disinfectant residuals in part per million for each outlet tested (Engineer may perform sampling and analysis, if desired).
   8. Time and date of flushing start.
   9. Time and date of flushing completion.
   10. Disinfectant residual after flushing in parts per million for each outlet tested.

11. OWNER will perform sampling and analysis. Coordinate microbiological testing with Engineer. OWNER to collect samples for microbiological testing - OWNER to perform all laboratory analyses.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect against damage and contamination.

B. Maintain caution labels on hazardous materials.

C. Maintain storage room dry and with temperatures as uniform as possible between 60 degrees Fahrenheit and 80 degrees Fahrenheit.

1.05 PROTECTION

A. Comply with all applicable regulations, including but not limited to OSHA and COP Combined Space Entry SOP.

PART 2 PRODUCTS

2.01 MATERIALS

A. Disinfectant: Sodium hypochlorite in liquid form conforming to ANSI/AWWAB300.

PART 3 EXECUTION

3.01 CLEANING VESSELS

A. Prior to chlorination, remove by flushing or other means, soil, and debris from adsorption vessels.

B. Wash Garnet support media, prior to loading, to eliminate fines. Install support media prior to disinfection.

C. DO NOT INSTALL IX RESIN PRIOR TO DISINFECTIN OF VESSEL. IX MEDIA WILL FOUL IF DISINFECTION IS PERFORMED WITH MEDIA IN VESSELS. IX resin will be installed after the vessels have been disinfected successfully.

3.02 INSPECTION

A. Verify that vessels are completed and cleaned.

B. Start disinfection of vessels when conditions are satisfactory.

3.03 SYSTEM TREATMENT

A. METHOD: Perform disinfection of the adsorption vessel in accordance with AWWA C 653-97 Sec. 4.4.1 and as specified in this Section.
   1. The adsorption vessel shall be filled to the overflow level with potable water to which enough chlorine is added to provide a free chlorine residual in the full facility of not less than 15 mg/L at the end of the appropriate 12-hour period. The Chlorine, Sodium Hypochlorite, shall be introduced into the water as described in section 3.03B.

B. APPLICATION: Sodium Hypochlorite shall be poured into the adsorption vessel, manually, and allow the flowing water provide the mixing. The filling of the adsorption vessel shall begin as soon as cleaning of the vessel is completed. See Section 3.01. The Sodium Hypochlorite shall be poured through the roof manhole. The Sodium Hypochlorite shall be poured into the water in the adsorption vessel when the water is not more than 3 ft (0.9m) in depth, nor less than 1 ft (0.3m) in depth, followed by filling each vessel until water flow is detected in the vent line. The solution shall thoroughly coat all surfaces to be treated, including the inlet and outlet piping, and shall be applied to any separate drain piping such that it will have available chlorine of not less than 15 mg/L when filled with water.

C. RETENTION: The disinfected surfaces shall remain in contact with the strong chlorine solution for at least 24 hours, after which each vessel will be drained of the 10 mg/L chlorinated water. Bacteriological sampling of the vessel effluent should be performed after the disinfection procedure is complete. Conduct bacteriological testing in accordance with sub-section 3.05.

D. Drain or pump chlorinated water into the Backwash Holding Tank.

E. Test for disinfectant residual at each of following locations and other locations in accordance with submitted disinfection test plan:
   1. IX Vessel outlets.

3.04 DISPOSAL OF CHLORINATED WATER

A. Dechlorinate water in the backwash holding tank in accordance with AWWA C653-97 prior to disposal.
B. Apply and mix Sodium Bisulfite to the Backwash Holding Tank before discharging test water on site.

3.05 BACTERIOLOGICAL TEST

A. After the chlorination procedure is completed, and before the adsorption vessel is placed in service, water from the adsorption vessel will be sampled and tested for coliform organisms in accordance with the latest edition of Standard Methods for the Examination of Water and Wastewater.

B. At the end of 24 hours and before the water main is placed in service, the OWNER will collect bacteriological quality samples at adsorption vessel outlets in accordance with the submitted disinfection test plan and Standard Methods for the Examination of Water and Wastewater.

C. OWNER will arrange for and pay cost to analyze water samples in accordance with Standard Methods of Water and Wastewater.

D. When bacteriological test proves water quality to be unacceptable, repeat disinfection treatment.

END OF SECTION

DIVISION 16

ELECTRICAL

SECTION 16000

GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes
   1. Work and materials necessary for erecting a complete electrical system, tested and ready for continuous use.

B. Related Sections
   1. Division 0 Bid Requirements, Contract Forms, and Contract Conditions
   2. Division 1 General Requirements
   3. Division 2 Site Construction
   4. Division 3 Concrete
   5. Division 9 Finishes
   6. Division 11 Equipment
   7. Division 13 Special Construction
   8. Division 15 Mechanical
   9. Division 17 Instrumentation

1.02 DEFINITIONS

A. The term “Provide” means “Furnish and Install”.

1.03 SYSTEM DESCRIPTION

A. Design Requirements
   1. If any contradictions, contrasts, or inconsistency appears, the most strict criteria noted and the collective requirements in any and all of the project documents shall apply.

1.04 SUBMITTALS

A. Intent
   1. Organize work so that a complete electrical system for the facility will be provided and will be supported by accurate shop drawings, record drawings, and O&M manuals.
   2. Submit detailed shop drawings and data prepared and organized by the suppliers. Provide quantity of submittal sets in accordance with the requirements of Division 1.
   3. Submittals shall be neatly grouped and organized by specification section number, and sub-section. Related information shall be highlighted, and the specific product shall be marked. All submittals shall be complete, and presented in one package.

Incomplete submittals will be returned without review. If a portion of the project requires a fast track schedule, that portion only may be submitted earlier under a separate cover letter.

4. Work performed or equipment provided without engineer approved submittals is done at contractor's risk. Cost to re-work or re-supply will be born solely by the contractor.

B. Product Data

1. A complete list of the equipment and materials, including the manufacturer's name, product specification, descriptive data, technical literature, performance charts, catalog cuts, installation instructions, and spare part recommendations for each different item of the equipment specified. The above shall clearly show all the specified requirements as described in the Specifications including but not limited to specific UL and NEMA rating, technical capabilities, test result verifications, and acceptance letters.
2. Submittals not in compliance with the specifications must include the following information:
    a. Reason for non-compliance or variance
    b. Calculations and drawings for redesign of related components including detail drawings showing internal and assembly details, with installation instructions.
    c. Proposed layout showing any modifications or exceptions to related work made necessary by this work, with calculations and drawings showing such modifications or exceptions.

C. Shop Drawings

1. Drawings containing complete wiring and schematic diagrams, control diagrams, and any other details required to demonstrate that the system has been coordinated and will operate as intended. Drawings shall show proposed layout, anchoring, support, and appurtenances of equipment, and equipment relationship to other parts of the work including clearances for maintenance and operations.

D. Utility Coordination

1. Submit copies of service entrance shop drawings to the utility, per utility submittal requirements, prior to submittal to the Engineer. Obtain written approval from the power utility company that the service entrance equipment is acceptable prior to release the order to the supplier for fabrication. Provide a copy of the approval letter from the utility with the submittal.

E. Closeout Submittals

1. Provide "Record Drawings" of the electrical work to include:
    a. Step-by-step procedure manuals for the installation, operation start-up, and maintenance of the equipment.
    b. Installation, operating, troubleshooting, and maintenance and overhaul instructions in complete detail.
    c. Possible breakdowns and repairs, and troubleshooting guides, as well as simplified wiring and control diagrams of the system installed. This shall

provide the Owner with comprehensive information on all systems and components to enable operation, service, maintenance and repair.

d. Exploded or other detailed views of all equipment, devices, assemblies, and accessory components shall be included, together with complete parts lists and ordering instructions.

2. Provide an "As Built" set of Plans to Owner. Maintain at all times a marked up set of Plans showing the following information:
   a. Actual installed circuit numbers, conduit sizes, cable tray routing, number of conductors, conductor sizes (larger than #12 AWG), and all other deviations from the design Plans.
   b. Underground conduit, duct banks, and concealed items dimensioned on the Plans from permanent, visible, building features.
   c. Actual motor size, starter size, and overload heater size, along with all other protective equipment for all 480 V and 4160 V motor circuits.
   d. Conductor identification and panel schedules.

1.05 QUALITY ASSURANCE

A. Regulatory Requirements
   1. Electrical work, including connection to electrical equipment integral with mechanical equipment, shall be performed in accordance with the latest published regulations, codes, and standards, of the following:
      a. National Electrical Code (NEC)
      b. State and local codes
      c. Institute of Electrical and Electronic Engineers (IEEE)
      d. American National Standards Institute (ANSI)
      e. American Society for Testing and Materials (ASTM)
      f. Insulated Cable Engineers Association (ICEA)
      g. National Electrical Manufacturers Association (NEMA) Standards
      h. Federal Occupational Safety and Health Act (OSHA)
      i. National Fire Protection Association (NFPA)
      j. National Electrical Testing Association (NETA)

1.06 DELIVERY, STORAGE, AND HANDLING

A. Electrical panels, switchgear, motor control centers, and other electrical equipment, shall be shipped in sealed dust and moisture proof plastic sheet enclosures, and the seal maintained until units are installed. Said units shall be new and free of any dirt, dust, water, grease, rust, damaged parts or components.

1.07 PROJECT/SITE CONDITIONS

A. Verify site conditions before bidding or performing work.

1.08 SCHEDULING

A. Maintain a work schedule showing work to be performed, sequence of work, major milestones, and manpower loading. Coordinate schedule requirements with other trades. Provide adequate staff to perform the work in the time required by the schedule.

1.09 SYSTEM STARTUP

A. After installation and testing of all electrical and instrumentation equipment and systems, energize all equipment and leave ready for continuous operation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers and model numbers shown on Plans or listed in the specifications are intended to establish a minimum standard of quality and acceptability.

2.02 MATERIALS

A. Materials, equipment, and parts comprising any unit, or part thereof, specified or indicated on the Plans, shall be new and unused, of current manufacture, and of highest grade consistent with the state of the art. Damaged materials, equipment, and parts, are not considered to be new and unused, and will not be accepted.

2.03 MANUFACTURED UNITS

A. The fabricator of major components and manufactured units, such as distribution panel boards, switchgear, and motor control centers, shall also be the manufacturer of the major devices therein.

B. Electrical equipment provided with mechanical equipment assemblies shall be in compliance with this specification.

2.04 EQUIPMENT

A. Minimum sizes of equipment, and electrical devices, are indicated but it is not intended to show every offset and fitting, nor every structural or mechanical difficulty that will be encountered during the installation of the work.

B. Electrical equipment shall be capable of operating successfully at full-rated load, without failure, at an ambient air temperature of 60 degrees C, and specifically rated for the altitude indicated on the Plans. Provide air conditioning to meet the manufacturers' operating temperature for electrical equipment not rated for operation at that temperature.

C. When applicable, the material used in the performance of the electrical work shall be listed by the Underwriters' Laboratories, Inc. (UL) for the class of service for which they are intended.

D. Provide nameplates where indicated elsewhere in these specifications or on the Plans. Nameplates shall be black laminate with white letters and fastened to the various devices with round head stainless steel screws. Provide nameplates for each disconnecting means for service, feeder, branch, or equipment conductors, indicating its purpose.

2.05 FABRICATION

A. Shop Assembly
   1. Equipment assemblies, such as Service Entrance Sections, Switchgear, Switchboards, Control and Distribution Panels, and other custom fabricated electrical enclosures shall bear a UL label as a complete assembly. The UL label on the individual components making up the assembly will not be considered sufficient to meet the present requirement. Whenever a generic UL label does not apply for the assembly, a serialized UL label shall be affixed to the assembly, and the serial number shall be submitted with the assembly record shop drawings.
   2. Custom fabricated electrical control panels, and enclosures, shall bear a UL label affixed by a local UL inspector.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Site Verification of Conditions
   1. Verify site conditions before bidding or performing work.

3.02 INSTALLATION

A. Coordinate work with other trades and with certified vendor shop drawing submittals.

B. Provide equipment in accordance with the manufacturers' requirements.

C. Identify each conductor as required by the Contract Documents.

D. Equipment Access:
   1. Install equipment so it is readily accessible for operation and maintenance.
   2. Equipment shall not be blocked or concealed.
   3. Do not install electrical equipment such that it interferes with normal maintenance requirements of other equipment.

E. Equipment shall be installed plumb, square and true with the building construction, and shall be securely fastened.

F. Outdoor wall-mounted equipment, and indoor equipment mounted on earth, or water bearing walls, shall be provided with corrosion-resistant spacers to maintain ¼-inch separation between the equipment and the wall.

G. Arrange for the building in of equipment during structure construction. Where equipment cannot be built-in during construction, arrange for sleeves, box-outs, and other openings, as required to allow installation of equipment after structure construction is complete.

H. Verify that equipment will fit support layouts indicated.

I. Screen or seal all openings into outdoor equipment to prevent the entrance of rodents and insects.

J. Equipment fabricated from aluminum shall not be imbedded in earth or concrete.

K. Provide all necessary anchoring devices and supports.
   1. Use supports as detailed on the Plans and as specified.
   2. Supports and anchoring devices shall be rated and sized based on dimensions and weights verified from approved equipment submittals.
   3. Hardware shall be stainless steel.
   4. Do not cut, or weld to, building structural members.
   5. Do not mount safety switches and external equipment to other equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.

L. Verify exact rough-in location and dimensions for connection to electrical items furnished by others.
   1. Obtain shop drawings from those furnishing the equipment.
   2. Proceeding without proper information may require the Contractor to remove and replace work that does not meet the conditions imposed by the equipment supplied.
   3. Provide sleeves wherever openings are required through new concrete or masonry members. Place sleeves accurately and coordinate locations with the Engineer.
   4. Do not endanger the stability of any structural member by cutting, digging, chasing, or drilling and shall not, at any time, cut or alter the work without the Engineer's written consent.
      a. Provide additional reinforcing if required.
      b. Use proper tools and methods to cut, core drill, or make other penetrations.
      c. Restore walls, ceilings, or floors to their original condition.

M. Provide concrete foundations or pads required for electrical equipment as indicated or specified.
   1. Provide a 4-inch concrete housekeeping pad for floor mounted electrical equipment. Pour on top of the finished floor or slab. Drill existing slab and epoxy rebar to anchor housekeeping pad in place.

N. Do not use equipment that exceeds the indicated dimensions except as approved in writing by the Engineer.

O. Do not use equipment or arrangements of equipment that reduce required clearances or exceed the space allocation.

P. Work indicated on the Plans is approximately to scale, but actual dimensions and detailed Plans should be followed as closely as field conditions permit. Field verification of scale dimensions on Plans is governed by field conditions. Installation of systems and equipment is subject to clarification as indicated in reviewed shop drawings and field coordination.

Q. Discrepancies indicated on different Plans, between Plans and actual field conditions, or between Plans and Contract Documents shall be promptly brought to the attention of the Engineer for clarification, prior to purchasing and installing equipment.

R. Adjust the alignment of equipment and conduit to accommodate architectural changes or to avoid work of other trades.

S. Provide parts and pieces necessary to the installation of equipment, in accordance with the best practice of the trade, and in conformance with the requirements of these Contract Documents.

T. Items not specifically mentioned in these Contract Documents, or noted on the Plans, or indicated on reviewed shop drawings, but which are obviously necessary to make a complete working installation, shall be deemed to be included herein.

U. Lay out and install electrical work prior to placing floors and walls. Provide sleeves and openings through floors and walls, required for installation of conduits. Sleeves shall be rigidly supported and suitably packed, or sealed, to prevent ingress of wet concrete. Spacers shall be installed in order to prevent conduit movement. Dimensions indicated for electrical equipment and their installation are restrictive dimensions.

V. Provide inserts and hangers required to support conduits and other electrical equipment. Coordinate inserts and hangers with other trades. Replace inserts, hangers, sleeves, or other mounting hardware which are improperly placed.

W. Perform necessary saw cutting, core drilling, excavating, removal, shoring, backfilling, and other work required for the proper installation of conduits, whether inside, or outside of the buildings and structures. Use core drills to make circular holes.

