

NTUA - Iyanbito Lift Station Design and Construction

Project Specifications

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202 E. Earll Drive Suite 110
Phoenix, AZ 86012
T. (602) 629-0206
F. (602) 629-0223

TABLE OF CONTENTS

SPECIFICATIONS

DIVISION 1 - GENERAL REQUIREMENTS

01030	SUMMARY OF WORK
01040	ORDER OF CONSTRUCTION
01060	SPECIAL CONDITIONS
01072	PROJECT RECORD DOCUMENTS
01200	MOBILIZATION/ DEMOBILIZATION
01210	CONTINGENCY ALLOWANCES
01330	SUBMITTALS
01331	REFERENCE FORMS
01350	SPECIAL PROCEDURES
01420	DEFINITIONS AND STANDARDS
01423	REFERENCE STANDARDS
01450	MEASUREMENTS AND PAYMENTS
01560	ENVIRONMENTAL PROTECTION AND SPECIAL CONTROLS
01600	PRODUCT DELIVERY, STORAGE AND HANDLING
01610	REGULATORY REQUIREMENTS
01631	SUBSTITUTIONS
01715	EQUIPMENT OPERATION AND MAINTENANCE INSTRUCTIONS
01770	CLOSEOUT PROCEDURES

DIVISION 2 - SITEWORK

02072	DEMOLITION, CUTTING AND PATCHING
02100	CLEARING AND GRUBBING
02110	REMOVAL OF EXISTING EQUIPMENT
02200	EARTHWORK
02600	SUBGRADE PREPARATION

DIVISION 3 - CONCRETE

03100	CONCRETE WORK
03200	CONCRETE REINFORCEMENT
03300	CAST-IN-PLACE CONCRETE
03301	EPOXIES
03356	TOOLED CONCRETE FINISHES
03600	GROUT

DIVISION 5 - METALS

05052 ANCHOR BOLTS, TOGGLE BOLTS AND CONCRETE INSERTS
05500 METAL FABRICATIONS
05501 MISCELLANEOUS METALS

DIVISION 9 - FINISHES

09900 PROTECTIVE COATINGS

DIVISION 11 - EQUIPMENT

11005 GENERAL REQUIREMENTS
11210 PUMPING EQUIPMENT: GENERAL STATEMENT
11227 SUBMERSIBLE NON-CLOG PUMPS

DIVISION 15 - MECHANICAL

15050 BASIC PROCESS PIPING MATERIALS AND METHODS
15062 DUCTILE IRON PIPING
15110 VALVES
15111 BALL VALVES
15114 CHECK VALVES
15116 ECCENTRIC PLUG VALVES, OPERATIONS AND APPURETENANCES
15141 MECHANICAL - PROCESS PIPE SUPPORTS

DIVISION 16 - ELECTRICAL

16000 GENERAL ELECTRICAL REQUIREMENTS
16010 ELECTRICAL- BASIC REQUIREMENTS
16050 BASIC MATERIALS AND METHODS
16060 ELECTRICAL DEMOLITION
16111 CONDUITS
16123 600 VOLT CLASS CABLE
16124 INSTRUMENTATION CLASS CABLE
16130 OUTLET, PULL, AND JUNCTION BOXES
16141 WIRING DEVICES
16142 WEATHERPROOF WHILE IN USE OUTLET ENCLOSURES
16160 ENCLOSURES
16170 GROUNDING
16190 SUPPORTING DEVICES
16195 ELECTRICAL IDENTIFICATION
16470 PANELBOARDS
16500 LIGHTING
16505 SURGE PROTECTIVE DEVICEDS

16920 ELECTRICAL ACCEPTANCE TESTING

DIVISION 17 - INSTRUMENTATION AND CONTROLS

17000 INSTRUMENTATION

17052 RADAR LEVEL TRANSMITTER

17111 FLOAT SWITCHES

DIVISION 1

GENERAL REQUIREMENTS

SECTION 01030

SUMMARY OF WORK

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Identification and summary description of the Project, the Work, location, OWNER furnished equipment, Work by OWNER, activities by others, and coordination.
- B. The Project consists of the renovation of the wastewater lift station facility at the Iyanbito site that includes a pump improvements and supporting equipment. Specific elements include new submersible pumps, canopy, electrical float sensors, fall protection, and replacements of concrete slab and chain link fence.

1.02 LOCATION OF PROJECT

- A. The Project is located at the following address: 35°29'54.5"N 108°28'48.9"W.

1.03 WORK BY THE OWNER

- A. Concurrent to this Project, the OWNER will:
 - 1. Provide site access.
 - 2. Coordinate startup and shutdown of facilities.

1.04 ACTIVITIES BY OTHERS

- A. OWNER, utilities, and others may perform activities within Project area while the Work is in progress:
 - 1. Schedule the Work with OWNER, utilities, and others to minimize mutual interference.
- B. Cooperate with others to minimize interference and delays:
 - 1. When cooperation fails, submit recommendations and perform Work in coordination with work of others as directed.
 - 2. When the Work depends for proper execution or results upon work performed by others, inspect and promptly report apparent discrepancies or defects in work performed by others.
 - 3. Assume responsibility for work performed by others, except for defects reported as specified in this paragraph and defects which may become apparent in work performed by others after execution of the Work.

1.05 OPERATION OF EXISTING FACILITIES

- A. There are existing operational facilities at this site. The existing propane tank and . All work must be scheduled with the OWNER to avoid interference with existing facilities. Refer to

Section 01040 for additional requirements:

1. Provide temporary facilities and make temporary modifications as necessary to keep the existing facilities in operation during the construction period.
 2. Any damage to existing property/equipment must be replaced to original working conditions.
 3. All relocations of existing piping shall be completed first before other construction activities.
- B. OWNER's vendors will be making deliveries and pickup of the following through- out construction. Contractor to facilitate access.

1.06 COORDINATION OF WORK

- A. Maintain overall coordination of the Work:
1. As more fully set forth in the General Conditions, CONTRACTOR shall be solely responsible for coordination of all of the work. 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.
 2. As more fully set forth in the General conditions, CONTRACTOR shall cooperate with and coordinate work with the work of any other contractors, utility service companies or OWNER's employees performing additional work related to the Project site.
 3. CONTRACTOR shall coordinate work with the work of others to assure compliance with schedules.
 4. CONTRACTOR shall attend and participate in all project coordination or progress meetings and report on the progress of all work and compliance with construction schedule.

1.07 POTABLE WATER SUPPLY PROTECTION

- A. All materials of construction which may come into contact with drinking water shall conform to NSF International Standards 60 and 61.

1.08 PERMITS

- A. CONTRACTOR shall include the cost for and obtain all construction related permits, except permits described in Paragraph 1.08.B. These permits include, but are not limited to:
1. Necessary permits for discharge of hydrostatic test water and chlorinated water used to disinfect piping and equipment.
 2. All requirements of the National Pollutant Discharge Elimination System (NPDES) and obtain NPDES permit for construction operations
 3. **Water use permit with Navajo Nation water Resources for construction water.**
- B. OWNER will pay for and provide the following permits to the CONTRACTOR

1.09 CONTRACTOR'S USE OF PREMISES

- A. CONTRACTOR shall limit his use of the premises for Work and storage, and allow for

work by other contractors/subcontractors. For CONTRACTOR staging areas:

1. See Drawings for two staging areas.
2. CONTRACTOR shall provide temporary fencing, and restore the ground surface to pre-construction conditions when staging areas are no longer needed.

- B. CONTRACTOR assumes full responsibility for the protection and safekeeping of products and materials CONTRACTOR has stored on the site.
- C. CONTRACTOR shall move any stored products, or materials, under CONTRACTOR's responsibility, which interfere with operations of OWNER and separate contractors/subcontractors.
- D. CONTRACTOR shall obtain and pay for the use of any additional storage or work areas if needed for CONTRACTOR's operations.
- E. CONTRACTOR shall restore any areas used for materials storage, equipment storage, or employee and subcontractor parking to their original condition or better, unless specified otherwise.

1.10 MAINTENANCE OF TRAFFIC

- A. Conduct Work to interfere as little as possible with public travel, whether vehicular or pedestrian.

1.11 WORK ON PRIVATE PROPERTY

1. CONTRACTOR shall work within the NTUA Right of way of the facility.

1.12 CONTRACT MODIFICATIONS

- A. Invitation to Bids, Article III, Part B, Article 3.38 - Plans and Shop Drawings, Samples and Substitution of Materials; delete the first sentence. Submittal process shall be per Section 01340.

1.13 REFERENCE DOCUMENTS

- A. The following documents were referred to during the design phase:
 1. 100% Approved Design Drawings
- B. The documents indicated in Article 1.14.A are available as pdfs at no cost.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

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 184 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 Lift Station System Components	60
Complete site grading and backfill and related concrete work and perimeter fencing.	90
Complete Installation of Equipment and Piping	120
Complete Electrical and Instrumentation and Control Wiring, and remainder of site work	150
Initiate Commissioning of Lift Station Facility	180

- 1. CONTRACTOR shall include sufficient and complete overhead costs in base Bid for a 184 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 184 calendar days:
 - a. No credit or refund will be given to CONTRACTOR if the work is substantially completed sooner than 184 calendar days.
- B. Tie-ins shall be coordinated with the OWNER and shall be scheduled as to minimize the disruption of services:
 - 1. Thirty calendar days before start of tie-ins between new and existing facilities and shutdown of facilities, CONTRACTOR shall provide a written proposed

- maintenance of plant operation (MOPO) for tie-in activities and shutdowns for review by the OWNER.
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 and install gates and fence repair, backfill and rough grading.
 2. Install pump around port and manhole
 3. Install concrete slabs around lift station and Generator.
 4. Repair and trouble shoot Generator
 5. Install electrical conduit, concrete slab and Canopy.
 6. Install hoist, lift station pumps, railing system, and discharge piping.
 7. Perform final site grading and Aggregate Base Course Material.
 8. Install electrical floats/radar and instrumentation and controls wiring.
 9. Conduct point to point and loop check for instrumentation and controls.
 10. Work with ENGINEER to conduct commissioning. Conduct training of OWNER'S staff.
 11. Complete remaining work and punchlist items.
 12. Clean facilities.

END OF SECTION

SECTION 01060

SPECIAL CONDITIONS

PART 1 - GENERAL

1.01 SITE MAINTENANCE AND TEMPORARY FACILITIES

- A. Maintain in good repair temporary structures, fences, barricades and related items.
- B. Keep site clean of debris. Store and stockpile materials in an orderly manner and protect against damage.

1.02 TESTING

- A. Except as set out in other sections of Contract Documents, payment for testing is as follows:
 - 1. Soils, masonry, asphaltic concrete pavement, rebar, and concrete testing: The CONTRACTOR shall retain a materials testing firm for soils, masonry, asphaltic concrete pavement, rebar, and concrete testing on the Project, and include the cost of sampling and testing in Bid. Cost of corrective action, costs of “failing” tests, and cost of testing associated with establishment of mix designs are the sole responsibility of the CONTRACTOR.
 - 2. Flush and perform hydrostatic leak test of all piping that is replaced prior to placing into service. Testing is per Section 15050. Leak test to be coordinated with OWNER and ENGINEER a minimum of 48 hours in advance. OWNER or ENGINEER to witness leak test.

1.03 PROJECT MEETINGS

- A. The OWNER/ENGINEER shall conduct a preconstruction conference and progress meetings involving:
 - 1. CONTRACTOR’s Project Manager.
 - 2. CONTRACTOR’s Project Superintendent.
 - 3. OWNER’s designated Representative(s).
 - 4. ENGINEER’s designated Representative(s).
 - 5. CONTRACTOR’s Subcontractors as appropriate to the work in progress.
- B. Progress meetings will be held bi-weekly at a location designated by OWNER.
- C. The ENGINEER shall take meeting minutes and distribute copies of meeting minutes to the designated recipients. Corrections, additions or deletions to the minutes shall be noted and distributed as required.
- D. The CONTRACTOR shall have available at each meeting up-to-date red line as-built drawings.

1.04 SPECIAL CONSIDERATIONS

- A. CONTRACTOR shall be responsible for negotiations of any waivers or alternate arrangements required to enable transportation of materials to the site.

1.05 CONSTRUCTION SCHEDULE AND WORK HOURS

- A. The CONTRACTOR shall prepare a construction schedule:
 - 1. The CONTRACTOR shall submit a complete computer software generated critical path method schedule (CPM) to the OWNER at the pre-construction meeting (Primavera or approved equal). This schedule shall include a complete critical path schedule to cover the CONTRACTOR's anticipated time schedule.
 - 2. The schedule shall include a detailed network diagram acceptable to the OWNER with the following features:
 - a. The schedule shall be time-scaled in calendar days.
 - b. The schedule shall show the order and interdependence of activities and the sequence of work as reflected in the schedule report as described below. The critical activities shall be prominently distinguished.
 - c. The schedule shall include, in addition to all construction activities, such tasks as mobilization and demobilization, submittal and approval of samples of materials and shop drawings, procurement of significant materials and equipment, fabrication of special items, installation, startup, commissioning, site work, cleanup, and interfacing with other projects/contractors/utility companies, etc.
 - d. The schedule diagram shall be organized and described as to conform to the schedule of values.
 - e. The diagram shall be accompanied by a schedule report of the network with a tabulation of the following data for each activity:
 - 1) preceding and following event numbers
 - 2) activity description
 - 3) activity duration
 - 4) earliest start date
 - 5) earliest finish date
 - 6) latest start date
 - 7) latest finish date
 - 8) total float time
 - 9) responsibility for activity (for example, CONTRACTOR, subcontractor, supplier, etc.)
 - 3. The CONTRACTOR shall provide updated schedules and reports every month commencing from notice to proceed in conformation with the following:
 - a. The OWNER or ENGINEER shall determine if the detailed network diagram and/or report requires revision in whole or in part, and shall so inform the CONTRACTOR of noncompliance with Contract schedule within 5 calendar days.

- b. The report shall show the activities or portion of activities completed during the one month period and the portion completed on the project to date; actual start and finish dates shall be shown plus future activities for the next four week period.
 - c. The report shall state the percentage of revenue actually earned as of the report date.
 - d. The report shall be accompanied by a narrative description of progress, problem areas, and current and anticipated delaying factors and their anticipated effect, and any correction actions proposed or taken. This report shall identify departures from earlier schedules or changes in logical sequence or logical ties.
 - e. The report shall include a summary of all activities scheduled to begin in the next four week period that are critical path, those activities whose float had changed and those activities with less than the ten day float. The activities shall be sequenced by critical path activities, by least total float and by greatest float respectively.
 - f. The CONTRACTOR shall use computer generated critical path scheduling software.
- 4. At each progress meeting the CONTRACTOR shall provide a two week look ahead schedule.
- 5. Acceptance of the CONTRACTOR's schedule by the OWNER is not to be construed as relieving the CONTRACTOR of its obligation to complete the Contract work within the Contract time.
- B. The CONTRACTOR shall plan construction activities between normal work hours (6:00 a.m. to 6:00 p.m.) Monday through Friday excluding National holidays:
 - 1. Work hours outside these hours including Saturday may be permissible provided a construction schedule has been prepared, submitted to, and found acceptable to the OWNER. Work hours on Saturday shall be between 7:00 am to 6:00 pm.
 - 2. The schedule shall identify the Work to be performed, including the location and duration of planned activities.
 - 3. Submittals shall be made a minimum of seven days prior to the planned work to allow sufficient time for the OWNER and to review the request and schedule any necessary inspections.
 - 4. The CONTRACTOR shall be responsible for payment for all overtime and off-hours inspection for ENGINEER and testing that occur outside the normal and expected working hours indicated above.

1.06 SITE SECURITY

- A. CONTRACTOR shall store small equipment and tools in secure, locked storage containers at the end of the work day.
- B. CONTRACTOR assumes all risk associated with leaving construction materials, tools, vehicles, and equipment on site. OWNER is not liable for any damages or theft.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01072

PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Prepare and maintain record documents for the project to accurately reflect the construction work as built. The record documents must be submitted at completion of the construction work as a condition of final acceptance of the Work by the OWNER.

1.02 MAINTENANCE OF RECORD DOCUMENTS

- A. The CONTRACTOR shall maintain at the project site one copy each of the following record documents:
 - 1. Contract Drawings.
 - 2. Specifications.
 - 3. Design addenda.
 - 4. Reviewed shop drawings.
 - 5. Contract Change Orders and field orders.
 - 6. Supplemental drawings and written material provided by the ENGINEER to clarify the Contract Documents.
 - 7. Other contract modifications.
 - 8. Approved samples and/or sample results.
- B. The CONTRACTOR shall store the project record documents in an approved location apart from other documents. Record documents are not to be used for construction purposes. The CONTRACTOR shall provide files and racks as needed for orderly storage of the documents, maintain the documents in clean, dry, legible condition, and make the documents and samples available at all times for inspection by the ENGINEER.

1.03 MARKING DEVICES

- A. Mark all changes with red pencil or pen.

1.04 RECORDING

- A. The CONTRACTOR shall keep the record documents current with construction in progress. Completed construction work shall not be permanently concealed until required information has been recorded.
- B. The CONTRACTOR shall provide a rubber stamp for use in marking all project

record documents. The stamp shall have a line border of approximately 4" x 1" with the words "PROJECT RECORD" printed inside the border.

- C. The CONTRACTOR shall neatly stamp, in red, each record document "PROJECT RECORD", and legibly mark the Contract Drawings to record actual construction deviations as follows:
 - 1. Horizontal and vertical location of underground utilities and appurtenances referenced to permanent surface improvements.
 - 2. Field changes of dimension and detail.
 - 3. Changes made by design addenda, change order or field order.
 - 4. Details not on original Contract Drawings.
- D. The red line as-builts shall also include buried conduit in yard.

1.05 SUBMITTAL

- A. Red line record drawings shall be available for review by the ENGINEER whenever an application for a monthly progress payment is made. The partial record drawings shall be up-to-date through the end of the progress payment application period.
- B. At completion of construction, and prior to the final inspection and final acceptance of the project by the OWNER, the CONTRACTOR shall deliver the project record documents to the ENGINEER bound into rolls of convenient size for ease of handling and properly labeled.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01200

MOBILIZATION/DEMOBILIZATION

PART 1 - GENERAL

1.1 Description

A. Description of Work

The work to be performed in accordance with this section includes the movement of personnel, equipment, supplies, and incidentals to the project site; for the establishment of offices, buildings and other facilities necessary for work on the project; for premiums on bonds and insurance for the project and for all other work and operations which must be performed or costs incurred before beginning work on the various contract items.

Demobilization at the end of the job includes removal of tools, materials, equipment and facilities used by the CONTRACTOR during construction of the project. Also included is final cleanup to leave the site with a neat, clean appearance.

PART 2 - MATERIALS

2.1 General

Materials shall consist of equipment, buildings, and tools necessary to move to the project site to perform work. Material for bid items shall not be included in Mobilization.

PART 3 - EXECUTION

3.1 General

Setting up of offices, and the use of private property for storage or work area shall be executed in a legal manner in accordance with local and state codes and ordinances.

Use of private property will require a signed agreement with the property owner, and shall be submitted to Engineer for approval prior to use. Sign off from property owner regarding restored property conditions will be required prior to project closeout.

PART 4 - MEASUREMENT AND PAYMENT

SECTION 01210

CONTINGENCY ALLOWANCES

PART 1 – GENERAL

1.01 SUMMARY

- A. This Section includes administrative and procedural requirements governing allowances.

1.02 CONTINGENCY ALLOWANCES

- A. Allowances are stipulated amounts available as a reserve for sole use by OWNER.
- B. When OWNER authorizes use of funds from the allowances, submit Change Order request to ENGINEER. Prepare Change Order request in accordance with the provisions of the General Conditions.
- C. The bond, taxes, and insurance amounts for the total allowance amount shall be included in the respective allowances.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 ALLOWANCES

- A. OWNER'S Contingency:
 - 1. Include a contingency allowance for miscellaneous construction in accordance with OWNER's instructions.

END OF SECTION

SECTION 01300

FORCE ACCOUNT

PART 1 - GENERAL

1.1 Description of Work

The work to be performed in accordance with this section includes additional work that is outside the general scope of the proposed project. The work to be performed shall be specifically requested in writing by the OWNER or the ENGINEER. As the project is completed, it is anticipated that the OWNER may request additional work to be performed that currently is not a part of this Contract and it is the intent that the requested work shall be performed in accordance with this section.

PART 2 - MATERIALS

2.1 General

Any materials utilized under this Section shall conform specifically with the appropriate Materials Section of these Specifications unless the OWNER specifically requests in writing a deviation from the Specifications. If the materials are not covered by an appropriate Specification of this document, then the OWNER will provide a written specification for the materials requested.

PART 3 - EXECUTION

3.1 Workmanship

Furnish all materials, equipment and labor required to complete the work. All workmanship shall meet or exceed the appropriate Specifications included in this document or any supplemental Specifications that may be provided. Perform work in accordance with the contract Plans or in accordance with any supplemental plans that may be provided by the OWNER.

PART 4 - MEASUREMENT AND PAYMENT

4.1 Measurement

The method of measurement shall be in accordance with the appropriate specification or as included in specific written instructions from the OWNER or the

ENGINEER.

4.2 Payment

Payment for work performed under this section shall be made for those items specifically requested in writing by the OWNER. The value of any work performed in this Section shall be determined by one or more of the following methods in the order of precedence listed below.

A. Unit prices previously approved.

B. An agreed upon price.

The amount specified for Force Account in the Bid Documents is an estimate that is provided so each potential bidder has an equal opportunity in the bidding. The amount does not in any way represent what work may be requested or the quantity or value of the work. The CONTRACTOR shall only be compensated for the actual work requested and performed.

See Section 00310 Bid Schedule for Bid Items.

END OF SECTION

SECTION 01320

PROJECT MEETINGS, SCHEDULES, AND REPORTS

PART 1 - GENERAL

1.1 Summary

This Section includes the following administrative and procedural requirements:

A. Project Meetings

1. Preconstruction conference.
2. Progress/Coordination meetings.

B. Schedules and Reports

1. Initial Project schedules.
2. Weekly Construction progress schedule.
3. Procurement schedule.
4. Construction progress reports.
5. Schedule of values.
6. Special reports.
7. Quality Control Testing Plan and Reports.
8. Health and Safety Plan.

C. Related Work Specified Elsewhere

Submittals.....Section 01330

1.2 Project Meetings

A. Preconstruction Conference

1. Engineer will conduct a meeting as described in Section 800, Special Provisions, Paragraph 4.0, to review items stated in the following agenda and to establish a working understanding between the parties as to their relationships during performance of the Work.
2. Preconstruction conference shall be attended by the following.
 - a. Contractor and his superintendent
 - b. Engineer/Owner
 - c. Utilities
 - d. City Departments
 - e. Representatives of principal Subcontractors and Suppliers.

3. Meeting Agenda

- a. Construction schedules.
- b. Critical Work sequencing plan/Baseline schedule with milestones
- c. Designation of responsible personnel
- d. Project coordination.
- e. Procedures and Processing of:
 - (1) Field decisions.
 - (2) Substitutions.
 - (3) Submittals.
 - (4) Change Orders.
 - (5) Applications for Payment.
- f. Procedures for testing.
- g. Procedures for maintaining record documents.
- h. Use of Premises:
 - (1) Office, work, and storage areas.
 - (2) Owner's requirements.
- i. Construction facilities, controls, and construction aids.
- j. Temporary utilities.
- k. Safety and first-aid.
- l. Security.

4. Location of Meeting: To Be Determined.

5. Reporting:

- a. Within 5 working days after the meeting, Engineer will prepare and distribute minutes of the meeting to Owner and Contractor.
- b. Contractor shall provide copies to Subcontractors and major Suppliers.

B. Coordination Schedules

- 1. Engineer will conduct a meeting at least 10 days before submission of the first Application for Payment to finalize the initial coordination schedules requested under ARTICLE 1.3 this Section.
- 2. The meeting shall be attended by:
 - a. Contractor and his superintendent.
 - b. Representatives of principal Subcontractors and Suppliers.

Engineer

C. Progress Meetings

1. Engineer will schedule and conduct a weekly meeting, and as necessary, as determined by the Engineer. Representatives of the Owner, Engineer, and Contractor shall be present at each meeting. With Engineer's concurrence, Contractor may request attendance by representatives of Subcontractors, Suppliers, or other entities concerned with the Project or involved with planning, coordination, or performance of future activities. All participants in the meeting shall be familiar with the Project and authorized to conclude matters relating to the Work.
2. Contractor and each Subcontractor represented shall be prepared to discuss the current construction progress report and any anticipated future changes to the schedule. Each Subcontractor shall comment on the schedules of Contractor and other Subcontractors and advise if their current progress or anticipated activities are compatible with the proposed Work.
3. Contractor shall be responsible for addressing any issues with subcontractors, and provide directions as are necessary to resolve the situation and promote construction progress.
4. Meeting Agenda:
 - a. Review of construction progress since previous meeting.
 - b. Field observations, interface requirements, conflicts.
 - c. Problems which impede construction schedule.
 - d. Off-site fabrication.
 - e. Delivery schedules.
 - f. Submittal schedules and status.
 - g. Site use and responsibilities.
 - h. Temporary facilities and services.
 - i. Hours of Work.
 - j. Hazards/Safety.
 - k. Housekeeping.
 - l. Quality and Work standards.
 - m. Change Orders.
 - n. Documentation of information for payment requests.
 - o. Corrective measures and procedures to regain construction schedule if necessary.
 - p. Revisions to construction schedule.
 - q. Review of proposed activities for succeeding Work period.
 - r. Review proposed Contract modifications for:
 - (1) Effect on construction schedule and on completion date.
 - (2) Effect on other contracts of the Project.
 - s. Other business.
5. Location of Meetings: Meeting shall be held at the office of the Owner, unless otherwise approved.
6. Reporting:

- a. Within 5 working days after each meeting, Engineer will prepare and distribute minutes of the meeting to Contractor. Contractor shall distribute copies to principal subcontractors and Suppliers.

1.3 Schedules and Reports

A. Initial Coordination Schedules

1. Within 10 days after the Effective Date of the Agreement, Contractor shall submit to Engineer for review and acceptance:
 - a. A preliminary procurement schedule of Equipment and Materials.
 - b. A preliminary schedule of values for partial pay purposes.
 - c. A preliminary schedule of Submittals, as stated in Section 01330.
 - d. Preliminary cash requirement prediction.

B. Baseline Construction Schedule

1. Within 20 days after issuance of Notice of Award of the Contract, Contractor shall submit to Engineer for review and acceptance a detailed baseline construction schedule employing the critical path scheduling method.
 - a. The schedule shall show the Work in a horizontal bar chart, and indicate the start date, duration, and end date for each activity.
 - b. The Contractor shall submit to the Engineer, 1 electronic copy in approved format for review. Sheet size shall be a minimum 11 x 17-inches.
 - c. No single activity shall be more than 15 days in duration.
 - d. The Contractor shall include all work by Subcontractors in the baseline construction schedule.
 - e. The schedule shall be resourced base and include work breakdown structures.
 - f. Within each activity, indicate estimated completion percentage in 10% increments.
2. After the construction schedule is approved, the schedule shall serve as the Contractor's Baseline Schedule for all Work on the project. Activity ID's shall not be changed without the Engineer's written permission from this point forward. New activity ID's will be

allowed, but only for new work outside the original project baseline schedule activities.

3. If required by Engineer, the Contractor shall provide sub schedules to define in more detail, critical portions of the baseline schedule, including inspections and tests.
4. The Contractor shall coordinate the baseline construction progress schedule with the schedule of values, Submittal schedule, procurement schedule, progress reports, and payment requests.
5. The Contractor shall revise the construction baseline schedule after each meeting, event, or activity where revisions have been recognized and accepted in accordance with the GENERAL CONDITIONS.
6. The Contractor shall update and submit one (1) electronic copy in approved format of the revised schedule to the Engineer at least once each month to show actual progress compared to the originally accepted baseline construction schedule and any proposed changes in the schedule of remaining Work. The revised schedule shall be updated and submitted to the Engineer prior to each payment request. Engineer's approval for payment will not be recommended to be paid by the Owner until the monthly revised schedule is accepted by the Engineer. Include the schedule with construction progress report (See Section 1320.1.3.D).

C. Procurement Schedule

1. After submittal of preliminary procurement schedule as stated above under "Initial Coordination Schedules", submit a detailed schedule for procurement of Equipment and Materials to be furnished by Contractor, Subcontractors, manufacturers, and Suppliers. Do not include minor items which are known to be regularly stocked by local suppliers or readily available upon short notice. Submit to Engineer for review with the construction progress schedule.
2. Engineer will review and comment on the schedule for procurement. Contractor shall make all required revisions as specified, prior to acceptance of schedule.
3. Procurement schedule shall coincide with the construction progress schedule and the Submittal schedule, and shall indicate the date each item will be needed at the Site and the time required for delivery after order is placed.
4. Update the accepted schedule for procurement at least once each month to show the status of orders placed, Submittals, and delivery. Submit with the construction progress report.
5. If requested by Engineer, submit copies of purchase orders placed by Contractor or Subcontractors.

D. Construction Progress Reports

1. Submit a report on actual construction progress on a monthly basis. More frequent reports may be required should the Work fall behind the accepted schedule.
 - a. Submit a weekly report to coordinate with, and supplement the monthly construction progress report, and which details Work scheduled for the following one-week interval, including:
 - (1) Work activities which will occur.
 - (2) Number and size of crews.
 - (3) Construction equipment on Site.
 - (4) Major items of Equipment and Material to be installed.
 - (5) CONTRACTOR quality control testing update.
 - (6) Health and safety update.
 - b. Format shall be on 11 x 17- inch paper, submitted to Engineer in seven (7) copies.
2. Construction progress reports shall consist of the revised construction progress schedule and a narrative report which shall include but not be limited to the following:
 - a. Comparison of actual progress to planned progress shown on originally accepted schedule.
 - b. Summary of activities completed since the previous construction progress report.
 - c. Identification of problem areas and proposed corrective actions.
 - d. A description of current and anticipated delaying factors, if any.
 - e. Impact of possible delaying factors.
3. Submit a construction progress report to Engineer with each application for partial payment. Work reported complete but not readily apparent to Engineer must be substantiated with supporting data when requested by Engineer.
4. If a schedule update reveals that, through no fault of Owner, the Work is likely to be completed later than the Contract completion date, Contractor shall:
 - a. Establish a plan for making up lost time.
 - (1) Increase number of workers, or
 - (2) Increase amount or kinds of tools, or
 - (3) Work overtime or additional shifts, or
 - (4) A combination of the above actions.
 - b. Submit plan to Engineer before implementing the plan.
 - c. Take actions as accepted to get the Work back on schedule at no additional cost to Owner.

E. Schedule of Values

1. Submit as set forth in GENERAL CONDITIONS, based on the preliminary schedule of values.
2. Coordinate preparation of schedule of values with preparation and content of construction progress schedule.
3. Content
 - a. Schedule shall list the installed value of the component parts of the Work in sufficient detail to serve as a basis for computing values for progress payments during construction.
 - b. Follow the construction progress schedule breakdown of Work activities as format for listing component items and assigning values.
 - c. For each major line item, list sub values of major products or operations under the item.
 - (1) Each item shall include a directly proportional amount of the Contractor's overhead and profit.
 - (2) For items on which progress payments will be requested for stored materials received, but not installed, break down the value into:
 - (a) The cost of the materials delivered and unloaded, including taxes paid, unless taxes are exempted. Contractor shall provide a paid in full invoice.
 - (b) The total installed value.
 - d. The sum of all values listed in the schedule shall equal the total Contract Price.

F. Special Reports

1. When an event of an unusual and significant nature occurs at the site, prepare and submit a special report. List the chain of events, persons participating, response by Contractor's personnel, an evaluation of the results or effects, and similar pertinent information. Advise the Owner in advance when such events are known or predictable.
2. Submit original report to Engineer.

G. Quality Control Testing Plan and Reports

1. A Quality Control Testing Plan shall be developed by the CONTRACTOR and submitted to the ENGINEER no later than the Preconstruction Conference. The Plan will include the following items:
 - a. Qualifications of the proposed laboratory including laboratory accreditations and certifications for technicians

- proposed for the work.
- b. Test Frequency Table (one table for each specification section requiring CONTRACTOR quality control) establishing the proposed number of tests. The Table shall include columns for:
- (1) Material Tested
 - (2) Sampling and Testing Points
 - (3) Test Method
 - (4) Minimum Sampling Frequency
 - (5) Estimated Quantity of Materials
 - (6) Number of Tests Required
 - (7) The Table shall also include columns for number of tests complete and % of tests complete. These last two columns are for use in periodic reporting of QC testing to the ENGINEER.
2. The CONTRACTOR shall submit reports of Quality Control Testing to the ENGINEER at each Coordination Meeting. The report shall include all Quality Control test reports for testing completed during the prior week, and shall include updated Test Summary Tables. The Tables shall include updated values for cumulative number of tests completed and % of required number of tests completed. One Table shall be submitted for each specification item requiring CONTRACTOR quality control testing, and it shall be updated through the end of the prior week.

PART 2 - PRODUCTS -_Not Applicable.

PART 3 - EXECUTION - Not Applicable.

PART 4 - MEASUREMENT AND PAYMENT - Not Applicable.

END OF SECTION

SECTION 01325

CONSTRUCTION PHOTOGRAPHS

PART 1 - GENERAL

1.1 Summary

This Section specifies administrative and procedural requirements for construction photographs.

1.2 Submittals

- A. Provide a link to download the photographs specified in Section 01330, Submittals and in PART 3 - this Section.
- B. Photographer shall submit a digital sample set of the type and quality required during construction, for review and acceptance by Engineer.

1.3 Quality Assurance

- A. Contractor shall provide adequate photography to document conditions. Inadequate documentation not being able to prove responsibility for damages will hence cause the contractor to be responsible.

PART 2 - PRODUCTS

2.1 Photographic Requirements

Specified in PART 3, this Section.

PART 3 - EXECUTION

3.1 Project Site Photographs

- A. The CONTRACTOR shall be responsible for photographing the entire project site to show the existing and general condition of the site prior to construction. Each photograph must be time stamped with the date of the photograph. In addition, the CONTRACTOR shall take photographs before, during, and after each of the following phases of construction:

1. Site clearing
 2. Demolitions
 3. Excavations
 4. Installation
 5. Final completion
- B. Photographs shall be taken of the following areas and at the following times at a minimum.
1. Existing Site conditions before Site work is started. Number of views shall be adequate to cover the Site.
 2. Finished Project after completion of Work. Number of views shall be adequate to show the finished Work. It is particularly important to provide a view of the restoration of each property upon completion of construction.
 3. If Project is not completed during the Contract Time or authorized extensions, photographs shall continue to be taken at no increase in Contract Price.
- C. The principal reason for obtaining photographs is to document the existing condition of items not scheduled for replacement or items to be removed and replaced in kind such as landscaping, privacy walls, wash locations, etc., as may be necessary for the completion of the WORK. The photographs may, in some degree, preclude the possibility of post construction litigation between CONTRACTOR, adjacent property owners, and the OWNER.
- D. Digital Images
1. Submit one (1) complete set of digital image electronic files for each area of work prior to starting work.
 - a. Provide images in JPEG format, with minimum sensor size of 5.0 mega pixels.
 - b. Submit images that have same aspect ratio as the sensor, uncropped.
 - c. The photos of each residence and areas adjacent shall be labeled electronically on each photograph by address.
 - d. Any media submitted shall be labeled with Project name, area and street. Station and/or address shall be included as applicable.
 - e. Identify electronic media with date digital photographs were taken.
- E. Deliver to Engineer/Owner
- 1 PROPERTY PHOTOGRAPHS FOR WORK ON PRIVATE PROPERTY
 - a. Photographs shall be taken at each residential property in sufficient

detail to record the existing condition of the property and all existing improvements including trees, shrubs decorative rock and other ornamental or functional improvements. The photographs must be approved by the Engineer and Owner prior to any construction activities on the property. When taking property photos, the street name needs to be properly defined.