X. CORROSION PROTECTION

1. Wherever dissimilar metals, except conduit and conduit fittings, come in contact, the Contractor shall isolate these metals, as required, with neoprene washers, 9 mil polyethylene tape, or gaskets. Where fastening conduit, electro plated, or equivalent fasteners and stainless steel bolts shall be used.

3.03 REPAIR/RESTORATION

A. Repair damage caused by construction or demolition work to restore damaged areas to original condition.

B. Factory finishes damaged during shipping, or construction, shall be restored to original new condition. Rust shall be removed, and bare metal surfaces shall be primed and painted to match the original surrounding finish.

3.04 FIELD QUALITY CONTROL

A. Site Tests
   1. The electrical work shall be free from improper grounds and from short circuits. Visually compare the conductor connections with connection diagrams. Perform individual circuit continuity checks using electrical circuit testers. Demonstrate proper operation of the energized electrical and mechanical devices. Correct any wiring deficiencies.

3.05 COORDINATION STUDY

A. A coordination study shall be provided for power distribution system protective devices unless specified elsewhere in the contract documents. Provide the Power System Coordination Study after the electrical equipment submittals have been reviewed and approved. The Coordination Study to be performed using ETAP, SKM or other approved power system analysis software.

B. The final deliverable shall be a certified report summarizing the coordination study.

C. As a minimum, the coordination study for the power distribution system shall include the following:
   1. Time-current curves for each protective relay or fuse showing graphically that the settings will provide protection and selectivity within industry standards. Each curve shall be identified, and the protective device settings shall be specified.
   2. Time-current curves for each device shall be positioned to provide maximum selectivity to minimize system disturbances during fault clearing. Where selectivity cannot be achieved, the ENGINEER shall be notified as to the cause.
   3. Time-current curves and points for cable and equipment damage.
   4. Circuit interrupting device operating and interrupting times.
   5. Indicate maximum fault values on the graph.
   6. Sketch of bus and breaker arrangement.

D. Contractor to field-adjust and set trip settings associated with protective devices per coordination study results.

E. Coordination Study to comply with the provisions and recommendations of IEEE 242-2001, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.

3.06 ADJUSTING

A. Calibrate and set all adjustable electrical equipment including circuit breakers, motor circuit protectors, overload relays. Align photo cells and lights to achieve desired effects.

3.07 CLEANING

A. Relays, starters, circuit breakers, switches, contacts, insulators, mechanisms, and buses shall be free of dust, dirt, oil, moisture, metal shavings, and other debris before testing and energizing equipment. Vacuum and wipe down inside and outside of electrical enclosures and control panels.

3.08 PROTECTION

A. Once equipment is installed, it shall be protected at all times with plastic sheet covers until the area is free of dirt, dust, paint spray, water, and other trades. Provide heat to eliminate condensation.

End of Section

SECTION 16010

ELECTRICAL: BASIC REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Basic requirements for electrical work.

B. Install and wire all equipment, including prepurchased equipment, and perform all tests necessary to assure conformance to the Drawings and Specifications and ensure that equipment is ready and safe before energizing.

C. Related Sections include but are not necessarily limited to:
Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
Division 1 - General Requirements.

D. Drawings Use and Interpretation:
   1. Drawings indicate the location and arrangement of electrical equipment and the approximate location of other equipment requiring electrical work.
      a. For exact locations of building elements, refer to dimensioned architectural/structural drawings.
      b. Field measurements take precedence over dimensioned drawings.

E. Installation of all systems and equipment is subject to clarification as indicated in reviewed shop drawings and field coordination drawings.

1.02 AREA CLASSIFICATIONS

A. Outdoor locations may contain corrosive and hazardous areas:
   1. Corrosive and hazardous areas are identified on the Drawings.
      a. Areas not identified as such shall be considered wet.

B. Indoor locations may contain damp, wet corrosive and hazardous areas:
   1. Damp, wet, corrosive and hazardous areas are identified on the Drawings.
      a. Areas not identified as such shall be considered unclassified.

1.03 DEFINITIONS

A. Outdoor Areas:
   1. Those locations on the Project site where the equipment is normally exposed to wind, dust, rain, snow, etc.

B. Indoor Areas:

1. Those locations on the Project site where the equipment is normally protected from wind, dust, rain, snow, etc.

C. Shop Fabricated:
   1. Manufactured or assembled equipment for which a UL test procedure has not been established.

1.04 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Iron and Steel Institute (AISI):
      a. Steel Products Manual - Stainless and Heat Resisting Steel.
   2. American National Standards Institute (ANSI):
      a. C2, National Electrical Safety Code.
   3. American Society for Testing and Materials (ASTM):
      a. A36, Specification for Structural Steel.
      b. A153, Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   4. Factory Mutual System (FM):
      a. A Guide to Equipment, Materials and Services.
   5. Institute of Electrical and Electronics Engineers (IEEE):
      a. 141, Recommended Practice for Electrical Power Distribution for Industrial Plants.
      b. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
   6. National Electrical Manufacturers Association (NEMA):
      a. ICS 6, Enclosures for Industrial Controls and Systems.
   7. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   8. Underwriters Laboratories, Inc (UL):
      a. 508, Safety Industrial Control Equipment.
      b. 698, Industrial Control Equipment for Use in Hazardous Locations.

B. When a specific code or standard has not been cited, the applicable codes and standards of the following code-making authorities and standards organizations shall apply:
   1. American Association of State Highway and Transportation Officials (AASHTO).
   2. American Iron and Steel Institute (AISI).
   3. American National Standard Institute (ANSI).
   4. American Society for Testing and Materials (ASTM).
   5. ETL Testing Laboratories, Inc (ETL).
   6. Insulated Cable Engineers Association (ICEA).
   7. Institute of Electrical and Electronic Engineers (IEEE).
   8. Illuminating Engineering Society of North America (IES).
   9. Instrument Society of America (ISA).
   10. Lightning Protection Institute (LPI).
   11. National Electrical Manufacturers Association (NEMA).
   12. National Fire Protection Association (NFPA).
   13. Occupational, Health and Safety Administration (OSHA).

14. Underwriters Laboratories Inc (UL).

C. In case of conflict or disagreement between codes, standards, laws, ordinances, rules, regulations, drawings and specifications, or within either document itself, the more stringent condition shall govern.

1.05 SYSTEM DESCRIPTION

A. Provide functional systems in compliance with manufacturer's instructions, performance requirements specified or shown on the Drawings, and modifications resulting from reviewed shop drawings and field coordinated drawings.

1.06 SUBMITTALS

A. Shop Drawings:
1. See Contract Documents for other requirements.
2. Submit shop drawings prior to purchase or fabrication of equipment. See individual Division 16 sections for specific requirements.
3. Prior to submittals of shop drawings, coordinate electrical equipment, particularly motor control equipment, control panels, and instrumentation, with all applicable equipment and systems interfacing with that equipment.
4. For each product, clearly identify manufacturer by name.
5. Provide manufacturer's technical information on products to be used, including:
   a. Product descriptive bulletin.
   b. Electrical data pertinent to the Project and necessary to assure compliance with Specifications and Drawings.
   c. Equipment dimensions, where applicable.
   d. Evidence that the products submitted meet the requirements of the standards referenced.
6. When general data sheets are provided as part of the submittal, specifically identify the products to be used on this Project.
7. Ensure that all submittals clearly indicate the equipment is UL or ETL listed or is constructed utilizing UL or ETL listed or UL recognized components. Where an UL standard has not been established clearly identify that no UL standard exists for that equipment.
8. For all equipment, provide manufacturer's installation instructions.

B. Operation and Maintenance Manuals:
1. See Contract Documents for requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. See Section 01600.

B. Ensure that equipment is not used as steps, ladders, scaffolds, platforms, or for storage-either inside or on top of enclosures.

C. Protect nameplates on electrical equipment to prevent defacing.

D. Repair, restore or replace damaged, corroded and rejected items at no additional cost to the Owner.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Refer to related Division 16 sections.
   1. All equipment of a similar type shall be by one manufacturer unless otherwise noted in the Specifications.

2.02 MATERIALS

A. Trade names and catalog numbers may be used in the Drawings or Specifications to establish quality standards and basics of design.
   1. Other listed manufacturers in the applicable specification sections with equal equipment may be acceptable.
   2. If no other manufacturer is listed, then manufacturers of equal equipment may be acceptable.

B. Listed:
   1. Where UL test procedures have been established for the product type, electrical equipment shall be approved by UL or ETL and shall be provided with the UL or ETL label.

C. Structural Steel Supports:
   1. Galvanized steel: ASTM A36.
      a. PVC coated in Class I and in corrosive areas.
   2. Stainless steel: AISI Type 316.

2.03 FABRICATION

A. When equipment is shop fabricated for the Project, the electrical devices and enclosures utilized shall be UL or ETL listed and labeled or shall be UL recognized.

B. Shop or Factory Finishes:
   1. Interiors of other painted equipment shall be either white or light gray.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment shall be installed in accordance with the requirements of the NEC.

B. Enclosures for Use with Electrical Equipment:
   1. NEMA 12: Use in unclassified indoor locations.
   2. NEMA 3R: Use with HVAC equipment in wet outdoor locations.
   3. NEMA 4:
      a. Use in wet indoor locations.
      b. Use in wet outdoor locations except with HVAC equipment.
   4. NEMA 4X: Use in all corrosive locations.
   5. Exceptions:
      a. As modified in other Division 16 sections.
      b. As otherwise indicated on the Drawings.
   6. Standards:
      a. NEMA ICS-6, Enclosures for Industrial Controls and Systems.
      b. UL 508, Safety Industrial Control Equipment.
      c. UL 698, Industrial Control Equipment for Use in Hazardous Locations.

C. Coordinate the installation of electrical equipment with other trades.
   1. Arrange for the building in of equipment during structure construction.
   2. Where equipment cannot be built-in during construction, arrange for sleeves, box-outs, openings, etc., as required to allow installation of equipment after structure construction is complete.

D. Verify that equipment will fit support layouts indicated.

E. Equipment Dimensions and Clearances:
   1. Do not use equipment that exceeds the indicated dimensions.
      a. Except as approved in writing by the Engineer.
   2. Do not use equipment or arrangements of equipment that reduce required clearances or exceed the space allocation.

F. Install equipment in accordance with the manufacturer's instructions.

G. Equipment Access:
   1. Install equipment so it is readily accessible for operation and maintenance.
   2. Equipment shall not be blocked or concealed.
   3. Do not install electrical equipment such that it interferes with normal maintenance requirements of other equipment.

H. Equipment shall be installed plumbed, square and true with the building construction and shall be securely fastened.

I. Outdoor wall-mounted equipment and indoor equipment mounted on earth or water bearing walls shall be provided with corrosion-resistant spacers to maintain 1/4 IN separation between the equipment and the wall.

J. Screen or seal all openings into outdoor equipment to prevent the entrance of rodents and insects.

K. Equipment fabricated from aluminum shall not be placed in direct contact with earth or concrete.

L. Provide all necessary anchoring devices and supports.
   1. Use supports as detailed on the Drawings and as specified.
      a. Where not detailed on the Drawings or specified, use supports and anchoring devices rated for the equipment load and as recommended by the manufacturer.
   2. Supports and anchoring devices shall be rated and sized based on dimensions and weights verified from approved equipment submittals.
   3. Hardware shall be malleable type, corrosion resistant and shall be supported by heavily plated machine screws or brass, bronze or stainless steel bolts.
   4. Do not cut, or weld to, building structural members.
   5. Do not mount safety switches and external equipment to other equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.

M. Provide concrete foundations or pads required for electrical equipment as indicated or specified.
   1. Floor-mounted equipment shall be mounted on a 4 IN high concrete housekeeping pad. Pad shall be poured on top of the finished floor or slab.

N. Material that may cause rusting or streaking on a building surface shall not be used.

O. To avoid interference with structural members and equipment of other trades, it may be necessary to adjust the intended location of electrical equipment. Unless specifically dimensioned or detailed, the Contractor may, at his discretion, make minor adjustments in equipment location without obtaining the Engineer's approval.

P. Provide tagging of electrical equipment, conduits, and conductors in accordance with the Contract Documents.
   1. Each equipment item shall be provided with a nameplate identifying the equipment by the tag number shown on the Drawings.
   2. Each branch circuit and feeder shall be provided with a nameplate identifying, by name and tag number as shown on the Drawings, the load served.
      a. Do not abbreviate.
   3. Each control device shall be provided with an escutcheon defining the device function and a nameplate identifying the controlled equipment.

Q. Provide electrical danger, caution, warning or safety instruction signs in accordance with applicable safety standards.

R. Conduit and wire between temperature control thermostats and the associated HVAC equipment shall be furnished and installed with the equipment (see Division 15 of the Specifications).

1. Conduit and wire between alarm or shutdown thermostats and air flow switches and the associated alarm devices or panels shall be furnished and installed as part of Division 16.
2. Thermostats included as part of a heat trace system shall be installed as part of Division 16.

3.02 FIELD QUALITY CONTROL

A. Do not remove or damage fireproofing materials.
   1. Install hangers, inserts, supports, and anchors prior to installation of fireproofing.
   2. Repair or replace fireproofing removed or damaged.

B. Make all penetrations through roofs prior to installation of roofing.
   1. For penetrations required after installation of roofing:
      a. In built-up roofing (BUR), provide all curbs, cants and base flashings.
      b. In elastic sheet roofing (ESR), arrange and pay for base flashing work by authorized roofer.

C. Make all penetrations of electrical work through walls and roofs water and weather-tight.

D. Equipment furnished under this Contract for use on future work and all concealed equipment, including conduits, shall be dimensioned, on the record drawings, from visible and permanent building features.

E. After installation, test all electrical equipment and systems as recommended by the manufacturer and in accordance with Specification 16920 – ELECTRICAL ACCEPTANCE TESTING.

F. Test Equipment Interface:
   1. Verify systems coordination and operation.

3.03 CLEANING

A. Clean dirt and debris from all surfaces.

B. Apply touch-up paint as required to repair scratches, etc.

C. Replace nameplates damaged during installation.

D. Thoroughly vacuum the interior of all enclosures to remove dirt and debris.

3.04 DEMONSTRATION

A. Demonstrate equipment in accordance with the Contract Documents.

End Of Section

SECTION 16050

BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section consists of general electrical materials and methods. Electrical materials that are a part of equipment specified under other sections shall meet the requirements of this section, unless part of larger factory-assembled equipment.

1.02 SUBMITTALS

A. Submit manufacturer's literature for raceways and fittings, boxes, wires and cables, wiring devices, nameplates, legend plates, labels, panelboards, and safety switches, service entrance equipment, control panels and any other electrical component utilized in this project.

1.03 QUALITY ASSURANCE

A. Refer to Section 16000.

1.04 SPARE PARTS

A. Provide spare components as indicated on drawings and elsewhere herein.

PART 2 - PRODUCTS

2.01 BASIC MATERIALS

A. Electrical safety switches, distribution and control equipment shall be rated for heavy duty service.

B. Wiring devices shall be specifications grade.

2.02 MISCELLANEOUS METAL AND MOUNTING CHANNELS

A. Metal Framing:
   1. Unless otherwise shown, mounting channels shall be cold rolled from mild strip steel, 12-gauge, 1-5/8 inches by 1-5/8 inches, with a galvanized finish by Unistrut, Unistrut P-1000, as manufactured by Unistrut, or equal.
   2. Screws, bolts, washers and nuts shall be stainless steel. Parts and brackets for assembly of channels shall be hot dipped galvanized.

B. Miscellaneous Metal: Galvanized steel, unless otherwise shown.

2.03 NAMEPLATES, LEGEND PLATES, AND LABELS

A. Nameplates: Laminated sheet plastic, approximately 1/16 inch-thick, with engraved white letters on a black background, with adhesive backing and mounting screw holes. Stainless steel or brass screws, minimum height of letters, 5/16 inch. Card holders are not acceptable.

B. Legend Plates: Type KN-3 standard legend plates, Square D, or equal.

C. Control Wire Markers: Heat shrink sleeve types, manufactured by W.H. Brady Company, or equal.

PART 3 - EXECUTION

3.01 BASIC MATERIALS

A. The completed installation shall conform to all applicable federal, state, and local code ordinances and regulations. Contractor shall obtain necessary permits and inspections required by the governing authorities. Work shall be done in a neat, workmanlike, finished and safe manner, according to the latest published N.E.C.A. standards of installation, under competent supervision. Install grounding as required by the National Electrical Code.

3.02 MISCELLANEOUS METAL AND MOUNTING CHANNELS

A. Install where electrical equipment is to be surface mounted to walls and where indicated on Drawings. Where two or more devices are to be installed side by side, support on metal framing, bolt together, and brace as required to form a rigid structure.

B. Clean cuts and welds. Coat unpainted surfaces with cold application zinc galvanizing. Coat cuts and welds on painted surfaces with zinc chromate primer and finish to match existing paint.

3.03 NAMEPLATES, LEGEND PLATES, AND LABELS

A. Nameplates: Identify panels, switchgear, regulators, load-break junction boxes, disconnect switches, and component enclosures. Fasten nameplates with stainless steel, self-tapping screws or rivets.
   1. Panels: Identify panel number, voltage and amperage of panel bus.
   2. Switchgear: Identify equipment, voltage, amperage and phase and number of wires.
   3. Safety Switches and Relays: Identify equipment controlled and circuits from which they are fed.

B. Legend Plates: Install on selector switches, pushbuttons, pilot lights, starters, and other components.

C. Control Wire Markers: Install at both ends of each control wire interconnecting between such items as control panels, sensors, and control devices, and each end of control wires within control panels, and other such enclosures. Wiring markers shall correspond to control wire numbers on approved wiring diagrams.

End of Section

SECTION 16111

CONDUITS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Furnish and install conduits as required, and as shown on the Drawings. Materials employed shall be as shown on the Drawings.

1.02 SUBMITTALS

A. Submit product literature including manufacturer part number, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.

B. Shop Drawings shall be submitted for review and acceptance showing routing, conduit size, and number and size of wires in each conduit before installation of conduit and any related work.

C. Proposed routing of conduits buried under floor slabs-on-grade.

D. Identify conduit by tag number of equipment served or by circuit schedule number.

E. Proposed routing and details of construction including conduit and rebar embedded in floor slabs, columns, etc. Identify conduit by tag number of equipment served or by circuit schedule number.

F. Proposed location and details of construction for openings in slabs and walls for raceway runs.

G. Refer to Section 16000 for further submittal requirements.

1.03 REFERENCES

A. American National Standards Institute (ANSI): C80.1, Rigid Steel Conduit - Zinc-Coated.

B. National Electric Manufacturers Association (NEMA): RN-1, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit.

C. Underwriters Laboratories Inc. (UL):

1. 1, Flexible Metal Conduit.

2. 6, Rigid Metal Conduit.

3. 360, Liquid-Tight Flexible Steel Conduit.

4. 467, Grounding and Bonding Equipment.

5. 514, Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers.

6. 651, Schedule 40 and 80 Rigid PVC Conduit.

7. 870, Wireways, Auxiliary Gutters, and Associated Fittings.

8. 884, Underfloor Raceways and Fittings.

9. 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

PART 2 - PRODUCTS

2.01 RACEWAYS

A. Exposed conduit in an unclassified or hazardous area shall be galvanized rigid steel (GRS) unless specifically indicated otherwise on the Drawings. Conduits in the corrosive areas shall be PVC coated GRS unless otherwise indicated. Underground and/or concrete encased conduits shall be PVC, unless otherwise indicated. All wiring, except as otherwise noted, shall be in conduit. Conduit size shall not be less than the National Electrical Code (NEC) size required for the conductors therein and shall not be smaller than 3/4-inch.

B. Condulet type fittings shall be Crouse-Hinds, Appleton, or equal with wedge nut covers. All condulets located outdoors or in wet locations shall be weathertight.

C. In unclassified areas, flexible conduit shall be grounding type, weatherproof, corrosion resistant, and watertight.

D. Couplings, connectors, and fittings shall be standard types specifically designed and manufactured for the purpose. They shall be installed to provide a firm mechanical assembly and electrical conductivity throughout.

E. Expansion fittings shall be OZ type AX with jumper for exposed locations and type DX at structural expansion joints, Spring City, or equal. Conduits shall have expansion fittings in accordance with NEC.

F. The conduits and fittings shall be supported per NEC requirements as a minimum.

2.02 GALVANIZED RIGID STEEL (GRS)

A. Conduit and couplings shall be hot-dipped galvanized with zinc coated threads and outer coating of zinc bichromate, in accordance with ANSI C80.1 standards, as manufactured by Jones & Laughlin Steel Corporation, Allied Tube & Conduit Corporation, Triangle PWC, or equal.

B. Steel conduit shall not be buried in earth without concrete encasement and additional corrosion protection. A half lapped rapping of 20 mil PVC based corrosion protection tape shall be used.

2.03 PVC COATED GALVANIZED RIGID STEEL (PVC-GRS)

A. PVC coated GRS conduit shall be installed where shown on the Drawings or elsewhere specified and shall conform to NEMA RN-1 and ANSI C80.1 standards.

B. The PVC coated galvanized rigid conduit must be UL Listed. The PVC coating must have been investigated by UL as providing the primary corrosion protection for the rigid metal conduit. Ferrous fittings for general service locations must be UL Listed with PVC as the primary corrosion protection. Hazardous location fittings, prior to plastic coating must be UL listed. All conduit and fittings must be new, unused material. Applicable UL standards may include: UL 6 Standard for Safety, Rigid Metal Conduit, UL514B Standard for Safety, Fittings for Conduit and Outlet Boxes.

C. The zinc surface of the conduit shall remain intact on both the inside and the outside of the conduit throughout the preparation and application processing. A Polyvinyl Chloride (PVC) coating shall be bonded to the galvanized outer surface of the conduit. The bond between the PVC coating and the conduit surface shall be greater than the tensile strength of the plastic. The thickness of the PVC coating shall be a minimum of 0.040-inch (40 mil).

D. A loose coupling shall be furnished with each length of conduit. A PVC coating shall be bonded to the outer surface of the coupling and a PVC sleeve equal to the outside diameter of the uncoated conduit shall extend beyond both ends of the coupling approximately one pipe diameter or 1-1/2 inches, whichever is smaller. The wall thickness of the coating on the coupling and the sleeve shall be a minimum of 0.040-inch (40 mil).

E. A PVC coating shall be bonded to the outer surface of all conduit bodies and fittings and a PVC sleeve shall extend from all hubs. A urethane coating shall be uniformly and consistently applied to the interior of all conduit and fittings. This internal coating shall be a nominal 2 mil thickness. Conduit or fittings having areas with thin or no coating shall be unacceptable. The wall thickness of the coating on conduit bodies and fittings and the sleeve walls shall be identical to those on couplings in length and thickness. The covers on all conduit bodies shall be coated on both sides and shall be designed to be completely interchangeable within size and family of fitting. Form 8 Condulets, 1/2” through 2” diameters, shall have a v-seal tongue-in-groove gasket to effectively seal against the elements. Form 8 condulets shall be supplied with plastic encapsulated stainless steel cover screws.

F. Type 304 stainless steel screws shall be furnished and used to attach the cover to the conduit body. All coated material shall be installed and patched according to the manufacturer's recommended installation and patching instructions.

G. Conduit straps shall be PVC coated or stainless steel.

H. PVC coated conduit and fittings shall be as manufactured by Plasti-Bond, Perma-Cote, KorKap or equal

I. PVC coated flexible conduits shall be liquid and vaportight and manufactured in accordance with UL 360 standards.

J. Installation of the PVC Coated Conduit System shall be performed in accordance with the Manufacturer's recommendations and Installation Manual. Install with manufacturer-approved tools and compounds to prevent damage to the PVC coating. The installer should be certified by Manufacturer to install coated conduit.

2.04 RIGID NONMETALLIC - PVC

A. Where specifically indicated on the Drawings, or elsewhere specified, conduit may be high density Schedule 40, 90 degrees C, heavy-duty PVC. The conduit shall be manufactured from virgin polyvinyl chloride compound which meets ASTM D1784, NEMA TC-2, ANSI C33.91, and UL 651 standards. Smoke emissions shall be limited to less than 6 grams per 100 grams of material tested.

B. Where conduit concrete encasement is indicated on the Drawings, conduit supports shall be installed at five foot intervals. PVC conduit shall be manufactured by Carlon, Triangle Conduit & Cable, or equal.

2.05 INTERMEDIATE METAL CONDUIT

A. Conduit and couplings shall be galvanized intermediate metal conduit manufactured in accordance with UL 1242 and as manufactured by Allied Tube & Conduit Corporation, Jones & Laughlin Steel Corporation, or equal.

B. Intermediate metal conduit shall not be buried without concrete encasement. Threadless couplings and connectors shall not be used.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Liquidtight flexible metal conduit shall be liquid and vaportight, oil and ultraviolet ray resistant and manufactured in accordance with UL 360 standards. Liquidtight flexible metal conduit shall be formed of a continuous, spiral wound, galvanized steel core with an extruded PVC jacket. The PVC jacket shall be rated for high ambient heat applications, 90 degrees Celsius.

B. For corrosive locations, liquidtight flexible metal conduit shall be formed of a continuous, spiral wound, aluminum core with an extruded PVC jacket. The PVC jacket shall be impervious to corrosive liquids and vapors.

C. An external bonding conductor shall be required for flexible conduit connections containing circuits rated at 60 amps or greater and for sizes 1 1/2 " or larger. Flexible conduit and connectors for 1 1/4" and smaller shall be listed for grounding.

D. Connectors for liquidtight flexible conduit shall be galvanized, furnished with a sealing ring and locknut, and suitable for wet locations.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Conduit runs are schematic only, and shall be modified as required to suit field conditions, subject to review and acceptance by the Engineer.

B. Conduit shall run continuously between outlets and shall be provided with junction boxes where connections are made. Couplings, connectors, and fittings shall be acceptable types designed and manufactured for the purpose, and shall provide a firm mechanical assembly, and electrical conductivity throughout.

C. Conduit runs shall be straight and true. Elbows, offsets, and bends shall be uniform and symmetrical. Changes in direction shall be made with long radius bends, or with fittings of the condulet type.

D. Conduit runs in buildings and structures shall be exposed except as specifically noted, or accepted by the Engineer.

E. Conduit runs shall not interfere with the proper and safe operation of equipment, and shall not block or interfere with ingress or egress, including equipment removal hatches.

F. Exposed conduits shall be securely fastened with clamps, or straps, intended for conduit use. All exposed conduit shall be run on the walls and ceiling only and shall be parallel to the planes of the walls or ceiling. No diagonal runs will be permitted. Flexible conduit shall be used only for short lengths required to facilitate connections between rigid conduit to motors from junction boxes, or control equipment.

G. Conduit runs on water-bearing walls shall be supported one inch away from the wall on an accepted channel. When channel galvanizing, or other coating, is cut or otherwise damaged, it shall be field coated to original condition. No conduit shall be run in water-bearing walls, unless specifically designated otherwise.

H. Conduit shall be thoroughly reamed to remove burrs. IMC or GRS shall be reamed during the threading process, and Rigid Nonmetallic PVC shall be reamed before applying fittings. A zinc rich cold galvanizing shall be used to restore corrosion protection on field cut threads. Bushings and lock nuts or hubs shall be used at conduit terminations. The total number of bends in any run between pull points shall not exceed 360 degrees. Junction boxes and pull boxes shall be installed at points acceptable to the Engineer. Conduit ends shall be plugged to prevent the entrance of moisture or debris during construction. All spare conduits shall be adequately capped and shall contain a suitable pull string.

I. Joints shall be set up tight. Hangers and fastenings shall be secure, and of a type appropriate in design, and dimensions, for the particular application.

J. Conduit runs shall be cleaned and internally sized (obstruction tested) so that no foreign objects, or obstructions remain in the conduit prior to pulling in conductors.

K. After installation of complete conduit runs 2 inches and larger, conduits shall be snaked with a conduit cleaner equipped with a cylindrical mandrel of a diameter not less than 85 percent of the nominal diameter of the conduit. Conduits through which the mandrel will not pass shall not be used.

L. Expansion fittings shall be installed across all expansion joints and at other locations where necessary to compensate for thermal expansion and contraction.

M. Provide trenching, backfill, and compaction for conduits installed underground.

N. Unless approved in advance by the Engineer, all conduits which transition from underground to aboveground will utilize galvanized rigid steel conduit for the bend from horizontal to vertical and for the extension above the ground. Factory 90 degree GRS bends shall be used. GRS bends and conduits shall be half lapped with 20 mil PVC tape in non-corrosive areas and shall be PVC coated rigid steel in corrosive areas. Tape wrapping shall extend a minimum 6 inches above top of slab or above finished grade.

O. Liquid tight flexible metallic conduit 1-1/2 inch and larger shall be provided with grounding style bushings and shall have an external ground wire sized and installed in accordance with the NEC.

End of Section

SECTION 16123

600 VOLT CLASS CABLE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers the furnishing and installation of 600 Volt Class cables and conductors, terminations and splicing, and pulling lubricants.

1.02 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000, and elsewhere in the Contract Documents, prior to installation.

1.03 REFERENCES

A. Insulated Cable Engineers Association/National Electrical Manufacturers Association (ICEA/NEMA):
   1. S-68-516/WC 8, ethylene-propylene rubber-insulated wire and cable for the transmission and distribution of electrical energy.
   2. S-61-402/WC 5, thermoplastic-insulated wire and cable for the transmission and distribution of electrical energy.
   3. S-66-524/WC 7, cross-linked thermosetting-polyethylene-insulated wire and cable for transmission and distribution of electrical energy.

B. Underwriters Laboratory, Inc.
   1. 44, rubber insulated wires and cables.
   2. 83, thermoplastic-insulated wires and cables.
   3. 486A, wire connectors and soldering lugs for use with copper conductors.
   4. 486B, wire connectors for use with aluminum conductors.
   5. 510, insulating tape.

C. National Electric Code

PART 2 - PRODUCTS

2.01 ACCEPTED MANUFACTURERS

A. Conductors and Multi Conductor Cables (MCC), subject to compliance with Contract Documents, the following manufacturers are acceptable: American Insulated Wire Corporation, Cablec Corporation, Okonite Company, Southwire Company, or equal.

2.02 CONDUCTORS

A. Wire sizes shall be American Wire Gauge (AWG) sizes with Class B stranded construction. Number 2 AWG and smaller shall be factory color coded with a separate color for each phase and neutral, which shall be used consistently throughout the system. Larger cables shall be coded by the use of colored tape. Conductors sized # 1 and larger shall be Type 2, rated for 90 degrees C. All circuit conductors, #6 or smaller shall be "THWN" stranded copper. All other conductors shall be "XHHW-2" stranded copper.

B. Individual or multiple conductor cables for power, control, and alarm circuits of 480 volts or less shall be insulated for not less than 600 volts and shall have insulation type as indicated on the Drawings. "THHW" shall conform to ICEA S-61-402/NEMA WC 5 and UL 83 and "XHHW" shall conform to ICEA S-66-524/NEMA WC 7 and UL 44. Where wire size is not indicated, they shall be of the size required by the NEC, except that no wire external to panels and motor control centers shall be less than No. 12 AWG, unless specifically noted on the Drawings. Panel control wiring shall not be less than No. 14 AWG.

C. All wiring shall be as indicated on the Drawings. Wires shall be new and shall be soft drawn copper with not less than 97 percent conductivity. The wire and cable shall have size, grade of insulation, voltage, and manufacturer's name permanently marked on the outer covering at not more than 2-foot intervals. All wires shall conform to the latest Standards of the ASTM, and ICEA, and shall be tested for their full length by these Standards. Insulation thickness shall be not less than that specified by the National Electrical Code.

D. Power conductors for lighting and receptacles only may utilize "THWN" solid conductors.

2.03 TERMINATIONS AND SPLICES

A. Cable shall be rated 600 volts. Other parts of cable systems such as splices and terminations shall be rated at not less than 600 volts. Splicing shall join conductors mechanically and electrically to provide a complete circuit prior to installation of insulation.

B. Splices in wires No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, Type I, Class 1, Grade B, Style G, or Type II, Class 1 of FS W-S-610 and conforming to the applicable requirements of UL 486A.

C. Splices in wires No. 8 AWG and larger shall be made with non-insulated, solderless, pressure type connector, Type II, Class 2 of FS W-S-610, conforming to the applicable requirements of UL 486A and UL 486B. They shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket.