2 Additional Photographs

- a. From time to time Engineer/Owner may issue requests for additional photographs, in addition to periodic photographs specified
- b. Engineer will give the contractor notice, where feasible.
 - i. In emergency situations, the contractor shall take additional photographs within 24 hours of Engineer's request.
- c. Circumstances that could require additional photographs include, but are not limited to:
- d. Substantial Completion of major phase or component of Work.
 - i. Owner's request for special publicity photographs.
 - ii. Special events planned at Project Site.
 - iii. Immediate follow-up when on-site events result in construction damage or losses
 - iv. Special events planned at Project Site.
 - v. Photographs to be taken at fabrication locations away from Project Site.
 - vi. Extra record photographs at time of final acceptance

4 MEASUREMENT AND PAYMENT - Not Applicable.

END OF SECTION

SECTION 01330

SUBMITTALS

PART 1 - GENERAL

1.1 Summary

- A. This Section includes definitions, descriptions, transmittal, and review of Submittals.

- B. Related Work Specified Elsewhere:

Project Meetings, Schedules, and Reports	Section 01320
Construction Photographs	Section 01325
Equipment and Materials	Section 01600
Substitutions	Section 01631
Closeout Procedures	Section 01770

1.2 General Information

- A. Definitions

- 1. Shop Drawings, product data, and Samples are technical Submittals prepared by Contractor, Subcontractor, manufacturer, or Supplier and submitted by Contractor to Engineer as a basis for approval of the use of Equipment and Materials proposed for incorporation in the Work or needed to describe installation, operation, maintenance, or technical properties.
 - a. Shop Drawings include custom-prepared data of all types including drawings, diagrams, performance curves, material schedules, templates, instructions, and similar information not in standard printed form applicable to other projects.
 - b. Product data includes standard printed information on materials, products, and systems; not custom- prepared for this Project. Designation of selection for the specific item must highlight the proposed choice.
 - c. Samples include both fabricated and not fabricated physical examples of materials, products, and Work; both as complete units and as smaller portions of units of Work; either for limited visual inspection or (where indicated) for more detailed testing and analysis. Mock-ups are a special form of Samples, which are too large to be handled

in the specified manner for transmittal of Sample Submittals.

2. Informational Submittals are those technical reports, administrative Submittals, certificates, and guarantees not defined as Shop Drawings, product data, or Samples.
 - a. Technical reports include laboratory reports, tests, technical procedures, technical records, and Contractor's design analysis.
 - b. Administrative Submittals are those non-technical Submittals required by the Contract Documents or deemed necessary for administrative records. These Submittals include maintenance agreements, Bonds, Project photographs, physical work records, statements of applicability, and copies of industry standards, Project record data, security/protection/safety data, and similar type Submittals.
 - c. Certificates and guarantees are those Submittals on Equipment and Materials where a written certificate or guarantee from the manufacturer or Supplier is called for in the Specifications.
3. Refer to ARTICLES 1.3 and 1.4 of this Part for detailed lists of documents and specific requirements.

B. Quality Requirements

1. Submittals such as Shop Drawings and product data shall be of suitable quality for legibility and reproduction purposes. Every line, character, and letter shall be clearly legible. Drawings such as reproducible shall be useable for further reproduction to yield legible hard copy.
2. Documents submitted to Engineer that do not conform to specified requirements shall be subject to rejection by Engineer, and upon request by Engineer, Contractor shall resubmit conforming documents. If conforming Submittals cannot be obtained, such documents shall be retraced, redrawn, or photographically restored as may be necessary to meet such requirements. Contractor's (or his Subcontractor's) failure to initially satisfy the legibility quality requirements will not relieve Contractor (or his Subcontractors) from meeting the required schedule for Submittals.

C. Language and Dimensions

1. All words and dimensional units shall be in the English

- language.
2. Metric dimensional unit equivalents may be stated in addition to the English units. However, English units of measurement shall prevail.

D. Submittal Completeness

1. Submittals shall be complete with respect to dimensions, design criteria, materials of construction, and other information specified to enable Engineer to review the information effectively.
2. Where standard drawings are furnished which cover a number of variations of the general class of Equipment, each drawing must be annotated to indicate exactly which parts of the drawing apply to the Equipment being furnished. Use hatch marks to indicate variations that do not apply to the Submittal. The use of "highlighting markers" will not be an acceptable means of annotating Submittals. Annotation shall also include proper identification of the Submittal permanently attached to the drawing.
3. Reproductions or copies of Contract Drawings or portions thereof will not be accepted as complete fabrication or erection drawings.

1.3 Submittals

Contract Drawings for erection drawings to indicate information on erection or to identify detail drawing references. Whenever the Drawings are revised to show this additional Contractor information, Engineer's title block shall be replaced with a Contractor's title block, and Engineer's professional seal shall be removed from the drawing. The Contractor shall revise these erection drawings for subsequent Engineer revisions to the Contract Drawings.

A. Items shall include, but not be limited to, the following:

1. Manufacturer's specifications.
2. Catalogs, or parts thereof, of manufactured Equipment.
3. Shop fabrication and erection drawings.
4. Instruction books and operating manuals.
5. Material lists or schedules.
6. Performance tests on Equipment by manufacturers.
7. Concrete mix design information.
8. All drawings, catalogs or parts thereof, manufacturer's specifications and data, samples, instructions, and other information specified or necessary:
 - a. For Engineer to determine that the Equipment and Materials conform to the design concept and comply with the intent of the Contract Documents.
9. Equipment List.
10. Hourly rate for equipment and labor.

B. Schedule of Submittals

1. Schedule all submittals required prior to fabrication, manufacture, or installation, for submission within 14 calendar days of the Notice to Proceed. Prepare for Engineer's concurrence, a schedule for submission of all Submittals specified or necessary for Engineer's approval of the use of Equipment and Materials proposed for incorporation in the Work or needed for proper installation, operation, or maintenance. Submit the schedule with the procurement schedule and construction progress schedule. Schedule submission of all Submittals to permit review, fabrication, and delivery in time so as to not cause a delay in the Work of Contractor or his Subcontractors or any other contractors as described herein.
2. In establishing schedule for Submittals, allow 20 calendar days in Engineer's office for reviewing original Submittals and 5 calendar days in Engineer's office for reviewing resubmittals.
3. The schedule shall indicate the anticipated dates of original submission for each item and Engineer's approval thereof, and shall be based upon at least one resubmission of each item.
4. Schedule Submittals pertaining to storage, installation, and operation at the Site for Engineer's approval prior to delivery of the Equipment and Materials.
5. Submittals shall be resubmitted until the Engineer determines the submittals are acceptable. Any delay in the submittal acceptance, due to the submission of unacceptable submittals, does not warrant any extension of contract times.
6. Contractor shall provide submittals for the following items no later than 30 days after Notice to Proceed:
 - a) Bypass pump system
 - b) Pumps and motors
 - c) Flow meters
 - d) Valves 20" and larger
 - e) Emergency Generator
 - f) Transformer
 - g) Shade canopy
 - h) Electrical Switchgear
 - i) Work Plan for Existing Pump Station Shutdown and Connections

C. Transmittal of Submittals

1. All Submittals for Equipment and Materials furnished by Contractor, Subcontractors, manufacturers, and Suppliers shall be submitted to Engineer by Contractor.
2. After checking and verifying all field measurements, transmit all Submittals to Engineer for approval as follows:

- a. Mark each Submittal by Project name and number, Contract title and number, and the applicable Specification Section and Article number. Include in the letter of transmittal the Drawing number and title, sheet number (if applicable), revision number, and electronic filename (if applicable). Unidentifiable Submittals will be returned for proper identification.
- b. Check and include Contractor's approval for Submittals of Subcontractors, Suppliers, and manufacturers prior to transmitting them to Engineer. Contractor's approval shall constitute a representation to Owner and Engineer that Contractor has either, determined and verified all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data, or Contractor assumes full responsibility for doing so, and that Contractor has coordinated each Submittal with the requirements of the Work and the Contract Documents.
- c. At the time of each submission, call to the attention of Engineer in the letter of transmittal any deviations from the requirements of the Contract Documents.
- d. Make all modifications noted or indicated by Engineer and return revised Submittals until approved. Direct specific attention in writing, or on revised Submittals, to changes other than the modifications called for by Engineer on previous Submittals. After Submittals have been approved, submit copies thereof for final distribution. Previously approved Submittals transmitted for final distribution will not be further reviewed and are not to be revised. If errors are discovered during manufacture or fabrication, correct the Submittal and resubmit for review.
- e. Following completion of the Work, and prior to final payment, furnish record documents and approved Samples and Shop Drawings necessary to indicate "as constructed" conditions, including field modifications, in the number of copies specified. Furnish additional copies for insertion in Equipment instruction books and operating manuals as required. All such copies shall be clearly marked "PROJECT RECORD."
- f. Keep a copy or sample of each Submittal in good order at the project site.

3. Information to Manufacturer's District Office: Contractor shall Project Specifications

arrange for manufacturers and Suppliers of Equipment and Materials to furnish copies of all agreements, drawings, specifications, operating instructions, correspondence, and other matters associated with this Contract to the manufacturer's district office servicing the Owner. Insofar as practicable, all business matters relative to Equipment and Materials included in this Contract shall be conducted through such local district offices.

D. Engineer's Review

1. Engineer will review and take appropriate action on Submittals in accordance with the accepted schedule of Submittals. Engineer's review and approval will be only to determine if the items of Equipment and Materials covered by the Submittals will, after installation or incorporation into the Work, conform to information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Engineer's review and approval will not extend to design data reflected in Submittals, which is peculiarly within the special expertise of Contractor or Contractor's Subcontractors or Suppliers. Review and approval of a component item as such will not indicate approval of the assembly in which the item functions.
2. Engineer's review and approval of Shop Drawings, product data, or Samples will not relieve Contractor of responsibility for any deviation from requirements of the Contract Documents unless Contractor has in writing called Engineer's attention to such deviation at the time of submission, and Engineer has given written approval of the specific deviation. Approval by Engineer shall not relieve Contractor from responsibility for errors or omissions in Submittals.

E. Submittal Action Stamp

1. Engineer's review action stamp, appropriately completed, will appear on all Submittals of Contractor when returned by Engineer. Review status designations listed on Engineer's action stamp are defined as follows:
 - a) - APPROVED: Signifies Equipment or Material represented by the Submittal, conforms to the design concept and complies with the intent of the Contract Documents and is approved for incorporation in the Work. Contractor is to proceed with fabrication or procurement of the items and with related Work. Copies of the Submittal are to be transmitted by Engineer for final distribution.

b) - APPROVED AS NOTED (RESUBMIT): Signifies Equipment and Material represented by the Submittal conforms to the design concept and complies with the intent of the Contract Documents and is approved for incorporation in the Work in accordance with Engineer's notations. Contractor is to proceed with fabrication or procurement of the items and with related Work in accordance with Engineer's notations and is to submit a revised Submittal responsive to notations marked on the returned Submittal or written in the letter of transmittal.

c) - RETURNED FOR REVISION (RESUBMIT): Signifies Equipment and Material represented by the Submittal appears to conform to the design concept and comply with the intent of the Contract Documents, but information is either insufficient in detail or contains discrepancies which prevent Engineer from completing his review. Contractor is to resubmit revised information responsive to Engineer's annotations on the returned Submittal or written in the letter of transmittal. Fabrication or procurement of items represented by the Submittal and related Work is not to proceed until the Submittal is approved.

d) - NOT APPROVED (SUBMIT ANEW): Signifies Equipment and Material represented by the Submittal does not conform to the design concept or comply with the intent of the Contract Documents and is disapproved for use in the Work. Contractor is to provide Submittals responsive to the Contract Documents.

e) - PRELIMINARY: Signifies Submittals of such preliminary nature that a determination of conformance with the design concept or compliance with the intent of the Contract Documents must be deferred until additional information is furnished. Contractor is to submit such additional information to permit layout and related activities to proceed.

f) - REFERENCE ONLY, NO APPROVAL IS REQUIRED: Signifies Submittals which are for supplementary information only; pamphlets, general information sheets, catalog cuts, standard sheets, bulletins and similar data, all of which are useful to Engineer or Owner in design, operation, or maintenance, but which by their nature do not constitute a basis for determining that items represented thereby conform with the design concept or comply with the intent of the Contract Documents. Engineer reviews such Submittals for general content but not for basic details.

g) - FOR DISTRIBUTION: (PREVIOUSLY APPROVED):
Signifies Submittals which have been previously approved and are being distributed to Contractor, Owner, Resident Project Representative, and others for coordination and construction purposes.

F. Instruction Books and Operating Manuals

1. Equipment instruction books and operating manuals prepared by the manufacturer shall include the following:
 - a. Index and tabs.
 - b. Instructions for installation, start-up, operation, inspection, maintenance, parts lists and recommended spare parts, and data sheets showing model numbers.
 - c. Applicable drawings.
 - d. Warranties and guarantees.
 - e. Address of nearest manufacturer-authorized service facility.
 - f. All additional data specified.
2. Information listed above shall be provided in a single .pdf file and bound into hard-back binders of three-ring type. Sheet size shall be 8-1/2 x 11. Binder color shall be white. Capacity shall be a minimum of 1-1/2-inches, but sufficient to contain and use sheets with ease.
 - a. Provide with following accessories:
 - (1) Label holder.
 - (2) Business card holder.
 - (3) Sheet lifters.
 - (4) Horizontal pockets.
 - b. The following information shall be imprinted, inserted or affixed by label on the binder front cover:
 - (1) Equipment name.
 - (2) Manufacturer's name.
 - (3) Project name.
 - (4) Contract name and number.
 - c. The following information shall be imprinted, inserted, or affixed by label on the binder spine:
 - (1) Equipment name.
 - (2) Manufacturer's name.
 - (3) Volume number (if applicable).

G. Samples

1. Office Samples shall be of sufficient size and quantity to clearly illustrate the following:
 - a. Functional characteristics of the product, with integrally related parts and attachment devices.
 - b. Full range of color, texture, and pattern.
2. Field Samples and Mock-ups:
 - a. Contractor shall erect field Samples and mock-ups at the Project Site and at a location acceptable to Engineer.
 - b. Size or area shall be as specified in the respective Specification Section.
 - c. Fabricate each Sample and mock-up complete and finished.
 - d. Remove mock-ups at conclusion of Work or when acceptable to the Engineer if not a permanent part of construction.

1.4 Information Submittals

A. Informational Submittals are comprised of technical reports, administrative Submittals, and guarantees, which relate to the Work, but do not require Engineer approval prior to proceeding with the Work. Informational Submittals include:

1. Welder qualification tests.
2. Welding procedure qualification tests.
3. X-ray and radiographic reports.
4. Hydrostatic testing of pipes.
5. Field test reports.
6. Concrete cylinder test reports.
7. ASME pressure vessel test reports.
8. Certification on Materials:
 - a. Steel mill tests.
 - b. Brick and concrete masonry unit lab tests.
9. Soil test reports.
10. Piping stress analysis.
11. Warranties and guarantees.

B. Transmittal of Informational Submittals

1. All informational Submittals furnished by Subcontractors, manufacturers, and Suppliers shall be submitted to Engineer by Contractor unless otherwise specified.
 - a. Identify each informational Submittal by Project name

and number, Contract title and number, and the Specification Section and Article number marked thereon or in the letter of transmittal. Unidentifiable Submittals will be returned for proper identification.

- b. At the time of each submission, call to the attention of Engineer in the letter of transmittal any deviations from the requirements of the Contract Documents.

2. Format Requirements:

- a. Technical reports and administrative Submittals except as otherwise specified shall be submitted in a .pdf format
- b. Responsibilities of Contractor, Owner, and Engineer regarding tests and inspections of Equipment and Materials and completed Work are set forth elsewhere in these Contract Documents.
- c. The party specified responsible for testing or inspection shall in each case, unless otherwise specified, arrange for the testing laboratory or reporting agency to distribute test reports in .pdf format.

C. Engineer's Review

- 1. Engineer will review informational Submittals for indications of Work or Material deficiencies.
- 2. Engineer will respond to Contractor on those informational Submittals, which indicate Work or Material deficiency.

PART 2 - PRODUCTS - Not Applicable.

PART 3 - EXECUTION – Not Applicable.

PART 4 - MEASUREMENT AND PAYMENT - Not Applicable

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 supersede 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:

Title

- 1. Request for Change Order Proposal
- 2. Change order Proposal
- 3. Request for Information
- 4. Contractor's Daily Construction Report
- 5. Field Order
- 6. Work Change Directive
- 7. Shop Drawing Transmittal Form

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

REQUEST FOR CHANGE ORDER PROPOSAL

Date: _____

Contractor: _____

Project Name:

Request for Change Order Proposal No. _____

NOTICE TO CONTRACTOR: Please submit a Change Order Proposal for the proposed modifications to the Contract Documents as described below. If acceptable, a Change Order will be issued to authorize the work. THIS IS NOT A CHANGE ORDER FOR AUTHORIZATION TO PROCEED WITH THE WORK AS DESCRIBED!

SCOPE OF WORK:

OWNER

CHANGE ORDER PROPOSAL

Date: _____

Contractor: _____

Project Name:

Project No.

Change Order Proposal No.:

Dear Sir:

Certain items of extra work have been found necessary which are not covered by the Contract for the above referenced Project. Therefore, we submit the following amounts as the basis of compensation for such extra work:

JUSTIFICATION:

The Contract Time will be (increased)(decreased)_____calendar days.

The Contract Amount will be (increased)(decreased) \$_____dollars.

By: _____

Title: _____

Contractor: _____

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

Work Performed:

Material and Equipment Delivered:

Remarks:

(Authorized Signature)

FIELD ORDER

Date: _____

Contractor: _____

Project Name:

Field Order No.: _____

By: _____
Owner's Authorized Signature

By _____
Contractor's Receipt Acknowledged

Date: _____

Date: _____

WORK CHANGE DIRECTIVE

No. _____

PROJECT:

DATE OF ISSUANCE _____ EFFECTIVE DATE _____

OWNER:

CONTRACTOR:

You are directed to proceed promptly with the following change(s):

Description:

Purpose of Work Change Directive:

Attachments: (List documents supporting change)

If a claim is made that the above change(s) have affected Contract Price or Contract Times, any claim for a Change Order based thereon will involve one or more of the following methods of determining the effect of the change(s).

Method of determining change in
Contract Price:

- ☐ Unit Prices
- ☐ Lump Sum
- ☐ Other _____

Estimated increase (decrease) in Contract
Price: \$ _____

If the change involves an increase, the
estimated amount is not to be exceeded
without further authorization.

Method of determining change in
Contract Times:

- ☐ Contractor's records
- ☐ OWNER's records
- ☐ Other _____

Estimated increase (decrease) in Contract
Times: Substantial Completion: _____ days

Ready for final payment: _____ days
If the change involves an increase, the
estimated time is not to be exceeded
without further authorization.

AUTHORIZED:

OWNER

By: _____

Submittal Transmittal

Project Name:			Transmittal No.:	
Project Location:			Date Received:	
To:	From:	Job No.:		
		Reviewed By:		
		Date Reviewed:		
Attn:	Attn:	Spec. Section:		
Date Transmitted:	Previous Transmittal Date:	1st. Sub. ☐ ReSub. ☐		
No. Copies	Description	Manufacturer	Drawing or Data No.	Action Taken*

Submitter's Remarks:

* The acceptance of this submittal by NCS in no way relieves the contractor of their contractual obligations to fulfill all requirements of the contract documents.

* The action Designated Above is in Accordance with the Following Legend:

A - No Exceptions Taken

B - Furnish as Noted

C - Revise and Resubmit

1. Not enough information for review.
2. No reproductions submitted.
3. Copies illegible
4. Not enough copies submitted.
5. Wrong sequence number.
6. Wrong resubmittal suffix.
7. Wrong specification section.
8. Wrong form used.
9. See comments.

D - Rejected

E - Engineer's review not required.

1. Submittal not required.
2. Supplemental information. Submittal retained for informational purposes only.
3. Information reviewed and approved on prior submittal.
4. See comments.

Reviewer's Comments:

Returned by (NCS) :

Date:

Distribution:	Supplier (if applicable)	_____ Copies	OWNER:	_____ Copies	
	Sub Consultant 1:	_____ Copies	NTUA:	_____ Copies	
		_____	Sub Consultant 2:	_____ Copies	

SECTION 01350

SPECIAL PROCEDURES

PART 1 - GENERAL

1.01 CONCEALED EXISTING FACILITIES

- A. Verify locations of utilities and facilities which may exist by consulting with OWNER, utility companies, and Blue Stake before you dig:
 - 1. Abide by easement and right-of-way restrictions.
- B. Notify owners of facilities when the Work will be in progress. Make arrangements for potential emergency repairs in accordance with requirements of owners of facilities including individual or residential facilities.
- C. Assume responsibility for repair of facilities damaged by performance of the Work.
- D. Expose sanitary and storm sewers, water, gas, electric, telephone utility lines, and other underground facilities indicated to permit survey of location and elevation prior to commencement of Work in affected area.
- E. Expose in ample time to permit relocation of interfering utilities with minimum delaying effect on contract time.
- F. Work required for raising, lowering, or relocating utilities in right of way not indicated will be performed by affected utility owners or as part of the Work at option of affected owners of utilities and OWNER.

1.02 PROTECTION OF THE WORK AND PROPERTY

- A. CONTRACTOR shall assume responsibility for taking all precautions, providing all programs, and taking all actions necessary to protect the Work and all public and private property and facilities from damage as specified in the General Conditions and herein.
- B. In order to prevent damage, injury or loss, CONTRACTOR'S actions shall include, but not be limited to the following:
 - 1. Store apparatus, materials, supplies, and equipment in an orderly, safe manner that will not unduly interfere with the progress of the Work or the Work of any other contractor or utility service company.
 - 2. Provide suitable storage facilities for all materials which are subject to injury by exposure to weather, theft, breakage, or otherwise.
 - 3. Place upon the Work or any part thereof only such loads as are consistent with the safety of that portion of the Work.

4. Clean up frequently all refuse, rubbish, scrap materials, and debris caused by CONTRACTOR's operations, to the end that at all times the site of the Work shall present a safe, orderly and workmanlike appearance.
 5. Provide barricades and guard rails around openings, for scaffolding, for temporary stairs and ramps, around excavations, elevated walkways and other hazardous areas.
- C. CONTRACTOR shall not, except after written consent from proper parties, enter or occupy privately owned land with personnel, tools, materials or equipment, except on easements provided herein.
- D. CONTRACTOR shall assume full responsibility for the preservation of all public and private property or facility on or adjacent to the site. If any direct or indirect damage is done by or on account of any act, omission, neglect or misconduct in the execution of the Work by the CONTRACTOR, it shall be restored by the CONTRACTOR, at his expense, to a condition equal to that existing before the damage was done.
- E. Underground Structures:
1. Underground structures are defined to include, but are not limited to, all sewer, water, gas, and other piping, and manholes, chambers, electrical conduits, tunnels and other existing subsurface work located within or adjacent to the limits of the Work.
 2. All underground structures known to ENGINEER, except water, gas, sewer, electric, and telephone service connections, are shown on Drawings. This information is shown for the assistance of CONTRACTOR, in accordance with the best information available, but is not guaranteed to be correct or complete.
 3. CONTRACTOR shall explore ahead of trenching and excavation Work and shall uncover all obstructing underground structures sufficiently to determine their location, to prevent damage to them and to prevent interruption to the services which such structures provide. If CONTRACTOR damages an underground structure, restore it to original condition at his expense.
 4. Necessary changes in the location of the Work may be made by the OWNER to avoid unanticipated underground structures.
 5. If permanent relocation of an underground structure or other subsurface facility is required and is not otherwise provided for in the Contract Documents, OWNER will direct CONTRACTOR, in writing, to perform the Work, which shall be paid for under the provisions of the General Terms and Conditions.
- F. Surface Structures: Surface structures are defined as all existing buildings, structures and other facilities above the ground surface. Included with such structures are their foundations or any extension below the surface. Surface structures include, but are not limited to, buildings, tanks, walls, roads, open

drainage, piping, poles, wires, posts, signs, markers, curbs, walks and all other facilities that are visible above the ground surface.

G. Protection of Underground and Surface Structures:

1. CONTRACTOR shall sustain in their places and protect from direct or indirect injury all underground and surface structures located within or adjacent to the limits of the Work. Such sustaining and supporting shall be done carefully and as required by the party owning or controlling such structure. Before proceeding with the work of sustaining and supporting such structure, CONTRACTOR shall satisfy the OWNER that the methods and procedures to be used have been approved by the party owning same.
2. CONTRACTOR shall assume all risks attending the presence or proximity of all underground and surface structures within or adjacent to the limits of the Work. CONTRACTOR shall be responsible for all damage and expense for direct or indirect injury caused by his Work to any structure. CONTRACTOR shall repair immediately all damage caused by his work, to the satisfaction of the OWNER of the damaged structure.

- H. All other existing surface facilities, including but not limited to guard rails, posts, guard cables, signs, poles, markers, and curbs, which are temporarily removed to facilitate installation of the Work, shall be replaced and restored to their original condition at CONTRACTOR's expense.

1.03 DAILY WORK REPORTS

- A. CONTRACTOR shall provide to OWNER and ENGINEER one copy of his daily field report indicating work completed, number and classification of personnel on site, number and types of construction equipment on site and weather conditions. The field reports shall be in pdf format and shall be submitted on Monday for the prior week.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01420
DEFINITIONS AND STANDARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Definitions

1. Basic contract definitions used in the Contract Documents are defined in the GENERAL CONDITIONS. Definitions and explanations are not necessarily either complete or exclusive, but are general for the Work.
2. General Requirements are the provisions or requirements of DIVISION 1 Sections, and which apply to the entire Work of the Contract.

- B. Related Information Specified Elsewhere: Specification standards and associations applicable to the Work are specified in each Section.

1.2 Specification Format and Content Explanations

- A. Specification Format: The Specifications are organized into Divisions and Sections based on the Construction Specifications Institute's (CSI) Section Format and Master Format numbering system. Some portions may not fully comply and no particular significance will be attached to such compliance or noncompliance.

1. Divisions and Sections: For convenience, a basic unit of Specification text is a "Section," each unit of which is numbered and named. These are organized with related Sections, into "Divisions," which are recognized as the present industry consensus on uniform organization and sequencing of Specifications. The Section title is not intended to limit meaning or content of Section, nor to be fully descriptive of requirements specified therein, nor to be an integral part of text.
2. Section Numbering: Used for identification and to facilitate cross-references in Contract Documents. Sections are placed in numeric sequence; however, numbering sequence is not complete, and listing of Sections in Table of Contents at beginning of the Project Manual must be consulted to determine numbers and names of Specification Sections in these Contract Documents.
3. Page Numbering: Numbered independently for each Section. Section number is shown with page number at bottom of each page,

- to facilitate location of text.
4. Parts: Each Section of Specifications generally has been subdivided into three basic "parts" for uniformity and convenience (PART 1 - GENERAL, PART 2 - PRODUCTS, and PART 3 - EXECUTION). These "Parts" do not limit the meaning of text within. Some Sections may not contain all three "Parts" when not applicable, or may contain more than three "Parts" to add clarity to organization of Section.
 5. Underscoring of Titles: Used strictly to assist reader of Specification in scanning text for key words in content. No emphasis on or relative importance is intended except where underscoring may be used in body of text to emphasize a duty, critical requirement, or similar situation.
 6. Project Identification: Project file number and identification are recorded at bottom of each page of Specifications to minimize possible misuse of Specifications, or confusion with other Project Specifications.

B. Specification Content

1. These Specifications apply certain conventions in the use of language and the intended meaning of certain terms, words, and phrases when used in particular situations or circumstances. These conventions are explained as follows:
 - a. Imperative and Streamlined Language: These Specifications are written in imperative and abbreviated form. This imperative language of the technical Sections is directed at the Contractor, unless specifically noted otherwise. Incomplete sentences shall be completed by inserting "shall," "the Contractor shall," and "shall be," and similar mandatory phrases by inference in the same manner as they are applied to notes on the Drawings. The words "shall be" shall be supplied by inference where a colon (:) is used within sentences or phrases. Except as worded to the contrary, fulfill (perform) all indicated requirements whether stated imperatively or otherwise.
 - b. Specifying Methods: The techniques or methods of specifying requirements varies throughout text, and may include "prescriptive," "compliance with standards," "performance," "proprietary," or a combination of these. The method used for specifying one unit of Work has no bearing on requirements for another unit of Work.
 - c. Overlapping and Conflicting Requirements: Where compliance with two or more industry standards or sets of requirements is specified, and overlapping of those different

standards or requirements establishes different or conflicting minimums or levels of quality, notify Engineer for a decision as specified in GENERAL CONDITIONS.

- d. Abbreviations: Throughout the Contract Documents are abbreviations implying words and meanings which shall be appropriately interpreted. Specific abbreviations have been established, principally for lengthy technical terminology and in conjunction with coordination of Specification requirements with notations on Drawings and in schedules. These are normally defined at first instance of use. Organizational and association names and titles of general standards are also abbreviated.

C. Assignment of Specialists: In certain instances, Specification text requires that specific Work be assigned to specialists in the operations to be performed. These specialists shall be engaged for performance of those units of Work, and assignments are requirements over which Contractor has no choice or option. These assignments shall not be confused with, and are not intended to interfere with, enforcement of building codes and similar regulations governing the Work, local trade and union jurisdictions, and similar conventions. Nevertheless, final responsibility for fulfillment of Contract requirements remains with Contractor.

D. Trades: Except as otherwise specified or indicated, the use of titles such as "carpentry" in Specification text, implies neither that the Work must be performed by an accredited or unionized tradesperson of corresponding generic name (such as "carpenter"), nor that specified requirements apply exclusively to work by tradespersons of that corresponding generic name.

1.3 Drawing Symbols

- A. Except as otherwise indicated, graphic symbols used on Drawings are those symbols recognized in the construction industry for purposes indicated. Refer instances of uncertainty to Engineer for clarification.

1.4 Industry Standards

- A. Applicability of Standards: Except where the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents. Such standards are made a part of the Contract Documents by reference and are stated in each Section.

- 1. Referenced standards, referenced directly in Contract Documents or by governing regulations, have precedence over nonreferenced

- standards which are recognized in industry for applicability to the Work.
2. Where compliance with an industry standard is required, standard in effect shall be as stated in GENERAL CONDITIONS.
 3. Where an applicable code or standard has been revised and reissued after the date of the Contract Documents and before performance of Work affected, the Engineer will decide whether to issue a Change Order to proceed with the updated standard.
 4. In every instance the quantity or quality level shown or specified shall be the minimum to be provided or performed. The actual installation may comply exactly, within specified tolerances, with the minimum quantity or quality specified, or it may exceed that minimum within reasonable limits. In complying with these requirements, indicated numeric values are minimum or maximum values, as noted, or appropriate for the context of the requirements. Refer instances of uncertainty to the Engineer for a decision before proceeding.
 5. Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to that entity's construction activity. Copies of applicable standards are not bound with the Contract Documents.
 - a. Where copies of standards are needed for performance of a required construction activity, Contractor shall obtain copies directly from the publication source.
- B. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Where such acronyms or abbreviations are used in the Specifications or other Contract Documents, they mean the recognized name of the trade association, standards generating organization, authority having jurisdiction, or other entity applicable to the context of the text provision.

PART 2 - PRODUCTS - Not Applicable.

PART 3 - EXECUTION - Not Applicable.

PART 4 - MEASUREMENT AND PAYMENT - Not Applicable.

END OF SECTION

SECTION 01423

REFERENCE STANDARDS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. When a reference standard is specified, comply with requirements and recommendations stated in that standard, except when they are modified by the Contract Documents, or when applicable laws, ordinances, rules, regulations or codes establish stricter standards. The latest provisions of applicable standards shall apply to the Work, unless otherwise specified. Reference standards include, but are not necessarily limited to, the following:
1. American Association of State Highway and Transportation Officials (AASHTO).
 2. American Concrete Institute (ACI).
 3. American Gear Manufacturers Association (AGMA).
 4. American Institute of Steel Construction (AISC).
 5. American Iron and Steel Institute (AISI).
 6. American National Standards Institute (ANSI).
 7. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
 8. American Society of Mechanical Engineers (ASME).
 9. American Society for Testing and Materials (ASTM).
 10. American Water Works Association (AWWA).
 11. American Welding Society (AWS).
 12. Concrete Reinforcing Steel Institute (CRSI)
 13. Factory Mutual (FM).
 14. Institute of Electrical and Electronics Engineers (IEEE).
 15. National Electrical Manufacturer's Association (NEMA).
 16. Occupational Safety and Health Administration (OSHA).
 17. National Fire Protection Association (NFPA).
 18. Underwriters' Laboratories, Inc. (UL).
 19. All other applicable standards listed in the Specifications and the standards of utility service companies, where applicable.
 20. NSF International (NSF).
 21. State Division of Industrial Safety (DIS)
 22. Institute of Makers of Explosives (IOMOE)
 23. Enclosures for Industrial Controls and Systems (ICS)
 24. (ISA) See 13329-3
 25. National Association of Corrosion Engineers (NACE)

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01450

MEASUREMENTS AND PAYMENTS

PART 1 - GENERAL

1.01 SCOPE

- A. Section includes the methods by which measurement will be made of the quantities for which payment will be made for the project. It is the intention of this Contract that payment will be made for those items listed in the Price Sheet only. All items of work not specifically listed in the Price Sheet shall be included in the prices for the various items listed in the Price Sheet.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (UPDATE PER PROJECT)

- A. The following describes the measurements and payments of the Work performed in this Contract:
 - 1. Bid Item No. 1 - Mobilization, Demobilization, and Project Closeout: Mobilization shall include but not be limited to, all preparatory work; preliminary operations; movement of personnel, equipment, and supplies to project site; establishment of field offices and other facilities needed prior to beginning construction. Demobilization shall include but not be limited to, removal of equipment of materials, equipment, and temporary facilities. Project closeout shall include but not be limited to, correction of incomplete or deficient items identified in the final inspection, final cleaning, submittal of red line record drawings, warranties, and other project records and documents, and completion of closeout procedures and requirements. Bid Item shall not exceed 10% of the total of Bid Items No. 1 to 22. CONTRACTOR shall receive payment in three (3) equal amounts. The first payment request can include 1/3 of this Item. At 50% completion of the project, the second 1/3 can be requested. The last payment request shall include the final 1/3. Payment for mobilization, demobilization, and project closeout shall be made at the lump sum price submitted on the Price Sheet.
 - 2. Bid Item No. 2 - Removals: Shall include removals and demolition. Measurement shall be based on complete removals. Measurement shall be based on complete removals. Payment shall be at the lump sum price submitted on the Price Sheet.
 - 3. Bid Item No. 3 - Over-excavation: Shall include over-excavation of soil, and where indicated, disposal off site. Measurement shall be based on complete over-excavation. Payment shall be at the lump sum price submitted on the Price Sheet.