D. Insulated conductor splices below grade or in wet locations shall be sealed type conforming to ANSI C119.1 or shall be waterproofed by a sealant-filled, thick wall, heat

shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

E. Bare conductor splices in wet locations or below grade shall be of the exothermic type.

2.04 PULLING LUBRICANT

A. All cables shall be properly coated with pulling compound such as ClearGluide, Aqua Gel, Polywater, or equal before being pulled into conduits so as to prevent mechanical damage to the cables during installation. "Yellow 77" is not acceptable.

B. Other lubricants to be substituted must be accompanied by a statement from the cable manufacturer as to its acceptable use with the cable being installed.

2.05 IDENTIFICATION

A. All conductors shall be numbered with "tube sleeve" type tags with heat impressed letters and numbers.

B. Color code all wiring as follows:

1. Lighting and power wiring:

CONDUCTOR	**120/208 VAC**	**480VAC**	**24V DC**	**120 VAC Control/ Power**
Phase 1	Black	Brown	Blue	Red
Phase 2	Red	Orange	(-) Blue w/ white stripe	
Phase 3	Blue	Yellow		
Neutrals	White	White or Gray		White

2. Color code ends of feeder phase conductors only.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The pulling tension and side-wall pressures, as recommended by the cable manufacturer, shall not be exceeded.

B. As far as practical, all circuits shall be continuous from origin to termination without splices in intermediate pull boxes. Sufficient slack shall be left at the termination to make proper connections. In no case shall a splice be pulled into the conduit. Conductor splicing shall not be permitted without the Engineer's approval.

C. Install all cables in conduit.

D. Each feeder and branch circuit shall be installed in its own individual conduit unless combining feeder and branch circuits is permitted as defined in the following:
   1. As specifically indicated on the Drawings.
   2. For lighting, multiple branch circuits may be installed in a conduit as allowed by the NEC and with the wire ampacity derated in accordance with the requirements of the NEC. Conduit fill shall not exceed the limits established by the NEC.
   3. When field conditions dictate and written permission is obtained from the Engineer.

E. Feeder and branch circuits shall be isolated from each other and from all instrumentation and control circuits.

F. Control circuits shall be isolated from all other feeder, branch and instrumentation circuits, except as noted below.
   1. 12 V DC, 24 V DC and 48 V DC control circuits may be combined in common conduit.
   2. 125 V DC control circuits shall be isolated from all other DC and AC control circuits.
   3. 120 V AC control circuits shall be isolated from all DC control circuits.

G. Make splices only at pull or junction boxes.
   1. Crimp or indented-type connectors are not allowed, except for control circuits landed on terminal strips.

3.02 TESTING

A. In accordance with Specification 16920 – ELECTRICAL ACCEPTANCE TESTING.

End of Section

SECTION 16124

INSTRUMENTATION CLASS CABLE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers cable use for process signal and controls.

1.02 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000, and elsewhere in the Contract Documents, prior to installation.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with Contract Documents, the instrumentation cable shall be as manufactured by Belden, Okonite, or equal.

2.02 INSTRUMENTATION CABLE

A. Instrument cable shall be Type TC, and have the number of individually shielded twisted pairs indicated on the Drawings and shall be insulated for not less than 600 volts. Unless otherwise indicated, conductor size shall be No. 18 AWG minimum. Shielded, grounded instrumentation cable shall be used for all analog signals.

B. The jacket shall be flame retardant with 90 degrees C temperature rating. The cable shield shall be a minimum of 2.3 mil aluminum or copper tape overlapped to provide 100 percent coverage and a tinned copper drain wire.

C. The conductors shall be bare soft annealed copper, Class B, 7 strand minimum concentric lay with 15 mils nominal thickness, nylon jacket, 4 mil nominal thickness, 90 degrees C temperature rating. One conductor within each pair shall be numerically identified.

D. Pairs shall be assembled with a nominal 2-inch lay and shall then be group shielded with a minimum of 1.3 mil aluminum or copper tape overlapped to provide 100 percent coverage. All group shields shall be completely isolated from each other.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Feeder and branch circuits shall be isolated from each other, and from instrumentation and control circuits. Instrumentation cables shall be installed in separate raceways from other cables and wiring. This includes portions running through manholes. Instrumentation cable shall be continuous between instruments or between field devices and instrument enclosures. There shall be no intermediate splices or terminal boards, unless otherwise shown on the Drawings.

B. Maintain electrical continuity of the shield when splicing twisted shielded pair conductors. Drain wires shall be terminated inside enclosures at grounded terminal blocks. Only one end of each instrument loop cable drain wire shall be grounded. Ground drain wire of shielded conductors at one end only.

C. Terminate instrumentation and control wiring, including spare wires, at control panels and motor control centers on terminal boards mounted inside the equipment.
   1. Contractor shall supply terminal boards as required.
   2. Do not field wire directly to devices.

End of Section

SECTION 16130

OUTLET, PULL, AND JUNCTION BOXES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Outlet, pull and junction boxes.

B. Related Sections include but are not necessarily limited to:
   Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   Division 1 - General Requirements.
   Section 16000 - Electrical: Basic Requirements.
   Section 16111 - Conduits.
   Section 16141 - Wiring Devices.
   Section 16170 - Grounding.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. Refer to Section 16000.

1.03 SUBMITTALS

A. Shop Drawings:
   1. Refer to the Contract Documents and Section 16000.

1.04 DELIVERY, STORAGE, AND HANDLING

A. See Section 16000.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Galvanized steel boxes:
      a. Appleton Electric Co.
      b. Steel City.
      c. Raco.
   2. Sheet metal boxes for non-classified areas:
      a. Hoffman Engineering Co.
   3. Corrosion-resistant boxes:

a. Hoffman Engineering Co.
b. Crouse-Hinds.

4. Hazardous location boxes (Class I, II & III):
   a. Appleton Electric Co.
   b. Crouse-Hinds.
   c. Killark.
   d. O-Z/Gedney.
5. Raintight and watertight boxes:
   a. Appleton Electric Co.
   b. Crouse-Hinds.
6. Terminal boxes:
   a. Hoffman Engineering Co.
7. Boxes in sidewalk:
   a. Appleton Electric Co.
   b. Crouse-Hinds.
   c. O-Z/Gedney.
8. Boxes in earth:
   a. Carlon Electric Products.
9. Exposed switch and receptacle boxes:
   a. Appleton Electric Co.
   b. Crouse-Hinds.
   c. Killark.

B. Submit requests for substitution in accordance with Specification Section 01630.

2.02 MATERIALS

A. Pull and Junction Boxes for Offices and other Dry Architecturally Finished Areas:
   1. Material: 14 GA, galvanized steel.
   2. Concentric knockouts on all four sides.
   3. Flat cover fastened with screws.
   4. NEMA 1 classification.
   5. UL listed.

B. Pull and Junction Boxes for General Use Unclassified Areas Suitable for NEMA 12 Enclosures:
   1. Material: 14 GA galvanized steel with seams continuously welded, ground smooth and no knockouts.
   2. Zinc rich coating on all seams.
   3. Stainless steel captivated cover screws threaded into sealed wells.
   4. Flat door with oil resistant gasket.
   5. NEMA 12 classification.
   6. UL listed.

C. Pull and Junction Boxes for Wet Areas:
   1. Material: 14 GA steel with polyester powder coating inside and out over phosphatized surfaces.

2. Seams continuously welded, ground smooth, no knockouts.
3. Stainless steel clamps on four sides.
4. Flat cover with oil resistant gasket.
5. NEMA 4 classification.
6. UL listed.

D. Pull and Junction Boxes for Corrosive Areas:
1. Material: 304L or 316L stainless steel or fiberglass-reinforced polyester material.
2. Stainless steel boxes:
   a. Seams continuously welded, ground smooth, no knockouts.
   b. Rolled lip around all sides.
   c. Hinged door.
   d. Captivated stainless steel door screws.
   e. Flat door with oil-resistant gasket.
3. Fiberglass-reinforced polyester boxes:
   a. Hinged door with latch and lockout.
   b. Neoprene door gasket.
   c. Grounding bushing(s).
4. NEMA 4X classification.
5. UL listed.

E. Pull and Junction Boxes for Hazardous Areas:
1. Material: Cast gray iron alloy or copper-free cast aluminum.
2. Drilled and tapped openings or tapered threaded hub equipped.
3. Flat bolted-down or threaded cover with neoprene gasket.
4. Stainless steel hex head screws.
5. Explosion proof, UL listed for Class 1 Groups C and D.

F. Pull and Junction Boxes for Sidewalks:
1. Cast-iron box and cover, hot-dip galvanized.
2. Flange for flush mounting.
3. Checkered cover with neoprene gasket, pry bar slots and stainless steel screws.
4. UL listed.
5. Drilled and tapped holes.
6. Watertight NEMA 4 classification.

G. Large Pull and Junction Boxes (100 CU IN and larger):
1. Located in offices and other dry architecturally finished areas where EMT is utilized:
   a. NEMA 1 gasketed without knockouts.
2. Located in general use areas:
   a. NEMA 12 construction:
      1) Welded steel.
      2) Furnished with gray enamel inside and out over phosphatized surfaces.
3. Located in wet and corrosive areas:
   a. NEMA 4X with stainless steel screws.
   b. Type 304 L welded stainless steel:

4. Constructed of 14 GA steel with seams continuously welded, ground smooth, no knockouts.
5. Rolled lip around all sides.
6. Rigid handles for covers larger than 9 SF or heavier than 25 LBS.
7. Split covers when heavier than 25 LBS.

H. Terminal Boxes:
1. Galvanized 16 GA steel box provided with plain blank screw cover, subpanel, and terminal points.
2. Refer to Drawing for dimensions and number of terminals.

I. Fiberglass Cable-Pulling Enclosure:
1. Use: Access points to facilitate pulling of electrical cables in buried conduit runs.
2. Size and quantity: As shown on Drawings.
3. Type: Rectangular fiberglass composite, suitable for direct burial pedestrian traffic on top, -50 DegF, chemical, sunlight, and weather resistant.
4. Provide matching top with "ELECTRIC" logo.

J. Outlet Boxes:
1. Use: Installation of wiring devices.
2. Boxes for exposed wiring:
   a. Cadmium plated, cast, ferrous metal, with threaded hubs.
3. Boxes for concealed wiring:
   a. Code gage, hot-dip galvanized steel.
   b. Include bar hangers for metal stud partitions.
   c. Provide barriers between switches in boxes with 277 V switches on opposite phases.
   d. Use extension and plaster rings where required.
   e. Provide grounding screw.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Use locknut and bushing for boxes in non-classified areas.

B. Use cast metal boxes with threaded conduit hubs in hazardous areas.

C. Use Type FS and FD boxes in wet areas and where exposed rigid steel conduit is required.

D. Fill unused punched-out, tapped, or threaded hub openings with insert plugs.

E. Use outlet boxes sized to accommodate quantity of conductors enclosed.

F. Use boxes sized to accommodate conduit tying into box.

G. Install pull boxes or junction boxes in conduit runs where indicated or required to facilitate pulling of wires or making connections.
   1. Make covers of boxes accessible.

H. Install pull boxes or junction boxes rated for the area classification.

I. Install rigid conduit squarely into boxes which do not have hubs or are drilled and tapped.
   1. Install with locknut on the outside and bushing on inside.

J. Install conduit into boxes with hubs, or that are tapped, using thread lubricant.

K. Do not use back-to-back boxes on this Project.

L. Seal all points of conduit entry into fiberglass cable-pulling enclosures for a waterproof installation.

M. Support outlet boxes for incandescent fixtures and other ceiling-mounted devices in lay-in acoustical tile ceilings by bar hangers anchored to ceiling construction members which do not interfere with tile removal.

End Of Section

SECTION 16141

WIRING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Light switches, receptacles, device plates, dimmers, plug-in strips and tele-power poles.

B. Related Sections include but are not necessarily limited to:
Division 0 -Bidding Requirements, Contract Forms, and Conditions of the Contract.
Division 1 - General Requirements.
Section 16000 - Electrical: Basic Requirements.
Section 16130 -Outlet, Pull, and Junction Boxes.
Section 16170 - Grounding.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. Refer to Section 16000.

1.03 SUBMITTALS

A. Shop Drawings:
   1. Refer to the Contract Documents and Section 16000.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Light switches (except explosion proof):
      a. Hubbell.
      b. Slater.
      c. P&S.
      d. Arrow Hart.
      e. General Electric.
      f. Leviton.
   2. Explosion proof light switches:
      a. Crouse-Hinds.
      b. Appleton Electric Co.
      c. Killark.

3. Door switches:
    a. General Electric.
    b. Slater.
    c. P&S.
    d. Arrow Hart.
    e. Micro-switch.
4. Receptacles (except explosion proof):
    a. Hubbell.
    b. Slater.
    c. P&S.
    d. Arrow Hart.
    e. General Electric.
    f. Leviton.
5. Explosion proof receptacles:
    a. Crouse-Hinds.
    b. Appleton Electric Co.
    c. Killark.
6. Welding receptacles:
    a. Crouse-Hinds.
    b. Appleton Electric Co.
7. Tele-power poles:
    a. Wiremold.
    b. Walker.
8. Dimmers:
    a. Lutron.
    b. General Electric.
    c. P&S.
9. Plug-in strip:
    a. Wiremold.
    b. Walker.

B. Submit requests for substitution in accordance with Specification Section 01630.

2.02 MATERIALS

A. Light Switches for Unclassified Areas:
1. Toggle type, quiet action, specification grade with grounding terminal.
2. Back and side wired.
3. Solid silver cadmium oxide contacts.
4. One-piece switch arm rated 20 A, 120/277 V AC.
5. UL listed.
6. Color: Ivory.
7. Wall plate: Type 304 stainless steel.
8. Type: As indicated on Drawings.

B. Receptacles for Unclassified Areas:
1. Straight blade, grounding type, specification grade.

2. Back and side wired with wrap-around bridge.
3. Rated 20 A, 125 V AC.
4. UL listed.
5. Color:
    a. For use on normal power: Ivory.
    b. For use on UPS systems: Red.
    c. For use on isolated ground systems: Orange.
6. Wall plate: Type 304 stainless steel.
7. Type: As indicated on Drawings.

C. Light Switches for Wet Areas:
1. Presswitch type, quiet action, specification grade, with grounding terminal.
2. Back and side wired.
3. Solid silver cadmium oxide contacts.
4. One-piece switch arm rated 20 A, 120/277 V AC.
5. UL listed.
6. Color: Ivory.
7. Wall plate: Gray weatherproof presswitch type.
8. Type: As indicated on Drawings.

D. Receptacles for Wet Areas:
1. Straight blade, grounding type, specification grade.
2. Back and side wired with wrap around bridge.
3. Rated 20 A, 125 V AC.
4. UL listed.
5. Color: Ivory.
6. Wall plate: Weatherproof, cast aluminum, UL listed, WDL open and closed.
7. Type: As indicated on Drawings.

E. Ground Fault Circuit Interrupter Receptacles:
1. Straight blade, grounding type, specification grade.
2. Rated 20 A, 125 V AC.
3. UL listed.
4. Test and reset buttons.
5. Wall plate: Indoor or weatherproof as required.
6. Feed-through type.

F. Light Switches for Corrosive Areas:
1. Corrosion-resistant NEMA 4X enclosure with switch consisting of:
    a. Fiberglass reinforced polyester enclosure.
    b. Fiberglass reinforced polyester gasketed wall plate with built-in toggle lever switch with stainless steel shaft.
    c. Grounding bushing.
    d. Rated 20 A, 125 V AC.
    e. UL listed.
    f. Type: As indicated on Drawings.
    g. Color: Yellow.

2. Optional: Corrosion-resistant enclosure and switch consisting of:
    a. Cast copper-free aluminum "FS" or "FD" ridge type hub box.
    b. Toggle type, quiet action, specification grade with grounding terminal.
    c. Rated 20 A, 125 V AC with solid silver cadmium oxide contacts.
    d. UL listed.
    e. Neoprene gasket.
    f. Cast aluminum cover with stainless steel screws and lever to activate switch.
    g. Type: As indicated on Drawings.
    h. Color: Yellow.