4. Bid Item No. 4 - Engineered Fill: Shall include but not be limited to, furnishing engineered fill from off site where specified and reworking on site soils, placing, compacting, and sampling and testing. Measurement shall be based on complete engineered fill. Payment shall be at the lump sum price submitted on the Price Sheet.
5. Bid Item No. 5 - Site Piping: Shall include but not be limited to, furnishing and installing yard piping, excavating and backfilling pipe trenches, sampling and testing of trench backfill, pressure testing of piping, and disinfecting piping. Measurement shall be based on complete installation. Payment shall be at the lump sum price submitted on the Price Sheet.
6. Bid Item No. 6 - Site Grading: Shall include site rough and finish grading, and furnishing and placing decomposed granite, and soils sampling and testing. Measurement shall be based on complete installation. Payment shall be at the lump sum price submitted on the Price Sheet.
7. Bid Item No. 7 - Site Paving: Shall include but not be limited to, grading; furnishing and installing aggregate base course and asphaltic concrete pavement; and materials sampling and testing. Measurement shall be based on complete installation. Payment shall be at the lump sum price submitted on the Price Sheet.
8. Bid Item No. 8 - Perimeter Walls and Gates: Shall include but not be limited to, excavation; backfilling; furnishing and installing concrete footings, walls, gate and drive system, electrical, instrumentation and controls, painting; and materials sampling and testing. Measurement shall be based on complete installation. Payment shall be at the lump sum price submitted on the Price Sheet.
9. Bid Item No. 9 - Treatment Systems: Shall include but not be limited to, excavation; backfilling; furnishing and installing concrete foundation, treatment systems, ladders and platforms, piping, pipe supports, valves and equipment, air blowers and local control panel, PLC panel, electrical, instrumentation and controls, coatings, and materials sampling and testing. Measurement shall be based on complete installation. Payment shall be at the lump sum price submitted on the Price Sheet.
10. Bid Item No. 10 - Site Electrical and Lighting: Shall include but not be limited to, excavation and backfill of trenches; furnishing and installing conduit and conductors for electrical distribution and instrumentation and controls, pull boxes, upgrade to switchboard, electrical distribution equipment, site lighting, canopies; and soil sampling and testing. Measurement shall be based on complete installation. Payment shall be at the lump sum price submitted on the Price Sheet.
11. Bid Item No. 11 - Startup and Commissioning: Shall include but not be limited to, providing materials and labor and equipment vendor representatives for startup and commissioning of the treatment facility, training, and providing equipment operation and maintenance manuals. Measurement shall be based on completion of commissioning. Payment shall be at the lump sum price submitted on the Price Sheet.

12. Bid Item No. 12 - Allowance - Site Security: See Section 01210 for description of potential work. Measurement shall be based on scope of work authorized by OWNER and completion of installation. Payment shall be based on the invoices approved by OWNER.
13. Bid Item No. 13 - Owner's Contingency: Measurement shall be based on scope of work authorized by OWNER and completion of installation. Payment shall be based on the change order amount authorized by OWNER.

END OF SECTION

SECTION 01560

ENVIRONMENTAL PROTECTION AND SPECIAL CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

- A. The CONTRACTOR shall perform all work in such manner as to minimize the polluting of air, water, or land, and shall, within reasonable limits, control noise and the storage of solid waste materials.

1.02 QUALITY ASSURANCE

- A. Employ and utilize environmental protection methods, and obtain all necessary permits required at the site for air quality, solid waste, storm water pollution, and hazardous wastes. CONTRACTOR shall comply with all state, county, and Federal regulations.

1.03 SUBMITTALS

- A. See Section 01330.
- B. See Section 3.01.C.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 ERECTION AND INSTALLATION

- A. Land Protection:
 - 1. Manage and control all work or storage areas, access routes and embankments to prevent sediment from entering nearby water or land adjacent to site of work.
 - 2. Restore all disturbed areas including haul areas and establish permanent type of locally adaptable vegetative cover.
 - 3. Unless earthwork is immediately paved or surfaced, protect all side slopes and backslopes immediately upon completion of final grading.
 - 4. Plan and execute earthwork in a manner to minimize duration of exposure of unprotected soils.

- B. Erosion Protection:
1. Utilize methods necessary to effectively prevent erosion and control of sediment and include the following:
 - a. Retardation: Mechanically retard rate of runoff by construction of diversion ditches, terraces, and berms. Divert run off to protect damage courses.
 - b. Borrow constraints: Do not borrow soils from areas where environmental controls are not possible.
 - c. Protect side and backslopes as soon as rough grading is complete by accelerated growth of permanent vegetation, temporary vegetation, mulching or netting. Where slopes are too steep for stabilization, use hydroseeding, mulching anchored in placed, cover anchored in placed, cover by anchored netting, sodding, or combination to prevent erosion. Remove temporary protection prior to final grading.
 2. Comply with requirements of NPDES storm water regulations for construction sites.
- C. Control of Responsibilities:
1. Collect and dispose of solid waste on a daily basis.
 2. Provide disposal of degradable debris to an approved solid waste disposal site.
 3. Provide disposal of nondegradable debris to an approved solid waste disposal site or in an alternate manner approved by OWNER and regulatory agencies.
 4. Store chemical wastes in watertight containers and remove from project site and dispose of to sites approved by regulatory agencies. Assure maximum disposal frequency of 1 month.
 5. Control dust at all times, including nonworking hours, weekends and holidays. Sprinkle site or treat with dust suppressors as necessary to control dust. Utilize methods and practices of construction to eliminate dust in full observance of regulatory agencies.
 6. Minimize noise by fitting equipment with appropriate mufflers. The use of explosives or blasting operations are not approved.
 7. On completion of work, leave area in a clean condition representative of current conditions. Assure all signs of temporary construction and activities incidental to construction of required permanent work in place are obliterated.
- D. Historical Protection:
1. If during the course of construction evidence of deposits of historical or archaeological interests are found, cease work affecting find and notify the OWNER. Do not disturb deposits until written notice from OWNER is given to proceed. Lost time or changes in construction to avoid the find shall be compensated for based upon partial suspension of work.

END OF SECTION

SECTION 01570
TEMPORARY UTILITIES AND FACILITIES

PART 1 - GENERAL

1.1 Summary

- A. This Section includes contractor requirements of a temporary nature not normally incorporated into final Work. It includes the following:
 - 1. Temporary Construction Fence
 - 2. Utility services.
 - 3. Construction and support facilities.
 - 4. Construction aids.
 - 5. Safety and health.
 - 6. Fire protection.

1.2 Quality Assurance

- A. Reference Standards and Specifications
 - 1. American National Standards Association (ANSI)
A10 Series - Safety Requirements for Construction and Demolition.
 - 2. National Electrical Contractors Association (NECA)
 - 3. Electrical Design Library - Temporary Electrical Facilities.
 - 4. National Fire Protection Association (NFPA)
 - 10 - Portable Fire Extinguishers.
 - 70 - National Electrical Code.
 - 241 - Safeguarding Construction, Alterations, and Demolition Operations.
- B. National Electrical Manufacturers Association (NEMA).
- C. Underwriters Laboratories (UL).

D. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction, including but not limited to:

1. Building Code requirements.
2. Health and safety regulations.
3. Utility company regulations.
4. Environmental Protection Regulations.

E. Standards

1. Comply with NFPA 10 and 241, and ANSI A10 Series standards "Temporary Electrical Facilities."
2. Comply with NEMA, NECA, and UL standards and regulations for temporary electric service. Install service in compliance with NFPA 70.

F. Inspections

1. Contractor shall obtain required certifications and permits. Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Owner to witness operation of bypass pumps and associated instrumentation prior to taking Lift Stations out-of-service.

1.3 Submittals

A. Temporary Utilities

1. Submit reports of tests, inspections, meter readings, and similar procedures performed on temporary utilities.
2. Submit shop drawings and pump curves for the bypass pumps, temporary piping, and associated instrumentation and control for approval by Engineer.

1.4 Project Conditions

A. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not allow hazardous, dangerous, unsanitary conditions, or public nuisances to develop or persist on the Site.

PART 2 - PRODUCTS

2.1 Materials and Equipment

A. Provide new materials and equipment, except for the bypass pumps and

temporary piping and valves. Provide materials and equipment suitable for the use intended, of capacity for required usage, and meeting applicable codes and standards. Comply with requirements of DIVISIONS 2 through 16.

B. Bypass Pump System

1. Provide two diesel bypass pumps per bypass pump system that are sized for full redundancy. The second bypass pump should not be utilized during normal operations, only when liquid levels reach the hi-hi liquid level. Pump design criteria are provided on the Construction Drawings.
2. Provide cellular auto-dialer for remote monitoring of bypass pumps and associated level sensors. Auto-dialer to be the Co-Pilot™ by Cornell Pump Company or equal.
3. Auto-dialer to notify Owner and Contractor of hi-hi levels in the manhole via text and email.
4. Provide Smartcover® by Badger Meter or equal to provide real-time monitoring of liquid levels in the manhole.
5. Bypass pumps can be primarily operated based on the level transmitter provided with the Smartcover®, but three floats must also be installed as backup with a low level (pumps off), high level (lead pump on), and hi-hi level (both pumps on).

PART 3 - EXECUTION

3.1 Temporary Utilities

- A. Furnish, install, and maintain temporary utilities required for adequate construction, safety, and security. Modify, relocate, and extend systems as Work progresses. Repair damage caused by installation or use of temporary facilities. Remove on completion of Work or until service or facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 Temporary Sanitary Facilities

A. Contractor-Furnished Facilities

1. Furnish, install, and maintain temporary sanitary facilities for use through construction period. Remove on completion of Work.
2. Provide for all construction workers under this Contract and representatives at the Site.
3. Toilet facilities shall be of the chemical, aerated recirculation, or combustion type, properly vented, and fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.

4. Drinking Water Fixtures: Provide containerized tap dispenser type drinking water units.
5. Supply and maintain toilet tissue, paper towels, paper cups and similar disposable materials as appropriate for each facility. Provide appropriate covered waste containers for used material.
6. Supply garbage containers for misc. construction trash and debris, with cover.

3.3 Temporary Safety and Health

- A. General: Contractor shall be responsible for development of safety and health programs for personnel at Project Site.
- B. Contractor to provide temporary fencing as shown on the Drawings. Contractor to submit to Owner and Engineer for approval prior to procurement.

3.4 Installation and Removal

- A. Relocation: Relocate construction aids as required by progress of construction, storage limitations, or Work requirements and to accommodate requirements of Owner and other contractors at the Site.
- B. Removal: Remove temporary materials, equipment, and services when construction needs can be met and allowed by use of permanent construction, or at completion of the Project.
- C. Repair: Clean and repair damage caused by installation or by use of temporary facilities.

PART 4 - MEASUREMENT AND PAYMENT - Not Applicable.

**** END OF SECTION 01570 ****

SECTION 01580

PROJECT IDENTIFICATION AND SIGNS

PART 1 - GENERAL

1.1 Summary

- A. This Section includes basic requirements for temporary Project identification and informational signs required during construction.
- B. Related Work Specified Elsewhere

Submittals..... Section 01330

1.2 Quality Assurance

- A. Design sign and structure to withstand wind and environmental conditions of locality. Provide with finish adequate to withstand weathering, fading, chipping, and peeling for duration of construction.

1.3 Submittals

- A. Submit as specified in Section 01330.
- B. Includes, but not limited to, the following
 - 1. Shop Drawings and product data as applicable.
 - 2. Show content, layout, lettering, colors, structure, and foundation.

PART 2 – PRODUCTS

2.1 Identification Signs

- A. Project Identification
 - 1. Construct signs to design, size, and material indicated.
 - 2. Construct structure and framing of wood that is structurally adequate to resist design requirements of locality.
 - 3. Construct sign surface with a minimum 3/4-inch thickness exterior grade plywood with medium density overlay. Panels shall be of size to minimize joints. Overall size shall be 4' x 8'.
 - 4. Rough hardware shall be galvanized or aluminum.
 - 5. Coating: Paint as specified of colors selected by Engineer.
 - 6. Information Content:
 - a. Project title, logo, and name of Owner as shown on

Contract Documents.

- b. Names and titles of authorities.
- c. Name and title of Engineer.
- d. Name of prime Contractor and major Subcontractors.
- e. Responsible Individual Phone Number

- B. Contractor Identification: If not part of Project identification sign, provide and install Contractor's standard sign.

2.2 INFORMATIONAL SIGNS

A. Construction

- 1. This includes signs for traffic, construction workers, and general public in regards to directions, warnings, hazards, locations of areas, facilities, equipment, and others of a similar nature.
- 2. Provide signs of design, size, color, and lettering as required by regulatory agencies. Signs shall be painted metal, wood, plastic, or fiberglass and of materials suitable for the conditions in which they are placed, such as weathering and fading.
- 3. Construct structure and framing of wood or metal, structurally adequate to resist design requirements of area of Project. If within ROW signs should be designed with quick releases or break points.

PART 3 - EXECUTION

3.1 Installation

A. Project and Contractor Identification Sign

- 1. CONTRACTOR shall obtain OWNER's approval for the location of the CONTRACTOR's identification sign. The sign shall be installed in an appropriate location so as not to obstruct traffic, pedestrians, or construction operations.
- 2. Erect on framing or foundation, and rigidly brace.
- 3. Maintain sign in good repair, in a clean and neat condition.
- 4. Remove upon completion of Project.

B. Informational Signs

- 1. Install at appropriate locations and in sufficient quantities to assure visibility. Relocate as required by progress of work, or Engineer's request.
- 2. Maintain signs in good repair, in a neat, clean, readable condition.

3. Remove all signs, framing, supports, and foundations upon completion of Project.

PART 4 - MEASUREMENT AND PAYMENT - Not Applicable.

END OF SECTION

SECTION 01600

EQUIPMENT AND MATERIALS

PART 1 - GENERAL

1.1 Summary

- A. This Section includes administrative and procedural requirements governing Contractor's selection of products for use in the Project.
- B. Related Work Specified Elsewhere
 - 1. For the applicability of industry standards to products specified: DIVISIONS 2 through 16.
 - 2. For submittal of Contractor's construction progress schedule and the Submittal schedule: Section 01320 and Section 01330.
 - 3. For handling requests for substitutions made after award of the Contract: Section 01631.

1.2 Definitions

- A. Definitions used in this Article are not intended to change the meaning of other terms used in these Contract Documents, such as "specialties," "systems," "structures," "finishes," "accessories," and similar terms. Such terms are self-explanatory and have well- recognized meanings in the construction industry.
 - 1. "Products" are items purchased for incorporation in the Work, whether purchased for the Project or taken from previously purchased stock. The term "product" includes the terms "Material," "Equipment," "system," and terms of similar intent.
 - a. "Named Products" are items identified by the manufacturer's product name, including make or model number or other designation, shown or listed in the manufacturer's published product literature, that is current as of the date of the Contract Documents.
 - b. "Foreign Products," as distinguished from "domestic products," are items substantially manufactured (50% or more of value) outside the United States and its possessions. Products produced or supplied by entities substantially owned (more than 50%) by persons who are not citizens of, nor living within, the United States and its possessions are also considered to be foreign products.
 - 2. "Materials" are products substantially shaped, cut, worked, mixed,

finished, refined or otherwise fabricated, processed, or installed to form a part of the Work.

3. "Equipment" is a product with operational or non-operational parts, whether motorized, or manually operated, that may require service connections, such as wiring or piping.

1.3 Submittals

- A. Submittal of preliminary procurement schedule is specified in Section 01320 - PROJECT MEETINGS, SCHEDULES, AND REPORTS.
- B. Submittals for products are specified in Section 01330 and in applicable Sections of DIVISIONS 2 through 16.

1.4 Quality Assurance

- A. Source Limitations: To the fullest extent possible, provide products of the same kind from a single source.
- B. Nameplates: Along with required labels and operating data, manufacturer or producer's nameplates, imprints, or trademarks may be placed on surfaces exposed to view.
 1. Labels: Locate required product labels and stamps on concealed surfaces or, where required for observation after installation, on accessible surfaces that are not conspicuous.
 2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated Equipment. Locate on an easily accessible surface that is inconspicuous in occupied spaces. The nameplate shall contain the following information and other essential operating data:
 - a. Name of product and manufacturer including address (and telephone number).
 - b. Model and serial number.
 - c. Capacity.
 - d. Speed.
 - e. Ratings.

1.5 Transportation and Shipment

- A. Shipment Preparation
 1. Contractor shall require manufacturers and Suppliers to prepare products for shipment in a manner to facilitate unloading and handling, and to protect against damage, deterioration, or

unnecessary exposure to the elements in transit and storage. Provisions for protection shall include the following:

- a. Crates or other suitable packaging materials.
 - b. Covers and other means to prevent corrosion, moisture damage, mechanical injury, and accumulation of dirt in motors, electrical equipment, and machinery.
 - c. Suitable rust-preventive compound on exposed machined surfaces and unpainted iron and steel.
 - d. Grease packing or oil lubrication in all bearings and similar items.
- B. Marking: Each product item shall be tagged or marked as identified in the delivery schedule or on Submittals. Complete packing lists and bills of material shall be included with each shipment. Each piece of every item need not be marked separately, provided that all pieces of each item are packed or bundled together and the packages or bundles are properly tagged or marked.

1.6 Product Delivery, Storage and Handling

- A. Deliver, store, and handle products according to the manufacturer's recommendations, using means and methods that will prevent damage, deterioration, and loss, including theft.
1. Schedule delivery to minimize long-term storage at the Site and to prevent overcrowding of construction spaces. Allow ample time to avoid delay of the Work.
 2. Coordinate delivery with installation time to assure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
 3. Deliver products in an undamaged condition in the manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
 4. Inspect products upon delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected. Inspect shipment to assure:
 - a. Product complies with requirements of Contract Documents and reviewed Submittals.
 - b. Quantities are correct.
 - c. Containers and packages are intact and labels are legible.
 - d. Products are properly protected and undamaged.
 5. Store products at the Site in a manner that will facilitate inspection and measurement of quantity or counting of units. Mark deliveries

of component parts of Equipment to identify the Equipment, to permit easy accumulation of parts, and to facilitate inspection and measurement of quantity or counting of units.

6. Store heavy materials in a manner that will not endanger the supporting construction.
7. Store products subject to damage by the elements above ground, under cover in a weather tight enclosure, and with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instructions.
8. Protect motors, electrical Equipment, plumbing fixtures, and machinery of all kinds against corrosion, moisture deteriorations, mechanical injury, and accumulation of dirt or other foreign matter.
9. Protect exposed machined surfaces and unpainted iron and steel as necessary with suitable rust-preventive compounds.
10. Protect bearings and similar items with grease packing or oil lubrication.
11. Handle and store steel plate, sheet metal, and similar items in a manner to prevent deformation.
12. For storage of pipe and other products on easements and rights-of-way in residential and commercial areas, do not exceed the minimum required by scheduled laying operations, and conform to all requirements of public authorities. Store or place pipe along roads, set back from shoulder or curb, and at an angle tending to deflect vehicles if struck. Place or block pipe to preclude its accidental movement.

B. Handling

1. Provide equipment and personnel necessary to unload and handle products, by methods to prevent damage or soiling to products, or packaging.
2. Handle by methods to prevent bending or overstressing. Where lifting points are designated, lift components only at those points.
3. Provide additional protection to surrounding surfaces as necessary to prevent damage.

C. Maintenance of Storage

1. Inspect stored products on a scheduled basis as approved by engineer.
2. Verify that storage facilities comply with manufacturer's product storage requirements, including environmental conditions continually maintained.
3. Verify that surfaces of products exposed to elements are not adversely affected; that any weathering of finishes is acceptable under requirements of Contract Documents.
4. For mechanical and electrical Equipment in long-term storage,

provide manufacturer's service instructions to accompany each item, with notice of enclosed instructions on exterior of package. Service Equipment on a regularly scheduled basis.

- D. Protection After Installation: Provide substantial coverings as necessary to protect installed products from damage from subsequent construction operations.

PART 2 - PRODUCTS

2.1 Product Selection

- A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise specified or indicated, new at the time of installation.
 - 1. Provide products complete with accessories, trim, finish, safety guards, and other devices and details needed for a complete installation and the intended use and effect.
 - 2. Where available, provide standard products of types that have been produced and used successfully in similar situations on other projects.
 - 3. Continued Availability: Where, because of the nature of its application, Owner is likely to need replacement parts or additional amounts of a product at a later date, either for maintenance and repair, or replacement, provide standard products for which the manufacturer has published assurances that the products and its parts are likely to be available to Owner at a later date.
 - 4. Conform to applicable Specifications, codes, standards, and regulatory agencies.
 - 5. Comply with size, make, type, and quality specified, or as specifically approved in writing by Engineer.
 - 6. Manufactured and Fabricated Products:
 - a. Design, fabricate, and assemble in accordance with the best engineering and shop practices.
 - b. Manufacture like parts of duplicate units to standard sizes and gages, to be interchangeable.
 - c. Equipment and Materials shall be suitable for service conditions intended.
 - d. Equipment capacities, sizes, and dimensions indicated or specified shall be adhered to unless variations are specifically approved in writing by Engineer.
 - e. Provide labels and nameplates where required by regulatory agencies or to state identification and essential operating data.

7. Do not use products for any purpose other than that for which designed.
8. To the fullest extent possible, provide products of the same kind from a single source.

PART 3 - EXECUTION

3.1 Installation of Products

- A. Comply with manufacturer's instructions and recommendations for installation of products in the applications indicated. Anchor each product securely in place except as required for proper movement and performance, and accurately located and aligned with other Work.
 1. Obtain and distribute copies of manufacturer's printed instructions and recommendations if not a part of submittals, containers, or packaging to parties involved in the installation, including a copy to Engineer (and Resident Project Representative).
 2. Maintain one complete set of instructions at the Site during installation and until completion.
 3. Handle, install, connect, clean, condition, and adjust products in accordance with such instructions and in conformance with specified requirements. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with Engineer for further instructions.
- B. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of completion.

PART 4 - MEASUREMENT AND PAYMENT - Not Applicable

END OF SECTION

SECTION 01610

REGULATORY REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Description of applicable codes, ordinances, and regulations.

1.02 CODES AND ORDINANCES

- A. Applicable Codes: Compliance with all laws, ordinances, and regulations of authorities having jurisdiction is an integral requirement of the Contract Documents, whether each code is mentioned or not in the Contract documents.
- B. Compliance: Comply with all applicable codes, ordinances and regulations in effect at the time of bid opening, including but not necessarily limited to the following:
1. 2018 International Building Code with Local amendments.
 2. 2017 National Electrical Code with Local amendments.
 3. 2018 International Plumbing Code with Local amendments.
 4. 2018 International Fire Code with Local amendments and supplemental rules and regulations.
 5. National Fire Protection Association Standards.
 6. Utility Company requirements.
 7. State and Federal Safety and Health Laws.
 8. National Electrical Safety Code (NESC).
 9. Amendments to Codes.
 10. Clean Water Act compliance for storm water and potable water discharges.
 11. NSF International Standards 60 and 61.
- C. Detailed Requirements: Be familiar with and verify detailed requirements of applicable codes to verify that items and their installation provided under Work of this Contract meet or exceed legal requirements.
1. Discrepancies: If discrepancies occur between the Contract Documents, local codes, local utility requirements, etc., most stringent requirements shall apply.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01631

SUBSTITUTIONS

PART 1 - GENERAL

1.1 Submittals

- A. Substitution Request Submittal: Engineer will consider written requests for substitution if received within 14 calendar days of Notice to Proceed. Requests received more than 14 calendar days after Notice to Proceed may be considered or rejected solely at the discretion of the Owner.
1. Submit 3 copies of each request for substitution for consideration. Submit requests in the form and according to procedures required for Change Order proposals. Requests for substitution shall not be submitted in the form of a Request for Information (RFI).
 2. Identify the Equipment or Material, the fabrication, or installation method to be replaced in each request. Include related Specification Section/Article and Drawing numbers.
 3. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
 - a. Statement indicating why specified product or method of construction cannot be provided.
 - b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate the proposed substitution.
 - c. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
 - d. Product data, including drawings and descriptions of products and fabrication and installation procedures.
 - e. Samples, where applicable or requested.
 - f. Identification of available sales, maintenance, repair, and replacement services.
 - g. A statement indicating the effect of the substitution on Contractor's construction progress schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on the overall Contract

Times. If specified product cannot be provided within the Contract Times, provide letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delay in delivery.

- h. An itemized estimate of costs that will result directly or indirectly from approval of the substitution, including:
 - (1) A proposal of the net change, if any, in the Contract Price.
 - (2) Costs of redesign required by the proposed change.
 - (3) Costs of resulting claims as determined in coordination with other contractors having work on the Project affected by the substitution.
 - i. Statement indicating whether or not incorporation or use of the substitute is subject to payment of any license fee or royalty.
 - j. Contractor's certification that the proposed substitution conforms to requirements in the Contract Documents, will perform adequately the functions and achieve the results called for by the general design, is similar in substance to that specified, and is suitable for same use as that indicated and specified.
 - k. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.
4. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation within one week of receipt of a request for substitution. Engineer will notify Contractor of acceptance or rejection of the substitution within 14 calendar days of receipt of the request, or one week of receipt of additional information or documentation, whichever is later. Acceptance, if granted, will be in the form of a Change Order.

PART 2 - PRODUCTS

2.1 Substitutions

- A. Conditions: Engineer will receive and consider Contractor's request for substitution when one or more of the following conditions are satisfied, as determined by Engineer. If the following conditions are not satisfied, Engineer will return the requests without action except to record noncompliance with these requirements.
 - 1. Extensive revisions to the Contract Documents are not required.

2. Proposed substitution is in keeping with the general intent of the Contract Documents and will produce indicated results.
 3. Substitution request is timely, fully documented, and properly submitted.
 4. The specified product or method of construction cannot be provided within the Contract Times. Engineer will not consider the request if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.
 5. The requested substitution offers Owner a substantial advantage, in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
 6. The specified product or method of construction cannot receive necessary approval by a governing authority, and the requested substitution can be approved.
 7. The specified product or method of construction cannot be provided in a manner that is compatible with other materials and where Contractor certifies that the substitution will overcome the incompatibility.
 8. The specified product or method of construction cannot be coordinated with other materials and where Contractor certifies that the proposed substitution can be coordinated.
 9. The specified product or method of construction cannot provide a warranty required by the Contract Documents and where Contractor certifies that the proposed substitution provides the required warranty.
- B. Engineer's review and acceptance of Submittals shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents. Engineer's acceptance of Submittals not complying with the Contract Documents does not constitute an acceptable or valid request for substitution, nor does it constitute approval of a substitution. Acceptance by Engineer shall not relieve Contractor from responsibility for errors or omissions in the Submittals.

PART 3 - EXECUTION - Not Applicable.

PART 4 - MEASUREMENT AND PAYMENT - Not Applicable.

END OF SECTION

SECTION 01715

EQUIPMENT OPERATION AND MAINTENANCE INSTRUCTIONS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

- A. This section of the specification describes the project requirements for equipment manufacturer representatives' instruction of the OWNER's operation and maintenance personnel in the proper operation and maintenance of the equipment furnished under the Contract.
- B. The CONTRACTOR shall require the equipment manufacturer or supplier to include the costs for the on-site operation and maintenance equipment instructions specified herein in their price quotations for the equipment to be furnished under the Contract.
- C. It is the goal and intent of the equipment operation and maintenance instruction specified herein to provide the OWNER's operation and maintenance personnel with technically accurate and current information on the theory, design, practical operation and maintenance, appropriate hands-on or field experience such that the equipment, systems and/or components can be efficiently operated and maintained by the OWNER's staff upon completion of the instruction program.

1.02 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. An experienced and authorized representative of the manufacturer or supplier of each item of equipment listed below shall conduct an instruction program on the proper operation and maintenance of the equipment. Instruction shall be given only by qualified persons who are familiar with the equipment and systems installed in the work. The required amount of continuous on-site instruction for each item of equipment is specified in Divisions 11, 13, 15, 16, and 17.
- B. Equipment manufacturer operation and maintenance manuals, conforming to the requirements of Section 01330 of these specifications, shall be available for use in training.
- C. The CONTRACTOR shall be solely responsible for scheduling the respective equipment operation and maintenance instruction sessions with the ENGINEER and OWNER. The instruction sessions shall be conducted with the installed equipment being fully tested, adjusted and operational. The equipment operation and maintenance instruction may be scheduled to immediately follow the manufacturer or supplier's representative's field inspection and final adjustment of the equipment provided that the representative can certify that the equipment has been installed in accordance with manufacturer's instructions and procedures and

the equipment and controls operate properly.

- D. The equipment operation and maintenance instruction sessions shall, as a minimum, cover the material presented in the manufacturer's O&M user manuals which shall serve as the manual for the instruction program, and the instruction sessions shall consist of both classroom instruction and field hands-on instruction. The instruction sessions for equipment or systems shall include separate material presentations for the mechanical, electrical, and instrumentation portions of the equipment or system. The manufacturer's representative who will be conducting the training program shall prepare an outline of the material to be covered during both the classroom and hands-on field portions of instruction. The outline shall briefly describe what is to be discussed under each item, audio visual aids and other materials to be used in support of the O&M user manual material. The CONTRACTOR shall submit the training program outline to the ENGINEER at least thirty (30) days in advance of the start of the program to allow the ENGINEER adequate time to review its contents. The format and contents of the respective equipment instruction programs shall be changed to incorporate the OWNER's and ENGINEER's review comments on the program outline.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 OPERATION TRAINING - THE OPERATION TRAINING SESSIONS SHALL INCLUDE, BUT NOT BE LIMITED TO, THE FOLLOWING

- A. Overview of the equipment and auxiliary or support systems covering nomenclature, function and theory of operation.
- B. General safety requirements for operation of the equipment and auxiliary or support systems, including suggested safety equipment.
- C. Pre-startup safety and equipment check.
- D. Equipment and auxiliary or support systems startup procedures covering manual and automatic modes, if applicable.
- E. Equipment or system operation and monitoring requirements; including specifics on normally expected ranges for items such as oil, water pressure and temperature, discharge pressures, sensory observations, and procedures to change operation parameters (such as air or flow rate).
- F. Equipment and systems shut down procedures covering manual and automatic and

modes (if available).

- G. Operational troubleshooting of equipment and auxiliary or support systems.
- H. Procedure for handling non-routine operational problems such as response to alarms, power failures, emergency shutdown, and auxiliary or support system failures.

3.02 MAINTENANCE TRAINING - THE MAINTENANCE TRAINING SESSIONS SHALL BE COORDINATED AS EXPLAINED HERE UNDER

- A. If a session is specific to a discipline (electrical, mechanical, electrical/instrumentation) include only appropriate maintenance items for that discipline; if sessions are to include multiple disciplines, include all items for all disciplines and indicate in submittal outline which discipline the material refers to.
- B. All disciplines shall include, but not be limited to, the following:
 - 1. Overview of the equipment and auxiliary or support systems covering nomenclature, function and theory of operation.
 - 2. General safety requirements for maintenance of the equipment and auxiliary support systems appropriate to each discipline including suggested equipment and practices. Cover local and remote lockout procedures, safe procedure for handling alarms and built-in safety devices during preventive and corrective maintenance.
 - 3. Overview of pre-startup, routine operation monitoring, and shutdown procedures covering automatic and manual modes (if applicable).
- C. Each specific discipline shall include, but not be limited to, the following:
 - 1. Provide preventive maintenance procedures to be followed; include parts, lubrication quantities, types, frequencies, application points, and time requirements to perform procedures.
 - 2. Specific procedures to cover adjustments required for alignment, wear, calibration for all preventive maintenance and corrective maintenance procedures including time required to perform.
 - 3. Special tools, techniques or procedures required for either preventive or corrective maintenance of equipment or its' auxiliary or support systems.
 - 4. Assembly and disassembly procedures required for preventive or corrective maintenance (the use of models, "exploded" views, part listed, hands-on field training or other audio visual materials are recommended for this area of training). Include time requirements for procedures performed.
 - 5. Maintenance troubleshooting of equipment and auxiliary systems.

3.03 CERTIFICATES OF INSPECTION

- A. Provide Certificate signed by equipment manufacturer, CONTRACTOR and

OWNER documenting that training was successfully completed.

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.

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 or Guaranty Form if required by Contract Documents.
- B. Provide specified additional warranties, guarantees, and bonds from manufacturers and suppliers.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

DIVISION 2

SITEWORK

SECTION 02072

DEMOLITION, CUTTING AND PATCHING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. All demolition, cutting and patching.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 1 - General Requirements.

1.02 QUALITY ASSURANCE

- A. Use only firms or individual trades qualified to perform work required under this Section.

1.03 SUBMITTALS

- A. Not Used.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. General:
 - 1. Salvage items, designated for OWNER's salvage, as a unit. Clean, list, and tag for storage. Protect from damage and store on site where designated by OWNER. Salvage each item with auxiliary or associated equipment required for operation.

1.05 PROJECT/SITE CONDITIONS

- A. Perform preliminary investigations as required to ascertain extent of work. Conditions which would be apparent by such investigation will not be allowed as cause for claims for extra costs.

1.06 SEQUENCING AND SCHEDULING

- A. Coordinate and reschedule work as required to preclude interference with other operations.

1.07 PERMITS

- A. Obtain and pay for all permits required by all authorities having jurisdiction and notify all involved utility companies.

- B. Obtain approval of authorities having jurisdiction for any work which affects access
- NTUA - Iyanbito Project Specifications
Lift Station Design and Construction

to or exit from such areas. Obtain approval of authorities for any temporary construction which affects such areas.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Non shrink grout:
 - a. Master flow 713 by Master Builders.
 - b. Approved equal.
 - 2. Epoxy bonding adhesive:
 - a. Euco No. 452 MV by Euclid Chemical Co.
 - b. Sikadur 32 Hi-Mod by Sika Corporation.
 - c. Or approved equal.

2.02 MATERIALS

- A. Non shrink Grout:
 - 1. Nonmetallic, noncorrosive and non-staining.
 - 2. Premixed with only water to be added in accordance with manufacturer's instructions at jobsite.
 - 3. Grout to produce a positive but controlled expansion. Mass expansion not to be created by gas liberation or by other means.
 - 4. Minimum compressive strength at 28 days to be 6500 psi.
 - 5. Coat exposed edges of grout with a cure/seal compound recommended by grout manufacturer.
- B. Epoxy Bonding Adhesive:
 - 1. Two component, moisture insensitive adhesive manufactured for the purpose of bonding fresh concrete to hardened concrete.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Provide substantial barricades and safety lights as required.
- B. Provide temporary weather protection as necessary.

3.02 INSTALLATION

- A. Cutting and Removal:
 - 1. Remove existing work indicated to be removed, or as necessary for installation of new work.
 - 2. Neatly cut and remove materials and prepare all openings to receive new work.
 - 3. Remove masonry or concrete in small sections.
- B. Modification of Existing Concrete:
 - 1. Where indicated, remove existing concrete and finish remaining surfaces as specified in Section 03356 (if applicable):
 - a. Protect remaining concrete from damage.
 - b. Make openings by sawing through the existing concrete.
 - c. Concrete may be broken out after initial saw cuts in the event concrete thickness prevents cutting through.
 - d. Where sawing is not possible, make openings by drilling holes around perimeter of opening and then chipping out the concrete:
 - 1) Holes shall be sufficient in number to prevent damage to remaining concrete.
 - 2. Oversize required openings in existing concrete 1 IN on all sides and build back to required opening size by means of non-shrink grout epoxy bonded to the existing concrete.
 - 3. Where oversized openings cannot be made, remove the concrete to the required opening size and cut back exposed reinforcing 1 IN from face of concrete and fill resulting holes with non-shrink grout.
- C. Matching and Patching:
 - 1. Methods and materials:
 - a. Similar in appearance, and equal in quality to adjacent areas for areas or surfaces being repaired.
 - b. Subject to review of ENGINEER.
 - 2. Thoroughly dry and clean all metal surfaces.
 - 3. Prime all bare metal in accordance with Section 09800(if applicable).
 - 4. Dispose of items or materials not designated for OWNER's salvage or reuse. Promptly remove from site.
 - 5. Do not store or sell CONTRACTOR salvaged items or materials on site.
- D. Clean up:
 - 1. Transport debris and legally dispose of off-site.

END OF SECTION

SECTION 02100

CLEARING AND GRUBBING

PART 1 - GENERAL

1.1 Description

A. Description of Work

The work to be performed in accordance with this section includes clearing, grubbing, and disposal of materials, for all ground surfaces within the limits designated on the plans. The work shall include the furnishing of all labor, tools, equipment, materials and the performing of all operations required to provide a complete item in accordance with the project plans and these specifications.

Clearing and grubbing includes the removal of all brush, undergrowth, heavy growth of grass or weeds, debris, rubbish of any nature, obstructions or material which is unsuitable for the foundation of fills, pavements, or other required structures and the disposal of all spoil materials resulting from clearing and grubbing in an approved landfill.

B. Related Work Specified Elsewhere

Removal of Existing Improvements Section 02110
Earthwork Section 02200

1.2 Protection of Property

Protect existing improvements, adjacent property, utilities, trees, plants, or any other existing items which are not specifically intended to be removed.

1.3 Submittals

A. Disposal Area

Describe the location of the disposal area and provide written approval for the use of the area for disposing of waste from the operation. Work performed at the disposal area shall meet all local codes and ordinances.

PART 2 - MATERIALS (NOT APPLICABLE)

PART 3 – EXECUTION

3.1 Limits of Work

Clearing and grubbing operations are to remain within the limits of construction and/or the right-of-way as shown on the plans. Clear and grub only in areas that are affected by excavation or other earthwork operations.

3.2 Construction Methods

Remove all stumps, roots, buried logs, brush, grass, and other unsuitable materials. Grub roots and other projections over 1-1/2 inches in diameter to a depth of at least 18 inches below the finished subgrade or slope elevation.

Backfill all holes remaining after the grubbing operation in accordance with Section 2200, Earthwork.

3.3 Disposal

Dispose of all debris at an approved landfill.

3.4 Burning

No burning shall be permitted.

3.5 Existing Vegetation to Remain

Save all trees and shrubs which will not interfere with excavation or embankment or cause disintegration of the improvements. Coordinate removal of vegetation with the OWNER. Protect trees, shrubbery, vines, plants, grasses and other vegetation growing outside of the limits of construction.

PART 4 - MEASUREMENT AND PAYMENT

4.1 Measurement

No measurement will be made for this item.

4.2 Payment

No payment will be made for Clearing and Grubbing. Clearing and grubbing

shall be considered incidental to other items.

END OF SECTION

SECTION 02110
REMOVAL OF EXISTING
IMPROVEMENTS

PART 1 - GENERAL

1.1 Summary

A. Description of Work

The work to be performed in accordance with this section includes the removal and disposal of various existing improvements, such as concrete pads, structures, pipes, pumps, electrical equipment and other items necessary for the accomplishment of the improvement. The work shall include the furnishing of all labor, tools, equipment, materials and the performance of all operations required to provide a complete item in accordance with the project plans and these specifications.

1.2 Protection of Property

Protect existing improvements, adjacent property, utilities, trees, plants, or any other existing items which are not specifically intended to be removed.

1.3 Disposal

All materials shall be disposed of at an approved landfill, unless otherwise approved by the Owner.

1.4 Submittals

A. Landfill

Provide a copy of the permit to use the landfill.

B. Disposal Area

For sites other than the landfill, describe the location of the disposal area and provide written approval for the use of the area for disposing of waste from the operation. Work performed at the disposal area shall meet all local codes and ordinances.

PART 2 -MATERIALS

2.1 General

Materials required for relocation work shall be as specified herein or as otherwise indicated.

PART 3 - EXECUTION

3.1 Limits of the Work

Confine removal of existing improvements to within the area of construction. Pavement removal shall be limited to an area that is no more than the one week ahead of the projected work. At no time shall the Contractor have asphalt removed from any street longer than 60 days.

3.2 Construction Methods

A. Removal of Existing Concrete pads

1. Saw cut concrete to neat, vertical, true lines in such a manner that the adjoining surface will not be damaged. The full depth of the existing concrete shall be saw cut.

B. Removal of Existing Equipment like pumps, pipes, valves and electrical panels and instrumentation.

Remove all the equipment and instrumentation shown as in plans to accommodate the new installations and improvements.

C. Miscellaneous Removals

Perform all miscellaneous removals as required by the Owner or where indicated on the plans. The miscellaneous removals shall include but not be limited to the following tasks:

1. Relocate existing fences and gates.
2. Remove planter boxes, block walls, concrete walls and footings.
3. Remove existing irrigation systems and replace or plug.
4. Removal and relocation of signs and mailboxes. All City owned signs shall be removed from the areas of construction and delivered to the City as directed. All privately owned signs located within the areas of construction shall be removed and delivered to the property Owner or placed on the adjacent property as directed.

5. All mailboxes located within the areas of construction shall be removed and temporarily reset on the adjacent property for use. When grading and construction is adequately completed, the mailboxes shall be permanently reset at the back of the curb and restored to a better than or equal condition than existing.

3.3 Backfill and Densification

Backfill all holes remaining after removal of existing improvements.

PART 4 - MEASUREMENT AND PAYMENT

4.1 Measurement

No Measurement shall be made for this item.

4.2 Payment

A. Removal of Existing Improvements

If no item is listed in the bid tab or the measurement and payment section, this item is to be considered incidental.

B. Removal of Existing Improvements

Payment will be made at the contract lump sum price. This price shall be full compensation for furnishing all materials, labor, equipment, tools and appurtenances necessary to complete the work.

C. Miscellaneous Removals

All other removals shall be considered incidental to other items. No payment will be made for miscellaneous removals.

See Section 00310 Bid Schedule for Bid Items.

END OF SECTION

SECTION 02200
EARTHWORK

PART 1 - GENERAL

1.1 Description

A. Description of Work

The work to be performed in accordance with this section includes excavation, fill, borrow, spoil and compaction for roadways, structures, channels and embankments. The work shall include the furnishing of all labor, tools, equipment, materials and the performing of all operations required to provide a complete item in accordance with the project plans and these specifications.

B. Related Work Specified Elsewhere

Removal of Existing Improvements Section 02110
Subgrade Preparation.....Section 02600

1.2 Quality Assurance

A. Reference Test Standards and Specifications

ASTM D698, Test Methods for Moisture Density of Soils and Soil-Aggregate Mixtures Using 5.5 lb. Rammer and 12-inch Drop.

ASTM D1556, Density of Soil in Place by the Sand-Cone Method.

ASTM D6938-08a, Density of Soil and Soil-Aggregate in Place by Nuclear Methods.

ASTM D6938-08a, Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods.

Rock Correction Procedure for Maximum Density Determination, ARIZ 227.

B. Frequency of Testing

1. Maximum Dry Density and Optimum Moisture Content, ASTM D698.
 - a. One test for each different class or type of material shall be provided by the CONTRACTOR prior to any earthwork operations.
 - b. CONTRACTOR shall provide additional test when previous test is suspect, due to subtle changes in the material, as determined by the OWNER.
2. Density of Soil In-Place by the Sand Cone or by Nuclear Methods, ASTM D1556 or D6938-08a.
 - a. OWNER will perform a minimum of one test per lift per 5,000 square yards per each type of material.
 - b. OWNER will perform additional tests as required to ensure proper compaction.

C. Testing Tolerances

1. Relative Percent Compaction

Not less than as specified on plans or in these specifications.

2. In-Place Moisture Content

As required to achieve minimum relative compaction.

3. Soft or Yielding Surfaces

Regardless of the percent compaction obtained by test, areas which are soft and yield under the load of construction equipment are to be removed and replaced at no additional cost.

1.3 Submittals

A. Materials Test Reports

Report on maximum dry density and optimum moisture content of soils proposed for use in the work prior to beginning of construction.

B. Disposal Area

Provide the location of the disposal area(s) and provide written approval for the use of the area(s) for disposing of excess soils from the operation. Work

performed at the disposal areas shall meet all local codes and ordinances.

PART 2 - MATERIALS

2.1 Soil and Soil Aggregate Materials

A. Unsuitable materials not to be incorporated in the work.

1. Organic matter such as peat, mulch, organic silt or sod.
2. Soils containing expansive clays.
3. Material containing excessive moisture.
4. Poorly graded coarse material.
5. Material with particle sizes in excess of 12 inches.
6. Material which will not achieve density and/or bearing requirements.
7. Asphalt concrete or Portland cement concrete that does not conform to 3.5 Engineered Fill under Section 2200, Earthwork.

2.2 Earthwork Balance

No attempt has been made to estimate cut and fill earthwork quantities. The CONTRACTOR is solely responsible for the estimation of the earthwork quantities required to construct the project as indicated on the plans and described herein.

PART 3 - EXECUTION

3.1 Preliminary Investigation of the Work

Verify that all preliminary work including clearing, grubbing and staking has been performed in accordance with these specifications prior to earthwork operations.

3.2 Blasting

No blasting will be permitted unless approved by the OWNER. All permits shall be obtained by the CONTRACTOR at his own expense.

3.3 Spoil Disposal Area

Disposal of surplus excavated material shall be in an approved spoil area, outside of the project right-of-way. Make all arrangements necessary for disposal of material at an off-site location. The disposal of surplus materials in the designated area shall meet all local codes and ordinances.

3.4 Excavation

A. Unsuitable Material

Over excavate existing unsuitable material below the lower limit of excavation to a depth that will provide adequate bearing, as determined by the OWNER. Remove unsuitable material from the site and dispose of the material at approved spoil area. Replace the over excavated material with suitable material in accordance with Subsection 3.5 Engineered Fill.

B. Slides and Slipouts

Excavate and grade material outside the finished work which is unstable, or which has slipped out, to the slope and elevation determined by the OWNER. Dispose of excess material at approved spoil disposal area.

C. Slopes

Finish excavation slopes to the lines and grades shown on the plans. Remove all debris and loose materials. Round all grade breaks and slope transitions. Finish elevations on slopes shall not deviate from the plan elevation by more than ".25 feet. Variations from the plan grade and cross section shall be compensating so that the average grade and cross section are obtained.

D. Foundation Excavation

1. Cast in Place Concrete on Rock

Remove sufficient depth of rock surface to expose sound rock. Cut rock to approximate horizontal and vertical steps to provide minimum dimensions. Grout seams and faults in rock surfaces as directed by the OWNER.

2. Cast in Place Concrete on In-Situ Soil

Excavate to the lines shown such that the surface on which the concrete is to rest is undisturbed native material with no loose materials or debris. Replace over excavation with concrete as specified for the structure.

E. Roadway Excavation

Remove the existing pavement and excavate the existing base course and subgrade materials to the new subgrade elevation. Excavate to the cross section as shown on the plan. Prepare the existing soil at the new subgrade elevation in accordance with Section 2600, Subgrade Preparation.

F. Shoring and Sheet piling

Provide such bracing, sheeting or shoring necessary to perform and protect the excavation as required for safety. Shore, sheet and brace excavations as set forth in the rules, orders and regulations of the United States Department of Labor Occupational Health and Safety Administration (OSHA). Provide detailed plan and calculations as prepared by a registered professional engineer for excavations 20 feet in depth or greater or when shoring, sheeting or bracing deviates from OSHA standards. Place and remove shoring, sheeting and bracing so as not to damage adjacent improvements, utilities or utility being placed. Costs for shoring, sheeting and bracing to be incidental to the other items.

3.5 Engineered Fill

A. Subgrade Preparation

Prior to fill placement, plow or scarify the surface to a minimum depth of 6 inches. Moisture condition and compact surface to 95 percent of the maximum density in accordance with Section 2600, Subgrade Preparation.

B. Moisture Conditioning

Condition the soil by aerating or wetting to obtain the moisture content required to achieve the relative percent compaction. Mix the soil such that the moisture content is uniform throughout the lift.

C. Fill Placement

1. Lift Thickness

The uncompacted lift thickness shall not exceed eight (8) inches. When material contains more than 25 percent of rock larger than six (6) inches, the uncompacted lift thickness shall not exceed the maximum particle size dimension.

2. Rock Fill

Rock, broken portland cement concrete and crushed asphalt concrete is permitted in fill areas when conforming to the following:

- a. Place earth or other fine material around the interstices of the pieces to form a dense fill layer. Nesting is not permitted.
- b. Do not place pieces larger than 4 inches closer than 12 inches from any structure.
- c. Do not place pieces larger than 2-1/2 inches closer than 12 inches from the finish subgrade.
- d. Existing asphalt concrete conforming to these requirements for rock fill may be used as fill material only in areas to receive pavement.

3. Benching

When fill is to be placed and compacted on slopes steeper than 5:1 or where new fill is to be compacted against existing fill or where embankment is built 1/2 width at a time, the slopes of original and old or new fills shall be benched as the fill is placed. A new bench shall be started wherever the vertical cut of the next lower bench intersects the existing ground. Material thus cut out shall be recompacted along with the new embankment material by the CONTRACTOR at no additional cost. The vertical bench cut shall not exceed three (3) feet.

D. Compaction

1. Compaction Methods

Water consolidation will not be permitted.

2. Percent Relative Compaction

Compact fill and backfill as indicated on the plan. When not indicated on the plan, compact as specified herein.

a. 95% of maximum dry density

1. Areas to receive fill
2. Areas to receive structures, including pavement, upper two feet of fill
3. Structural backfill

b. 90% of maximum dry density

1. All other areas

PART 4 - MEASUREMENT AND PAYMENT

4.1 Measurement

A. No measurement will be made for the item, Earthwork.

B. Over excavation

Over excavation shall be measured by the cubic yard. The quantity will be computed by the average end area method. The end area is that bound by the original ground line established by field cross sections and the final theoretical pay line established by cross sections shown on the plans subject to verification by the OWNER. After completion of all operations and prior to the placing

of base or subbase material, the final embankment shall be verified by the OWNER by means of field cross sections taken randomly at intervals not exceeding 500 linear feet.

Final field cross sections shall be employed if the following changes have been made:

1. Plan width of embankments or excavations are changed by more than plus or minus 1.0 foot; or
2. Plan elevations of embankments or excavations are changed by more than plus or minus 0.5 foot.

4.2 Payment

A. Earthwork

Payment for earthwork will be made at the contract lump sum price. The lump sum payment shall be full compensation for excavation of existing materials to the new subgrade elevation, subgrade preparation, fill placement, waste, borrow, hauling, and testing required to complete the item. The item shall be full compensation for all materials; for all preparation, hauling, and placing of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

B. Over excavation

Payment for over excavation will be made at the contract cubic yard price. The payment shall be full compensation for excavating the existing material to the depth and section required, hauling and wasting the over excavated material and backfilling with suitable material. This item shall be full compensation for all work including furnishing all materials; for all preparation, hauling, and placing of these materials; and for all labor, equipment, tools, and incidentals necessary to complete the item.

The quantity of this item listed in the bid schedule represents no actual estimate, is nominal only, and may be greatly increased or decreased or reduced to zero. The increase or reduction of this quantity as compared with that set forth in the bid schedule shall not constitute a basis for claim by the CONTRACTOR for extra payment or damages.

See Section 00310 Bid Schedule for Bid Items.

SECTION 02600
SUBGRADE PREPARATION

PART 1 - GENERAL

1.1 Description

A. Description of the Work

The work to be performed in accordance with this section includes the preparation of native or excavated soils prior to the placement of subbase, base course, equipment pads other structures.

The work shall include the furnishing of all labor, tools, equipment, materials and performing all required operations to provide a complete item in accordance with the project plans and these specifications.

B. Related Work Specified Elsewhere

Earthwork Section 2200

1.2 Quality Assurance

A. Reference Test Standards and Specifications

ASTM D1556, Density of Soil in Place by the Sand-Cone Method.

ASTM 1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.

ASTM D6938-08a, Density of Soil and Soil-Aggregate in Place by Nuclear Methods.

ASTM D6938-08a, Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods.

Rock Correction Procedure for Maximum Density Determination, ARIZ 227.

B. Frequency of Testing

1. Maximum Dry Density and Optimum Moisture Content, ASTM D1557.
 - a. One test for each different class or type of material shall be provided by the prior to beginning construction.
 - b. CONTRACTOR shall provide additional test when previous test is suspect, due to subtle changes in the material, as determined by the OWNER.
2. Density of In-Place Soil by the Sand Cone or by Nuclear Methods, ASTM D1556 or D6938-08a
 - a. CONTRACTOR will perform a minimum of one test per lift per 2,000 square yard per type of material.
 - b. CONTRACTOR will perform additional test as required to ensure proper compaction.

C. Testing Tolerances

1. Percent Relative Compaction

Not less than as specified on plans or in these specifications.
2. In-Place Moisture Content

As required to achieve minimum relative compaction.
3. Soft or Yielding Surfaces

Regardless of the percent compaction obtained by test, areas which are soft and yield under the load of construction equipment are to be removed and replaced at no additional cost.

1.3 Submittals

A. Materials Test Report

1. Report on maximum dry density and optimum moisture content prior to beginning of construction.

1.4 Job Conditions

A. Soils Report

This section does not apply to this project.

PART 2 - MATERIALS

2.1 General

A. Unsuitable materials not to be incorporated in the work.

1. Organic matter such as peat, mulch, organic silt or sod
2. Soil containing expansive clays
3. Material containing excessive moisture
4. Poorly graded coarse material
5. Material with particle sizes in excess of 6 inches
6. Material which will not achieve density and/or bearing requirements

2.2 Earthwork Balance

No attempt has been made to estimate cut and fill earthwork quantities. The CONTRACTOR is solely responsible for an estimation of quantities of earthwork materials to construct the project as shown.

PART 3 - EXECUTION

3.1 Preliminary Investigation of the Work

The CONTRACTOR is to satisfy himself that all preliminary work including clearing, grubbing and staking has been performed in accordance with these specifications prior to subgrade preparation.

3.2 Subgrade Preparation

A. Scarification

Scarify and loosen to a minimum depth of 6 inches. Remove any particles

larger than 6 inches.

B. Moisture Conditioning

Condition the soil by aerating or wetting to the moisture content required to obtain the minimum compaction requirements. Mix the soil such that the moisture content is uniform throughout the lift. No payment will be made for conditioning of the soil, wetting, or drying.

C. Compaction

Construct subgrade cut and fill areas to achieve a uniform soil structure. Compact the subgrade to the percent relative compaction indicated on the plans. When not shown on the plan, compact as indicated herein.

Major streets, other streets and traffic ways	95%
Curbs, gutters and sidewalks	95%
Area to receive Engineered fill	95%

D. Subgrade Tolerances

Below pavement, sidewalk, curb and gutter	+1/4 inch
Below base course	+3/4 inch

Variations from the plan grade and cross section shall be compensating so that the average grade and cross section are obtained.

PART 4 - MEASUREMENT AND PAYMENT

4.1 Measurement

No measurement will be made for this item.

4.2 Payment

No payment will be made separately for subgrade preparation. This item shall be considered incidental.

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 - Specification for Tolerances for Concrete Construction and Materials and Commentary.

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 a more, 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 a minimum of 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 water seal 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. Dry pack Mortar for Filling Taper Tie Holes:
 - 1) Consist of mix of one part of Portland Cement to one part of plaster sand.
 - 2) The 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 dry pack 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 the 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, provided 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 for a minimum of 24 hours after concrete is placed.
 - b. If, after 24 hours, concrete has sufficient strength and hardness to resist surface or other damage, forms may be removed.
 - 2. Other Forms 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 dry pack 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 plugs into each of taper tie holes with steel rod. The 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 dry pack mortar as specified in Section 03600.
 - a) Dry pack Mortar: Place in holes in layers with thickness no exceeding tie hole diameter and heavily compact each layer.
 - b) Dry pack the outside of the hole no sooner than 7 days after the inside of the hole has been dry packed.
 - c) Wall surfaces in area of dry packed tie holes: On the water side of water containing structures and the outside of below grade walls:
 - i. Cover with a minimum of 10 mils of epoxy gel.
 - ii. Provide epoxy gel coating on wall surfaces that extend a minimum of 2 inches past dry pack mortar filled tie holes.
 - iii. 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 in the 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 plies 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 deflection 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 or 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 suitable materials.
- 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 required 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 Detailing of Concrete Reinforcement.
 - 3. 318 - Building Code Requirements for Structural Concrete and Commentary.
- 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 Reinforcement, Plain for Concrete.
 - 3. A 615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - 4. A 767 - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
 - 5. E 8 - Standard Test Methods for Tension Testing of Metallic Materials.
 - 6. A 706 - Standard Specification for Deformed and Plain Low-Alloy Steel 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 a 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 a 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 ASTM 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 pattern 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 was 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, loose mill scale, or thick rust coat.
 - 2. Cleaning of Reinforcement Materials: Remove concrete or 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 indicated 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 a 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 placed 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 (do 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 a perfectly flat sheet before placing it 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 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes: Cast-in-place concrete.
- B. Related Sections:
 - 1. Section 03100 - Concrete Formwork.
 - 2. Section 03200 - Concrete Reinforcement.
 - 3. Section 03301 - Epoxies.

1.02 REFERENCES

- A. American Concrete Institute (ACI):
 - 1. 318 - Building Code Requirements for Structural Concrete and Commentary.
 - 2. Manuals of Concrete Practice.
 - 3. Recommended Practices.
- B. American Society for Testing and Materials (ASTM):
 - 1. C 31 - Standard Test Practice for Making and Curing Concrete Test Specimens in the Field.
 - 2. C 33 - Standard Specification for Concrete Aggregates.
 - 3. C 39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - 4. C 40 - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
 - 5. C 42 - Standard Test Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - 6. C 88 - Standard Test Method of Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
 - 7. C 94 - Standard Specification for Ready-Mixed Concrete.
 - 8. C 114 - Standard Test Methods for Chemical Analysis of Hydraulic Cement.
 - 9. C 117 - Standard Test Method for Materials Finer Than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing.
 - 10. C 123 - Standard Test Method for Lightweight Particles in Aggregate.
 - 11. C 131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - 12. C 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

13. C 142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregates.
14. C 143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
15. C 150 - Standard Specification for Portland Cement.
16. C 157 - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
17. C 172 - Standard Practice for Sampling Freshly Mixed Concrete.
18. C 173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
19. C 203 - Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation.
20. C 227 - Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method).
21. C 260 - Standard Specification for Air-Entraining Admixtures for Concrete.
22. C 1260 - Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Mortar Bar Method).
23. C 295 - Standard Guide for Petrographic Examination of Aggregates for Concrete.
24. C 309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
25. C 311 - Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete.
26. C 469 - Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression.
27. C 494 - Standard Specification for Chemical Admixtures for Concrete.
28. C 595 - Standard Specification for Blended Hydraulic Cements.
29. C 618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
30. D 75 - Standard Practices for Sampling Aggregates.

1.03 DEFINITIONS

- A. Alkali: Is defined to mean sum of sodium oxide and potassium oxide calculated as sodium oxide.
- B. Hairline Crack: Crack with a crack width of less than 4 thousandths of an inch.

1.04 SYSTEM DESCRIPTION

- A. Performance Requirements:
 1. General:
 - a. Except as otherwise specified, provide concrete composed of Portland Cement, fine aggregate, coarse aggregate, and water so proportioned and mixed as to produce plastic, workable mixture in accordance with requirements as specified in this Section and suitable to specific conditions of placement.

- b. Proportion materials in manner such as to secure lowest water-cement ratio which is consistent with good workability, plastic, cohesive mixture, and one which is within specified slump range.
 - c. Proportion fine and coarse aggregate in manner such as not to produce harshness in placing nor honeycombing in structures.
- 2. Watertightness of Concrete Work: It is intent of this Section to secure for every part of the Work, concrete and grout of homogeneous structure, which when hardened will have required strength, watertightness, and durability.
 - a. It is recognized that some surface hairline cracks and crazing will develop in the concrete surfaces.
 - b. Construction, contraction, and expansion joints have been positioned in structures as indicated on the Drawings, and curing methods specified, for purpose of reducing number and size of these expected cracks, due to normal expansion and contraction expected from specified concrete mixes.
 - c. Class A and Class B Concrete: Watertight. Repair cracks which develop in walls or slabs and repair cracks which show any signs of leakage until all leakage is stopped.
 - d. Pressure injects visible cracks, other than hairline cracks and crazing, in following areas with epoxy injection system:
 - 1) Floors and walls of water bearing structures.
 - 2) Walls and slabs which are exposed to weather or may be washed down and are not specified to receive separate waterproof membrane.
 - 3) Epoxy used for Injection: Provide epoxy materials that are new and use them within shelf-life limitations set forth by manufacturer. Water-insensitive 2-part type low viscosity epoxy adhesive material containing 100 percent solids and meeting or exceeding the following characteristics when tested in accordance with standards specified Manufacturer:
 - a) Master Builders, Inc., Concessive Standard LVI.
 - b) Sika Chemical Corp.'s, Sikadur 35, Hi-Mod LV.
 - e. Walls or Slabs, as Specified Above, That Leak or Sweat Because of porosity or Cracks too Small for Successful Pressure Grouting: Seal on water or weather side by coatings of surface sealant system, as specified in this Section.
 - f. Grouting and Sealing: Continue as specified above until structure is watertight and remains watertight for not less than one year after final acceptance or date of final repair, whichever occurs later in time.
- 3. Workmanship and Methods: Provide concrete work, including detailing of reinforcing, conforming with best standard practices and as set forth in ACI 318, Manuals, and Recommended Practices.

1.05 SUBMITTALS

- A. Product Data: Submit data completely describing products.
- B. Information on Heating Equipment to be used for Cold Weather Concreting: Submit information on type of equipment to be used for heating materials and/or new concrete in process of curing during excessively cold weather.
- C. For Conditions that Promote Rapid Drying of Freshly Placed Concrete Such as Low Humidity, High Temperature, and Wind: Submit corrective measures proposed for use prior to placing concrete.
- D. Copies of Tests of Concrete Aggregates: Submit certified copies in triplicate of commercial laboratory tests of all sample's concrete aggregates.
 - 1. On tests of concrete aggregates, indicate as minimum all specified tests.
- E. Concrete Mixes: Prior to placement of concrete, submit full details, including mix design calculations for concrete mixes proposed for use for each class of concrete.
 - 1. Include information on correction of batching for varying moisture contents of fine aggregate.
 - 2. Submit source quality test records with mix design submittal.
- F. If there is Change in Aggregate Source, or Aggregate Quality from Same Source: Submit new set of design mixes covering each class of concrete.
- G. Batch Test Data (from supplier):
 - 1. Submit data for each test cylinder.
 - 2. Submit data that identifies mix and slump for each test cylinder.
- H. Repair of defective concrete: Submit mix design for grout.
- I. Acceptance of Method of Concrete Repair: Do not make any repairs until the ENGINEER has accepted method of preparing surfaces and proposed method of repair.
- J. Quality Control Submittals:
 - 1. Certificates of Compliance:
 - a. Cement: Submit certified copy of mill tests, including alkali content, representative of each shipment of cement for verification of compliance with specified requirements.
 - b. Pozzolan:
 - 1) Submit certificates by Pozzolan supplier.
 - 2) Submit certificates that identify source of Pozzolan and certify compliance with requirements of ASTM C 618.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping:
 - 1. Deliver, store, and handle concrete materials in a manner to prevent damage and inclusion of foreign substances.
 - 2. Deliver and store packaged materials in original containers until ready for use.
 - 3. Deliver aggregate to mixing site and handle in such manner that variations in moisture content will not interfere with steady production of concrete of specified degree of uniformity and slump.
- B. Acceptance at Site: Reject material containers or materials showing evidence of water or other damage.

1.07 PROJECT CONDITIONS

- A. Environmental Requirements:
 - 1. Hot Weather Conditions:
 - a. When Ambient Air Temperature is Above 90 Degrees Fahrenheit: Prior to placing concrete, cool forms and reinforcing steel by water cooling to below 90 degrees Fahrenheit.
 - b. Temperature of Concrete Mix at Time of Placement: Keep temperature below 90 degrees Fahrenheit by methods which do not impair quality of concrete.
 - 2. Cold Weather Conditions:
 - a. Concrete Placed Below Ambient Air Temperature of 45 degrees Fahrenheit and falling or below 40 degrees Fahrenheit: Make provision for heating water.
 - b. If Material Have Been Exposed to Freezing Temperatures to Degree That Any Material is Below 35 degrees Fahrenheit: Heat such materials.
 - c. Heating Water, Cement, or Aggregate Materials:
 - 1) Do not heat in excess of 160 degrees Fahrenheit.
 - d. Protection of Concrete in Forms:
 - 1) Protect by means of covering with tarpaulins, or other acceptable covering.
 - 2) Provide means for circulating warm moist air around forms in manner to maintain temperature of 50 degrees Fahrenheit for at least 5 days.
 - 3. For Conditions That Promote Rapid Drying of Freshly Placed Concrete Such As Low Humidity, High Temperature, and Wind: Take corrective measures to minimize rapid water loss from concrete:
 - a. Furnish and use a sufficient number, of maximum and minimum self-recording thermometers to adequately measure temperature around concrete.

1.08 SEQUENCING AND SCHEDULING

- A. Schedule placing of concrete in such manner as to complete any single placing operation to construction, contraction, or expansion joint.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Aggregate:
1. General:
 - a. Provide concrete aggregates that are sound, uniformly graded, and free of deleterious material in excess of allowable amounts specified.
 - b. Grade aggregate in accordance with ASTM D 75 and C 136.
 - c. Provide unit weight of fine and coarse aggregate which produces in place concrete with weight of not less than 140 pounds per cubic foot.
- B. Fine Aggregate:
1. Provide fine aggregate for concrete or mortar consisting of clean, natural sand or of sand prepared from crushed stone or crushed gravel.
 2. Do not provide aggregate having deleterious substances in excess of following percentages by weight of contaminating substances. In no case shall total exceed percent listed.

Item	Test Method	Percent
Removed by decantation (dirt, silt, etc.)	ASTM C 117	3
Shale or Chert	ASTM C 295	1
Clay Lumps	ASTM C 142	1

3. Except as otherwise specified, grade fine aggregate from coarse to fine in accordance with requirements of ASTM C 33.
- C. Coarse Aggregate:
1. General: Provide coarse aggregate consisting of gravel or crushed stone made up of clean, hard, durable particles free from calcareous coatings, organic matter, or other foreign substances.
 2. Weight: Not exceeding 15 percent, for thin or elongated pieces having length greater than 5 times average thickness.
 3. Deleterious Substances: Not in excess of following percentages by weight, and in no case having total of all deleterious substances exceeding 2 percent.

Item	Test Method	Percent
Shale or chert	ASTM C 295	1
Coal and Lignite	ASTM C 123	1/4
Clay lumps and friable particles	ASTM C 142	1/4
Materials finer than Number 200 sieve	ASTM C 117	½*
* Except when material finer than Number 200 sieve consists of crusher dust, maximum amount shall be 1 percent.		

4. Grading:
 - a. Aggregate: As specified in ASTM C 33, Size Number 57, except as otherwise specified or authorized in writing by the ENGINEER.
 - b. Aggregate for Class CE Concrete for Encasement of Electrical Conduits:
 - 1) Graded as specified in ASTM C 33, Size Number 8.
 - 2) Provide concrete utilizing this aggregate equal to Class C concrete in all other respects and is designated as Class CE.

- D. Portland Cement:
 1. General: Conform to specifications and tests for ASTM C 150, Types II or III, Low Alkali, except as specified otherwise.
 2. Low Alkali Portland: Have total alkali containing not more than 0.60 percent.
 3. Exposed Concrete in Any Individual Structure: Use only one brand of Portland cement.
 4. Cement For Finishes: Provide cement from same source and of same type as concrete to be finished.

- E. Portland-Pozzolan Cement:
 1. General: Conform to requirements of ASTM C 595, Type IP (MS).
 2. Portland Cement Clinker Used In Manufacture of Portland-Pozzolan Cement: Type II low alkali as specified in Paragraph 2.01D.
 3. Pozzolan Content of Portland-Pozzolan Cement: Not exceed 15 percent by weight.
 4. Exposed Concrete in Any Individual Structure: Use only one brand of Portland-Pozzolan Cement.

- F. Admixtures:
 1. General:
 - a. Do not use admixtures of any type, except as specified, unless written authorization has been obtained from the ENGINEER.

- b. Compatible with concrete and other admixtures.
 - c. Do not use admixtures containing chlorides calculated as chloride ion in excess of 5% by weight.
 - d. Use in accordance with manufacturer's recommendations accordance with manufacture's recommendations and add each admixture to concrete mix separately.
 - e. A single manufacturer shall provide all concrete admixtures.
- 2. Air Entraining Admixture:
 - a. Provide all concrete with 5 percent, plus or minus 1 percent, entrained air of evenly dispersed air bubbles at time of placement.
 - b. Conform to ASTM C 260.
- 3. Fly Ash Pozzolan Admixture:
 - a. Pozzolan:
 - 1) Adding a mixture shall conform to requirements of ASTM C618, Class F in concrete made with Type II Portland Cement.
 - 2) Pozzolan may replace Portland Cement at ratio of 1.0-pound fly ash for each pound of Portland Cement replaced.
 - 3) Maximum of 20 percent by weight of minimum quantities of Portland Cement listed in Table A under paragraph 2.03E may be replaced with Pozzolan.
 - 4) Do not use Pozzolan as an admixture in concrete made with Portland-Pozzolan cement.
 - b. Loss on Ignition for Pozzolan: Not exceed four percent.
- 4. Water Reducing Admixture:
 - a. May be used at the CONTRACTOR's option in all areas.
 - b. Conform to ASTM C 494, Type A or Type D.
 - c. Not contain air entraining agents.
 - d. Liquid form before adding to the concrete mix.
 - e. No decrease in cement is permitted as result of use of water reducing admixture.
- 5. Superplasticizers: Are not to be used without acceptance by ENGINEER.