G. Receptacles for Corrosive Areas:
1. Corrosion-resistant straight blade, grounding type, specification grade.
2. Back and side wired with wrap-around bridge.
3. Rated 20 A, 125 V AC.
4. UL listed.
5. Color: Yellow.
6. Box: "FS" or "FD" ridge type cast hub box of copper-free aluminum.
7. Gasket: Neoprene.
8. Wall plate: Weatherproof, cast aluminum, UL listed, WDL open or closed.
9. Type: As indicated on Drawings.

H. Explosion proof Light Switches for Use in Hazardous Areas:
1. Explosion proof, UL listed for Class I, Division 1 and 2, Groups B, C, and D; and Class II, Division 1 and 2 areas, Groups E, F, and G.
2. EDS factory sealed.
3. Malleable iron body and cover.
4. Aluminum sealing chamber.
5. Front operated handle with stainless steel shaft.
6. Rated 20 A, 125 V AC.
7. With grounding screw.
8. Type: As indicated on Drawings.

I. Explosion proof Receptacles for Use in Hazardous Areas:
1. Explosion-proof, UL listed for Class I, Division 1 and 2, Groups B, C, and D; and Class II, Division 1 and 2, Groups F and G.
2. Factory-sealed malleable iron receptacle with spring-loaded cover.
3. Malleable iron mounting box.
4. Rated 20 A, 125 V AC.
5. "Dead-front" construction requiring plug to be inserted and rotated to activate receptacle.
6. Type: As indicated on Drawings.

J. Welding Receptacles:
1. 60 A, 480 V, 3 pole, 4 wire, grounding type.

K. Plug-In Strip: Surface steel raceway plug-in strip with single 15 A, 125 V, 3 wire grounding-type receptacles spaced 18 IN on center.

1. Prewired with two #12 TW and one #12 TW green insulated ground.
2. Minimum 1-1/4 IN wide x 3/4 IN deep.
3. Suitable fittings and snap-in cover.
4. Finish:
    a. Stainless steel.
5. Receptacle color:
    a. For use on normal power: Ivory.
    b. For use on UPS systems: Red.
    c. For use on isolated ground systems: Orange.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Mount devices where indicated on the Drawings and as scheduled in Section 16010.

B. Surface mount receptacles and light switches in concrete construction.

C. In masonry and metal stud construction, recess mount receptacles and light switches unless device precludes recessed mounting or unless otherwise noted on the Drawings.

D. Where more than one receptacle is installed in a room, they shall be symmetrically arranged.

E. Set switches and receptacles plumb and vertical to the floor.

F. Set recess-mounted switches and receptacles flush with face of walls.

G. Do not connect dimmers to loads in excess of 80 percent of the rating of the dimmer.

H. Provide blank plates for empty outlets.

End Of Section

SECTION 16160

ENCLOSURES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This specification includes enclosures to house electrical controls, instruments, terminal blocks, and serve as junction boxes where shown on the Drawings.

1.02 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000, and elsewhere in the Contract Documents, prior to installation.

1.03 MANUFACTURERS

A. Enclosures shall be manufactured by Hammond, Hoffman, Rittal, or equal.

PART 2 - PRODUCTS

2.01 STEEL

A. Enclosures shall be fabricated from 14 gauge steel with seams that are continuously welded. Doors shall have full length piano hinges with the door removable by pulling the hinge pin.

B. A rolled lip shall be provided around three sides of the door and around all sides of the enclosure opening. The gasket shall be attached with oil-resistant adhesive and held in place with steel retaining strips. Exterior hardware, such as clamps, screws, and hinge pins, shall be of stainless steel for outdoor installations. A hasp and staple shall be provided for padlocking. Each enclosure shall have a print pocket. All wires entering or leaving the enclosure shall terminate on terminal strips. All wires and terminals shall be clearly identified as specified elsewhere in these specifications.

C. Finish shall be white enamel interior, light gray enamel, ANSI 61 exterior, over phosphatized surfaces. Special finishes and colors shall be furnished for wet locations. Drawings should be checked for special conditions.

2.02 NEMA RATING

A. Unless otherwise indicated on the Drawings, enclosures shall be NEMA 12 for indoors, NEMA 4X for corrosive areas, and NEMA 4 for outdoor installations. NEMA 4X enclosures shall be stainless steel, unless noted otherwise. NEMA 4 enclosures shall also be used in wet, or wash down areas.

2.03 FIBERGLASS

A. Enclosures shall be heavy-duty, compression molded, fiberglass reinforced polyester, high impact, heat resistant, NEMA 4X.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Enclosures shall be installed as indicated on the Drawings, and according to manufacturer's instructions.

B. Enclosures shall be properly grounded, and shall include ground straps connected to hinged doors and accessories.

End of Section

SECTION 16170

GROUNDING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. A ground grid system consisting of the indicated configuration of copper wires, and ground rods, or concrete encased grounding electrodes ("UFERs") shall be provided to minimize station potential gradient irregularities and drain leakage and fault currents to earth.

B. Whether indicated on the Drawings or not, neutral conductors, cable shields, metallic conduits, cable terminations, junction boxes, poles, surge arresters, and other noncurrent-carrying metallic parts of equipment shall be grounded.

1.02 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000, and elsewhere in the Contract Documents, prior to installation.

1.03 REFERENCES

A. National Electrical Code (NEC) Article 250.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

2.02 GROUND RODS

A. Ground rods shall be copper-clad steel conforming to UL 467, 3/4 inch in diameter by 10 feet in length.

2.03 CONNECTIONS

A. Connections above grade shall be made with bolted solderless connectors, and those below grade shall be made by a fusion-welding process. In lieu of a fusion-welding process, a compression ground grid connector of a type which uses a hydraulic compression tool to provide the correct circumferential pressure may be used. Tools and dies shall be as recommended by the manufacturer. An embossing die code or other standard method shall provide visible indication that a connector has been adequately compressed on the ground wire.

2.04 GROUNDING ELECTRODE CONDUCTOR

A. Service entrance ground wires shall be sized in accordance with NEC Table 250.66, unless otherwise indicated on the Drawings. After being located to provide maximum physical protection, exposed ground wires shall be securely attached to structural supports at not more than 2-foot intervals with suitable fasteners. Bends greater than 45 degrees in ground wires are not permitted. Routing of ground conductors through concrete should be avoided, except where specifically called for in these Documents. When concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit, so as to provide an opening for the ground wire. The opening shall be sealed with a suitable compound after installation of the ground wire.

2.05 EQUIPMENT GROUNDING CONDUCTOR

A. Neutral conductors shall be grounded where indicated. Equipment grounding conductors shall be sized in accordance with NEC Table 250.122, unless otherwise indicated. Ground wires shall be protected by conduit, where such wires run exposed above grade in nonfence-enclosed areas, or are run through concrete construction. Where concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit, so as to provide an opening for the ground wire. The opening shall be sealed with a suitable compound after installation of the ground wire. Bends greater than 45 degrees in ground wire connections to the ground rods, or counterpoises are not permitted.

2.06 EQUIPMENT GROUNDING

A. Equipment frames of motor housings, metallic tanks, metallic equipment enclosures, metal splicing boxes, chain-link fencing, and other metallic noncurrent-carrying metal items, shall be grounded. Connections to earth shall be made in the same manner as required for system grounding. Equipment or devices operating at less than 750 volts may be connected to secondary neutral grounding electrodes.

2.07 SURGE ARRESTER GROUNDING

A. Surge arresters shall be grounded. Resistance to ground for intermediate-class arresters shall be not more than 10 ohms and for distribution-class arresters shall be not more than 25 ohms. Ground wire connections shall be not less than No. 4 AWG for distribution arresters and No. 1/0 AWG for intermediate arresters. Connections to earth shall be made in the same manner as required for neutral conductors. Surge arrester grounds may use the same ground wires provided for equipment operating at more than 750 volts. Surge arrester and secondary neutral grounds shall be separate from and independent of each other but both grounds shall be bonded together below grade at the ground rods or may utilize a common counterpoise.

2.08 LIGHTING POLE GROUNDING

A. Base of lighting poles shall be connected to an adjacent ground rod as indicated on Drawings. A ground connection from poles back to neutral ground points shall also be provided utilizing equipment grounding conductor.

2.09 METALLIC STRUCTURES

A. Metallic structures and buildings shall be grounded per NEC.

2.10 GROUNDING RINGS

A. When required, grounding rings shall be installed using bare copper cable with ground rods at least 25 feet intervals using thermoweld connecting means as indicated on Drawings in accordance with NEC requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

A. It is the intent of these Contract Documents that all device and equipment grounds shall be run as a separate conductor in the conduit from the equipment to the distribution panels or system ground. Wireways and enclosures shall be properly bonded and grounded, and ground conductors shall be run for all circuits.

B. Equipment cases and devices shall be grounded. Ground rods shall be driven, and concrete encased conduits installed, before a building, or structure is built, and ground conductors brought through the concrete to accessible points for grounding equipment. These systems shall be installed at each structure, where transformers, switchboards, panelboards, and MCCs are installed.

C. Duct banks shall contain a concrete encased system bare copper ground conductor. The system ground conductors shall run continuously in duct banks, through handholes and other raceway boxes. The system ground shall be connected to the structure grounding systems to provide a continuous grounding system. Each metallic raceway, panel, switchboard, and other metallic devices associated with the electrical and control systems shall be bonded to this grounding system.

D. Ground rod shall be installed not less than 6 inches below grade. In counterpoise systems, tops of ground rods shall be approximately at elevations of counterpoises. Where the specified ground resistance cannot be met with the indicated number of ground rods, additional ground rods, longer ground rods, or deep-driven sectional rods shall be installed and connected until the specified resistance is obtained, except that not more than three additional ground rods shall be required at any one installation. Ground rods shall be spaced as evenly as possible at least 6 feet apart and connected below grade. Equipment, neutral, and surge arrester ground wires shall be connected to the ground grid as indicated.

E. A resistance of not greater than 25 ohms shall be provided, unless otherwise specified. Ground resistances shall be measured as herein described. Resistances of systems requiring separate ground rods, rather than a counterpoise, shall be measured separately before bonding below grade. The combined ground resistance of separate systems bonded together below grade may be used to meet the specified ground resistance, but the minimum number of rods indicated must still be provided.

3.02 TESTS

A. Test the grounding and bonding system in accordance with Specification 16920 – ELECTRICAL ACCEPTANCE TESTING.

B. No part of the electrical system shall be energized until all station grounding system components have been tested and demonstrated to comply with the requirements specified, and until associated test reports have been submitted and approved.

3.03 TEST RESULTS

A. Perform the above tests and submit a certified test report prior to energizing the equipment.

End Of Section

SECTION 16190

SUPPORTING DEVICES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Supports, anchors, sleeves, and seals, are indicated on the Drawings, schedules, and specified in other sections of these Specifications.

B. Types of supports, anchors, sleeves and seals specified in this section include the following:
   1. One-hole Conduit Straps
   2. One-Hole Conduit Straps with Clamp Backs
   3. Two-Hole Conduit Straps
   4. Conduit Hangers
   5. I-beam Clamps
   6. Channel Clamps
   7. Round Steel Rods
   8. Drop-in Anchors
   9. Wedge Type Anchor Bolts
   10. Lead Expansion Anchors
   11. Toggle Bolts
   12. Wall and Floor Seals
   13. Cable Supports
   14. U-Channel Strut System
   15. Sleeves

1.02 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000, and elsewhere in the Contract Documents, prior to installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following: Abbeon Cal Inc., Ackerman Johnson Fastening Systems Inc., Elcen Metal Products Co., Ideal Industries, Inc., Josyln Mfg and Supply Co., McGraw Edison Co., Rawlplug Co. Inc., Star Expansion Co., U.S. Expansion Bolt Co., Allied Tube and Conduit Corp., B-Line Systems, Inc., Greenfield Mfg Co., Inc., Midland-Ross Corp., O-Z/Gedney Div; General Signal Corp., Power-Strut Div.; Van Huffel Tube Corp., and Unistrut Div; GTE Products Corp., and Robroy Industries.

2.02 GENERAL

A. Provide supporting devices that comply with manufacturers standard materials, design, and construction, in accordance with published product information, and as required for complete installations, and as specified herein.

2.03 SUPPORTS

A. Provide supporting devices of types, sizes, and materials indicated, and having the following construction features:
   1. One-Hole Conduit Straps: For supporting electrical metallic tubing, and liquidtight flexible conduit; zinc plated steel, stainless steel or galvanized steel; snap-on, heavy duty.
   2. One-Hole Conduit Straps with Clamp Backs: For supporting rigid metal conduit, and intermediate metal conduit; cast galvanized steel.
   3. Two-Hole Conduit Straps: For supporting electrical metallic tubing, rigid metal conduit, and intermediate metal conduit; zinc plated steel, stainless steel or galvanized steel.
   4. Conduit Hangers: For supporting electrical metallic tubing, rigid metal conduit, and intermediate metal conduit; zinc plated steel, stainless steel or galvanized steel.
   5. I-Beam Clamps: Electroplated zinc or hot dipped galvanized malleable iron.
   6. Channel Clamps: Electroplated zinc or hot dipped galvanized steel.
   7. Round Steel Rod: National coarse thread, electroplated.

2.04 ANCHORS

A. Provide anchors of types, sizes, and materials indicated, with the following construction features:
   1. Lead Expansion Anchors: For CMU walls, 1/4”-20 threads, set tool required.
   2. Toggle Bolts: Electroplated steel, size as required.
   3. Drop-in Anchors: Stainless steel, size as required.
   4. Anchor Bolts: Stainless steel, size as required.
   5. Half-round head, non-removable anchor bolts shall not be used.

2.05 SEALS

A. Provide seals of types, sizes and materials indicated; with the following construction features:
   1. Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals, of types and sized indicated; suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.
   2. Conduit sealing bushings shall be manufactured by O-Z/Gedney, Model CSMI, or equal.
   3. The conductor sealing bushings shall be manufactured by O-Z/Gedney, Model CSBG, or equal.

2.06 CONDUIT CABLE SUPPORTS

A. Provide cable supports with insulating wedging plug for non-armored type electrical cables in risers; construct 2" rigid metal conduit; 3-wires, type wire as indicated; construct body of malleable-iron casting with hot-dip galvanized finish.

2.07 U-CHANNEL STRUT SYSTEM

A. Provide U-channel strut system for supporting electrical equipment, 12-gage hot-dip galvanized steel, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with the following fittings that mate and match with U-Channel:
   1. Fixture hangers
   2. Channel hangers
   3. End caps
   4. Beam clamps
   5. Wiring stud
   6. Thinwall conduit clamps
   7. Rigid conduit clamps
   8. Post Bases
   9. U-bolts

2.08 PIPE SLEEVES

A. Provide pipe sleeves from the following:
   1. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.

2.09 PVC COATED U-CHANNEL STRUT SYSTEM

A. Provide PVC Coated U-channel strut system for supporting electrical equipment, 20 mil PVC coated steel, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with all Stainless Steel hardware, and the following fittings that mate and match with PVC Coated U-Channel:
   1. PVC Coated Strut nut
   2. PVC Coated Pipe straps
   3. Touch up compound (Gray)

2.10 STAINLESS STEEL U-CHANNEL STRUT SYSTEM

A. Provide Stainless Steel U-channel strut system for supporting electrical equipment, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with all stainless steel hardware, and the following stainless steel fittings that mate and match with Stainless Steel U-Channel:
   1. Fixture hangers
   2. Channel hangers
   3. End caps
   4. Beam clamps
   5. Wiring stud

6. Post bases
7. Rigid conduit clamps
8. U-bolts

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installation of supporting devices.

B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

C. Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of 2 or more parallel runs of conduits to be supported together on channel type hangers where possible. Install supports with spacing indicated and in compliance with NEC requirements.

D. Torque sleeve seal nuts, complying with manufacturer's recommended values. Ensure that sealing grommets expand to form watertight seal.

E. Comply with manufacturer’s recommendations for touch up of field cut ends or damaged PVC coated U-channel and fittings.