G. Water:

- 1. Water for Concrete, Washing Aggregate, and Curing Concrete: Clean and free from oil and deleterious amounts alkali, acid, organic matter, or other substances.
- 2. Chlorides and Sulfate Ions:
 - a. Water for Conventional Reinforced Concrete: Use water not containing more than 1,000 milligrams per liter of chlorides calculated as chloride ion, nor more than 1,000 milligrams per liter of sulfates calculated as sulfate ion.

- H. Nonslip Abrasive:
 - 1. Type: Aluminum oxide abrasive of size 8/16, having structure of hard aggregate, homogenous, non-glazing, rustproof, and unaffected by freezing, moisture, or cleaning compounds.
 - 2. Manufacturers: One of the following or equal:
 - a. Exolon Company, Tonawanda, New York.
 - b. Abrasive Materials, Incorporated, Hillsdale, Michigan.
- I. Concrete Sealer:
 - 1. Manufacturers: One of the following or equal:
 - a. Hillyard Chemical Company, St. Joseph, Missouri, SEAL 341.
 - b. A. C. Horn, Inc., Horn Clear Seal EM-180.
- J. Conduit Encasement Coloring Agent:
 - 1. Color: Red color concrete used for encasement of electrical ducts, conduits, and similar type items.
 - 2. Manufacturers: One of the following or equal.
 - a. Frank D. Davis Company, Red Oxide Number 1117.
 - b. I. Reiss Company, Inc., equivalent product.
- K. Keyway Material: Steel, plastic, or lumber.
- L. Sprayed Membrane Curing Compound: Clear type with fugitive dye conforming to ASTM C 309, Type 1D, unless noted otherwise. After curing, and if subsequent coatings or toppings are specified, the curing compound shall be removed per manufacturer's recommendations.
- M. Surface Sealant System: Manufacturers: One of the following or equal:
 - 1. Radcon Laboratories, Inc., Las Vegas, Nevada, Formula Number 7.
 - 2. IPA Systems, Philadelphia, Pennsylvania, Duripal.

2.02 EQUIPMENT

- A. Mixing Concrete:
 - 1. Mixers may be of stationary plant, paver, or truck mixer type.
 - 2. Provide adequate equipment and facilities for accurate measurement and control of materials and for readily changing proportions of material.
 - 3. Mixing Equipment:
 - a. Capable of combining aggregates, cement, and water within specified time into thoroughly mixed and uniform mass and of discharging mixture without segregation.
 - b. Maintain concrete mixing plant and equipment in good working order and operated at loads, speeds, and timing recommended by manufacturer or as specified.
 - c. Proportion cement and aggregate by weight.

B. Machine Mixing:

1. Batch plant shall be capable of controlling delivery of all material to mixer within 1 percent by weight of individual material.
2. If bulk cement is used, weigh it on separate visible scale which will accurately register scale load at any stage of weighing operation from zero to full capacity.
3. Prevent cement from coming into contact with aggregate or with water until materials are in mixer ready for complete mixing with all mixing water.
4. Procedure of mixing cement with sand or with sand and coarse aggregate for delivery to project site, for final mixing and addition of mixing water will not be permitted.
5. Retempering of concrete will not be permitted.
6. Discharge entire batch before recharging.
7. Volume of Mixed Material Per Batch: Not exceed manufacturer's rated capacity of mixer.
8. Mixers:
 - a. Perform mixing in batch mixers of acceptable type.
 - b. Equip each mixer with device for accurately measuring and indicating quantity of water entering concrete, and operating mechanism such that leakage will not occur when valves are closed.
 - c. Equip each mixer with device for automatically measuring, indicating, and controlling time required for mixing.
 - 1) Interlock device to prevent discharge of concrete from mixer before expiration of mixing period.

C. Transit-Mixed Concrete:

1. Mix and deliver in accordance with ASTM C 94.
2. Total Elapsed Time between Addition of Water at Batch Plant and Discharging Completed Mix: Not to exceed 90 minutes of elapsed time. At project site shall not exceed 30 minutes.
3. Under conditions contributing to quick setting, total elapsed time permitted may be reduced by the ENGINEER.
4. Equip each truck mixer with device interlocked so as to prevent discharge of concrete from drum before required number of turns and furnish such device that is capable of counting number of revolutions of drum.
5. Continuously revolve drum after it is once started until it has completely discharged its batch:
 - a. Do not admit water until drum has started revolving.
 - b. Right is reserved to increase required minimum number of revolutions or to decrease designated maximum number of revolutions allowed, if necessary, to obtain satisfactory mixing. The Contractor will not be entitled to additional compensation because of such increase or decrease.

D. Other Types of Mixers:

1. In case of other types of mixers, mixing shall be as follows:

- a. Mix concrete until there is uniform distribution of materials, and discharge mixer completely before recharging.
- b. Neither speed nor volume loading of mixer shall exceed manufacturer's recommendations.
- c. Continue mixing for minimum of 1-1/2 minutes after all materials are in drum, and for batches larger than one cubic yard increase minimum time 15 seconds for each additional cubic yard or fraction thereof.

2.03 MIXES

A. Measurements of Materials:

1. Measure materials by weighing, except as otherwise specified or where other methods are specifically authorized in writing by the ENGINEER.
2. Furnish apparatus for weighing aggregates and cement that is suitably designed and constructed for this purpose.
3. Accuracy of Weighing Devices: Furnish devices that have capability of providing successive quantities of individual material that can be measured to within one percent of desired amount of that material.
4. Measuring or Weighing Devices: Subject to review by the OWNER and bear valid seal of the Sealer of Weights and Measures having jurisdiction.
5. Weighing Cement:
 - a. Weigh cement separately.
 - b. Cement in Unbroken Standard Packages (Sacks): Need not be weighed.
 - c. Bulk Cement and Fractional Packages: Weigh such cement.
6. Mixing Water: Measured by volume or by weight.

B. Concrete Proportions and Consistency:

1. Concrete Consistency and Composition:
 - a. Provide concrete that can be worked readily into corners and angles of forms and around reinforcement without excessive vibration and without permitting materials to segregate or free water to collect on surface.
 - b. Prevent unnecessary or haphazard changes in consistency of concrete.
2. Ratio of Coarse Aggregate to Fine Aggregate: Not less than 1.0 nor more than 2.0 for all concrete Classes, with exception of Class CE.
3. Aggregate:
 - a. Obtain aggregate from source, which has capability of providing uniform quality, moisture content, and grading during any single day's operation.
4. Concrete Mix Water to Cement Ratio, Minimum Cement Content, and Slump Range: Conform to values specified in Table A in this Section unless otherwise specified.
5. Concrete Batch Weights: Control and adjust to secure maximum yield and at all times maintain proportions of concrete mix within specified limits.
6. Mixture Modification: If required, by the OWNER, modify mixture within limits set forth in this Section.

- C. Concrete Mixes:
1. Proportioning of Concrete Mix: Proportion mixes with required average compressive strength (f'_{CR}) as defined in Subparagraph 2.04A.
 2. Mixes:
 - a. Adjusting of Water: After acceptance, do not change mixes without acceptance by ENGINEER, always, except when adjust batching of water to compensate for free moisture content of fine aggregate.
 - b. Total Water Content of Each Concrete Class: Not exceed those specified in Table A in this Section.
 - c. Checking Moisture Content of Fine Aggregate: Furnish satisfactory means at batching plant for checking moisture content of fine aggregate.
 3. Change in Mixes:
 - a. Undertake new trial batch and test program as specified in this Section.
 - b. Each New Trial Batch and Test Program: Cost of such trial batches and test program shall be borne by CONTRACTOR.
- D. Hand Mixed Concrete:
1. Perform hand mixing of concrete only when requested by the CONTRACTOR in writing and accepted by the OWNER.
 2. Prepare hand mixed concrete on watertight, level platform in batches not to exceed 1/3 cubic yard each.
 3. Aggregate:
 - a. First spread required amount of coarse aggregate on platform in an even and uniform layer, and then over such aggregate spread proper proportion of fine aggregate.
 - b. Combined Depth of Both Such Layers: Not be greater than one foot.
 4. Cement:
 - a. First evenly spread required quantity of cement over fine aggregate.
 - b. Then turn entire batch with shovels at least twice before adding water.
 5. Water:
 - a. Then uniformly sprinkle or spray proper amount of water over batched materials.
 - b. Then turn with shovels not less than three times before being removing from platform.
- E. Classes of Concrete (See Table A on Next Page for Details):
1. Unless specified or otherwise indicated on the Drawings: Use Class A concrete.
 2. Provide concrete consisting of six classes, referred herein as Classes A, AAA, B, C, D and CE specified in this Section and use where specified or indicated on the Drawings.
 3. Weight of Concrete Classes: Provide classes of concrete having minimum weight of 140 pounds per cubic foot.
 4. Class B Concrete: Class B concrete may be substituted for Class A concrete, if high-early strength concrete is desired by the CONTRACTOR, only in

those areas specifically accepted by ENGINEER and which do not require sulfate resistant concrete.

5. Class C Concrete: Class C concrete may be used for fill for unauthorized excavation, for thrust blocks and ground anchors for piping, for bedding of pipe, and where indicated on the Drawings.
6. Class D Concrete: Use Class D for precast concrete items.
7. Class CE Concrete: Use Class CE for electrical conduit encasements.
8. Pumped Concrete: Provide pumped concrete that complies with all requirements of this Section.
9. Do not place concrete with slump outside limits indicated in Table A.
10. Classes:
 - a. Classes A, C, D, and CE Concrete: Make with Type II low alkali cement.

TABLE A - CONCRETE				
Class	Specified Compressive Strength F _c at 28 Days (Pounds per Square Inch)	Maximum Net Water to Cement Ratio	Minimum Cement per Cubic Yard of Concrete by Weight (Pounds)	Slump Range (Inches)
A	4,000	0.53	564	2 to 4*
AAA	3,000	0.57	470	2 to 4*
B (Type III cement)	4,000	0.53	564	2 to 4*
C	2,500	0.71	423	3 to 6
D	4,500	0.45	658	2 to 4
CE	2,500	0.71	423	3 to 6

b. Class B Concrete: Make with Type III low alkali cement.

c. Admixtures: Provide admixtures as specified in this Section.

* NOTE: Slump for slabs, decks, walks, and beams shall be not more than 3-1/2 inches.

2.04 SOURCE QUALITY CONTROL

A. Tests:

1. Concrete Mixes:

- a. After acceptance of concrete mixes, have trial batches of the accepted proposed concrete mix designs prepared by testing laboratory acceptable to the ENGINEER.
- b. Prepare trial batches by using specified cement and aggregates proposed to be used for the Work.
- c. Trial Batches: Provide batches of sufficient quantity to determine slump, workability, consistency and finishing characteristics, and to provide sufficient test cylinders.

- d. Test Cylinders: Provide cylinders having six-inch diameter by 12-inch length and that are prepared in accordance with ASTM C 31 for tests specified in this Section.
 - e. Determine slump in accordance with ASTM C 143.
 - f. Test Cylinders:
 - 1) Test 4 cylinders for compressive strength in accordance with ASTM C 39:
 - a) Test 1 cylinder at 7 days and 2 at 28 days.
 - b) Establish ratio between 7 day and 28-day strength for mix. Seven-day strength may be taken as satisfactory indication of 28 day strength provided effects on concrete of temperature and humidity between 7 day and 28 day are taken into account.
 - 2) Average Compressive Strength of 2 Test Cylinders Tested at 28 Days: Equal to or greater than required average compressive strength F'_{CR} on which concrete mix design is based.
2. Pozzolan:
- a. Sampling and Testing:
 - 1) Sample and test Pozzolan in accordance with ASTM C 311.
 - 2) In Computing Water-Cement Ratio and Cement Content Per Cubic Yard of Concrete: Consider cement weight to be weight of Portland cement plus 100 percent of weight of fly ash.
3. Aggregate:
- a. Testing of concrete aggregate is at CONTRACTOR's expense.
 - b. Sieves:
 - 1) Use sieves with square openings for testing grading of aggregates.
 - 2) Sieve Analysis: If sieve analyses indicate significant change in materials, the ENGINEER may require that new mix design be submitted and accepted before further placing of concrete.
 - c. Sample aggregate in accordance with ASTM D 75 and C 136.
 - d. Fine Aggregate:
 - 1) Provide fine aggregate not containing strong alkali nor organic matter which gives color darker than standard color when tested in accordance with ASTM C 40.
 - 2) Provide aggregate having soundness complying with requirements of ASTM C 33 when tested in accordance with ASTM C 88.
 - 3) Provide aggregate complying with reactivity requirements of ASTM C 33 when tested in accordance with ASTM C 1260.
 - e. Coarse Aggregate:
 - 1) Soundness when tested in accordance with ASTM C 88: Have loss not greater than 10 percent when tested with sodium sulfate.
 - 2) Abrasion Loss: Not exceed 45 percent after 500 revolutions when tested in accordance with ASTM C 131.
 - 3) Reactivity: Not exceed limits specified in Appendix of ASTM C 33 when tested in accordance with ASTM C 227.

f. Portland Cement:

- 1) Determination Alkali Content: Determine by method set forth in ASTM C 114.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Conduit Encasement Concrete: Mix into each cubic yard of concrete 10 pounds of coloring agent.
- B. Joints and Bonding:
 1. As far as practicable construct concrete work as monolith.
 2. Locations of contraction, construction, expansion, and other joints are indicated on the Drawings or as specified in this Section.
 3. Construction Joints:
 - a. Where construction joints are not indicated on the Drawings, provide slabs and walls with construction joints at intervals not greater than 30 feet.
 - b. In order to preserve strength and watertightness of structures, make no other joints, except as authorized by the ENGINEER.
 - c. At construction joints, thoroughly clean concrete of laitance, grease, oil, mud, dirt, curing compound, mortar droppings, or other objectionable matter by means of sandblasting, and wash surfaces just prior to succeeding concrete placement.
 - d. At Horizontal Joints: Immediately prior to resuming concrete placing operations, thoroughly spread bed of grout not less than ½ inch in thickness nor more than 1 inch in thickness over horizontal joint surfaces.
 4. Keyways in Joints:
 - a. Provide keyways in joints as indicated on the Drawings.
 - b. Treat lumber keyway material with form release coating, applied in accordance with manufacturer's instructions.
 5. Take special care to ensure that concrete is well consolidated around and against water stops and that water stops are secured in proper position.
 6. Cleaning of Construction Joints:
 - a. Wash construction joints free of sawdust, chips, and other debris after forms and built and immediately before concrete or grout placement.
 - b. Should formwork confine sawdust, chips, or other loose matter in such manner that it is impossible to remove them by flushing with water, use vacuum cleaner for their removal, after which flush cleaned surfaces with water.
 - c. Provide cleanout hole at base of each wall and column for inspection and cleaning.

7. Expansion, Contraction, and Construction Joints:
 - a. Constructed where and as indicated on the Drawings.
 - b. Expansion Joint Material, Synthetic Rubber Sealing Compound, and Other Similar Materials: As specified in Section 07900.
 8. Repair of Concrete: Where it is necessary to repair concrete by bonding mortar or new concrete to concrete which has reached its initial set, first coat surface of set concrete with epoxy bonding agent as specified in Section 03301.
- C. Conveying and Placing Concrete:
1. Convey concrete from mixer to place of final deposit by methods which prevent separation or loss of materials.
 2. Use equipment for chuting, pumping, and conveying concrete of such size and design as to ensure practically continuous flow of concrete at delivery end without separation of materials.
 3. Design and use chutes and devices for conveying and depositing concrete that direct concrete vertically downward when discharged from chute or conveying device.
 4. Keep equipment for conveying concrete thoroughly clean by washing and scraping upon completion of any day's placement.
- D. Delivery of Concrete:
1. Delivery time of concrete from batch to site of placement shall not exceed 90 minutes at 90° F. The ENGINEER has the right to reject the load if it fails to meet this criteria.
- E. Placing Concrete:
1. Do not place concrete without prior authorization of the ENGINEER.
 2. Do not place concrete until:
 - a. Reinforcement is securely and properly fastened in its correct position and loose form ties at construction joints have been retightened.
 - b. Dowels, bucks, sleeves, hangers, pipes, conduits, bolts, and any other fixtures required to be embedded in concrete have been placed and adequately anchored.
 - c. Forms have been cleaned and oiled prior to placement around rebar to prevent form oil from pelting on rebar.
 3. Placement of concrete in which initial set has occurred, or of retempered concrete, will not be permitted.
 4. Do not place concrete during rainstorms or high velocity winds.
 5. Protect concrete placed immediately before rain to prevent water from having contact with such concrete or winds causing excessive drying.
 6. Always keep sufficient protective covering on hand, for protection of concrete.
 7. After acceptance, adhere to proposed sequence of placing concrete, except when specific changes are requested by the CONTRACTOR and accepted by the ENGINEER.

8. Notify the ENGINEER in writing of readiness, not just intention, to place concrete in any portion of the work:
 - a. Provide this notification in such time in advance of operations as the ENGINEER deems necessary to make final inspection of preparations at location of proposed concrete placing.
 - b. Place forms, steel, screeds, anchors, ties, and inserts in place before notification of readiness is given to the ENGINEER.
 - c. Depositing Concrete:
 - 1) Deposit concrete at or near its final position to avoid segregation caused by rehandling or flowing.
 - 2) Do not deposit concrete in large quantities in one place and work along forms with vibrator or by other methods.
 - 3) Do not drop concrete freely into place from height greater than 4 feet.
 - 4) Use tremies for placing concrete on slopes, at bottom of slope.
 - 5) Commence placement of concrete on slopes, at bottom of slope.
 9. Place concrete in approximately horizontal layers not to exceed 24 inches in depth and bring up evenly in all parts of forms.
 10. Continue concrete placement without avoidable interruption, in continuous operation, until end of placement is reached. The ENGINEER reserves the right to reject the placement if a cold joint is determined to affect the structural integrity.
 11. If more than 20 minutes lapse prior to placement of new concrete over concrete previously placed, reduce depth of layers being placed at one time, and/or increase placing operation to previously placed concrete within 20 minutes.
 12. If concrete is to be placed over previously placed concrete and more than 20 minutes have elapsed, then spread layer of grout not less than ½ inch in thickness nor more than 1 inch in thickness over surface before placing additional concrete.
 13. Placement of Concrete for Slabs, Beams, or Walkways:
 - a. If cast monolithically with walls or columns, do not commence until concrete in walls or columns has been allowed to set and shrink.
 - b. Allow set time of not less than one hour for shrinkage.
- F. Consolidating Concrete:
1. Place concrete with aid of acceptable mechanical vibrators.
 2. Thoroughly consolidate concrete around reinforcement, pipes, or other shapes built into the work.
 3. Provide sufficiently intense vibration to cause concrete to flow and settle readily into place and to visibly affect concrete over radius of at least 18 inches.
 4. Vibrators:
 - a. Always keep sufficient vibrators on hand, to vibrate concrete as placed.

- b. In addition to vibrators in actual use while concrete is being placed, have on hand minimum 1 spare vibrator in serviceable condition.
 - c. Do not place concrete until it has been ascertained that all vibrating equipment, including spares, are in serviceable condition.
 - 5. Take special care to place concrete solidly against forms to leave no voids.
 - 6. Take every precaution to make concrete solid, compact, and smooth, and if for any way defective, repair such concrete in manner acceptable to the ENGINEER.
- G. Footings and Slabs on Grade:
- 1. Do not place concrete on ground or compacted fill until subgrade is in moist condition acceptable to the ENGINEER.
 - 2. If necessary, sprinkle subgrade with water not less than 6 nor more than 20 hours in advance of placing concrete.
 - 3. If it becomes dry prior to actual placing of concrete, sprinkle again, without forming pools of water.
 - 4. Do not place concrete if subgrade is muddy or soft.
- H. Curing Concrete - General:
- 1. Cure concrete by methods specified in this Section.
 - 2. Cure concrete minimum of 7 days.
 - 3. Cure concrete that is to be painted or coated with water or plastic membrane.
 - 4. Do not use curing compound on any concrete surface that is to receive paint or upon which any material is to be bonded.
 - 5. Water cure or plastic membrane cure concrete slabs which are specified to be sealed by concrete sealer.
 - 6. Cure other concrete by water curing or sprayed curing membrane at the CONTRACTOR's option.
- I. Water Curing:
- 1. Keep surfaces of concrete being water cured constantly and visibly moist day and night for period of not less than 7 days.
 - 2. Each day forms remain in place may count as 1 day of water curing.
 - 3. No further curing credit will be allowed for forms in place after contact has once been broken between concrete surface and forms.
 - 4. Do not loosen form ties during period when concrete is being cured by leaving forms in place.
 - 5. Flood top of walls with water at least 3 times per day and always keep concrete surfaces moist, for a 7-day curing period.
- J. Sprayed Membrane Curing:
- 1. Apply curing compound to concrete surface after repairing and patching, and within 1 hour after forms are removed.
 - 2. If more than one-hour elapses after removal forms, do not use membrane curing compound, but apply water curing for full curing period.
 - 3. If surface requires repairing or painting, water cure such concrete surfaces.

4. Curing Compound:
 - a. Do not remove curing compound from concrete in less than 7 days.
 - b. Curing compound may be removed only upon written required by the CONTRACTOR and acceptance by the ENGINEER, stating what measures are to be performed to adequately cure structures.
 - c. Take care to apply curing compound in area of construction joints to see that curing compound is placed within construction joint silhouette.
 - d. Remove curing compound placed within construction joint silhouette by heavy sandblasting prior to placing any new concrete:
 - 1) CONTRACTOR's Option: Instead of using curing compound for curing of construction joints such joints may be water cured.
 - e. Apply curing compound by mechanical, power operated sprayer and mechanical agitator that will uniformly mix all pigment and compound.
 - f. Apply compound in at least 2 coats.
 - g. Apply each coat in direction 90 degrees to preceding coat.
 - h. Apply compound in sufficient quantity so that concrete has uniform appearance, and that natural color is effectively and completely concealed at time of spraying.
 - i. Continue to coat and recoat surfaces until specified coverage is achieved and until coating film remains on concrete surfaces.
 - j. Thickness And Coverage of Compound: Provide compound having film thickness that can be scraped from surfaces at all points after drying for at least 24 hours.
 - k. The CONTRACTOR is cautioned that the method of applying curing compound specified herein may require more compound than normally suggested by manufacturer of compound and also more than is customary in the trade.
 - l. Apply amounts specified herein, regardless of manufacturer's recommendations or customary practice, if curing compound is used in place of water curing.
 - m. If the CONTRACTOR desires to use curing compound other than specified compound, coat sample areas of concrete wall with proposed compound also similar adjacent area with specified compound in specified manner for comparison:
 - 1) If proposed sample is not equal or better, in opinion of the ENGINEER, in all features, proposed substitution will not be allowed.
 - n. Prior to final acceptance of the work, remove, by sandblasting or other acceptable method, any curing compound on surfaces exposed to view, so that only natural color of finished concrete is visible uniformly over entire surface.

K. Plastic Membrane Curing:

1. Polyethylene film may be used to cure slabs. Seal joint and edges with small sand berm.

2. Install plastic membrane as soon as concrete is finished and can be walked on without damage. Keep concrete moist under plastic membrane.

3.02 CONCRETE FINISHING

- A. Provide smooth troweled finish for all process basins and containment structures.
- B. Edges of Joints:
 1. Provide joints having edges as indicated on the Drawings.
 2. Protect wall and slab surfaces at edges against concrete spatter and thoroughly clean upon completion of each placement.

3.03 FIELD QUALITY CONTROL

- A. Testing of Concrete:
 1. During progress of construction, the CONTRACTOR shall have tests made to determine whether the concrete, as being produced, complies with requirements specified.
 2. Tests will be performed in accordance with ASTM C 31, ASTM C 39, and ASTM C 172.
 3. The testing laboratory will make and deliver test cylinders to the laboratory and testing expense will be borne by the CONTRACTOR.
 4. Required Number Cylinders:
 - a. Not less than four-cylinder specimens, 6-inch diameter by 12 inch long, will be tested for each 150 cubic yards of each class of concrete with minimum of four specimens for each class of concrete placed and not less than four specimens for each half day's placement.
 - b. One cylinder will be broken at 7 days and 2 at 28 days.
 5. The CONTRACTOR shall:
 - a. Test slump of concrete using slump cone in accordance with requirements of ASTM C 143.
 - b. Furnish test equipment.
 - c. Do not use concrete that does not meet specification requirements regarding slump but remove such concrete from project site.
 - d. Test slump at the beginning of each placement, as often as necessary to keep slump within the specified range, and when requested to so by the ENGINEER.
 - e. Make provisions for and furnish concrete for test specimens and provide manual assistance to the testing laboratory in preparing said specimens.
 - f. Assume responsibility for care of and providing of curing conditions for test specimens in accordance with ASTM C 31.
- B. Air Entraining Admixture:
 - a. Test percent of entrained air in concrete at beginning of each placement, as often as necessary to keep entrained air within specified ranges, and when requested to do so by the ENGINEER.

- b. Provide test equipment.
 - c. Do not use concrete that does not meet Specification requirements as to air entrainment and shall remove such concrete from project site.
 - d. Test air entrainment in concrete in accordance with ASTM C 173.
- C. Enforcement of Strength Requirement:
 - 1. Concrete is expected to reach higher compressive strength than that which is indicated in Table A as specified compressive strength F'_c .
 - 2. Strength Level of Concrete: Will be considered acceptable if following conditions are satisfied.
 - a. Averages of all sets of 3 consecutive strength test results is greater or equal to specified compressive strength F'_c .
 - b. No individual strength test (average of 2 cylinders) falls below specified compressive strength F'_c by more than 500 pounds per square inch.
 - c. Whenever one, or both, of 2 conditions stated above is not satisfied, provide additional curing of affected portion followed by cores taken in accordance with ASTM C 42 and ACI 318 and comply with following requirements:
 - 1) If additional curing does not bring the average of 3 cores taken in affected area to at least specified compressive strength F'_c , designate such concrete in affected areas defective.
 - 2) The ENGINEER may require the CONTRACTOR to strengthen defective concrete by means of additional concrete, additional reinforcing steel, or replacement of defective concrete, all the CONTRACTOR's expense.

3.04 ADJUSTING

- A. Repair of Defective Concrete:
 - 1. Remove and replace or repair defective work.
 - 2. Correct defective work as specified in this Article.
 - 3. Do not patch, repair, or cover defective work without inspection by the ENGINEER.
 - 4. Provide repairs having strength equal or greater than specified concrete for area involved:
 - a. Chip out and key imperfections in the work and make them ready for repair.
 - 5. Dry-Pack Method:
 - a. Dry Pack Method: Use for holes having depth nearly equal to or greater than least surface dimension of hole, for cone-bolt, and narrow slots cut for repair.
 - b. Smooth Holes: Clean and roughen by heavy sandblasting before repair.
 - 6. Mortar Method of Replacement: Use for following:
 - a. Holes too wide to dry pack and too shallow for concrete replacement.
 - b. Comparatively shallow depressions, large or small, which extend no deeper than reinforcement nearest surface.

7. Concrete Replacement:
 - a. Use: When holes extend entirely through concrete section or when holes are more than 1 square foot in area and extend halfway or more through the section.
 - b. Method of Repair For Surfaces of Set Concrete to be Repaired: First coat with epoxy bonding agent.
8. Acceptable Method of Concrete Repair:
 - a. Make no repair until the ENGINEER has accepted method of preparing surfaces and proposed method of repair.

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 - Standard Test Method for Tensile Properties of Plastics.
 - 2. D 695 - Standard Test Method for Compressive Properties of Rigid Plastics.
 - 3. D 790 - Standard 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., Concessive 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., Concessive 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

SECTION 03356

TOOLED CONCRETE FINISHES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Tooled concrete finishes.

1.02 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping:
 - 1. Deliver and store packages materials in original containers until ready for use.

PART 2 - PRODUCTS

2.01 MIXES

- A. Mortar Mix for F4 Finish: Consist of one part cement and 1-1/2 parts of fine sand passing Number 100 screen, mixed with enough water emulsified bonding agent to have consistency of thick cream.

PART 3 - EXECUTION

3.01 CONCRETE FINISHING

- A. Cement for Finishes:
 - 1. Addition of white cement may be required to produce finish which matches color of concrete to be finished.
- B. Vertical Concrete Surfaces: Use Following Finishes for Vertical Concrete Surfaces (use F4 finish if not otherwise indicated on drawings):
 - 1. F1 Finish: No special treatment other than repair defective work and fill depressions 1 inch or deeper and tie holes with mortar after removal of curing membrane.
 - 2. F2 Finish: No special treatment other than repair defective work, remove fins, fill depressions 1/2 inch or deeper and tie holes with mortar after removal of curing membrane.
 - 3. F3 Finish: Repair defective work, remove fins, offsets, and curing membrane, and grind projections smooth. Fill depressions 1/4 inch or larger in depth or width and tie holes with mortar after removal of curing membrane.
 - 4. F4 Finish:
 - a. Same as specified for F3 Finish, and in addition fill depressions and holes 1/16 inch or larger in width with mortar.

- b. “Brush-Off” sandblast surfaces prior to filling holes to expose all holes near surface of the concrete.
 - c. Thoroughly wet surfaces and commence filling of pits, holes, and depressions while surfaces are still damp.
 - d. Perform filling by rubbing mortar over entire area with clean burlap, sponge rubber floats, or trowels.
 - e. Do not let any material remain on surfaces, except that within pits and depressions.
 - f. Wipe surfaces clean and moist cure.
- 5. F5 Finish: Receive same finish specified for F3 Finish, and, in addition, receive special stoned finish, in accordance with following requirements:
 - a. Remove forms and perform required repairs, patching, and pointing as specified in this Section.
 - b. Wet surfaces thoroughly with brush and rub with hard wood float dipped in water containing 2 pounds of portland cement per gallon.
 - c. Rub surfaces until form marks and projections have been removed.
 - d. Spread grindings from rubbing operations uniformly over surface with brush in such manner as to fill pits and small voids.
 - e. Moist cure brushed surfaces and allow to harden for 3 days:
 - 1) After curing, obtain final finish by rubbing with carborundum stone of approximately Number 50 grit until entire surfaces have smooth texture and are uniform in color.
 - 2) Continue curing for remainder of specified time.
 - f. If any concrete surface is allowed to become too hard to finish in above specified manner, sandblast and wash related surfaces exposed to view, whether finished or not:
 - 1) While still damp, rub over surface, plastic mortar, as specified for brushed surfaces and hand stoned with Number 60 grit carborundum stone, using additional mortar for brushed surfaces until surface is evenly filled without an excess of mortar.
 - 2) Continue stoning until surface is hard.
 - 3) After moist curing for 3 days, make surface smooth in texture and uniform in color by use of Number 50 or Number 50 grit carborundum stone.
 - 4) After stoning, continue curing until 7 day curing period is completed.
- C. Horizontal Concrete: After proper and adequate vibration and tamping, use following finishes for horizontal concrete surfaces as indicated on the Drawings (Use finish S4 unless otherwise indicated on Drawings):
 - 1. S1 Finish: Screened to grade and leave without special finish.
 - 2. S2 Finish: Smooth steel trowel finish.
 - 3. S3 Finish: Steel trowel finish free from trowel marks. Provide smooth finish free of all irregularities.
 - 4. S4 Finish: Steel trowel finish, without local depressions or high points, followed by light hair broom finish. Do not use stiff bristle brooms or brushes. Perform brooming parallel to slab-drainage. Provide resulting finish that is rough enough to provide nonskid finish. Finish shall be subject to review and acceptance by the OWNER.

5. S5 Finish: Nonslip abrasive: After concrete has been screened level and hardened enough to support man standing on a board, sprinkle abrasive from shake screen into surface at uniform rate of 25 pounds for each 100 square feet of surface area, wood float into finish, then trowel abrasive into surface with steel trowel properly exposing abrasive in surface as required to provide nonslip surface.
- D. Concrete Floor Surfaces to Which Surfacing Material is Applied: Finish smooth with tolerance within 1/8 inch in 10 feet in any direction from lines indicated on the Drawings.

END OF SECTION

SECTION 03600

GROUT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Concrete mortar, grout, drypack mortar, nonshrink grout, and epoxy grout.
- B. Related Sections:
 - 1. Section 03301 - Epoxies.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. C 109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars.
 - 2. C 157 - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
 - 3. C 191 - Standard Test Method for Time of Setting of Hydraulic Cement by Vicat Needle.
 - 4. C 827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.
- B. U. S. Corps of Engineers (USCE):
 - 1. CRD C-621 - Corps of Engineers Specification for Non-Shrink Grout.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Concrete Mortar:
 - 1. General: Consist of concrete mixture with coarse aggregate removed and water quantity adjusted as required.
 - 2. At Exposed Concrete Surfaces not to be Painted or Submerged in Water: White cement.
- B. Grout:
 - 1. Consist of mixture of Portland Cement and sand.
- C. Dry-Pack Mortar:
 - 1. Consist of mixture of Portland cement and sand.

- D. Non-Shrink Grout:
1. Consist of hydraulic cement, which when mixed with water hardens rapidly to produce permanent high strength material suitable for exterior use.
 2. Nonmetallic and not contain calcium chloride or other chemicals which accelerate corrosion of embedded steel.
 3. Physical Characteristics:
 - a. When Tested in Accordance with ASTM C 827: Show no shrinkage prior to initial setting.
 - b. When Tested in Accordance with ASTM C 157 and Corps of Engineers CRD C-621: Show no shrinkage in hardened state.
 4. Manufacturers: One of the following or pre-approved equal:
 - a. Master Builders, Inc., Masterflow 928 Grout.
- E. Epoxy Grout:
1. Consist of mixture of epoxy and sand.
 2. Sand: Clean, bagged, graded, and kiln dried silica sand.

2.02 MIXES

- A. Concrete Mortar Mix:
1. Use water-cement ratio that is no more than that specified for concrete being repaired.
 2. At Exposed Concrete Surfaces not to be Painted or Submerged in Water: Use sufficient white cement to make color of finished patch match that of surrounding concrete.
- B. Grout Mix:
1. For Concrete Repair: Mix in same proportions used for concrete being repaired, with only sufficient water to give required consistency for spreading.
 2. For Spreading over the Surfaces of Construction or Cold Joints: Mix with no more water used than allowed by water-cement ratio specified for concrete.
 3. For grout not specified in subparagraph 2.02B1 or 2.02B2, mix in proportions by weight of one part cement to four part of concrete sand.
- C. Dry-Pack Mortar Mix: Use only enough water so that resulting mortar will crumble to touch after being formed into ball by hand.
- D. Non-Shrink Grout: Mix accordance with manufacturer's installation instructions such that resulting mix has semi-fluid, flowable consistency and is suitable for placing by pouring.
- E. Epoxy Grout:
1. Mix in accordance with manufacturer's installation instructions for mixing.
 2. Proportioning:
 - a. For horizontal work, consist of mixture of one part epoxy as specified in Section 03301 with not more than 2 parts sand.
 - b. For vertical or overhead work, consist of 1 part epoxy gel as specified in Section 03301 with not more than 2 parts sand.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Surface Preparation:
 - 1. Concrete Surfaces: Clean and roughen by heavy sandblasting. For portland cement based mortars and grouts, concrete shall be saturated and surface damp before mortar or grout is placed.
 - 2. Epoxy Grout:
 - a. Wet contact surface with prepared grout as required to provide proper adhesion.
 - b. Where required to wet the concrete surfaces, apply coat of epoxy for horizontal work or epoxy gel for vertical or overhead work prior to placing epoxy grout.

3.02 APPLICATION

- A. Cement Mortar and Grout:
 - 1. For Imperfect Concrete Repair:
 - a. Filling: Filling of voids around items through the concrete.
 - b. Grout Spreading: Spread over construction joints, cold joints, and similar type items.
 - 2. Concrete Surfaces:
 - a. Apply epoxy bonding agent to clean, roughened, and dry surface before placing mortar or grout.
 - 3. Placing:
 - a. Exercise particular care in placing portland cement mortar or grout since they are required to furnish structural strength or impermeable water seal or both.
 - b. Do not use cement mortar or grout that has not been placed within 30 minutes after mixing.
- B. Epoxy Grout:
 - 1. Apply in accordance with manufacturer's installation instructions.
 - 2. Use where specified herein or where indicated on the Drawings.

3.03 FIELD QUALITY CONTROL

- A. Tests:
 - 1. Non-Shrink Grout:
 - a. A set of three specimens shall be made for testing. One at seven days, one at 25 days, and the third of a later date if needed.
 - b. Compression test specimens shall be taken during construction from the first day of placement of grout.
 - c. The costs of all laboratory tests shall be borne by the CONTRACTOR.
 - d. Compressive Strength When Tested In Accordance With ASTM C 109:
 - 1) At One Day: Not less than 3,000 pounds per square inch. At 28 days: Not less than 6,000 pounds per square inch.

- e. Setting Time when Tested In Accordance with ASTM C 191: Not less than 30 minutes.

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 necessarily 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 A36M-14 - Standard Specification for Carbon Structural Steel.
2. ASTM A123M-17 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM A153M-16a - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
4. ASTM A307-14e1 - Standard Specification for Carbon Steel Bolts, Studs and Threaded Rod 60,000 psi Tensile Strength.

5. ASTM A484M-18a - Standard Specification for General Requirements for Stainless Bars, Billets and Forgings.
6. ASTM A536-84(2019)e1 - Standard Specification for Ductile Iron Castings.
7. ASTM B633-19 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
8. ASTM F593-17 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
9. Federal Specification FF-S-325 - Shield Expansion; Nail Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry).
10. Federal Specifications WW-H-171E - Hangars and Support, Pipe.
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)
1/2	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 indicated 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. The 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. The 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 embedded concrete is placed, remove protection and clean bolts and inserts.

END OF SECTION

SECTION 05500
METAL FABRICATIONS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. The following shop fabricated steel and aluminum items, including:
 - 1. Cage Ladders
 - 2. Bollards.
 - 3. Gates.
 - 4. Sheet Metal Fabrications.
 - 5. Miscellaneous Steel and Aluminum Shapes.
 - 6. Metal Strut Framing Components.
 - 7. Stud Anchors, Chemical Anchors, Expansion Anchors, and Miscellaneous Fasteners.

1.02 RELATED REQUIREMENTS

- A. Section 03300 - Cast-in-Place Concrete: Placement of metal fabrications in concrete.
- B. Section 09800 – Protective Coating

1.03 REFERENCE STANDARDS

- A. ASTM A36/A36M-14 - Standard Specification for Carbon Structural Steel.
- B. ASTM A53/A53M-18 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- C. ASTM A108-18 - Standard Specification for Steel Bars, Carbon, Cold Finished.
- D. ASTM A123/A123M-17 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- E. ASTM A153/A153M-18 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- F. ASTM A276/A276M-17 - Standard Specification for Stainless Steel bars and Shapes.
- G. ASTM A283/A283M-18 - Standard Specification for Low and Intermediate

Tensile Strength Carbon Steel Plates.

- H. ASTM A307-14e1 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
- I. ASTM A500/A500M-18 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
- J. ASTM A575-96(2018) Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
- K. ASTM A576-17 Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
- L. ASTM A635/A635M-15 - Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, General Requirements for.
- M. ASTM A653/A653M-18 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanized) by the Hot-Dip Process.
- N. ASTM A666-15 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- O. ASTM A1011/A1011M-18a - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
- P. ASTM B117-18 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
- Q. ASTM B209-14 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- R. ASTM B209M-14 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
- S. ASTM B210/B210M-19 - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes.
- T. ASTM B211/B211M-19 - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire.
- U. ASTM B221-14 - Standard Specification for Aluminum and Aluminum-Alloy

Extruded Bars, Rods, Wire, Profiles, and Tubes.

1. ASTM B221M-13 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric].
- V. ASTM C1107/C1107M-17 - Standard Specification for Packaged, Dry, Hydraulic-Cement Grout (Non-shrink).
- W. ASTM E488/E488M-18 - Standard Test Methods for Strength of Anchors in Concrete Elements.
- X. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; American Welding Society; 2012.
- Y. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society; 2015.
- Z. AWS D1.2/D1.2M - Structural Welding Code - Aluminum; American Welding Society; 2007, and Errata 2004.
- AA. SSPC-Paint 15 - Steel Joist Shop Primer; Society for Protective Coatings; 1999 (Ed. 2004).
- BB. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); Society for Protective Coatings; 2002 (Ed. 2004).
- CC. SSPC-SP 2 - Hand Tool Cleaning; Society for Protective Coatings; 2018.

1.04 SUBMITTALS

- A. See Section 01330 for submittal procedures.
- B. Product Data: Provide data for the following.
- C. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
 1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
 2. Gates: Indicate materials, dimensions, connections, and screen wall locations.
- D. Welders' Certificates: Submit certification for welders employed on the project, verifying AWS qualification within the previous 12 months.

PART 2 - PRODUCTS

2.01 MATERIALS – STEEL

- A. Steel Sections: ASTM A36/A36M.
- B. Steel Tubing: ASTM A500, Grade B cold-formed structural tubing.
- C. Bars: ASTM A 36/A 36M.
- D. Plates: ASTM A283.
- E. Pipe: ASTM A 53, Standard Weight, black finish.
- F. Stud Anchors: ASTM A 108, Grade 1015.
 - 1. Product and Manufacturer: S3L, TRW Nelson Stud Welding Division; www.nelsonstudwelding.com or approved equal.
- G. Bolts, Nuts, and Washers: ASTM A307.
- H. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- I. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.
- J. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.02 SHEET MATERIALS

- A. Galvanized Steel Sheet: ASTM A 653/A 653M, with G90/Z275 zinc coating; gage as indicated.
 - 1. If gage is not indicated provide 16 gage sheets.
- B. Stainless Steel Sheet: ASTM A 666 Type 304, soft temper, 0.015 inch thick; smooth No. 4 finish.

2.03 MATERIALS – ALUMINUM

- A. Aluminum Plates, Shapes and Bars: ASTM B 308.
- B. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T5 temper.

- C. Sheet Aluminum: ASTM B209 (ASTM B209M), 5052 alloy, H32 or H22 temper.
- D. Aluminum-Alloy Drawn Seamless Tubes: ASTM B210 (ASTM B210M), 6063 alloy, T6 temper.
- E. Aluminum-Alloy Bars: ASTM B211 (ASTM B211M), 6061 alloy, T6 temper.
- F. Bolts, Nuts, and Washers: Stainless steel.
- G. Welding Materials: AWS D1.2/D1.2M; type required for materials being welded.

2.04 ANCHORS

- A. Anchors with capability to sustain, without failure, load imposed within factors of safety indicated, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency; designed for use in concrete and masonry.
 - 1. Expansion Anchors: Stud type zinc plated carbon steel expansion anchor with a single piece wedge.
 - a. Location: Provide only at locations specifically indicated to receive expansion anchors.
 - 2. Threaded Inserts: Internally threaded, flush mounted, expansion type zinc-plated carbon steel.
 - 3. Chemical Anchors: Two-component injectable adhesive type.

2.05 METAL STRUT FRAMING MATERIALS

- A. Metal Strut Framing System: Structural support system with capability to sustain, without failure, imposed loads; consisting of channels, angles, tubes, and accessories as recommended by manufacturer for application indicated.
 - 1. Channels: Cold formed from structural grade steel conforming to ASTM A570, GR 33 or ASTM A 653, GR 33.
 - 2. Fittings: Fabricated from steel conforming to ASTM A 36, ASTM A 575, ASTM A576, or ASTM A 635.
 - 3. Accessories: Manufacturer's standard nuts, bolts, washers, clamps, hangers, plates, fittings, brackets, threaded rod, inserts, splices, and other fabrications as recommended by manufacturer.
- B. Finish components in accordance with one of the following:
 - 1. Rust-inhibiting acrylic enamel paint, thoroughly baked; conforming to ASTM B 117.

2. Zinc-coated by the hot-dipped process prior to roll-forming, G90 conforming to ASTM A 653.
 3. Zinc coated after all manufacturing, conforming to ASTM A 123 or ASTM A 153.
- C. Product and Manufacturer: Unistrut Metal Framing, Unistrut Corporation, Division of Tyco International LTD: www.unistrut.com or approved equal.

2.06 GROUT AND ANCHORING CEMENT

- A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.07 FABRICATION

- A. Fit and shop assemble items in largest practical sections, for delivery to site.
- B. Fabricate items with joints tightly fitted and secured.
- C. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- D. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- E. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.08 FABRICATED ITEMS

- A. Cage Ladders: Aluminum, in compliance with ANSI A14.3, with extruded heavy-duty tubular side rails, safety cage, ladder platform, cleats, mounting brackets and attachments; Mill finish
1. Product and Manufacturer: 531 Heavy Duty Tubular Rail Access Ladder, O'Keeffe's, Inc.; www.okeeffes.com or approved equal.
 2. Ladder Bottom Support: Manufacturer's standard support bracket designed to anchor bottom of ladder to wall.
 - a. Product and Manufacturer: Alternate Bottom Bracket, O'Keeffe's, Inc.; www.okeeffes.com or approved equal.
 3. Ladder Safety Post: Factory assembled telescoping post, designed for mounting to fixed ladder, complete with brackets, hardware, and fasteners.

- a. Factory Finish: Mill finish aluminum.
 - b. Product and Manufacturer: Model LU-4, The Bilco Company: www.bilco.com or approved equal.
- B. Gates: Steel tubing assembly as detailed; prime paint finish; welded construction with butt joints; drill and tap units to receive hardware, anchors, and similar items.
 - 1. Leaves: Steel tube frame as detailed.
 - 2. Infill Panels: 3/4 inch center to center, woven carbon steel, 10 gage wire mesh, welded to infill channels.
 - a. Infill Channels: 1-1/4 x 1-1/4 x 1/8 inch steel channels as detailed, welded to steel tube frame.
 - 3. Jambs: Structural steel tubes of sizes indicated; fill steel tubes with concrete in field and strike flush with top of tube.
 - a. Stud Anchors: Provide at quarter points of steel tubes in contact with concrete foundation, spaced vertically 24 inches on center; locate studs in staggered arrangement with 12 inch vertical spacing from adjacent quarter point.
 - 4. Gate Hinges: Two pieces, nominal 4 inch high assembly, tooled from 1-1/2 inch diameter solid steel bars; with flat edge for welded connection to gate frame and steel tube (jamb).
 - a. Male (top) piece: Non-removable, 1 inch diameter x 1 inch long solid steel pin, tooled from 1-1/2 inch diameter x 1-1/2 inch long solid steel bar; provide flat edge on side of pin head for welding to gate frame.
 - b. Female (bottom) piece: Non-removable, 1-1/2 inch long solid steel bar with tooled 1-1/16 inch diameter x 1-1/8 inch deep hole to receive pin of male piece; provide flat edge alongside of bar for welding to steel tube (jamb).
 - c. Position hinges on jambs to allow gate leaves to open 90 degrees, minimum.
 - 5. Gate Hasp: Two pieces, non-removable, welded to gate frames.
 - a. Hasp: 1/4 inch thick x 2 inch high steel plate with tooled opening to receive staple; welded to gate frame.
 - b. Staple: 3/16 inch diameter, U-shaped steel rod, aligned with tooled opening on hasp; configured to provide an opening to receive a 1/2 inch diameter padlock when gate is closed; welded to gate frame.
 - 6. Cane Bolts: Non-removable, 1/2 inch diameter L-shaped steel rod, with 6-1/2 inch long handle; fabricated to slide through two pipe guides; and to rest on a keeper stud during closing and opening operations; provide one cane bolt for each gate leaf.

- a. Pipe guides: For each cane bolt provide two, 6 inch long x 5/8 inch inside diameter steel pipes welded to gate frame; locate approximately 24 inches on center vertically.
 - b. Keeper studs: For each cane bolt provide one, 1/2 inch diameter x 1 inch long keeper stud welded to gate frame approximately 6 inches above upper pipe guide; locate to allow leg of cane bolt to rest on keeper stud during closing and opening of gate leaves.
 - c. Sleeves: Galvanized steel pipe sleeves whose inside diameter is sized for close fit with cane bolts, anchored into concrete
- C. Bollards: Steel pipe, with stud anchors, concrete filled, flush concrete cap, as detailed.
 - 1. Diameter: 6-inch.

2.09 FINISHES – STEEL

- A. Prime paint all steel items.
 - 1. Exceptions: Galvanized items indicated.
 - 2. Exceptions: Do not prime surfaces in direct contact with concrete, where field welding is required, and items to be covered with sprayed fireproofing.
- B. Prepare surfaces to be primed in accordance with SSPC-SP2.
- C. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- D. Prime Painting: One coat.
 - 1. Provide shop primer compatible with specified field-applied topcoats.
- E. Galvanizing of Structural Steel Members: Galvanize after fabrication to ASTM A123/A123M requirements. Provide minimum 2.0 oz/sq ft galvanized coating.
- F. Galvanizing of Non-structural Items: Galvanize after fabrication to ASTM A123/A123M requirements.
- G. Stainless Steel Bars and Shapes: ASTM A 276, Type 304 finish.
- H. Stainless Steel Plate: ASTM A 276, Type 304 finish.
- I. Stainless Steel Sheet: ASTM A 666 Type 304, soft temper, 0.015 inch thick; smooth No.4 finish.
- J. Finish Painting: Refer to Section 09 9000.

2.10 FABRICATION TOLERANCES

- A. Squareness: 1/8 inch maximum difference in diagonal measurements.
- B. Maximum Offset Between Faces: 1/16 inch.
- C. Maximum Misalignment of Adjacent Members: 1/16 inch.
- D. Maximum Bow: 1/8 inch in 48 inches.
- E. Maximum Deviation from Plane: 1/16 inch in 48 inches.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

- A. Clean and strip primed steel items to bare metal where site welding is required.
- B. Supply setting templates to the appropriate entities for steel items required to be cast into concrete or embedded in masonry.

3.03 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Field weld components indicated on shop drawings.
- D. Perform field welding in accordance with AWS D1.1/D1.1M.
- E. Obtain approval prior to site cutting or making adjustments not scheduled.
- F. After erection, prime welds, abrasions, and surfaces not shop primed.
- G. Ladders: Install in accordance with manufacturer's recommendations.
- H. Ladder Safety Posts: Install in accordance with manufacturer's recommendations.
- I. Metal Strut Framing Components: Install in accordance with manufacturer's

recommendations.

- J. Anchors: Provide anchorage devices and fasteners where necessary for securing metal fabrications; including, but not limited to: chemical anchors, expansion anchors, threaded inserts, toggle bolts, through-bolts, dowels, threaded rod, lag-bolts, and anchor bolts, and other connections as required to provide for loads; Install in accordance with manufacturer's instructions.
- K. Gate Hinges: Apply white lithium grease to hinge pins prior to assembly; after hinges have been welded in place; remove excess grease prior to field painting.

3.04 TOLERANCES

- A. Maximum Variation from Plumb: 1/4 inch per story, non-cumulative.
- B. Maximum Offset from True Alignment: 1/4 inch.
- C. Maximum Out-of-Position: 1/4 inch.

END OF SECTION

SECTION 05501
MISCELLANEOUS METALS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Miscellaneous metal fabrications including:
 - 1. Miscellaneous aluminum.
 - 2. Miscellaneous cast iron.
 - 3. Miscellaneous stainless steel.
 - 4. Miscellaneous structural steel.
 - 5. Associated accessories to the above items.
- B. Related Sections:
 - 1. Section 05052 - Anchor Bolts, Toggle Bolts, and Concrete Inserts.
 - 2. Section 09900 – Protective Coatings.
- C. See Drawings.

1.02 REFERENCES

- A. Aluminum Association (AA) - Specification M32-C22-A41 - Aluminum Finishes.
- B. ANSI A12.1 - Safety Requirements for Floor and Wall Openings, Railings, and Toe boards.
- C. American Society for Testing and Materials (ASTM):
 - 1. ASTM A36/ A36M-14 - Standard Specification for Carbon Structural Steel.
 - 2. ASTM A48/A48M-03(2016) - Standard Specification for Grey Iron Castings.
 - 3. ASTM A53/A53M-18 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 4. ASTM A123/A123M-17 - Standard Specification for Zinc (Hot-Dip Galvanized) Coating on Iron and Steel Products.
 - 5. ASTM A240/A240M-18 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - 6. ASTM A269/A269M-15a - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
 - 7. ASTM A276/A276M-17 - Standard Specification for Stainless Steel Bars and Shapes.

8. ASTM A307-14e1 - Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
9. ASTM A489-18e1 - Standard Specification for Carbon Steel Lifting Eyes.
10. ASTM A500/A500M-18 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
11. ASTM A501/A501M-14 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
12. ASTM A554-16 - Standard Specification for Welded Stainless Steel Mechanical Tubing.
13. ASTM A635/A635M-15 - Standard Specification for Steel, Sheet and Strip, Heavy Thickness Coils, Hot-Rolled, Alloy, Carbon, Structural, High-Strength Low-Alloy, and High Strength Low Alloy with Improved Formability, General Requirements for.
14. ASTM A653/A653M-18 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-iron Alloy-coated (Galvanized) by the Hot-Dip Process.
15. ASTM B209-14 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
16. ASTM B221-14 - Standard Specification for Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.
17. ASTM F3125/F3125M-18 - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength.

D. AWS D 1.1 - Structural Welding Code.

E. OSHA Part 1910.23 - Guarding Floor and Wall Openings and Holes.

F. International Building Code (IBC).

1.03 SUBMITTALS

A. Shop Drawings: Submit fabrication drawings for approval.

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials: Unless otherwise specified or indicated on the Drawings, structural and miscellaneous metals shall conform to the standards of the American Society for Testing and Materials, including the following:

Item	ASTM Standard No.	Class, Grade Type or Alloy No.
Cast Iron		
Cast Iron	A 48	Class 40B
Steel		
Galvanized sheet iron or steel	A 653	Coating G90
Black steel, sheet or strip	A 569	—
Coil (plate)	A 635	—
Structural plate, bars, rolled shapes,	A 36	—
Standard bolts, nuts, and washers	A 307	—
High strength bolts, nuts and hardened flat washers	F3125	—
Eyebolts	A 489	Type 1
Tubing, cold-formed	A 500	—
Tubing, hot-formed	A 501	—
Steel pipe	A 53	Grade B
Stainless Steel		
Plate, sheet and strip	A 240	Type 304 or 316*
Bars and shapes	A 276	Type 304 or 316*
Aluminum		
Sheet aluminum-flashing	B 209	Alloy 5005-H14, 0.032 inches minimum thickness
Sheet aluminum-structural	B 209	Alloy 6061-T6
Structural aluminum	B 308 B 209	Alloy 6061-T6
Extruded aluminum	B 221	Alloy 6063-T42
* Use Type 304L or Type 316L if material will be welded.		

B. Stainless steels are designated by type or series defined by ASTM.

C. Where stainless steel is welded, use low-carbon stainless steel.

2.02 MISCELLANEOUS ALUMINUM

- A. General: Fabricate aluminum products, not covered separately herein, in accordance with the best practices of the trade and field assemble by riveting or bolting. Do not weld or flame cut.

2.03 MISCELLANEOUS CAST IRON

- A. General:
 - 1. Tough, gray iron, free from cracks, holes, swells, and cold shuts.
 - 2. Quality such that hammer blow will produce indentation on rectangular edge of casting without flaking metal.
 - 3. Before leaving the foundry, clean castings and apply 16 mil dry film thickness coating of coal-tar epoxy, unless otherwise specified in or indicated on the Drawings.

2.04 MISCELLANEOUS STAINLESS STEEL

- A. Provide miscellaneous stainless steel items not specified herein as indicated on the Drawings or specified elsewhere. Fabricate and install in accordance with the best practices of the trade.

2.05 MISCELLANEOUS STRUCTURAL STEEL

- A. Provide miscellaneous steel items not specified herein as indicted on the Drawings or specified elsewhere. Fabricate and install in accordance with the best practices of the trade.
- B. Fastenings and Fasteners: As recommended or furnished by railing manufacturer for use with this system.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Examine Work in place to verify that it is satisfactory to receive the Work of this Section. If unsatisfactory conditions exist, dot not begin this Work until such conditions have been corrected.

3.02 INSTALLATION, GENERAL

- A. Install products as indicated on the Drawings, and in accordance with shop drawings and manufacturer's printed instructions, as applicable except where

specified otherwise.

3.03 LADDERS

- A. Secure to supporting surface with bent plate clips providing minimum 8 inches between supporting surface and center of rungs.
- B. Where exit from ladder is forward over top rung, extend side rails 3 feet 6 inches minimum above landing, and return the rails with a radius bend to the landing.
- C. Where exit from ladder is to side, extend ladder 5 feet 6 inches minimum above landing and rigidly secure at top.
- D. Erect rail straight, level, plumb, and true to position indicated on the Drawings. Correct deviations from true line or grade which is visible to the eye.
- E. Ladders to be fabricated of aluminum, unless noted otherwise.

3.04 RAILING

- A. During construction, keep exterior surfaces of railing covered with 0.4 millimeters, minimum, heat shrink polyethylene film.
- B. Do not remove protective film before railing have been accepted by OWNER nor before other Work in proximity of handrails and guardrails has been completed.
- C. Discontinue railing at lighting fixtures.
- D. Provide 1/8 inch diameter weep hole at base of each post.
- E. Where protection is applied for prevention of dissimilar materials electrolysis, make application such that none of the protective material is visible in the completed assembly.
- F. Space posts as indicated on the Drawings.
- G. Anchor post into concrete by grouting posts into core drilled holes in concrete, into stainless steel sleeves cast in concrete; or bracket mount to face of concrete surfaces; as specified and indicated on the Drawings.
- H. Space rails as indicated on the Drawings.
- I. Make adequate provision for expansion and contraction of kickplates and rails. Make provisions for removable sections where indicated on the Drawings.

- J. Make lower rails a single, unspliced length between posts, or continuous.
- K. Make top rails continuous whenever possible, and attach single, unspliced length to 3 posts minimum.
- L. Draw up fasteners tight with hand wrench or screw driver.
- M. Space attachment brackets as indicated on shop drawings or in manufacturer's installation instructions.
- N. Completed installation shall have railing rigid and free of play at joints and attachments.
- O. Protect railing finish from scratches, gouges, dents, stains, and other damage.
- P. Replace damaged or disfigured railing with new.
- Q. Shortly before final acceptance of the Work, and after removal of protective polyethylene film, clean railing with mild detergent or with soap water.
- R. After cleaning, thoroughly rinse railing and wipe with soft cloth.
- S. Erect railing straight, level, plumb, and true to the positions as indicated on the Drawings. Correct deviations from true line of grade which are visible to the eye.

3.05 MISCELLANEOUS ALUMINUM

- A. Coat aluminum angles cast into concrete with bituminous materials.

END OF SECTION

DIVISION 9

FINISHES

SECTION 09900

PROTECTIVE COATINGS

PART 1 - GENERAL

1.1 Summary

- A. This Section includes coating of exterior and interior surfaces throughout the Project and which are listed in PART 2 with systems specified in PART 2.
- B. Coating systems include surface preparation, prime coat (first coat), finish coats (second and third coats), inspection, cleaning, and touch-up of surfaces and equipment. Shop preparation, prime coat, and finish coats to be shop-applied, may be specified elsewhere or referenced to this Section so that a complete system is specified and coordinated.
 - 1. Where surface preparation and first (prime) coat are specified in other Sections to be shop-applied, such as for structural steel, or equipment, only the touch-up and finish coats are a part of field painting. Surface preparation is the required degree of preparation prior to application of first (prime) coat regardless if done in shop or field.
 - 2. If materials are provided without shop primer then surface preparation, first, second, and third coats are a part of field painting.
 - 3. Concealed surfaces are generally not required to have finish-coats unless otherwise specified, but prime coat should be applied and touched up prior to concealment.
 - 4. Where Equipment and Materials are provided with shop-applied finished coating system, only touch-up is a part of field painting.
 - 5. Refer to applicable Sections to determine whether surface preparation and first coat, or complete coating system, is to be shop-applied.
- C. Related Work Specified Elsewhere
 - 1. Shop Painting and Coatings: All applicable Divisions.
 - 2. Factory Prefinished Items: All applicable Divisions.

D. Colors

1. Color of finish coatings shall match accepted color Samples.
2. When second and finish coats of a system are of same type, tint or use an alternate color on second coat to enable visual coverage inspection of the third coat. When first and second coats only are specified and are of same or different types, tint or use an alternate color on first coat to enable visual coverage inspection of the second coat.
3. Contract Price shall include the following approximate number of finish coat colors to form a basis for bidding:
 - a. Epoxy: Eight colors, with 50% deep tone colors.
 - b. Ceramic: Two colors, with 50% deep tone colors.

1.2 Quality Assurance

A. Reference Standards and Specifications

1. American National Standards Institute (ANSI)

ANSI A 13.1 - Scheme for the Identification of Piping Systems.

ANSI Z 53.1 - Safety Color Code for Marking Physical Hazards.
2. American Society for Testing and Materials (ASTM)

ASTM D4258 - Surface Cleaning Concrete for Coating.

ASTM D4261 - Surface Cleaning Concrete Unit Masonry for Coating.
3. Society for Protective Coatings (SSPC) Surface Preparation Specifications

SP1 - Solvent Cleaning: Removes oil, grease, soil, drawing and cutting compounds, and other soluble contaminants.

SP2 - Hand Tool Cleaning: Remove loose material. Not intended to remove adherent mill scale, rust, and paint.

SP3 - Power Tool Cleaning: Removes loose material. Not intended to remove all scale or rust.

SP5 - White Metal Blast Cleaning: Removes all scale, rust, foreign matter. Leaves surface gray-white uniform metallic color.

SP6 - Commercial Blast Cleaning: Two-thirds of each square inch free of all visible residues; remainder only light discoloration.

SP10 - Near-White Metal Blast Cleaning.

SP11 - Power Tool Cleaning to Bare Metal.

4. American Waterworks Association (AWWA)

Standard for Painting and Repainting Steel Tanks, Stand-Pipes, Reservoirs, and Elevated Tanks for Water Storage, D-102.

5. American Concrete Institute (ACI)

ACI 515.1R Guide to the Use of Waterproofing, Damp-proofing, Protective and Decorative Barrier Systems for Concrete

B. Include on label of container:

1. Manufacturer's name, product name, and number.
2. Type of paint and generic name.
3. Color name and number.
4. Storage and temperature limits.
5. Mixing and application instructions, including requirements for precautions which must be taken.
6. Drying, recoat, or curing time.

C. Pre-painting Conference

1. Before Project field painting starts, representatives for the Owner, Contractor, coating applicator, and coating manufacturer's technical representative shall meet with Engineer.

2. Agenda for the meeting will include details of surface preparations and coating systems to ensure understanding and agreement by all parties for compliance.

D. Warranty

1. The coating manufacturers and applicators shall warrant their products and applications respectively against defects for a period of five (5) years under normal use. The warranty shall be in printed form.

- E. In the event a problem occurs with coating system, surface preparation, or application, coating applicator and coating manufacturer's technical representative shall promptly investigate the problem and submit results to Engineer.

- F. Stated VOC shall be unthinned maximum VOC certified by manufacturer.

- G. A coating report shall be completed daily by Contractor at each phase of the coating system starting with surface preparation. These shall be submitted on the form attached at the end of this Section.

1.3 Submittals

- A. Submit as specified in Section 1330.

- B. Includes, but not limited to, the following:

1. Schedule of products and paint systems to be used. Schedule shall include the following information:
 - a. Surfaces for system to be applied.
 - b. Surface preparation method and degree of cleanliness.
 - c. Product manufacturer, name, and number.
 - d. Method of application.
 - e. Dry-film mil thickness per coat of coating to be applied.
2. Color charts for selection and acceptance.
3. Technical and material safety data sheets.

4. Certification by coating manufacturer(s) that all coatings are suitable for service intended as stated on each coating system sheet. If manufacturer has an equivalent product as that specified, but it is not suitable for the intended purpose, he shall submit the recommended product for approval at no increase in cost, and state reasons for substitution.
5. Contractor shall certify in writing to the Engineer that applicators have previously applied all the systems in this Specification and have the ability and equipment to prepare the surfaces and apply the coatings correctly.

1.4 Delivery, Storage, and Handling

A. Delivery of Materials

1. Deliver in original unbroken sealed containers with labels and information legible and intact. Containers shall also have correct labels with required information.
2. Allow sufficient time for testing if required.
3. Open and mix on the premises and in the presence of the Engineer. Any rejected material shall be at once removed from the premises. Colors shall be as selected by Engineer.

B. Storage of Materials

1. Store only acceptable materials on Project site in enclosed structures to protect them from weather and excessive heat and cold. Store in accordance with County and State Safety Codes.
2. Provide separate area and suitable containers for storage of coatings and related coating equipment.
3. Dispose of used or leftover containers, thinners, rags, brushes, and rollers in accordance with applicable regulations.

1.5 Regulatory Requirements

- A. In addition to requirements specified elsewhere for environmental protection, provide coating materials that conform to the restrictions of the local and regional jurisdiction. Notify Engineer of any coating specified herein that fails to conform to the requirements for the location of the project or location of application.

- B. Lead Content: Use only coatings that are totally lead free except for zinc-rich primers which shall not have a lead content over 0.06% by weight of nonvolatile content.
- C. Chromate Content: Do not use coatings containing zinc-chromate or strontium chromate.
- D. Asbestos Content: Materials shall not contain asbestos.
- E. Mercury Content: Materials shall not contain mercury or mercury compounds.

1.6 Project Conditions

- A. This Project is in a location in which drifting coatings, if spray-applied, could contaminate adjacent surfaces or vehicles nearby. All containment precautions and application methods shall be taken into consideration and implemented to prevent the above from occurring.

1.7 Inspection Service

- A. Owner will engage in the services of an independent NACE certified coating inspection service, Level III certification.
- B. Inspection service will provide full-time inspection of all field surface preparation and coating applications to ensure full compliance with the requirements of this Specification. The presence of the inspection service shall not relieve Contractor for compliance with Specifications or authorized changes.
- C. Inspection service will document all work, including nonconformance, using forms acceptable to Owner and Engineer. All documentation and reports will be prepared and signed by the Inspection service representative, and submitted to Engineer on a daily basis. At the completion of all coating applications, Inspection service representative will also submit a conformance report certifying that all Work relative to coatings complies with the Specifications or authorized change.
- D. Inspection service will be responsible for field verification and recommendations of the following field coating operations:
 - 1. Surface preparation methods, equipment.

2. Substrate conditions, moisture content of concrete, substrate profiles, and surface temperatures.
 3. Temperature, humidity, and wind conditions at times of coating applications.
 4. Specified or approved coating verification.
 5. Application equipment.
 6. Coating wet and dry film thickness.
 7. Proper coating curing.
 8. Coating system failure, causes, and remedy.
- E. Inspection service representative will discuss with Engineer, Owner, and Contractor all recommended Specification deviations, changes in products, or application methods.

PART 2 - MATERIALS

2.1 Acceptable Manufacturers

A. Acceptable manufacturers are as follows:

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

2.2 General

- A. Materials furnished for each coating system must be compatible to the substrate.

- B. When unprimed surfaces are to be coated, entire coating system shall be by the same coating manufacturer to assure compatibility of coatings.
- C. When shop-painted surfaces are to be coated, ascertain whether finish materials will be compatible with shop coating. Inform Engineer/ Architect of any unsuitable substrate or coating conditions.
- D. Coating system shall be as specified below or to the manufacturer's standard, whichever is more stringent.

2.3 Areas of Application

- A. Submerged Concrete Surfaces, exposed to H₂S vapor:
 - 1. Surface Preparation and coating system: In accordance with manufacturer's recommendations.
 - 2. Applied to all concrete surfaces including floors, walls, baffles and ceilings.
 - 3. Product and Manufacturer:
 - a. Sauereisen 210
 - b. Raven 405
 - c. Plasite 5371
 - d. Or approved equal.
- B. Ferrous Metals including all Structural Steel, Miscellaneous Ferrous Metals, and all Ferrous Piping; Interior Non-submerged:
 - 1. Surface Preparation: SSPC-SP6 Commercial Blast Cleaning as specified in Paragraph 3.1.
 - 2. Interior non-submerged applies to areas that are housed within a building and/or within a non-process, enclosed structure.
 - 3. Product and Manufacturer: Provide one of the following:
 - a. Tnemec:
 - 1) Shop Primer: 66 H.B. Epoxoline – two coats, 2-3 dry mils per coat
 - 2) Field Primer or Field Touchup: 66 H.B. Epoxoline – one coat, 2-3 dry mils per coat.
 - 3) Finish: 69 H.B. Epoxoline II – two coats, 4-5 dry mils per coat.
 - b. Or approved equal
- C. Ferrous Metals, Including all Ferrous Piping; Exterior Non-submerged:
 - 1. Surface Preparation: SSPC-SP6 Commercial Blast Cleaning as specified in Paragraph 3.1.

2. Exterior non-submerged applies to areas that are not housed within a building or structure, and that are not located within process and / or water carrying structures or tanks.
 3. Product and Manufacturer: Provided one of the following:
 - a. Tnemec:
 - 1) Primer: 66 H.B. Epoxoline – tow coats, 2-3 dry mils per coat.
 - 2) Intermediate: 69 H.B. Epoxoline II – one coat, 4-5 dry mils.
 - 3) Finish: 75 Endura-Shield – tow coats, 1.5-2 dry mils per coat
 - b. Or approved equal.
- D. Galvanized Metal and Non-Ferrous Metal; Interior Non-Submerged:
1. Surface Preparation: SSPC-SP1 Solvent Cleaning, as specified in Paragraph 3.1.
 2. Interior non-submerged applies to areas that are housed within a building and/or within a non-process, enclosed structure.
 3. Product and Manufacturer: Provide one of the following:
 - a. Tnemec:
 - 1) Primer: 66 H.B. Epoxoline – one coat, 3-4 dry mils
 - 2) Finish: 69 H.B. Epoxoline II – one coat, 4-5 dry mils.
 - b. Or approved equal.
- E. All Aluminum in Contact with Dissimilar Materials:
1. Surface Preparation: Remove all foreign matter.
 2. Product and Manufacturer: Provide one of the following:
 - a. Tnemec:
 - 1) 66 H.B. Epoxoline – two coats, 2.0 – 3.0 dry mils per coat
 - b. Or approved equal.
- F. PVC Piping, CPVC Piping, Fiberglass, Fiberglass Insulation Covering; Exterior:
1. Surface Preparation: Sand as specified by the coating manufacturer.
 2. Exterior applies to areas that are not housed within a building and/or within an enclosed structure.
 3. Product and Manufacturer: provide one of the following
 - a. Tnemec:
 - 1) Primer/Intermediate: 66 H.B. Epoxoline – one coat each, 2.0 – 3.0
 - 2) Finish: 75 Endura-Shield – one coat, 3.0 dry mils
 - b. Or approved equal.