F. Remove burrs and apply a cold zinc galvanizing paint to field cut galvanized U-channel strut.

End of Section

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Electrical identification work specified in this section covers the following:
   1. Buried cable warnings
   2. Electrical power, control and communication conductors
   3. Operational instructions and warnings
   4. Danger signs
   5. Equipment/system identification signs

1.02 SUBMITTALS

A. Submittals to the engineer shall include the following:
   1. Manufacturers data on electrical identification materials and products
   2. Samples of each color, lettering style and other graphic representation required for each identification material or system

1.03 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering electrical identification products maybe incorporated in the work include, but not limited to, the following:
   1. Brady, W.H. Co.
   2. Ideal Industries, Inc.
   3. Panduit Corp.
   4. or, equal

1.04 QUALITY COMPLIANCE

A. Comply with applicable requirements of UL Std. 969, "Marking and Labeling Systems", pertaining to electrical identification systems.

B. Comply with applicable requirements of NEMA Std. No's WC-1 and WC-2 pertaining to identification of power and control conductors.

PART 2 - PRODUCTS

2.01 GENERAL

A. Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an

application, selection is Installer's option, but provide single selection for each application.

2.02 CONDUIT MARKERS

A. Conduit tags shall be 1-1/2-inch diameter, round, aluminum tags, laser engraved or standard engraving with the conduit number. Punched or stamped lettering is not allowed. Font shall be 1/4-inch Arial or Helvetica. The conduit tags shall be manufactured by Brady, Catalog No. 49900 or equal.

B. Each tag shall be attached with nylon-coated 48-mil stainless steel wire and fasteners, as manufactured by Brady, Catalog No. 38091, and brass wire clamps, double ferrule design, as manufactured by Brady Catalog No. 38090 to secure the stainless steel wire or equal.

C. Unless otherwise indicated or required by governing regulations, provide white markers with black letters.

2.03 CABLE AND CONDUCTOR WIRE MARKERS

A. Cable and conductor wire markers shall be self laminating vinyl on white background, printed using a Brady TLS2200 printer, Seton printer, or equal. Handwritten wire markers are not acceptable.

2.04 SELF-ADHESIVE PLASTIC SIGNS

A. Provide manufacturer's standard, self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application, e.g., 208V, EXHAUST FAN, RECTIFIER.

B. Unless otherwise indicated or required by governing regulations, provide white signs with black lettering.

2.05 LETTERING AND GRAPHICS

A. Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of electrical systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install electrical identification products as indicated, in accordance with manufacturer's written instructions, and requirements of NEC.

B. Where identification is to be applied to surfaces that require finish, install identification after completion of painting.

C. Comply with governing regulations and requests of governing authorities for identification of electrical work.

3.02 CONDUIT IDENTIFICATION

A. Where electrical conduit is exposed in spaces with exposed mechanical piping that is identified by a color-coded method, apply color-coded identification on electrical conduit in manner similar to piping identification. Except as otherwise indicated, use white as coded color for conduit.

3.03 CABLE/CONDUCTOR IDENTIFICATION

A. Apply cable/conductor identification, including voltage, phase and feeder number, on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work.

3.04 EQUIPMENT/SYSTEM IDENTIFICATION

A. Install engraved plastic-laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system including communication-control-signal systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, 1/2” high lettering on 1-1/2” high sign (2” high where 2 lines are required), white lettering in black field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work:
   1. Panelboards, electrical cabinets and enclosures.
   2. Access panel/doors to electrical facilities.
   3. Major electrical switchgear.

B. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with brass or stainless steel screws, except use adhesive where screws should not or cannot penetrate the substrate.

3.05 CIRCUIT IDENTIFICATION

A. The 3-phase wires shall be identified at the switchgear, panelboards and motor control centers as Phases A, B, and C. At 277/480V, Phase A shall be brown, Phase B shall be orange, and Phase C shall be yellow. The neutral shall be gray or white.

B. In addition to color coding all conductors, each conductor shall be identified in each pull box, manhole, panelboard, cable tray, or termination with circuit identification markers. This identification is applicable to all power, control, alarm, and instrumentation conductors and these markings shall be recorded on the Record Documents. Markers shall be slip-on PVC sleeve type as manufactured by Brady, Seton, or equal.

C. Markers for other cabling shall be B-292 vinyl as manufactured by Brady, Seton, or equal.

D. Exposed medium voltage conduits shall be labeled at 50-foot intervals with 1-inch letters stating the voltage - example - "12,470 volts". Labels shall be vinyl plastic as manufactured by Brady, Seton, or equal.

3.06 AUTOMATIC EQUIPMENT WARNING SIGNS

A. Permanent warning signs shall be mounted at all mechanical equipment that may be started automatically or from remote locations. Signs shall be in accordance with OSHA regulations and shall be suitable for exterior use. The warning signs shall be fastened with round head brass screws or bolts, located and mounted in a manner acceptable to the Engineer.

B. Warning signs shall be 7 inches high by 10 inches wide, colored yellow and black, on not less than 18 gauge vitreous enameling stock. Sign shall read:

CAUTION
THIS EQUIPMENT STARTS
AUTOMATICALLY
BY REMOTE CONTROL

3.07 HIGH VOLTAGE WARNING SIGNS

A. Permanent and conspicuous warning signs shall be mounted on all equipment, doorways to equipment rooms, pull boxes, manholes, where the voltage exceeds 600 volts.

B. Signs shall be in accordance with OSHA regulation, and shall be suitable for exterior use. The warning signs shall be fastened with round head brass screws or bolts, located and mounted in a manner acceptable to the Engineer.

C. Signs shall be 7 inches high by 10 inches wide, colored red and white, on not less than 18 gauge vitreous enameling stock. Sign shall read:

WARNING

HIGH VOLTAGE
KEEP OUT

3.08 CONDUCTOR FASTENERS

A. Glue-on type conductor fasteners shall not be used in any panels, panelboards, switchboards, switchgear, motor control centers, or other enclosures containing electrical devices and/or conductors.

End of Section

SECTION 16470

PANELBOARDS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Panelboards furnished in accordance with the Plans and this specification.
   1. Service entrance rated main distribution panelboards.
   2. Distribution panelboards.
   3. Lighting and appliance branch circuit panelboards.
   4. Electronic Power Metering on panelboards per Section 2.05, when specified.

1.02 RELATED SECTIONS

A. Section 16000 – General Electrical Requirements

B. Section 16195 - Electrical Identification

C. Section 16505 – Transient Voltage Surge Suppression

1.03 CODES, STANDARDS, AND REGULATORY REQUIREMENTS

A. All parts, materials, assembly, installation, testing and commissioning shall meet the requirements of the latest edition of the following Codes and Standards, and Regulatory agencies. In case of the conflict between the codes' requirement, the most stringent shall apply.
   1. Underwriters' Laboratories:
      a. Panelboards: UL 67
      b. Enclosures for Electrical Equipment: UL 50
      c. Molded Case Circuit breakers and Circuit Breaker Enclosures: UL489
   2. FS W-C-375 - Circuit Breakers, Molded Case, Branch Circuit and Service.
   3. FS W-P-115 - Power Distribution Panel.
   4. NEMA AB 1 - Molded Case Circuit Breakers.
   5. NEMA PB 1 - Panelboards.
   6. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
   7. NEMA PB 1.2 - Application Guide for Ground-fault Protective Devices for Equipment.
   8. NFPA 70 - National Electrical Code.
   9. UBC - Uniform Building Code.
   10. NETA - International Electrical Testing Association.

1.04 SUBMITTALS

A. Shop drawings for equipment and component devices.

B. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker arrangement, sizes and numbering system.

C. Include information on all the accessories, locking hardware, shunt trip, under-voltage release mechanism, typical thermal magnetic curves for each size and type.

1.05 SPARE PARTS

A. Keys: Furnish two door keys for each panelboard.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. General Electric

B. Square D

C. Cutler-Hammer

D. Approved Equal

2.02 BUS AND HARDWARE

A. Panelboards shall be completely factory assembled and equipped with the type, size and number of branch circuit breakers, arranged and numbered as shown on the Plans. Panelboards shall be fully rated. Series rated panelboards are not acceptable.

B. All multi-pole breakers shall be common trip. Branch circuits shall be arranged using double row construction. Bus sequence shall be ABC top to bottom, left to right for both top and bottom fed panels. Provisions or space for future breakers shall be located at the bottom of the panel and be fully bussed, complete with all necessary mounting hardware. Use at least 100 ampere breaker-connecting bus straps and mounting hardware.

C. Where SPARE is indicated on the panel schedule(s), the specified circuit breaker and at least 100 ampere branch-circuit busing and mounting hardware shall be installed.

D. Where SPACE is indicated on the panel schedule(s), 100 ampere branch-circuit busing and mounting hardware shall be installed, ready for future installation of circuit breakers, furnished by others. At least 20% spare pole spaces, grouped in multiples of three, shall be provided in each panelboard, for future installation by the Owner. Provide single pole filler plates in the spaces, as required.

E. A nameplate shall be provided, and located near the top of the front trim on the exterior surface, listing panel type and ratings, as required by UL. Each circuit shall be permanently numbered to agree with the panel schedule, using plastic or metal buttons mounted adjacent to the breaker and secured by rivets or grommets with an engraved or

depressed number. Adhesive numbering tape, painted numbers, or use of more than one number per breaker is not acceptable.

F. Main vertical bus bars shall be copper and silver or tin plated per UL requirements. Bus bars shall be supported by glass-filled polyester-type insulators. All bolts, used to connect current-carrying parts together, shall be accessible for tightening from the front of the panel. Bus bars shall be factory drilled and tapped with spacing arranged to permit breaker interchange, from the front, while the panel is energized.

G. Neutral bus shall be copper and insulated from the cabinet and all other parts. It shall be rigidly mounted in the panel and shall be provided with a solderless cable connector for each circuit breaker and each space in the panelboard and the main connecting lug(s).

H. A 1/4-inch (8mm) thick copper equipment ground bus, of sufficient width and length, shall be solidly bolted and grounded to the enclosure at the bottom and shall leave clear space for the bottom cable entries. The bus shall be drilled and tapped for 1/4" (8mm) - #20 machine screws in number to agree with branch circuits and spaces. A solderless connector, for No. 2 to No. 4/0 cable size, shall be bolted to the ground bus.

I. Copper bus bars shall be of sufficient size to provide a current density of not more than 1000 amperes per square inch of cross section, and not more than 200 amperes per square inch at bolted connections.

J. Minimum Short Circuit Rating for Bus Bracing: The bus shall be braced for the minimum symmetrical short circuit rating of the panel, as shown on the panel schedule.

K. Provide main bus pressure connectors (main lugs) and separately supported sub-feed pressure connectors (lug landings) where noted. Provide additional bottom raceway space to accommodate pressure connectors and lug landings. In no instance shall the gutter space be less than required by NFPA-70.

L. Provide Surge Protective Devices (SPD's) where required on Plans.

M. Where required on Plans, provide re-installed locking devices for locking each circuit breaker in the OPEN position, by means of a padlock. Locking devices shall not be removable from the front of the panel with the trim in place. Attachment of the locking device to the panel with adhesives is not acceptable.

2.03 CIRCUIT BREAKERS

A. Molded Case Circuit Breakers: NEMA AB 1; provide bolt-on type circuit breakers with integral thermal and instantaneous magnetic trip in each pole and common trip handle for all poles. Provide circuit breakers, UL listed as Type HACR, for air conditioning equipment branch circuits. Provide circuit breakers, UL listed as Type SWD, for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where shown on Plans.

B. Instantaneous magnetic trips shall be accessible and adjustable from the front of the breaker on frame sizes above 100 amperes.

C. All breakers shall be rigidly mounted, separately removable and independent of trim plates for their support. Breakers shall be bolt on type.

D. The minimum width of one pole shall be 1-3/8 inches. The breaker shall be "E" frame minimum.

E. The minimum symmetrical interrupting rating for molded-case circuit breakers shall be as specified on the panel schedule(s). Series rated breakers are not acceptable.

2.04 CABINETS (BOXES)

A. All details of construction and methods of assembly shall meet the requirements of the "Enclosures for Electrical Equipment" of the Underwriters' Laboratories. The panel box shall not be less than 20” wide, 4.5” deep and of sufficient height to enclose the specified main and branch circuit breakers, buses, metering equipment and wire gutter. The panelboard enclosure shall be fabricated from code-gauge galvanized or galvanized-annealed steel without knockouts and with full front flange. The panel front shall be as shown on the plans and fabricated from cold rolled steel. Surface mounted panel boxes shall be finished with an ANSI-61 light grey baked enamel. There shall be no screws projecting into the wiring raceways. The panelboard enclosure type shall be coordinated with the environment and location shown on the plans. Unless noted otherwise on the panel schedule, provide NEMA 3R for panelboards located out of doors and NEMA 12 elsewhere.

B. The front trim shall have full-length hinged outer door designed to expose the wiring raceways and breakers, when open. Another, inner hinged door shall expose breakers only, when open, making this a door-in-door construction. Both doors shall open to the right.

C. Both doors shall be provided with concealed butt or piano hinges. A suitable latch, which can be operated without tools, shall be provided to properly hold the inner door closed. For doors 30 inches (765mm) high or less, a flush-type latch is satisfactory. For doors more than 30 inches (765) high, a vault-type handle shall be provided with a three-point latch that holds the door closed at the top and bottom. The outer door shall be secured with at least four (4) captured oval head machine screws.

D. A sturdy metal frame, with a clear plastic cover, for an 8-1/2 inch x 11 inch panel schedule, shall be attached inside of the panel door with the RTV adhesive.

E. Panel trim and doors, and surface mounted cabinets shall be thoroughly cleaned, given a rust-inhibiting treatment, and finished with an ANSI-61 light grey baked enamel.

F. All panelboards shall bear the Underwriters' Laboratories label.

2.05 EXCEPTIONS

A. The bidders shall list all the exceptions taken from the specification with their quote. If no exceptions are listed with the bid, it is understood that the bidder shall meet all the requirements of this specification and applicable Codes and Standards.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install panelboards plumb and flush with wall finishes, in conformance with NEMA PB 1.1. Where surface mounted, provide suitable supports and rack all branch circuit conduits. Where mounted on concrete wall, install with ½" (15mm) steel spacers behind the panel. All mounting attachments and connections shall be designed in conformance with the minimum lateral seismic force of 0.5g per the most current adopted version of the UBC.

B. Height: Install top of trim 78 inches above finished floor, unless otherwise noted on drawings.

C. Provide filler plates for unused spaces in panelboards.

D. Provide typed or neatly hand printed 8-1/2x11-inch circuit directory for each panelboard, in the format as shown on the drawings. Revise directory to reflect circuiting changes required to balance phase loads.

3.02 QUALITY CONTROL

A. Owner reserves the right to witness any of the following tests conducted by the contractor and shall be notified in advance of these tests. Test in accordance with Specification 16920 – ELECTRICAL ACCEPTANCE TESTING.

B. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Maintain proper phasing for multi-wire branch circuits.

3.03 FINAL SUBMITTALS

A. After completion of the installation, wiring and testing, submit the following information within two weeks of the equipment acceptance.
   1. As-Built Panel Schedules.
   2. Copy of the certified test report described in Section 3.02.

END OF SECTION

SECTION 16474

MOTOR CONTROL EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
Separately mounted combination motor starters.

B. Related Sections include but are not necessarily limited to:
Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
Division 1 - General Requirements.
Section 16000 - Electrical: Basic Requirements.
Section 16170 - Grounding.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
1. American National Standards Institute (ANSI):
   a. C62.41, Guide for Surge Voltages in Low Voltage AC Power Circuits.
2. Canadian Standards Association (CSA).
3. Institute of Electrical and Electronics Engineers (IEEE).
4. National Electrical Manufacturers Association (NEMA):
   a. ICS 2, Industrial Control Devices, Controllers, and Assemblies.
   b. 250, Enclosures for Electrical Equipment (1000 Volt Maximum).
5. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
6. Underwriters Laboratories, Inc (UL):
   a. 845, Electric Motor Control Centers.

B. Miscellaneous:
1. Verify motor horsepower loads, other equipment loads, and controls from approved shop drawings and notify Engineer of any discrepancies.
2. Verify the required instrumentation and control wiring for a complete system and notify Engineer of any discrepancies.

1.03 SUBMITTALS

A. Shop Drawings:
1. See Sections 16000.
2. Typical wiring diagrams for all control equipment.

B. Operation and Maintenance Manuals:
1. See Section 01340.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Combination motor starters:
      a. General Electric.
      b. Square D.
      c. Cutler Hammer.
      d. Siemens.