- G. PVC Piping, CPVC Piping, Fiberglass, Fiberglass Insulation Covering; Interior Non-Submerged:
1. Surface Preparation: Sand as specified by the coating manufacturer.
 2. Product and Manufacturer: Provide one of the following:
 - a. Tnemec:
 - 1) Primer/Intermediate/Finish: 66 H.B. Epoxoline – one coat each, 2.0 – 3.0 dry mils per coat.
 - b. Or approved equal.
- H. Steel and Galvanized Steel Pipe; Buried Exterior:
1. Surface Preparation: SSPC-SP10, Near-White Blast, as specified in Paragraph 3.1.
 2. Product and Manufacturer: Provide one of the following:
 - a. Tnemec:
 - 1) Primer: 66-1211 Epoxoline – two coats, 3-4 dry mils per coat.
 - 2) Field Primer or Field Touchup: Surface preparation as specified.
 - 3) Finish: 46-413 Tneme-Tar – two coats, 10.0 dry mils per coat.
 - b. Or approved equal.
- I. Submerged or Intermittently Submerged Ferrous Metals; Interior and Exterior:
1. Definition: Submerged shall apply to all metals below the maximum water surface elevation in open top structure unless otherwise noted or otherwise shown; and to all metals within liquid or residual solids carrying structures that are covered, including all metals on the underside of the covers unless otherwise noted or otherwise shown; and to all metals within an enclosed process structure. This shall apply to all metals whether intermittently or continuously submerged.
 2. Surface Preparation: SSPC-SP 10 Near-White Blast Cleaning as specified in Paragraph 3.1.
 - a. Tnemec:
 - 1) Primer: 69-1211 Epoxoline II – tow coats, 3-4 dry milsper coat.
 - 2) Intermediate: 69 H.B. Epoxoline II – tow coats, 5 dry mils per coat.
 - 3) Finish: 69 H.B. Epoxoline II – two coats, 5 dry mils per coat.
 - b. Or approved equal.

- J. Special Requirements for Aluminum:
1. Aluminum surfaces bearing in or embedded in concrete and fayin surfaces of bolted aluminum joints, except anchor bolts, shall be given two coats of 66 H.B. Epoxoline Primer, or approved equal. The primer shall be allowed to dry between coats and before concrete is poured against it.
 2. Where aluminum metals are placed in contact with or fastened to ferrous or stainless steel metals, the contact surfaces of each shall receive the protective coating specified for that metal and a gasket shall be placed between the two contact surfaces. The gasket material shall be non-conductive commercial grade neoprene, 60 durometer, 0.03-inch in thickness unless otherwise specified. Bolts shall be isolated using one piece non-conductive sleeves and washers as manufactured by PSI Products, Inc., Burbank, California: Parker Seal Col, Culvert City, California, or approved equal.
- K. Galvanizing: All galvanizing, where called for in the Contract Documents, shall be hot-dip process conforming to ASTM A-123:
1. Surface Preparation: All surfaces to be clean and free of contaminants prior to application of the coating system.
 2. Prime Coat: Series 104 H.S. Epoxy; one coat 4-5 mils DFT.
 3. Finish Coat: Series 104 H.S. Epoxy; one coat 4-54 mils DFT.
- L. Concrete Semi-Gloss Latex:
1. Surface Preparation: All surfaces to be clean and free of contaminants prior to application of the coating system.
 2. Prime Coat: Series 7 Tneme-Cryl; one coat 2-3 mils DFT.
 3. Finish Coat: Series 7 Tneme-Cryl; one coat 2-3 mils DFT.
- M. Ductile and Cast Iron (Exterior Exposure):
1. Surface Preparation: Solvent scrub with stiff bristle brush followed by brush-off abrasive blast cleaning to a minimum surfaces profile depth of 1.5 mils.
 2. Prime Coat: Series 69-1255 (beige) H.B. Epoxoline II: one coat 3-5 mils DFT.
 3. Finish Coat: Series 73 Endura-Shield; one coat 3-4 mils DFT.
- N. Ductile and Cast Iron (Interior Exposure):
1. Surface Preparation: Clean, dry, and free of contaminants

2. Prime Coat: Series 135 Chembuild; one coat 4-6 mils DFT.
3. Finish Coat: Series 69 H.B. Epoxoline II; one coat 4-6 mils DFT.

O. Ductile and Cast Iron (Buried):

1. Surface Preparation: Solvent scrub with stiff bristle brush followed by brush-off abrasive blast cleaning to a minimum surface profile depth of 1.5 mils.
2. Prime Coat: Series 69-1255 (beige) H.B. Epoxoline II; one coat 3-5 mils DFT.
3. Finish Coat: Series 69 H.B. Epoxoline II; one coat 4-6 mils DFT.

P. Ductile and Cast Iron (Immersion):

1. Surface Preparation: Solvent scrub with stiff bristle brush followed by brush-off abrasive blast cleaning to a minimum surface profile depth of 1.5 mils.
2. Prime Coat: Series 66 H.B. Epoxoline; one coat 4-6 mils DFT.
3. Finish Coat: Series 69 H.B. Epoxoline II; one coat 4-6 mils thick.

Q. Stainless Steel Duct (Buried):

1. Surface Preparation: SSPC-SP6 Commercial Blast Cleaning or manufacturer's recommendations, whichever is more stringent.
2. Prime Coat: Polyken 1019 or 1027, or approved equal.
3. Finish Coat: Polyken 905 tape, or approved equal.

2.4 Surfaces Not to be Coated

A. Do not field paint any of the following items unless specifically noted otherwise.

1. Factory finished equipment, except for touch-up.
2. Metal surfaces of aluminum, stainless steel, copper, bronze and similar finished materials.
3. Equipment nameplates, valve stems, moving shafts and linkages.

2.5 Color Coding of Piping

A. Color Coding of Piping: Exterior and interior by color coding entire pipe.

1. General

- a. Coat piping with solid colors as specified below for entire length of pipe in exposed finished and unfinished areas. Exclude areas in pipe chases and furred areas.
- b. Coat all other piping in colors matching adjacent surfaces. If adjacent area is unfinished, paint in color determined by Engineer/Architect.
- c. Identify piping with letters, arrows and bands as specified below. Apply after completion of finish coating.

2. Color Scheme

Description	Pipe and Band Color	Letter and Arrow Color
Potable Water (hot or cold)	Light blue	Black
Nonpotable or Raw Water	Light blue with red bands	Black
Seal Water	Dark blue with red bands	White
Low Pressure (Air) Aeration supply	Light green	Black
Sewage	Light gray	Black
Sludge	Light brown	White
Scum	Dark brown	White
Drain	Dark gray	White
Sample	Light gray with green bands	Black
Sprinkler Piping	Red	White

In addition, special painting of the following items will be required.

Item	Color
Valve handwheels and levers	Red

Number at least 2 inches high shall be painted on or adjacent to all accessible valves, pumps, flowmeters, and other items of equipment which are identified on the drawings or in the specifications by number.

3. Location of Letters, Arrows and Bands

- a. Place letters, arrows and bands on piping near connections to equipment, adjacent to valves or fittings, on both sides of walls penetrated, and at intervals not to exceed 25 feet.

- b. Place arrows adjacent to or below letters depending upon visibility. Place arrows in direction of flow. For dual-flow piping, indicate both directions.
 - c. Locate letters to be visible from normal line of vision above floor level. Letter locations subject to approval of Engineer/Architect.
 - d. Band to be full circumference of pipe.
4. Letter, Arrow and Band Size
- a. Block-style letters, all capitals, conforming to ANSI A13.1 and as follows:

Outside Diameter of Letters Pipe or Covering	Size of Letters and Arrows	Width of Banding
Less than 3/4"	Approved metal tag or band	6"
3/4" to 1-1/4"	1/2"	8"
1-1/2" to 2"	3/4"	8"
2-1/2" to 6"	1-1/4"	12"
8" to 10"	2-1/2"	24"
Over 10"	3-1/2"	32"

- 5. Vent lines, electrical conduit and related electrical accessories shall be painted to match adjacent wall surfaces as directed by ceiling space shall be painted same as surfaces adjacent to the wall surfaces.

PART 3 - EXECUTION

3.1 Surface Preparation

- A. Prepare surfaces for each coating system conforming to SSPC or ASTM surface preparation specifications listed.
 - 1. If grease or oils are present, SSPC-SP1 must precede any other method specified.
 - 2. Remove surface irregularities such as weld spatter, burrs, or sharp edges prior to specified surface preparation.
 - 3. Undertake specified surface preparation in accordance with the coating manufacturer's recommendations.

- B. Depth of profile will be as specified or as recommended by the manufacturer for each system, but in no instance shall it exceed one-third of the total dry film thickness of complete system.
- C. Prepare only those areas which will receive the first coat of the system on the same day.
 - 1. On steel substrates, apply coating before rust bloom forms.
- D. Concrete surfaces shall be adequately cured in accordance with SECTION 3300 and a minimum of 28 days old prior to coating application.
- E. Abrasives for blasting shall be free of oil, washed and dry, unused silica sand, coal, copper or nickel slag that have sharp and hard cutting surfaces. Abrasives approved by Powertech Laboratories are strongly recommended.
- F. Sharp projections and weld splatter shall be ground smooth. All areas ground smooth shall be reblasted prior to the coating application.
- G. Sharp edges shall be ground round and smooth to radius = 1/8 prior to the coating applications for structural steel in Highly Corrosive Areas and for Immersion Services.
- H. After abrasive blasting, steel surfaces must be completely dust free (cleaned by vacuum and/or blown off with oil/water-free compressed air), oil and grease free, and have a chloride concentration of less than 3 µg/cm².
- I. Unless otherwise specified, the steel profile must be 1.5 - 2.5 mils in depth and jagged as opposed to a peen pattern.
- J. All welds shall be stripe coated by brush with the primer, prior to the application of the full primer coat. Note that inorganic zinc coatings shall not be applied by brush except to very small areas. Stripe coating shall be by spray.
- K. Unless approved by the Paint Manufacturer to the contrary, the blast surface shall be primed prior to the development of rust bloom or other contaminants and not later than 8 hours after surface preparation.
- L. Oxidation of the steel due to deleterious conditions may necessitate reblasting or sweep blasting the surface to restore the specified cleanliness standard.

3.2 Application

- A. Apply coatings in accordance with coating manufacturer's recommendations.
- B. All work shall be undertaken by skilled applicators who are qualified to perform the required work and have a minimum of 5 years experience in similar applications. The work shall be done in a manner comparable to the best standards of practice found in that trade. All materials shall be evenly applied so as to be free from sags, runs, crawls, wrinkles, holidays, or any other defects. All coats shall be of the minimum of brush marks. When finished and dried, brush strokes shall appear in one direction only, and there shall be no curved brush marks showing. All coats shall be thoroughly dry before the succeeding coat is applied. All coats that are intended to hide shall be given another coat if the coating does not properly hide the undercoat.
- C. Use properly designed brushes, rollers, and spray equipment for all applications.
- D. Spraying shall be done in the cross lap method of spraying, streaking first in one direction and shortly later spraying across this section at right angles to the first set of passes.
- E. On unprimed surfaces apply first coat of the system the same day as surface preparation.
- F. Dry film thickness of each system shall meet the minimum specified. Maximum dry film thickness shall not exceed the minimum more than 20% or coating manufacturer's requirements if less. Where a dry film thickness range is specified, the range shall not be less than or exceeded.
- G. Shop and field painting shall remain 3 inches away from unprepared surface of any substrate such as areas to be welded or bolted. H. Environmental Conditions:
 - 1. Do not apply coatings when inclement weather or freezing temperature may occur within coating curing time requirements. Atmospheric temperature must be maintained between 60°F and 85°F for at least 48 hours prior to and during application, unless otherwise approved by coating manufacturer.
 - 2. Wind velocities for exterior applications shall be at a minimum to prevent overspray or fallout and not greater than coating manufacturer's limits.

3. Relative humidity must be less than 85% and the temperature of the surface to be painted must be at least 5°F above the dew point.
 4. Provide adequate ventilation in all areas of application to ensure that at no time does the content of air exceed the Threshold Limit Value given on the manufacturer's Material Safety Data Sheets for the specific coatings being applied.
- I. Recoat Time: In the event a coating, such as an epoxy, has exceeded its recoat time limit, prepare the applied coating in accordance with manufacturer's recommendations.
- J. Protection
1. Cover or otherwise protect surfaces not to be painted. Remove protective materials when appropriate.
 2. Provide signs to indicate fresh paint areas.
 3. Provide daily cleanup of both storage and working areas and removal of all paint refuse, trash, rags, and thinners. Dispose of leftover containers, thinners, rags, brushes, and rollers which cannot be reused in accordance with applicable regulations.
 4. Do not remove or paint over Equipment data plates or code stamps on piping.
 5. Mask, remove, or otherwise protect finish hardware, machined surfaces, grilles, lighting fixtures, and prefabricated units as necessary.
 6. Provide cover to prevent paints from entering orifices in electrical or mechanical equipment.

3.3 Inspection

- A. Contractor shall provide and use a wet film gauges to check each application approximately every 15 minutes in order to immediately correct film thickness under or over that specified.
- B. Contractor shall provide and use a dry film gauge to check each coat mm (mil) thickness when dry, and the total system mm (mil) thickness when completed.

- C. Use holiday or pinhole detector on systems over metal substrates to detect and correct voids when indicated on system sheet.
- D. Furnish a sling psychrometer and perform periodic checks on both relative humidity and temperature limits.
- E. Check temperature of the substrate at regular intervals to be certain surface is 5°F or more above the dew point.

3.4 Cleaning and Repairs

- A. Remove spilled, dripped, or splattered paint from surfaces.
- B. Touch up and restore damaged finishes to original condition. This includes surface preparation and application of coatings specified.

PART 4 - MEASUREMENT AND PAYMENT

- 4.1 Measurement: No measurement will be made for this item, Protective Coatings.
- 4.2 Payment: Payment will be made at the contract lump sum price bid and shall be considered full payment for providing labor and materials to perform this work.

COATING REPORT

Contract Name: _____ Contract No.: _____
 Coating Contractor: _____ Foreman: _____
 Unit or Surface Identification: _____
 Unit or Surface Location: Exterior: _____, Interior: _____

Surface Preparation:
 Date _____; Air Temp _____ °F; Relative Humidity _____ %
 Method of Surface Preparation: _____
 Profile achieved _____ mils (if applicable).

Touch-Up:

Date _____; Time _____; Air Temp _____°F; Surface Temp _____°F
Relative Humidity _____%; Dew Point _____°F
Coating Used _____; Dry Film Obtained _____mils.

First Coat:

Date _____; Time _____; Air Temp _____°F; Surface Temp _____°F
Relative Humidity _____%; Dew Point _____°F
Coating Used _____; Dry Time Before Recoat _____hrs.
Dry Film Obtained _____mils.

Second Coat:

Date _____; Time _____; Air Temp _____°F; Surface Temp _____°F
Relative Humidity _____%; Dew Point _____°F
Coating Used _____; Dry Time Before Recoat _____hrs.
Dry Film Obtained _____mils.

Third Coat:

Date _____; Time _____; Air Temp _____°F; Surface Temp _____°F
Relative Humidity _____%; Dew Point _____°F
Coating Used _____; Dry Film Obtained _____mils.

END OF SECTION

DIVISION 11

EQUIPMENT

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, 15 and 16, even if not specifically referenced as a related section in those Specifications.
 - 2. Premium efficiency motors shall be supplied.
- B. Related sections include, but are not necessarily limited to:
 - 1. Division 1 - General Requirements.
 - 2. Section 09900 – Protective Coatings.
 - 3. 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 for Carbon Steel Bolts, Studs and Threaded Rods 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 (1000 Volts Maximum).
 - b. ICS 6 - Enclosures - 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 01330 – Submittals for 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, ¾ load, ½ load and ¼ 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 01330.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Flygt
 - 2. Meyers
 - 3. Fairbanks-Morse
 - 4. Preapproved equal.

2.02 MANUFACTURED UNITS

- A. Electric Motors:
 - 1. Provide premium efficiency 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 Degree C ambient. Design in accordance with NEMA standards for Class F insulation with Class B temperature rise above 50 Degree 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. Provide high efficiency motors that are 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 09900.

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 1/2 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.

I. Field coat in accordance with Section 09900.

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 11210

PUMPING EQUIPMENT: GENERAL STATEMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. General work included in this Section:
 - 1. All pumping equipment.
- B. Related Sections include, but are not necessarily limited to:
 - 1. Division 1.
 - 2. Section 01330 - Submittals.
 - 3. Section 01650 - Demonstration of Systems/Commissioning.
 - 4. Section 01715 - Equipment Operation and Maintenance Instructions.
 - 5. Section 09900 – Protective Coatings.
 - 6. Section 11005 - Equipment: General Requirements.
 - 7. Section 11227 - Pumping Equipment: Submersible Non-Clog.
- C. Reference Standards:
 - 1. NSF International Standards 60- 61 - Drinking Water System Components.

1.02 QUALITY ASSURANCE

- A. The pumping equipment shall include furnishing and installing the specific type of pumps as shown, together with all accessories and appurtenances necessary for a complete installation. The work includes furnishing motors, variable frequency drives if required and all electrical and other controls:
 - 1. The pumps including drive units, controls and other accessories and appurtenances, shall be furnished by a single pumping manufacturer for each particular process category of pump types. The pumps shall be arranged as shown and suitable for installation in the space as shown. The equipment shall be designed for the foundation arrangements shown and piping connections shall be located to preclude any appreciable change in the arrangement of the suction and discharge lines shown.
 - 2. Fully coordinate all mechanical seal and seal water systems specified to assure pump/seal compatibility.
 - 3. For variable speed pumping applications, the pump manufacturer is designated to have single source responsibility for coordination for the pump motor/VFD drive system.
- B. DEFINITIONS
- C. NPSHR - Net Positive Suction Head Required.
- D. NPSHA - Net Positive Suction Head Available.

- E. VFD - Variable Frequency Drive.
- F. Pump Service Category - Pump or pumps having identical names (not tag numbers) used for specific pumping service.

1.03 SUBMITTALS

- A. Shop Drawings:
 - 1. Certified pump performance curves.
 - 2. Pump accessories data.
 - 3. Pump bearing supports, brackets, shafting details and lubrication provisions.
 - 4. Solids passage information.
 - 5. Anchor bolt sizes and locations.
 - 6. See Section 11005.
 - 7. NSF 61 Certification for all parts that are contact with water.
- B. Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.01 ACCESSORIES

- A. See Section 11005.

2.02 SOURCE QUALITY CONTROL

- A. If specifically required in the individual pump Sections, provide factory tests.
 - 1. Adjustable speed units:
 - a. Head (FT) versus flow (gpm) pump curves:
 - 1) Maximum, minimum and two equally spaced intermittent speeds.
 - 2) Efficiencies along each curve.
 - 3) Brake horsepower's along each curve.
 - 4) NPSHR along each curve.
 - b. Hydrostatic test at 150 percent of shutoff head for a minimum of 5 minutes.
 - 2. Constant speed units:
 - a. Head (FT) versus flow (gpm) pump curves:
 - 1) Efficiencies along curve.
 - 2) Brake horsepower along each curve.
 - 3) NPSHR along each curve.

B. Balance:

1. All rotating parts accurately machined and in as near perfect rotational balance as practical.
2. Excessive vibration is sufficient cause for equipment rejection.
3. Unit mass and distribution is such that resonance is avoided.
4. Max. shaft vibration displacement (peak-to-peak) at stuffing box face: 2.0 mils
5. Max. vibration displacement (peak-to-peak) at any point on the machine

<u>Nominal Rotative Speed</u>	<u>Maximum Displacement</u>
3,500 rpm	2.0 mils
1,800 rpm	2.0 mils
1,200 rpm	3.0 mils
900 rpm	3.5 mils
720 rpm	4.0 mils
600 rpm & below	5.0 mils

Ratio of rotative speed to critical speed of a unit or components thereof less than 0.8 or more than 1.3.

6. Each pump motor will have an electrical disconnect that is not integral to the motor, but located adjacent to the motor, for quick disconnection of electrical power supply. The local disconnect shall be NEC code approved.

PART 3 - EXECUTION

3.01 ERECTION/INSTALLATION/APPLICATION

A. See Section 11005.

B. Floor/pad mounted units (Non-Submersible):

1. Vertically and horizontally align, level, wedge and plumb units to match piping interface.
2. Assure no unnecessary stresses are transmitted to equipment flanges.
3. Tighten flange bolts at uniform rate and manufacturer's recommended torque for uniform gasket compression.
4. Support and match flange faces to uniform contact over entire face area prior to bolting pipe flange and equipment.
5. Permit piping connecting to equipment to freely move in directions parallel to longitudinal centerline when and while bolts in connection flange are tightened.
6. Grout equipment into place prior to final bolting of piping but not before initial fitting and alignment.

7. Assemble connecting piping with gaskets in place and minimum of four bolts per joint installed and tightened. Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment.
8. Coat units as defined in Section 09900.
9. Provide pressure gauge on discharge of all pumps and on suction of all non-submersible units.

3.02 FIELD QUALITY CONTROL

- A. Employ and pay for services of equipment manufacturer's field service representative(s) to:
 1. Conduct initial startup of equipment and perform operational checks.
 2. Provide a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by OWNER's personnel.
 3. Instruct OWNER's personnel for start-up testing for specified minimum number of hours at jobsite on operation and maintenance of the pumping equipment.

END OF SECTION

SECTION 11227

SUBMERSIBLE NON-CLOG PUMPS

PART 1 - GENERAL

1.01 SUMMARY

- A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown on the Drawings, specified, and required to furnish and install submersible pumps complete and operational with control panel and accessories:
- B. Related Sections include but are not necessarily limited to:
1. Division 01 - General Requirements.
 2. Division 16 - Electrical.
 3. Section 01330 - Submittals.
 4. Section 01715 - Operation and Maintenance Equipment Instructions.
 5. Section 09900 – Protective Coatings.
 6. Section 11005 - Equipment: General Requirements.
- C. See Drawings.
- D. Equipment Identification: Equipment to be installed are identified in the Drawings and Specifications as follows:

<u>Equipment Name</u>	<u>Identifier</u>
Lift Pump No. 1	PMP-501
Lift Pump No. 2	PMP-502

1.02 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
1. Manufacturer shall have a minimum of five years of experience of producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.
- B. Referenced Standards:
1. American National Standard Institute (ANSI).
 2. American Society for Testing and Materials (ASTM):
 - a. A48 - Standard Specification for Gray Iron Castings.
 3. American Water Works Association (AWWA).
 4. Factory Mutual (FM).
 5. Hydraulic Institute Standards for Centrifugal, Rotary and Reciprocating Pumps (HI).
 6. Institute of Electrical and Electronic Engineers (IEEE).
 7. National Electrical Manufacturer's Association (NEMA):

- a. 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- b. ICS 6 - Industrial Control and Systems: Enclosures.
- 8. National Fire Protection Agency (NFPA):
 - a. 70 - National Electrical Code (NEC).
- 9. Underwriters Laboratories, Inc. (UL).

1.03 SYSTEM DESCRIPTION

- A. Lift Station Pumps:
 - 1. Classic duplex system: pumps will work in lead-lag with Lead lag signals provided by RTU PLC.
 - 2. Provide single source coordination responsibility through the pump manufacturer for the entire system including, but not limited to, the following:
 - a. Pumps.
 - b. Motors.
 - c. Pump motor starters.
 - 3. Pumps will be controlled primarily by a submersible loop powered transducer. (See Electrical specifications #16902). Secondary control will be provided by four float level switches. High level shall start both pumps. Low level shall stop both pumps.
 - 4. One control panel shall be provided by the manufacturer to control the pumps.

1.04 SUBMITTALS

- A. Shop Drawings: Submit for approval the following:
 - 1. Manufacturer's literature, illustrations, specifications, and engineering data including dimensions, materials, size, weight, performance data and curves showing overall pump efficiencies, flow rate, head, brake horsepower, motor horsepower, speed, and shut-off head.
 - 2. Fabrication, assembly, installation, and wiring diagrams.
 - 3. Deviations from Contract Documents.
 - 4. Control Panel Diagrams.
- B. Operations and Maintenance Manuals:
 - 1. Submit complete installation, operation, and maintenance manuals, maintenance data and schedules, description of operation, and spare parts information.
 - 2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01330.
 - 3. Professional quality DVD color program of at least one hour duration that details operation and maintenance of pumps.

1.05 MOTOR REQUIREMENTS

- A. Submersible Pumps:
 - 1. 230 V, 60Hz, 3-phase power supply.
 - 2. Class H insulation rated for 311°F.

3. Current motor / insulation: air-filled, squirrel cage induction type, housed in air-filled watertight chamber.
4. Stator insulated using Class H insulation to minimum 95% winding fill factor.

1.06 WARRANTY

- A. The pump manufacturer shall warrant the units being supplied to the OWNER against defects in workmanship and material for a period of five years or 10,000 hours under normal use, operation, and service. The pro-rated warranty shall cover parts and labor and shall be in printed form and apply to all units.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Grundfos or Equal.

2.02 PERFORMANCE AND DESIGN

- A. All Units:
 1. Pump case: Cast Iron ASTM A48 Class 35B.
 2. Motor Housing: Cast Iron ASTM A48 Class 35B.
 3. Impeller: Cast Iron/Polyamide 66. **GRINDER SYSTEM**
 4. Shaft: Stainless Steel.
 5. O-rings: BUNA "N".
 6. Bolts and Nuts: Stainless Steel.
 7. Volute, Impeller, Motor Housing, Discharge Elbow, and Other: Gray cast iron ASTM A-48, Class 35 B, with smooth surfaces devoid of blow holes or other casting irregularities.
 8. Mechanical Seal: Tandem seals with all seal faces to be tungsten carbide.

2.03 EQUIPMENT

- A. PMP-501 and PMP-502: Performance and Configuration Requirements:
 1. Design Capacity: **100 gpm**
 2. Design Head: **85 ft**
 3. Pump configuration: Submersible.
 4. Maximum pump speed: **3463 RPM**
 5. Nameplate driver horsepower: **5.5 HP**
 6. Starter type: Direct-On-Line (DOL)
 7. Hydraulic efficiency at design point: 42.7%
 8. Model: **GRUNDFOS SEG.A20.55.EX2.60M**
 9. All circuits shall have intrinsically safe relays.

2.04 ACCESSORIES

A. Power Cables:

1. Provide power cable from controller to pump suitable for submersible applications in wastewater and indicated by a code or legend permanently embossed on cable.
2. Size cable in accordance with applicable NEC specifications.
3. Control panel is located approximately 20 ft. away from the lift station. Check Drawings to confirm lengths of power and control cables.
4. Provide cable with a strain relief.

B. Mechanical Controls:

1. Floats:
 - a. There are four float switches for pump operation (from bottom: 1st float - pump off, 2nd float - lead pump on, 3rd float - lag and lead pump on, 4th float - high high level-alarm) at the lift station.
 - b. All floats shall be N/O.
 - c. Provide a cable holder to suspend floats.
 - d. Float 1 Low Low Water level – Pump Stop
 - e. Float 2 Low Water – Lead Pump Start
 - f. Float 3 High Water Level – Lag Pump Start
 - g. Float 4 High High Water Level – Alarm
2. Provide MiniCas relays for leak and over temperature alarm.
 - a. Leak shall send alarm.
 - b. Over temperature shall send alarm and shut down pump. In auto only.
 - c. Provide level transmitter to monitor and control wetwell pump operations.

C. Electrical Controls:

1. As described in Division 16 and shown on drawings.
2. The local control panel will provide following status signals to the lift site auto dialer.
 - a. Lift Station Level Indication
 - b. Lift Pump No. 1 in Auto
 - c. Lift Pump No. 1 in Hand
 - d. Lift Pump No. 1 Run Status
 - e. Lift Pump No. 1 Phase Loss
 - f. Lift Pump No. 1 Overcurrent
 - g. Lift Pump No.1 VFD Fault
 - h. Lift Pump No. 2 in Auto
 - i. Lift Pump No. 2 in Hand
 - j. Lift Pump No. 2 Run Status
 - k. Lift Pump No. 2 Phase Loss
 - l. Lift Pump No. 2 Overcurrent
 - m. Lift Pump No. 2 VFD Fault

2.05 FABRICATION

A. General:

1. Submersible Pumps:
 - a. Provide pumps capable of handling municipal sewage with solids that have 2.5" minimum sphere size.
 - b. Design pumps to allow installation and removal of the pumps from concrete vaults. Pumps shall be removed using metal chains 304 SS.
 - c. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact. Sealing of the discharge interface with a diaphragm, O-ring, or profile gasket will not be acceptable.
 - d. Provide sliding guide rail for pump installation.
 - e. Where a watertight seal is required, machine and fit mating surfaces with O-rings.
2. Impeller:
 - a. Provide non-clog type dynamically balanced impeller in accordance with Hydraulic Institute Standards.
3. Discharge connection and lifting chains:
 - a. Provide stainless steel chain to allow pulling the pump out of the lift station with a hook guided along the sliding rails.
4. Shaft:
 - a. Design pump shaft of sufficient size to transmit full driver output.
 - b. Use shaft which is accurately machined and constructed with sufficient materials.
 - c. Design shaft for a maximum deflection of 0.002 inches measured at the stuffing box.
5. Shaft Seal:
 - a. Seal shaft with tandem mechanical type seal running in an oil filled chamber.
 - b. The lower seal between the pump and oil chamber shall contain one stationary and one positively driven rotating ring, both of corrosion resistant silicon carbide.
 - c. The upper seal between the oil sump and motor housing shall contain one stationary ring and one positively driven rotating ring, both of corrosion resistant carbon/ceramic.
 - d. Provide seals requiring neither routine maintenance nor adjustment, but capable of being easily inspected and replaced.
 - e. Hold interface in contact by its own spring system
6. Bearings:
 - a. Support shaft on upper and lower permanently lubricated bearings with B-10 life of 25,000 hrs.
7. Motors:
 - a. The pump and motor shall be designed and wired for NEMA Class I, Division I, Group D service as rated by UL or FM.
 - b. Provide motor of totally submersible design, constructed with epoxy or polyseal encapsulated windings, with Class F insulation and rated for continuous duty operation.

- c. 3 phase, 60 Hz, 208 V.
- 8. Coatings:
 - a. Provide high solids epoxy interior and exterior coatings for pumps. Refer to Section 09900.
- 9. Lubrication System:
 - a. Lubrication system shall use food grade mineral oil.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Per manufacturer's guidelines.
- B. Seal pump cable end with a high-quality protective covering, to make it impervious to moisture or water seepage prior to electrical installation.

3.02 MANUFACTURERS' SERVICES

- A. The CONTRACTOR shall provide the services of a qualified, factory trained representative of the manufacturer to check and approve the installation before pumps are placed in service, supervise the initial operation and testing in the presence of ENGINEER, and instruct the OWNER's personnel in the operation and maintenance of the equipment.
- B. Two (2) hours of training shall be provided for operation and maintenance of pumps. These two hours may not be consecutive if more than one training session is required.

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. A106/A106M - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
 - 2. D2240-15e1 - Standard Test Method for Rubber Property - Durometer Hardness.
 - 3. A536-84(2019)e1 - Standard Specification for Ductile Iron Castings.
- B. National Sanitation Foundation (NSF) 61 - Drinking Water System Components - Health Effects.
- C. AWWA C111 - Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
- D. Refer to Section 09900 for coating requirements for piping exterior.

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 (AS NEEDED)

- 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 MODULAR SEAL

- A. Manufacturers: One of the following or pre-approved equal:
 - 1. Linx by Calpico, Inc.
 - 2. Link-seal by 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.

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 A 536. 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 A 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/ANSI C111/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. Manufacturer: EBAA Iron Inc., Romac Industries Inc., or Pre-approved equal.
- B. Expansion Joint (Flexible Bellows Coupling):
 - 1. Manufacturer: General Rubber or 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 Buna-N 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 Fabric 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.

6. Product and Manufacturer: Provide one of the following:
 - a. Smith-Blair, Model 912.
 - b. Romac Industries Inc., FC400/FCA501/RFCA.
 - c. Ford FFCA.
- D. Dismantling Joint:
 1. Description: Adjustable telescoping restraint with tie-rods that can be adjusted to length to allow access for installation or removal of valves and other equipment.
 2. Pressure and Service: Same as connected piping.
 3. Material: Ductile iron or steel.
 4. Bolts and Nuts: Type 316 stainless steel or ASTM A588 HSLA bolt material.
 5. Product and Manufacturer: Provide one of the following:
 - a. Romac Industries Inc., DJ400
 - b. Or Approved Equal

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 $\pm$ dye inch.
- D. Compressive strength at 28 days shall be 70 psi $\pm$ 30 psi.

2.05 BURIED PIPING

- A. All buried plastic piping shall have tracer wire placed 1 foot above the crown of the pipe. The magnetic tracer wire shall be 12 gauge insulated solid copper wire.
- B. 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. 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. Modular Seal for Pipe Penetration: Provide Link-Seal or approved equal. Provide two modular seals to seal at wet wall sleeves or penetrations. 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. For dry wall penetrations, provide 1 modular seal.

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 joining 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.

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 200 psi for 2 hours, unless otherwise indicated. Pressure shall stabilize within 2% of 200 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 hours 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 15062

DUCTILE IRON PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Ductile iron piping, joints, fitting, and pipe lining and coating.

1.02 REFERENCES

- A. American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME):
1. B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
- B. American Society for Testing and Materials (ASTM):
1. A 47 - Ferritic Malleable Iron Casting.
 2. A 183 - Carbon Steel Tank Bolts and Nuts.
 3. A 536 - Ductile Iron Castings.
 4. A 674 - Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids.
 5. D 792 - Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement.
 6. D 4976 - Polyethylene Plastics Molding and Extrusion Materials.
- C. American Water Works Association (AWWA):
1. C 104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
 2. C 105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
 3. C 110 - Ductile-Iron and Gray-Iron fittings, 3 Inches through 48 Inches, for Water and Other Liquids.
 4. C 111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 5. C 115 - Flanged Ductile-Iron Pipe with Threaded Flanges.
 6. C 150 - Thickness Design of Ductile-Iron Pipe.
 7. C 151 - Ductile-Iron Pipe, Centrifugally Cast for Water or other Liquids.
 8. C 600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
 9. C 900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings.
- D. National Sanitation Foundation (NSF) 61.