B. Submit requests for substitution in accordance with Specification Section 01630.

2.02 COMPONENTS

A. Combination Motor Starters:
   1. Circuit breaker shall be motor circuit protector (MCP) type.
   2. Contactor shall be NEMA rated.
      a. One-half size and IEC sized starters not permitted.
   3. Operating handle shall clearly indicate whether circuit breaker is ON, OFF, or TRIPPED.
      a. Provide means to lock each circuit breaker handle in OFF position with cover closed by means of up to three padlocks.
      b. Interlock so that circuit breaker must be in OFF position before door can be opened. Provide defeater mechanism for use by authorized personnel.
   4. Provide starter unit with ambient compensated, external manually resettable, three bimetallic type overload relays. Coordinate size with actual motor full load current.
      a. For motors with power factor correction capacitors size heater elements to compensate for the capacitors effect on load current.
   5. Provide heavy-duty oiltight selector switches, pushbuttons, push-to-test pilot lights, or other devices as indicated on the Drawings. These devices will be accessible with the door closed.
   6. Provide each starter with two extra field reversible NO auxiliary contacts for future use, and as shown on the Drawings.

B. Control Relays:
   1. Provide industrial control relays as specified on the Drawings and as required for proper operation and control of supplied equipment.
   2. All control relays shall have 120 V coils capable of operating on line voltage fluctuations of +/-10 percent unless specified otherwise.
   3. Provide contacts for all required control plus two spares.

C. Terminal Blocks:
   1. Terminal blocks shall mount on standard DIN rail, and be of the size required for conductors therein. A minimum of 25 percent spares shall be provided in each terminal box. No more than 2 conductors shall be allowed per termination. Jumper

bar assemblies shall be installed for interconnecting terminal blocks, distributing power and signal commons. Terminal blocks shall be U.L. rated for 600 Volts, and 20 Amps, minimum.

2. Terminal blocks shall be available in a variety of colors, including red, green, blue, gray, black, yellow, and orange.
3. DIN rail shall be prepunched, zinc bichromate plated steel. Symmetrical DIN rail shall be 35mmX7.5mm, minimum.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

B. Mount other equipment as shown on the Drawings, and per NEC.

C. Ground all equipment per NEC.

End Of Section

SECTION 16476

LOW VOLTAGE CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish and install, low voltage circuit breakers, as indicated on the Drawings and specified herein.

1.02 SUBMITTALS

A. Products shall be submitted in accordance with Section 16000, and elsewhere in the Contract Documents, prior to installation.

1.03 QUALITY ASSURANCE

A. The breaker manufacturer's facilities shall be ISO 9001 certified.

PART 2 - PRODUCTS

2.01 GENERAL

A. Circuit breakers shall be as manufactured by Square D, Cutler-Hammer, Allen-Bradley, General Electric, or equal.

B. Circuit breaker frame, trip, short circuit, and interruption ratings shall be as indicated on the Drawings, except that they shall be coordinated with the ratings of the equipment actually furnished, and shall be modified where necessary to suit the equipment. Circuit breakers to be used in motor control centers shall be as indicated on the Drawings. Where no indication of type is given on the Drawings circuit breakers protecting motors shall be motor circuit protectors, and other circuit breakers shall be molded case type.

C. Circuit breaker for mounting in motor control centers, or for separate mounting shall be of the air-break type, quick-make and quick-break, 600 volt, with number of poles as indicated on the Drawings.

D. Each pole of the circuit breaker shall provide inverse time delay, and instantaneous circuit protection.

E. The breakers shall be operated by a handle, and shall have a switching mechanism that is mechanically trip free from the handle, so that the contacts cannot be held closed against short circuits, and abnormal currents. Tripping due to overload, or short circuit shall be clearly indicated by the handle automatically assuming a position between the manual

ON and OFF positions. Latch surfaces shall be ground and polished. Poles shall be constructed so that they open, close, and trip simultaneously.

F. Breakers must be completely enclosed in a molded case. Non-interchangeable trip breakers shall have their covers sealed; interchangeable trip breakers shall have the trip unit sealed to prevent tampering. Ampere ratings shall be clearly visible. Contacts shall be non-welding silver alloy. Arc extinction must be accomplished by means of arc chutes. The minimum interrupting ratings of the circuit breakers shall be at least equal to the available short circuit current at the line terminals.

G. Circuit breakers shall conform to the applicable requirements of NEMA Standards Publication No. AB1.

H. Molded case circuit breakers shall be ambient temperature compensating that provides inverse time delay overload and instantaneous short circuit protection by means of a thermalmagnetic element. Compensation shall be accomplished by a secondary bi-metal that will allow the breaker to carry rated current between 25 degrees C and 50 degrees C with tripping characteristics that are approximately the same throughout this temperature range.

I. On breakers with interchangeable, thermal, adjustable magnetic trip, the accessibility and position of the adjustment knob shall not be changed from those on the standard breaker.

J. Unless mounted in a switchboard, or panelboard, circuit breakers shall be housed in a NEMA rated enclosure as described elsewhere in these specifications.

K. Provide circuit breakers with shunt trip mechanisms where shown on the Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Circuit breakers shall be installed as indicated on the Drawings and per manufacturer's instructions.

End of Section

SECTION 16477

600 V FUSES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers the requirements for protective fusing on this project. The Contractor shall furnish and install fuses and fuse holders per the Drawings and equipment manufacturers recommendations.

B. This specification includes the general requirements for various types of fuses whether they are shown on the Drawings or not. If fusing is required by codes or manufacturers recommendations, but not shown on the Drawings, this specification shall apply to the type of fusing provided by the Contractor.

C. Types of fuses specified in this section include the following:
   1. Class L time-delay.
   2. Class L fast-acting.
   3. Class RK1 time-delay.
   4. Class RK1 and Class J current-limiting.
   5. Class RK5 time-delay.
   6. Class K5 time-delay, noncurrent-limiting.
   7. Class T current-limiting.

1.02 QUALITY ASSURANCE

The fuse manufacturer’s facilities shall be ISO 9001 certified.

1.03 CODES AND STANDARDS

A. UL Compliance and Labeling: Comply with applicable provisions of UL 198D, "High-Interrupting-Capacity Class K Fuses". Provide over-current protective devices which are UL-listed and labeled.

B. NEC Compliance: Comply with NEC as applicable to construction and installation of fusible devices.

C. ANSI Compliance: Comply with applicable requirements of ANSI C97.1 "Low-Voltage Cartridge Fuses 600 Volts or Less".

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data on fuses, including specifications, electrical characteristics, installation instructions, furnished specialties and accessories in accordance with Section 16000, and the Contract Documents. In

addition, include voltages and current ratings, interrupting ratings, current limitation ratings, time-current trip characteristic curves, and mounting requirements.

1.05 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering fusible devices which may be incorporated in the work include, but are not limited to, the following: Bussmann, Gould-Shawmut, Reliance, or equal.

PART 2 - PRODUCTS

2.01 GENERAL

A. Except as otherwise indicated, provide fuses of types, sizes, ratings, and average time-current and peak let-through current characteristics indicated, which comply with manufacturer's standard design, materials, and constructed in accordance with published product information, and with industry standards and configurations.

2.02 CLASS L TIME-DELAY FUSES

A. Provide UL Class L time-delay fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting transformers, motors, and circuit-breakers.

2.03 CLASS L FAST-ACTING FUSES

A. Provide UL Class L fast-acting fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting service entrances and main feeder circuit-breakers.

2.04 CLASS RK1 TIME-DELAY FUSES

A. Provide UL Class RK1 time-delay fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting motors and circuit-breakers.

2.05 CLASS RK1 CURRENT-LIMITING FUSES

A. Provide UL Class RK1 current-limiting fuses rated 250-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting circuit-breakers.

2.06 CLASS J CURRENT-LIMITING FUSES

A. Provide UL Class J current-limiting fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating.

2.07 CLASS RK5 TIME-DELAY FUSES

A. Provide UL Class RK5 time-delay fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting motors.

2.08 CLASS K5 ONE-TIME FUSES

A. Provide UL Class K5 one-time fuses rated 250-volts, 60 Hz, with 100,000 RMS symmetrical interrupting current rating for protecting non-inductive loads.

2.09 CLASS T FUSES

A. Provide UL Class T fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protection of physically small devices.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Fuse types and sizes shall be as indicated on the Drawings. Fuses shall be installed in accordance with the National Electric Code (NEC) requirements and the manufacturer's written instructions.

B. Install fuses in proper fuse holders.

C. Where fuses are installed in the motor starters, fuses shall be sized to match the actual motor full load current.

D. Where fuses are installed in disconnect switches at HVAC units, the fuse sizes shall be sized to meet the HVAC manufacturer's requirements.

E. Fuses for control transformers shall be sized in accordance with the National Electrical Code.

F. Fuses shall be installed with the labels clearly visible.

3.02 FIELD QUALITY CONTROL

A. Prior to energizing fusible devices, test devices for circuit continuity and for short-circuits.

3.03 SPARE PARTS

A. Furnish 3 spare fuses of each size and type.

End of Section

SECTION 16500

LIGHTING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install lighting fixtures.

1.02 QUALITY ASSURANCE

A. Reference Standards:
   1. National Electrical Code (NEC)
   2. UL Standard #57, Electric Lighting Fixtures
   3. UL Standard #844, Electric Lighting Fixtures for Use in Hazardous Location
   4. UL Standard #1570, Fluorescent Lighting Fixtures
   5. UL Standard #1571, Incandescent Lighting Fixtures
   6. UL Standard #1572, High Intensity Discharge Lighting Fixtures
   7. Illuminating Engineering Society (IES)
   8. All applicable local lighting ordinances

B. Miscellaneous:
   1. Lamps are identified for each luminaire in the Lighting Fixture Schedule on the Drawings.
   2. Lighting fixtures and electrical components:
      a. UL labeled, complete with lamps.
      b. Rated for area classification as indicated.
   3. Location of lighting fixtures on Drawings are intended to be used as a guide.
      a. Field conditions may affect actual locations.
      b. Coordinate with other trades to avoid conflicts in mounting of fixtures and other equipment.
   4. The quality standard is established by the fixture listed in the Lighting Fixture Schedule.
      a. This quality standard includes, but is not necessarily limited to construction features, materials of construction, finish, and photometrics.

1.03 SUBMITTALS

A. The following shall be submitted to the Engineer for review:
   1. Acknowledgment that products submitted meet requirements of standards referenced.
   2. Manufacturer’s technical information on products to be used including photometric performance curves for the fixture and ballast data.
   3. Acknowledgment that products submitted are UL or ETL listed.

4. When general data sheets constitute part of the submittal, identify the products to be used on this project.
5. Manufacturer’s installation instructions.
6. Identification of fixtures by Lighting Fixture Schedule.
7. UL nameplate data (Voltage, wattage, etc.).
8. Finishes, colors, and mounting type.
9. Pole, fixture, and accessories.
10. Pole wind loading.

B. Contractor shall submit shop drawings, manufacturer's data sheets, and a complete wiring diagram detailing all connections to the electrical system in accordance with Section 16000, and other requirements of the Contract Documents.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Lamps shall be manufactured by General Electric, North American/Phillips, Sylvania, or equal.

B. Lighting fixtures shall be provided as indicated on the Lighting Fixture Schedule on the Drawings.

C. Lighting ballasts shall be manufactured by General Electric, Advance, Jefferson, Universal, Bodine, Lithonia, or equal.

D. Light poles shall be as indicated on the Drawings. Include base template, anchor bolts, cadmium-plated hardware and pole grounding lug, handhole, anchor base and bolt covers. Pole foundations shall be as indicated on the Drawings.

2.02 MATERIALS

A. General:
   1. Lamps:
      a. See lighting fixture schedule on Drawings for wattage, voltage and number required.
   2. All Fixtures:
      a. There shall be no live parts normally exposed to contact.
      b. When intended for use in wet area:
         1) Mark fixtures “suitable for wet locations.”
      c. When intended for use in damp areas:
         1) Mark fixtures “suitable for damp locations” or “suitable for wet locations.”
      d. In wet or damp area, install fixtures so that water cannot enter or accumulate in the wiring compartment, lampholder, or other electrical parts.
      e. Gasket seals: Urethane foam

f. Diffusers: UV stabilized acrylic plastic

3. Underground wiring:
   a. Provide all wiring runs with separate green grounding conductor.
   b. Ground all pole bases.
4. Pole wiring from base to ballast:
   a. No. 12 type XHHW.
   b. Each phase shall be protected by a 30A, 600V, type Tron waterproof fuseholder, Bussman "Limitron" type fuse, size rating 3-times load current.

B. Incandescent Lamps:
1. Types:
   a. 30-135 watts: Energy efficient
   b. 200-500 watts: Standard
2. Inside frost
3. Base: Aluminum or brass
4. PAR/Halogen

C. Fluorescent Lamps:
1. Rapid start
2. Cool white (F32T8/41K-85CRI and F96T12/41K-70CRI/HO/ES)
3. Energy efficient or standard as noted on the lighting fixture schedule.

D. High-Pressure Sodium Lamps:
1. Bulb finish: Clear
2. Any burning position

E. Metal Halide Lamps:
1. Bulb finish: Clear
2. Any burning position

F. Furnish a minimum of 2 lamps, or ten percent spare lamps of each type and wattage, whichever is greater.

2.03 FIXTURES

A. Fluorescent Lighting Fixtures:
1. Ballast:
   a. Rapid start, high power factor type
   b. CBM/ETL certified
   c. Sound rating A
   d. Two internal automatic-resetting thermal switch devices for coil and capacitor
2. Internal wiring: AWM, TFN or THHN
3. Channel and end plates: 22 GA steel
4. Steel door frame and socket track: 20 GA steel
5. Channel cover: 24 GA steel
6. Emergency ballast:

a. Integral rechargeable nickel-cadmium battery, battery charger, and automatic transfer circuitry.
b. Charging indicator light.
c. Test Switch.
d. Provide a minimum of 900 lumen output for 90 minutes upon loss of normal power.
e. Mounted integral to the fixture.
f. UL 924 listed.

7. Provide fixtures with emergency ballasts with permanent caution labels warning that the fixture is fed from an unswitched source.
   a. Provide emergency ballast also with a similar caution label.

B. HID Lighting Fixtures:
1. Ballasts for high pressure sodium lighting fixtures:
   a. Type: Regulating
   b. Ballast design center variance: Maximum 5 percent from rated lamp wattage.
   c. Lamp wattage regulation spread at the lamp voltage: Maximum 10 percent for +/-10 percent line voltage variation.
   d. Ballast primary current during starting not to exceed normal operating current.
   e. Lamp current crest factor: Maximum 1.8 for +/-10 percent line voltage variation at any lamp voltage, from nominal through life.
   f. Power factor shall not drop below 90 percent for +/-10 percent line voltage variations at any lamp voltage, from nominal through life.
   g. Capacitor variance: Tolerance of +/-6 percent which will not cause more than a +/-8 percent variation in regulation throughout rated lamp life for nominal line voltage.
   h. Capable of operation with an open circuit condition for a maximum of 6 months without significant loss of ballast or starting circuitry life.
2. Ballasts for metal halide/mercury vapor lighting fixtures:
   a. Type: Auto-regulator
   b. Voltage input range: +/-10 percent
   c. Lamp regulation spread: 20 percent maximum
   d. Power factor: 90 to 95 percent
   e. Input voltage dip (4sec.): 40 to 50 percent
   f. Crest factor of lamp current: 1.6 to 2.0
3. Ballasts for exterior HID lamps:
   a. UL approved
   b. High power factor designed for -20 Deg F temperature starting
4. Fixtures for non-hazardous locations:
   a. Type: Industrial low bay
   b. Ballast housing: Die-cast
   c. Filter: Activated charcoal
   d. Refractor: UV stabilized molded acrylic

2.04 MISCELLANEOUS ELECTRIC DEVICES

A. PHOTOELECTRIC CONTROL UNITS shall meet the following requirements:
   1. Cadmium sulfide photocell
   2. Aluminum weatherproof enclosure
   3. 30 amp rated contacts
   4. 120-volt AC power
   5. The Photoelectric control unit shall be Tork Model 2100, or equal.

B. MOTION SENSORS shall meet the following requirements:
   1. 110 degrees field of view, 60 foot range
   2. Adjustable time setting from 15 seconds to 15 minutes
   3. Operating temperature of -20 to + 130 degrees F.
   4. Complete outdoor, weather proof sensor with complete mounting hardware
   5. UL listed
   6. The motion sensor(s) shall be manufactured by Leviton Model 50500-H or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install lamps in all luminaires.

B. Replace all failed fluorescent, incandescent, metal halide, mercury vapor and high pressure sodium lamps with new lamps prior to final acceptance by Owner.

C. Surface and flush mounted fixtures shall be solidly connected to a junction box. Suspended fixtures shall be hung utilizing pendant mounting or stainless steel chains and hooks. Each suspended fixtures, shall be electrically connected by a length of Type SO flexible cord. 3 conductor No. 14 AWG, minimum, with a twist-lock receptacle mounted in an individual junction box. Plugs and receptacles shall be as manufactured by Hubbell, General Electric Company, or equal.

D. Provide mounting brackets and/or structural mounting support for fixtures.
   1. Do not support fixture from conduit system.
   2. Do not support fixture from outlet boxes.

E. Install with approved mounting hardware following manufacturer’s recommendations.

F. Pole mounted fixtures shall be mounted on steel or aluminum poles as indicated on the Drawings. All metal poles shall be bonded to the facility ground system. Poles shall have adequate handholes and weatherproof receptacles where indicated.

G. All anchor bolts and nuts shall be stainless steel. Contractor shall paint all steel poles with aluminum paint or other color in accordance with these Contract Documents.

H. Fixture mounting heights and locations indicated on the Drawings are approximate and are subject to revision in the field where necessary to avoid conflicts and obstructions.

3.02 ADJUSTING AND CLEANING

A. Wipe all lighting fixture reflectors, lenses, lamps, and trims clean after installation and prior to acceptance of Project by Owner.

End of Section

SECTION 16902

ELECTRICAL CONTROLS AND RELAYS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This Section includes the following:
   1. Pushbutton and Selector Switches
   2. Relays
   3. Wireways
   4. Watthour Transducers
   5. Elapsed Time Meters and Time Clocks

1.02 RELATED SECTIONS

A. Section 16000 - General Electrical Requirements

B. Section 16160 - Enclosures

1.03 REFERENCES

A. NEMA ICS 1 - General Standards for Industrial Control Systems.

B. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers and Assemblies.

C. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

D. NEMA ST 1 - Standard for Specialty Transformers (Except General purpose Type).

1.04 SUBMITTALS

A. Data - a complete list of equipment and material including manufacturer's descriptive data and technical literature, performance charts, catalog cuts and installation instructions, spare parts data for each different item of equipment specified. The data shall include a complete Bill of Materials.

B. Drawings - containing complete wiring and schematic diagrams, control diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout, anchorage, support and appurtenances of equipment and equipment relationship to other parts of the work including clearances for maintenance and operations.

C. Submit shop drawings in accordance with the Contract Documents, and NEMA ICS 1 specifications indicating control panel layouts, wiring connections and diagrams, dimensions, support points.

1.05 PROJECT RECORD DOCUMENTS

A. Submit record documents in accordance with the Contract Documents.

B. Accurately record actual locations of control equipment. Revise diagrams included in Drawings to reflect actual control device connections.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit operation data in accordance with the Contract Documents.

B. Include instructions for adjusting and resetting time delay relays, timers, and counters.

C. Submit maintenance data in accordance with the Contract Documents.

D. Include recommended preventative maintenance procedures and materials.

PART 2 - PRODUCTS

2.01 PUSHBUTTONS AND SELECTOR SWITCHES

A. Pushbuttons, pilot lights and selector switches shall be of the full size, heavy-duty industrial, oil tight, 120 volt, with interchangeable pilot lights, plug-in construction, double break silver contacts, chrome plated lock rings, with modular contacts, and NEMA rating equal to that of the enclosure on which devices are installed. All components shall be flush mounted on front of panel, unless otherwise noted.

B. Provide individual legend plates for indication of switch, pushbutton, and light function (e.g., Open, Closed, Hand-Off-Auto). A list shall be submitted for review and approval.

C. Pilot lights shall be high intensity LED type. Pilot lights shall have clear lenses and LED lamps colored as shown on the Drawings. Common, remote push-to-test circuitry shall be provided for each control panel to simultaneously test all indicating lights on the panel using a single pushbutton when there are 10 or more lights on the panel. Control panels with less than 10 lights shall utilize individual push-to-test lights and control circuitry.

D. Pushbuttons shall be maintained or momentary as required and as shown on the Drawings. Provide extended head pushbutton for all stop functions, mushroom head for emergency stop functions, and flush head pushbuttons for all other functions. Where indicated on the Drawings pushbuttons shall be illuminated type. Provide locking mechanism for all lock out functions. Selector switches shall have black knob operator, be maintained contact type unless noted otherwise, number and arrangement as required to perform intended functions specified but not less than one double pole, double throw, double break contact per switch. Contact rating shall be compatible with AC or DC

throughput current of devices simultaneously operated by the switch contact but not less than 10 amperes resistive at 120 volts AC or DC continuous.

E. Potentiometers shall be provided with operators and resistive elements of the type and quantity indicated on the Drawings and as required with legend plates indicating percent of span.

F. The above devices shall be manufactured by Square D, Allen Bradley, General Electric, or equal.

2.02 RELAYS

A. TIMING RELAYS shall be heavy duty, have 250V/5A rated contacts, solid state design, poles as required per application, -10°C to +60°C, have timing repeatability of ±2.0% of setting, and be UL listed. The range shall be determined from the control descriptions and or schematic drawings. Provide mounting accessories, as required. The timing relays shall be manufactured by Allen Bradley, Square D, Cutler Hammer, or equal.

B. CONTROL RELAYS shall be of the plug-in socket base type with dust-proof plastic enclosures, with silver-cadmium oxide contacts rated 250-volt, 10 amperes, with contact arrangement and operating coils of the proper voltage as required by the control circuit sequence. Relays shall have indicating lamp to show energized state. Each relay shall have a minimum of two double pole, double throw contacts, or as required. Control relays shall be Allen Bradley, Square D, Cutler Hammer, or equal.

C. ALTERNATING RELAYS shall be UL listed, 120 VAC, with contacts rated for 10 amperes at 250 VAC, life expectancy of 100,000 operations, load indicating LEDs, and switch for load locking and load selecting options. Alternating relays shall be manufactured by TimeMark models 261, 271, and 471, Diversified Electronics model ARA, A.T.C. model “AR”, or equal.

2.03 WIREWAYS

A. WIREWAYS shall be PVC, snap-in slot design, with non-slip cover. Safe area wireways shall be light gray and marked “Safe Area Wiring.” Hazardous area wireways shall be intrinsic blue and marked “Hazardous Area Wiring.” The wireways shall be manufactured by Panduit Corporation, or equal.

2.04 WATTHOUR TRANSDUCERS

A. WATTHOUR TRANSDUCERS for active or reactive power shall be DIN rail and surface mount, single phase or three phase with balanced or unbalanced load, electrically isolated input and output signals, 4 to 20 mA output signal, 0-10 mA to 0-10 A input current, 0-10 V to 0-600 VAC input voltage, 16-500 Hz selectable frequency. The watthour transducers shall be manufactured by Sineax model PQ502, or equal.

2.05 ELAPSED TIME METERS AND TIME CLOCKS

A. ELAPSED TIME METERS shall be self powered, non-reset, solid state counter which provides silent, accurate and noise immune operation. Elapsed time meters shall require no external power, five year minimum battery life, 120 VAC power, accessories for panel mounting, nameplate below LCD display reading “HOURS”, liquid crystal display with 6 digits approximately 2 inches high with 50,000 hour minimum display life and indication of sufficient battery power. The elapsed time meters shall be manufactured by Durant, Automatic Timing and Controls a Division of Sycon Corp., or equal.

B. TIME CLOCKS shall be microprocessor based, have 24 hour time control, up to 24 operations per day, programmable from panel face keys, skip-a-day feature allowing schedule to be skipped for one to seven days, SPDT switch contact rated at 15 amps at 120 V AC, with battery carryover to maintain time and program during power outage for 275 hours. The time clocks shall be manufactured by Tork, Paragon Electric Company, or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Fasteners shall be type 304 stainless steel.

B. Install devices in strict accordance with NEC requirements and per manufacturers recommendation.

C. Coordinate with other trades as necessary during installation of these devices.

3.02 ACCEPTANCE

A. All installations are subject to evaluation in accordance with NEC requirements and manufacturers recommendations. Contractor shall remove the unacceptable work and correct work at no charge to Owner.

End of Section

SECTION 16920

ELECTRICAL ACCEPTANCE TESTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes
   1. Requirements for electrical acceptance testing of electrical equipment and materials.
   2. It is the intent of the tests described herein to assure that all electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.
   3. Acceptance testing performed by equipment vendors at the point of manufacturer must conform to all requirements of this specification. Testing performed at the point of manufacture which conforms to generally accepted industry practices is also acceptable so long as adequate test result documentation is provided.

B. Scope
   1. All of the Acceptance Tests are required to be performed whether they are described in this Section or other applicable Sections. At a minimum, the following electrical systems are to be tested:
      a. Grounding and Bonding System
      b. Lighting Fixtures and associated controls
      c. Other systems as listed under Part 3 of this specification

C. Related Documents
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 1 Specification sections, apply to the work of this section.
   2. All work performed under this Section of the work is subject to all requirements contained under Section 16000 "General Electrical Requirements".
   3. All Division 16 specifications for electrical equipment provided for this project that requires electrical acceptance testing.

1.02 REFERENCES

A. NETA ATS – Acceptance Testing Specifications, 2003 Edition

B. NFPA 70 – National Electrical Code, 2002 Edition

C. Incorporated by reference all Codes, Standards, and Specifications referred to in the "APPLICABLE REFERENCES" section of NETA ATS-2003.

1.03 DEFINITIONS

A. NETA InterNational Electrical Testing Association Inc.

B. NEC National Electrical Code

1.04 SYSTEM DESCRIPTION

A. Conditions
   1. Provide all items, articles, materials, operations or methods listed, mentioned or scheduled on drawings and/or herein including all labor, materials, equipment and incidentals necessary and required for Electrical Acceptance Testing.
   2. Following established procedures, equipment shall be energized after certification by the testing organization that the installation is satisfactory.
   3. Correct or replace any current-carrying circuit, electrical equipment, or system which is defective or grounded and correct all other troubles encountered by these tests. All defects, whether through faulty workmanship or materials furnished, shall be corrected under this Section at the Contractors expense.

1.05 SUBMITTALS

A. Test Report Forms
   1. All test reports shall be submitted using NETA or approved similar format and, where appropriate, test forms. Reports shall be legible using permanent ink. Pencil is not acceptable.
   2. Provide for engineers review and approval a copy of each test form to be used on the project. No testing shall be started prior to approval of all test forms.
   3. All test reports shall include the following information:
      a. Summary/Description of the Project
      b. Description of equipment tested.
      c. Description of the tests.
      d. Test data and analysis of the data indicating whether the equipment passed or failed the test.
   4. All test data records shall include the following minimum requirements:
      a. Equipment identification including tag numbers.
      b. Humidity, temperature, and other conditions that may affect the results of the tests and/or calibrations.
      c. Date of inspections, tests, maintenance, and/or calibrations.
      d. Identification of the testing technician and their employer.
      e. Indication of inspections, tests, maintenance, and/or calibrations to be performed and recorded.
      f. Indication of expected results when calibrations are to be performed.
      g. Indication of “as-found” and “as-left” results, as applicable.
      h. Sufficient spaces to allow all results and comments to be indicated..

B. Closeout Submittals

1. Provide one copy each to engineer and owner of all testing reports organized as follows:
    a. Bind report in 3-ring binder(s).
    b. Identify project name, description, testing organizations name, and submittal date on front face and back cover of binder.
    c. Provide all test reports, organized by equipment tag number.
    d. Separate different equipment numbers with colored or numbered tabs.
    e. Provide an index/table of contents.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Any materials provided as part of the testing shall be new, unused, and in manufacturer's original packing.

2.02 TEST INSTRUMENT CALIBRATION

A. Contractor performing the testing shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy for each test instrument calibrated.

B. Contractor performing the testing shall maintain up-to-date instrument calibration instructions and procedures for each test instrument calibrated.

C. It is preferred that instrument calibration accuracy be directly traceable to the national Institute of Standards and Technology (NIST).

D. Dated calibration labels shall be visible on all test equipment.

E. Records, which show date and results of instruments calibrated or tested, must be kept up to date.

F. Calibrating standard shall be better accuracy than that of the instrument tested.

PART 3 - EXECUTION

3.01 QUALIFICATIONS

A. It is preferred that the testing organization shall be an independent, third party entity which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems being evaluated. When such testing organization is used, it must meet the following requirements:
    1. The testing organization shall be regularly engaged in the testing of electrical equipment, devices, installations, and systems.

2. The testing organization shall use technicians who are regularly employed for testing purposes.
3. The testing organization shall be a member of NETA or be able to prove qualifications equal to or better than required for membership in NETA.
4. Submit appropriate documentation demonstrating that the testing organization meets the requirements listed above.
5. Technicians performing these electrical tests and inspections shall be trained and experienced concerning the apparatus and systems being evaluated. These individuals shall be capable of conducting the tests in a safe manner and with complete knowledge of the hazards involved. They must evaluate the test data and make a judgment on the serviceability of the specific equipment.
6. Technicians shall be certified in accordance with ANSI/NETA ETT-2000, "Standard for Certification of Electrical Testing Personnel". Each on-site crew leader shall hold a current certification, Level III or higher, in electrical testing.

B. Contractor may perform the electrical acceptance testing under the following conditions:
1. Contractor's personnel performing the testing and their testing equipment meets all other requirements of this specification.
2. Written approval is received from engineer after review of testing personnel qualifications. At a minimum, contractor's testing personnel must have specific instruction on the testing instruments, accessories, and tests being performed and must be able to evaluate the test results.

3.02 NOTIFICATION

A. Notify engineer and construction manager at least 2 days prior to testing so that they may be present during testing.

3.03 SAFETY AND PRECAUTIONS

A. Safety practices shall include, but are not limited to, the following requirements:
1. Occupational Safety and Health Act OSHA
2. Accident Prevention Manual for Industrial Operations, National Safety Council, Chapter 4
3. Applicable State and Local safety operating procedures
4. NETA Safety/Accident Prevention Program
5. National Fire Protection Association –NFPA 70E
6. ANSI Z244.1 American National Standards for Personnel Protection

B. All tests shall be performed with apparatus de-energized except where otherwise specifically specified.

C. The testing firm shall have a designated safety representative on the project to supervise operations with respect to safety.

3.04 EQUIPMENT TESTING REQUIREMENTS

A. The intent of this specification is not to duplicate testing performed at the point of manufacture or to impose additional burden on the contractor which does not benefit the project. The intent is to verify that electrical equipment has been securely fastened down, supported, and installed in accordance with the manufacturer's requirements. The intent is also to verify that all electrical connections are correctly torqued, properly aligned, properly insulated, and properly supported and that equipment is clean and ready for operation.

B. Except as noted below or as approved by engineer, test the following equipment and assemblies in full accordance with NETA-ATS 2003.

C. Circuit Breakers, Air, Insulated-Case, Molded-Case
   1. Perform visual and mechanical inspections in accordance with NETA for all circuit breakers.
   2. Perform electrical tests only on circuit breakers rated 100 amps or higher provided in power distribution and lighting/receptacle panelboards.
   3. No testing is required for circuit breakers provided as part of any of the following:
      a. A UL listed control panel.
      b. UL listed factory supplied motor control centers.
      c. Stand-alone combination motor starters.

D. Grounding Systems

E. Panelboards

3.05 CONSTRUCTION

A. Interface with Other Work
   1. Coordinate all testing activities with other disciplines. Retest any equipment disturbed or damaged in any manner after initial testing.

3.06 CLOSEOUT REPORT

A. Provide comprehensive bound test report in accordance with Part 1 of this specification.

End of Section