1.03 SUBMITTALS

- A. Layout Drawing: Detailed layout drawings showing alignment of pipes, location of valves, fittings, and appurtenances, types of joints, and connections to structures.

- B. Product Data: Photographs, drawings, and descriptions of fittings, gaskets, couplings, grooving of pipe and fittings, and pipe lining.
- C. Test Reports: Manufacturer's test reports for polyethylene lining certifying successful performance of the wet sponge spark tests.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Block piping material for shipment, prevent damage to castings and linings.
- B. Carefully handle piping material during loading, unloading, and installation. Do not drop piping material from trucks. Lower piping material by mechanical means. Do not drop or pound pipe to fit grade.
- C. Repair damaged pipe lining to match quality, thickness, and bonding or original lining. When lining cannot be repaired or repairs are defective, replace defective piping with undamaged piping.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Ductile Iron Piping:
 - 1. Type, Typical: AWWA C 150 and AWWA C 151 with minimum Class 350 wall thickness.
 - 2. Manufacturers: Griffin Pipe Prods, US Pipe, American Cast Iron Pipe Co.
- B. Joints:
 - 1. Flanged Joints:
 - a. Flanges: One of the following with diameter, thickness, drilling, and other characteristics in accordance with ANSI B 16.1:
 - 1) Cast integrally with the pipe.
 - 2) Screw-on: Comply with the following:
 - a) Ductile iron.
 - b) Long hub, threaded, and specially designed for ductile iron pipe.
 - c) After attaching to pipe, machine flange face to make pipe end and flange even and perpendicular to the axis of the pipe.
 - b. Bolt Holes: Two-holed and aligned at both ends of pipe.
 - c. Cap Screw or Stud Bolt Holes: Tapped.
 - d. Bolt and Nuts: ANSI/ASME B 16.1 or when connecting flanges underground, in concrete pipe valve boxes, or underwater, Type 304 or Type 316 stainless steel; cut and finished to project a maximum of 1/4 inch beyond nut when joints are assembled.
 - e. Class 150 flange.

2. Mechanical Joints: AWWA C 111/ANSI A 21.11.
3. Restrained Mechanical Joints:
 - a. Mega-lug restrained joints.
 - b. Or Pre-approved equal.
4. Gaskets for Ductile Iron:
 - a. Suitable for pressures equal to and less than 150 psi, temperatures equal to and less than 100 degrees Fahrenheit.
 - b. Neoprene with minimum durometer hardness value of 70 when tested in accordance with ASTM D 2240, Type A; minimum 3/32 inch thick for less than 10 inch pipe; minimum 1/8 inch thick for 10 inch and larger pipe.
 - c. Manufacturers: One of the following or equal:
 - 1) Garlock, Style 8798.
 - 2) John Crane.
 - 3) Or Pre-approved equal.

2.02 ACCESSORIES

- A. Fittings: AWWA C 110/ANSI A 21.10 or AWWA C 153/ANSI A 21.53 with the same pressure rating and joint configuration as that of the associated piping.

2.03 PIPE LININGS

- A. Cement-Mortar Lining and Coating (buried piping): AWWA C 104/ANSI A 21.4, applied on clean bare metal surfaces; extended to faces of flanges, ends of spigots, and shoulders of hubs; painted with bituminous material.
 1. Coating on Cement-Mortar Coating: Bituminous material, or none when specified to receive another coating (epoxy, etc.).
- B. Epoxy lining – NSF Approved
AWWA epoxy interior
Coating system to be applied for all above grade piping and manifolds.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General:
 1. Install ductile iron piping in accordance with AWWA C 600, modified as specified in Section 15050.
 2. Lay mechanical joint or bell and spigot pipe with 1/8 inch space between the spigot and shoulder of the pockets.
 3. All buried piping shall be restrained.

- B. Special Techniques:
 - 1. Polyethylene Encasement: Wrap ductile iron pipe to be buried with polyethylene encasement in accordance with ASTM A 674. Repair tears and make joints with double plastic tape wrap.
 - a. Polyethylene: AWWA C 105.
 - b. Plastic Tape Wrap: Manufacturers shall be one of the followings or Pre-approved equal:
 - 1) Polyken Pipeline Coatings, Polyken Number 910.
 - 2) The Tapecoat Company, Tapecoat CT.

3.02 JOINTS

- A. Install type of Joints as specified in Piping Schedule on Drawings.

3.03 FIELD QUALITY CONTROL

- A. Clean and test ductile iron 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 Iron 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, unless otherwise specified.
- 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:
 - a) AkzoNobel International Protective (Devco) Coatings - Bar Rust 223H.
 - 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 on 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 hand wheels.
3. Provide manually operated valves and gates located not more than 6 feet above the operating level with levers, tee handles, wrenches, or hand wheels, 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: ARI.
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 close.
- 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: NPS ½ through NPS 24 Metric/Inch.
- B. American Petroleum Institute (API).
- C. American Society for Testing and Materials (ASTM):
 - 1. A 351 – Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
- D. American Water Works Association (AWWA):
 - 1. C 507 – Ball Valves, 6 In. Through 60 In.
- E. National Sanitation Foundation (NSF) 61 - Drinking Water Components - Health Effects.

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, Type 21.
 - 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.
- E. Plastic Ball Valve Electric Operator
 - 1. Asahi America Series 94 Electric Actuator or approved equal.
 - 2. 120 VAC, single phase.
 - 3. Actuator will receive open/close command from New IX/GAC PLC.
 - 4. Valve shall provide open/close status signals to New IX/GAC PLC.
 - 5. Provide two limit switches for open/close status signals to PLC.

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 15114

CHECK VALVES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: silent check valves, and plastic body ball check valves

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. A 48 – Specification for Gray Iron Castings.
 - 2. A 126 – Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - 3. A 276 – Specification for Stainless Steel Bars and Shapes.
 - 4. B 582 – Specification for Nickel-Chromium-Iron-Molybdenum-Copper Alloy Plate, Sheet and Strip.
 - 5. B 584 – Specification for Copper Alloy Sand Castings for General Applications.
- B. American Water Works Association (AWWA):
 - 1. C 508 – Standard for Swing-Check Valves for Waterworks Service 2 Inch Through 24 Inch NPS.
- C. American Petroleum Institute (API).
- D. National Sanitation Foundation (NSF) 61

1.03 SYSTEM DESCRIPTION

- A. Design Requirements:
 - 1. Check Valves: When not otherwise specified as indicated on the Drawings, provide check valves suitable for service as follows:
 - a. In either horizontal or vertical position.
 - b. Under pressures equal and less than 150 psig.
 - c. Plastic body ball check valves on plastic pipelines.

PART 2 - PRODUCTS

2.01 SILENT CHECK VALVES (METAL BODY)

- A. Globe Style Silent Check Valves 3 Inches through 24 Inches:
1. Manufacturers: One of the following or equal:
 - a. APCO
 - b. Valmatic
 - c. Clow
 - d. Crispin
 - e. VSI
 2. Valve Design:
 - a. Globe
 - b. Valve plug will be spring loaded, normally closed, by means of one or more stainless steel springs.
 - c. Check valve must be capable of silent operation when installed in the vertical or horizontal position - flow up or down.
 - d. Spring must be helical or conical. Seat and plug shall be hand replaceable in the field for ease of maintenance.
 - e. The flow area through the body shall be equal to or greater than the cross sectional area of the equivalent pipe size.
 3. Materials:
 - a. Body: Cast-iron, ASTM A 126 Class B.
 - b. Doors: Ductile iron ASTM A536.
 - c. Hinge Pins: Stainless steel.
 - d. Sealing element: Buna-N.
 - e. End Connections: Flanged.

2.02 BALL CHECK VALVE (PLASTIC BODY)

- A. Valves ¼ inch through 6 Inches:
1. Manufacturers: One of the following or equal:
 - a. Asahi/America
 - b. Spears Manufacturing Company
 - c. Chemtrol Division, NIBCO, Inc.
 - d. Or pre-approved equal
 2. General:
 - a. End Connection: True union; solvent or heat welded to piping.
 3. Materials:
 - a. Body: CPVC or PVC.
 - b. Ball: CPVC or PVC.
 - c. Seats: FKM (Viton) or EPDM
 - d. O-rings: FKM (Viton) or EPDM
 - e. All ball check valves installed on chemical system lines shall be made of CPVC or PVC.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. General: Install with proper orientation of flow direction arrow on valve body.

3.02 ADJUSTING

- A. Adjust cushioned check valves in the field by means of external adjustment devices to minimize pressure surges.
- B. Adjust weight on check valves to affect proper closing action on equipment shutdown.

END OF SECTION

SECTION 15116

ECCENTRIC PLUG VALVES, OPERATIONS, AND APPURTENANCES

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes: Lubricated and non-lubricated plug valves.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. A 126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
- B. National Sanitation Foundation (NSF) 61 – Drinking Water Components – Health Effects.

PART 2 – PRODUCTS

2.01 NON-LUBRICATED PLUG VALVES

- A. Manufacturers:
 - 1. DeZurik.
 - 2. Or approved equal.
- B. Design:
 - 1. Type: Non-lubricated eccentric type.
 - 2. Plug Face: Resilient material which operates satisfactorily at a temperature of 180 degrees Fahrenheit continuous and 215 degrees Fahrenheit intermittent, except for valves in compressed air service.
 - 3. Compression Washer: Provide flat compression washer made of Teflon, or of a material having equal physical characteristics on valve stem between plug and bonnet.
 - 4. Stem Seals: Provide stem seals serviceable without unbolting the valve bonnet assembly.
 - 5. Clearly mark valves to indicate their open and closed positions.
 - 6. Provide valves with ends as required by piping details indicated on the Drawings.
- C. Materials:
 - 1. Body and Plug: ASTM A 126, Class B, cast-iron with plug face of neoprene, Buna N, isoprene, or hycar material suitable for the intended service.
 - 2. Body Seats in Valves 3 Inch Size and Larger: Provide with overlay of not less than 90 percent nickel and minimum thickness of 1/8 inch on surfaces contacting the plug face.
 - 3. Stem Bearing and Bottom Bearing: Stainless steel Type 316.
 - 4. Internal Parts, Except the Body and Plug: Type 316 stainless steel, Monel, or nickel.

5. Exposed Nuts, Bolts, and Washers: Zinc plated. Exception: exposed nuts, bolts, and washers for buried service: stainless steel.
6. Pressure Rating: 150 psi.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Install valves so that in the closed position the pressure in the pipeline applies a seating head on the valves.
- B. Lubrication: Lubricate plug valves and fill extended lubricant pipes with lubricant suitable for service intended.

3.02 SCHEDULE

- A. See 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 Hangers and Supports - Materials, Design, Manufacture, Selection, Application and Installation.
 - 2. SP 69 - Pipe Hangers and Supports - 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

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 and instrumentation 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, instrumentation, and control 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, control, and instrumentation 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 listed site altitude and at highest anticipated ambient temperature in which equipment will be expected to operate. 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 be built by a certified UL508A shop and shall bear a serialized and recorded UL label.

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.

- a. 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. ELECTRICAL UTILITY

1. Coordinate the electrical utility work with the electrical utility company. Note the additional submittal requirements under “SUBMITTALS – Utility Coordination” in Part 1 of this specification. Provide equipment and material required to bring electrical service to the service location in conformance with the electrical utility requirements. Provide the following for the electrical utility company's primary (from utility power line to the utility transformer) and secondary (from utility transformer to the service) electrical lines in accordance with the electrical utility company's specifications and requirements:
 - a. Conduits (verify quantity and sizes)
 - b. Trenching, backfill, and compacting (verify trench size(s), backfill material, and compaction percentage requirements)
 - c. Concrete pad(s) (for pad mounted transformer(s))
 - d. Cable protection along the vertical drop at the utility company's pole (if pole mounted transformer(s))
 - e. Other items required by the power utility company's specifications

Y. TELEPHONE SERVICE

1. Coordinate with the Telephone Company to provide telephone service as shown on the Plans. Provide trenching, conduit, and backfill for the Telephone Company's communication lines from the Telephone Company's main distribution panel to the telephone company's connection box at this project site, as required by the Telephone Company.

Z. TEMPORARY POWER

1. Provide and maintain temporary power and lighting systems needed for construction. Work shall include:
 - a. Weatherproof panel(s) for the Contractor's main breakers and distribution system.
 - b. Conduit and cable.
2. Use ground fault interrupting equipment.
3. Connections shall be watertight, with wiring done with Type SO portable cable.
4. Route and support cables to avoid mechanical damage.
5. Remove temporary power equipment and devices upon completion of construction.

AA. 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 otherwise elsewhere in 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:
 - 1. Division 0 Bidding Requirements, Contract Forms, and Conditions of the Contract.
 - 2. 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 product data in accordance with Section 16000, and the Contract Documents.
- B. 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 16060

ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Demolition of existing electrical shall be as indicated on the Drawings or as indicated elsewhere herein.
- B. Demolition information shown on the Drawings is based on visual field examination and existing record drawings. The Contractor is responsible for verification of all items indicated or not. All items affected that are not indicated on the Drawings shall be brought to the Engineer's attention before demolition for direction.
- C. The Contractor shall confine demolition work to the item specifically identified on the drawings. The Contractor shall be liable for any other damage he may inflict to the existing installations.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Care shall be taken in demolition or removal of items as indicated on drawings as being returned to the Owner. The Contractor shall notify the Owner prior to removing existing equipment.
- B. Whether indicated on the drawings or not, the Contractor shall provide patching material to fill voids where demolition has taken place. Patching materials shall match, as nearly as practical, the existing original structure material for each surface being patched.

PART 3 - EXECUTION

3.01 COORDINATION

- A. The Contractor shall verify existing field conditions, measurement, circuitry etc. as indicated on Drawings prior to performing any demolition.
- B. The Contractor shall verify that abandoned or demolished wiring and electrical equipment serve only abandoned facilities. If demolished or abandoned electrical

is necessary for proper operation of facilities to remain in service, the Contractor shall immediately notify the Engineer for direction.

- C. Demolition shall not be performed without coordinating with new construction to limit down time and ease of switchover. The Contractor must coordinate with the Engineer and the Owner prior to any demolition.
- D. Prior to performing any demolition work, the Contractor shall provide temporary wiring and connections to maintain existing systems in service during construction. Temporary wiring shall conform to the National Electrical Code.

3.02 PERFORMANCE

- A. General: The means and methods of performing electrical demolition and removal operations are the sole responsibility of the Contractor. However, equipment used, and methods of demolition and removal will be subject to approval of the Engineer.
 - 1. Remove exposed abandoned conduit systems, including abandoned conduit systems in false ceilings.
 - 2. Remove wiring in abandoned conduit systems to source of power supply, where indicated.
 - 3. In exposed through-structure conduit or foundation locations, cut conduits and foundation below the finished structure surfaces in order to perform adequate surface patching.
 - 4. Maintain electrical continuity of existing electrical installations which remain active. Modify installations as necessary to maintain continuity and provide adequate access as required by the National Electrical Code.
 - 5. Extend existing installations using materials and methods compatible with existing electrical installations, and as specified elsewhere herein.
 - 6. Disconnect and leave in place electrical devices and equipment serving utilization equipment that has been removed or demolished.
- B. Cutting: Perform cutting work of existing structure materials by such methods as will prevent extensive damage beyond the immediate area of cutting.
- C. Unless otherwise indicated existing, electrical equipment, conduit, wire, etc. indicated for demolition shall be removed and disposed of in a lawful manner, off Site.
- D. The Contractor shall move existing electrical equipment required to be returned to the Owner, to locations as directed by the Owner. Care shall be taken to ensure existing electrical equipment being returned to the Owner does not become damaged. The Contractor shall provide a means for storing and or stacking of the returned equipment prior to moving to final location, if necessary.
- E. Items Abandoned in Place:
 - 1. All items to be abandoned in place shall be de-energized.

2. Connections shown or otherwise indicated as disconnected shall be removed with lugs left in place and with all conduit and cable openings properly plugged and sealed as required by the NEC.
3. Any abandoned in-place equipment damaged by Contractor shall be repaired and restored to its original condition.

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 data in accordance with Section 16000, and the Contract Documents.
- B. 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.
- C. 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.
- D. Proposed routing of conduits buried under floor slabs-on-grade.
- E. Identify conduit by tag number of equipment served or by circuit schedule number.
- F. 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.
- G. Proposed location and details of construction for openings in slabs and walls for raceway runs.

1.03 REFERENCES

- A. American National Standards Institute (ANSI): C80.1-2015, Electric Rigid Steel.
- B. National Electric Manufacturers Association (NEMA): RN 1-2018, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
- C. Underwriters Laboratories Inc. (UL):
 - 1. 1, Standard for Flexible Metal Conduit.

2. 6, Electrical Rigid Metal Conduit - Steel.
3. 360, Standard for Liquid-Tight Flexible Metal Conduit.
4. 467, Grounding and Bonding Equipment.
5. 514C, Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
6. 651, Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
7. 870, Standard for Wireways, Auxiliary Gutters, and Associated Fittings.
8. 884, Standard for Underfloor Raceways and Fittings.

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. No underground conduit shall be less than one inch.
- B. Condulet type fittings shall be Crouse-Hinds Series by Eaton, Appleton (Emerson), 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 Emerson O-Z/Gedney type AX with jumper for exposed locations and type DX at structural expansion joints, 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 C80.1-2015 standards,

as manufactured by Nucor, Allied Tube & Conduit, Triangle PWC Inc., 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 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 D1784-11, NEMA TC 2:2003, 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 (ABB), Cantex, Allied Tube & Conduit, or equal.

2.04 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Liquidtight flexible metal conduit shall be liquid and vapor tight, 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 conduit 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. 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. Underwriters Laboratory, Inc.
 - 1. 44, Thermoset-Insulated Wires and Cables.
 - 2. 83, Thermoplastic-Insulated Wires and Cables.
 - 3. 486A-486B, Wire Connectors.
 - 4. 510, Standard for Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.
- B. NFPA 70 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: General Cable Corporation Group, 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 may 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 UL 83 and “XHHW” shall conform to 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 shall be tested for their full length by these Standards.

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-486B.
- 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 C119.4 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 ClearGlide,

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 Grey		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 unless otherwise indicated on the Drawings.
- 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 Company, 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, nylon jacket, 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, 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:
 - 1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
 - 2. Division 1 - General Requirements.
 - 3. Section 16000 Electrical: Basic Requirements.
 - 4. Section 16111 Conduits.
 - 5. Section 16141 Wiring Devices.
 - 6. 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. Emerson
 - b. ABB Steel City.
 - c. Hubbell Raco.

2. Sheet metal boxes for non-classified areas:
 - a. Nvent Hoffman.
3. Corrosion resistant boxes:
 - a. Nvent Hoffman.
 - b. Eaton.
4. Hazardous location boxes (Class I, II & III):
 - a. Emerson.
 - b. Eaton.
 - c. Hubbell.
5. Raintight and watertight boxes:
 - a. Emerson.
 - b. Eaton.
6. Terminal boxes:
 - a. Nvent Hoffman.
7. Boxes in sidewalk:
 - a. Emerson.
 - b. Eaton.
8. Boxes in earth:
 - a. ABB Carlon.
9. Exposed switch and receptacle boxes:
 - a. Emerson.
 - b. Eaton.
 - c. Hubbell.

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 rated, 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:
 - 1. Division 0 Bidding Requirements, Contract Forms, and Conditions of the Contract.
 - 2. Division 1 General Requirements.
 - 3. Section 16000 Electrical: Basic Requirements.
 - 4. Section 16130 Outlet, Pull, and Junction Boxes.
 - 5. 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. Pass & Seymour.
 - c. Arrow Hart (Eaton).
 - d. General Electric.
 - e. Leviton.
 - 2. Explosion proof light switches:
 - a. Eaton.

- b. Emerson.
 - c. Hubbell Killark.
- 3. Door switches:
 - a. General Electric.
 - b. Pass & Seymour.
 - c. Arrow Hart (Eaton).
 - d. Honeywell Micro switch.
- 4. Receptacles (except explosion proof):
 - a. Hubbell.
 - b. Pass & Seymour.
 - c. Arrow Hart (Eaton).
 - d. General Electric.
 - e. Leviton.
- 5. Explosion proof receptacles:
 - a. Eaton.
 - b. Emerson.
 - c. Killark.
- 6. Welding receptacles:
 - a. Eaton.
 - b. Emerson.
- 7. Tele power poles:
 - a. Legrand Wiremold.
- 8. Dimmers:
 - a. Lutron.
 - b. General Electric.
 - c. Pass & Seymour.
- 9. Plug in strip:
 - a. Wiremold.

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. Pressswitch 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 pressswitch 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 16142

WEATHERPROOF WHILE IN USE OUTLET ENCLOSURES

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. These specifications encompass outlet enclosures used on outlet devices where outlets are required to be weatherproof and/or physically protected while in use or idle.
- B. These safety outlet enclosures shall be used in locations where attachment plugs will be connected permanently, or for an indefinite period of time, in potentially wet or weather exposed environments.
- C. They are also to be used where outlets are subject to contamination, corrosion or damage.

1.02 DESCRIPTION

- A. The safety outlet enclosure shall consist of a suitable style outlet/receptacle plate with a hinged safety cover.
- B. The safety outlet enclosure shall have cord port(s) capable of allowing an appropriate size electrical cord(s) to pass through when safety cover is closed.
- C. The safety outlet enclosure shall have a latching mechanism to allow the enclosure to maintain weatherproof integrity. The latch shall be a tamper resistant (locking/security) style in areas where security is needed.
- D. The safety outlet enclosure shall be sufficient depth to allow full closure with attachment plug(s) in use.

1.03 SUBMITTALS

- A. Products shall be submitted in accordance with Section 16000, and the Contract Documents, prior to installation.

1.04 MANUFACTURER

- A. Manufacturer shall be Hubbell Taymac, or equal.

PART 2 - PRODUCTS

2.01 WEATHERPROOF WHILE IN USE OUTLET ENCLOSURES

- A. The enclosures shall be used in outdoor locations, where attachment plugs will be connected permanently, or for an indefinite period of time, in potentially wet or weather exposed environments, or as indicated on the Drawings.
- B. They are also to be used where outlets are subject to contamination, corrosion or damage.
- C. The enclosure shall consist of a suitable style outlet/receptacle plate with a hinged safety cover, and shall be of sufficient depth to allow full closure with attachment plugs in use.
- D. The enclosure shall have cord ports capable of allowing an appropriate size electrical cords to pass through when safety cover is closed.
- E. The enclosure shall have a latching mechanism to allow the enclosure to maintain weatherproof integrity. The latch shall be a tamper resistant, and locking style, in areas where security is needed, as shown on the Drawings.
- F. The enclosure shall be Underwriters Laboratories (UL) listed per UL Standard 514C for non-metallic boxes, flush device boxes and enclosures, and conform to National Electric Code (NEC), Article NOTE TO SPECIFIER: [choose 410-57 for 1999 NEC, 406.8 for 2002, 2005, 2008 NEC, or 406.9 for 2011 NEC] paragraphs a and b, Article 110.3 and Article 110.11, pertaining to damp, wet or possible corrosive installations.
- G. Body materials shall be of a flame resistant, self-extinguishing, ultraviolet inhibiting, impact resistant, polycarbonate resin such as GE Lexan 943A, or MobayMakrolon 6457. Material must meet UL Standard 94.
- H. Gasket materials shall be of sufficient thickness to form a weatherproof seal under normal mounting conditions. Thicknesses; 3/16" for base plate and 1/8" for covers. Material is to be closed cell neoprene foam by Monarch Rubber A5032, or equivalent, self-extinguishing and flame retardant. Material must meet UL Standard 94 HF-1.
- I. Mounting hardware shall be stainless steel, and of sufficient length to properly secure the device, and ensure seal to mounting surface.
- J. The enclosures shall be installed over a weatherproof box and outlet in conformance with the manufacturer's instruction. Cover shall be mounted to insure that access holes for the portable line cords will be located at the lower end of the

cover.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Equipment shall be installed in accordance with the manufacturer's recommendations.

END OF SECTION

SECTION 16143
TERMINAL BLOCKS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. This section covers terminal blocks for control and other wiring.

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. Terminal blocks shall be Entrelec, Phoenix Contact, Allen-Bradley, or equal.
- B. Surge protection blocks shall be Eaton MTL, Phoenix Contact, or equal.
- C. Power distribution blocks shall be Ferraz Shawmut, Allen-Bradley Corporation, or equal.

PART 2 - PRODUCTS

2.01 TERMINAL BLOCKS

- A. 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 30 Amps, minimum.
- B. Grounding terminal blocks shall be provided for instrumentation cable shields. The terminal blocks shall have distinctive 2-color bodies, and shall be mounted to the DIN rail with metal screw down type clamps, providing a positive ground connection. One grounding terminal block shall be installed for every 2 instrument cables terminated. Grounding terminal blocks shall be U.L. rated for 600 Volts, and 20 Amps, minimum.
- C. Terminal blocks shall be available in a variety of colors, including red, green, blue,

gray, black, yellow, and orange.

- D. DIN mount fuse holders shall have blown fuse indicators for DC and AC circuits. Fuse holders shall be of the compression clamp type. Fuse holders shall be U.L. listed, and rated for 600 Volts. Fuse sizes shall not exceed the U.L. current rating for the fuse holders.
- E. DIN rail shall be slotted, zinc plated steel. Symmetrical DIN rail shall be 35mmX7.5mm, minimum.
- F. Terminal blocks for 4 to 20 milliamp signals shall have knife disconnect switches, and accessible test points for testing and measurement of current loop signals, without the need for removing wire terminations.

2.02 SURGE PROTECTION BLOCKS (SPB)

- A. Analog inputs and outputs shall be terminated at surge protection blocks (SPB). The SPBs shall be designed for a working voltage of 32 volts, and shall be fused.
- B. SPBs shall provide full hybrid line to line protection, and shall have a GDT rating of 10,000 A (8/20 μ s pulse waveform).
- C. SPBs shall be UL94 V-2 listed.

2.03 POWER DISTRIBUTION BLOCKS (PDB)

- A. PDBs shall be Electro-tin plated and manufactured from high strength 6061-T6 aluminum alloy.
- B. PDBs shall be UL Recognized rated 90° C and CSA Certified.
- C. PDBs shall provide flexibility in using the connector as an in line splice or to reduce conductor size.
- D. PDBs shall be rated for 600 Volts and dual rated for Copper and Aluminum Conductor.
- E. PDBs shall have the sizes and ratings as shown on the Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Each terminal block and fuse holder shall be identified with the circuit number, or conductor number, corresponding to the identification appearing on the shop

Drawings for the equipment, or system.

- B. Terminal block and fuse holder markers shall be computer printed plastic-type, with permanent markings.
- C. End clamps and end sections shall be installed on each terminal block and fuse holder assembly.
- D. Terminal blocks for DC voltages shall be blue, and AC voltages shall be gray.

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 Manufacturing, Nvent 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 grounding electrode 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.
- B. Underwriters Laboratories (UL) Standard No. 467, Electrical Grounding and Bonding Equipment.
- C. ANSI-J-STD-607-A, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.

PART 2 - PRODUCTS

2.01 GROUND RODS

- A. Ground rods shall be copper-clad steel conforming to UL 467, 3/4 inch in diameter by 10 feet in length.
 - 1. Manufacturer:
 - a. ERICO
 - b. A.B. Chance Company
 - c. Harger

2.02 BARE GROUND WIRE

- A. Ground wire shall be annealed, bare, stranded copper.
 - 1. Manufacturer:
 - a. Southwire Corporation
 - b. Service Wire Corporation
 - c. Encore Wire Company

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.
 - 1. Manufacturer (Pressure Connectors):
 - a. O.Z./Gedney, Division of General Signal Corporation
 - b. Burndy Corporation
 - 2. Manufacturer (Welded Connections):
 - a. Cadweld by Erico Products, Inc.
 - b. Therm-O-Weld by Burndy Corporation

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, 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 non-fenced 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, 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. Provide ground rings as shown on drawings.
 - 1. Grounding rings shall be installed using bare copper cable with ground rods using thermoweld connecting means as indicated on Drawings and shall be in accordance with NEC requirements.
 - 2. Ground rings shall be buried a minimum of 2 feet-6 inches below grade, unless otherwise indicated on drawings.

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., MacLean Power Systems, Eaton B-Line, Rawlplug Inc., Allied Tube and Conduit, Greenfield Mfg

Co., Inc., Emerson O-Z/Gedney; Power-Strut; Unistrut; 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 Emerson O-Z/Gedney, Model CSMI, or equal.
- 3. The conductor sealing bushings shall be manufactured by Emerson 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 Corporation.
 - 2. Ideal Industries, Inc.
 - 3. Panduit.
 - 4. Or, equal.
- B. Custom signs and labels applied to electrical gear and panels shall be self-adhesive, UV and fade resistant, and rated for outdoor use. Labels shall be vinyl, 4mil (0.004") thick with adhesive, shall be 3M Controltac Print Film, type 40C-10R, or equal.

1.04 QUALITY COMPLIANCE

- A. Comply with applicable requirements of UL 969, "Standard for Marking and Labeling Systems", pertaining to electrical identification systems.
- B. Comply with applicable requirements of ICEA S-67-401 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 0.048 inch diameter stainless steel wire and fasteners, as manufactured by Brady, Catalog No. 38091, and zinc plated 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 BMP61 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 ASME A13.1-2015 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 – Surge Protective Devices

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. Standard for Panelboards: UL 67.
 - b. Enclosures for Electrical Equipment, Non-Environmental Considerations: UL 50.
 - c. Molded Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures: UL 489.
 - 2. Federal Specification W-C-375 - Circuit Breakers, Molded Case, Branch Circuit and Service.
 - 3. Federal Specification W-P-115 - Power Distribution Panel.
 - 4. NEMA AB 1 - Molded Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
 - 5. NEMA PB 1 - Panelboards.
 - 6. NEMA PB 1.1 – General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 V or Less.
 - 7. NFPA 70 - National Electrical Code.
 - 8. UBC - Uniform Building Code.

1.04 SUBMITTALS

- A. Submit product data in accordance with Section 16000, and the Contract Documents.
- B. Shop drawings for equipment and component devices.
- C. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker arrangement, sizes and numbering system.
- D. 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. Eaton
- B. General Electric
- C. Siemens
- D. Square D/Schneider Electric
- E. 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 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 250 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 inch.
- 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 outdoors 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 4-1/2 inch x 8 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 ELECTRONIC POWER METERING

- A. The panelboard shall be provided with the electronic power metering, where shown on Plans
 - 1. A digital electronic power shall be used. The meter shall measure the real-time RMS values of the phase currents (Ampere), Ampere demand, phase and line voltages (Volts), KW, KW demand, KWHR, KVA, KVA demand, KVAR, KVAR demand, power factor, and frequency.
 - 2. A communications module shall be provided using an industry standard RS-232 or RS-485 serial bus. Modbus RTU shall be the protocol.
 - 3. The electronic power meter shall have non-volatile memory to record at least 100 time-stamped alarms and events.
 - 4. All potential, control power and current transformers shall be completely installed and wired to the power meter in the panelboard.
 - 5. The electronic power meter shall be Multilin PQM, Eaton PXM 2270, Power Measurement Ltd. Model 3710 ACM, or approved equal.

2.06 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 4-1/2x8-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 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.
- B.
- C. Interior and exterior lighting shall use LED technology unless otherwise shown on the drawings or in the specifications.

1.02 QUALITY ASSURANCE

- A. LED lighting products shall comply with the following reference standards:
 - 1. National Electrical Code (NEC)
 - 2. UL Standard 844, Standard for Luminaires for Use in Hazardous (Classified) Locations
 - 3. ANSI/UL 8750, Safety Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products
 - 4. UL Standard 1571, Incandescent Lighting Fixtures
 - 5. UL Standard 1598, UL Standard for Safety Luminaires
 - 6. Illuminating Engineering Society (IES) Light Measurement LM-79: Electrical and Photometric Measurements of Solid-State Lighting Products.
 - 7. IES LM-80: Measuring Lumen Maintenance of LED Light Sources.
 - 8. IES Technical Memorandum TM-21: Projecting Long Term Lumen Maintenance of LED Light Sources.
 - 9. IEEE C62.41.2: Recommended Practice on Characterization of Surges in Low-Voltage (1,000 V and Less) AC Power Circuits.
 - 10. 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.
5. LED lighting systems manufacturer shall have a minimum of 10 years' experience producing LED lighting systems.

1.03 SUBMITTALS

- A. The following shall be submitted to the Engineer for review for each type of luminaire:
 1. Documentation proving that products submitted meet requirements of standards referenced in Section 1.02.A and B above.
 2. Submit test report on manufacturer's standard production model luminaire. Submittal shall include all photometric and electrical measurements, as well as all other pertinent data outlined under "14.0 Test Report" in IES LM-79.
 3. Manufacturer's technical information on products to be used including photometric performance curves for the fixture and ballast data.
 4. Life, output (lumens, CCT, and CRI), Kelvin temperature, and energy-efficiency data for LED light bars.
 5. Acknowledgment that products submitted are UL or ETL listed.
 6. When general data sheets constitute part of the submittal, identify the products to be used on this project.
 7. Manufacturer's installation instructions.
 8. Identification of fixtures by Lighting Fixture Schedule.
 9. UL nameplate data (Voltage, wattage, etc.).
 10. Finishes, colors, and mounting type.
 11. Pole, fixture, and accessories.
 12. 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.
- C. Submit warranty: Products specified herein shall have a 5 years warranty on complete mechanical assembly, electrical components of LED lamps, drivers, and fixture body.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Luminaires, fixtures, and lamps shall be manufactured by Eaton, General Electric, Lithonia, Phillips, or equal.
- B. Lighting fixtures shall be provided as indicated on the Lighting Fixture Schedule

on the Drawings.

- C. 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. LEDs shall be high efficiency with minimum output of 100 lumens per watt.
 - c. LEDs and driver system lifespan shall be greater than 50,000 hours.
 - d. LED color temperature shall be warm white in the range of 2700-3500 Kelvin. Mixing of color temperatures with different LEDs is not permitted.
 - e. LED drivers or fixtures shall have inrush current limiting circuits or devices to prevent tripping of breakers on startup or switching of LED lighting loads.
 - f. Outdoor LED systems shall be protected by UL 1449 listed surge-protection devices.
 - g. LED drivers shall be electronic, labeled as compliant with radio frequency interference (RFI) requirements of FCC Title 47 Part 15, comply with NEMA SSL 1, have a sound rating of “A,” and be rated for a THD of less than 20% at all input voltages with a minimum power factor of 0.90.
 - h. When intended for use in wet area mark fixtures “suitable for wet locations.”
 - i. When intended for use in damp areas mark fixtures “suitable for damp locations” or “suitable for wet locations.”
 - j. In wet or damp area, install fixtures so that water cannot enter or accumulate in the wiring compartment, lamp holder or socket, or other electrical parts.
 - k. Gasket seals: Urethane foam
 - l. Diffusers: UV stabilized acrylic plastic
- 3. Underground wiring:
 - a. Provide all wiring runs with separate green grounding conductor.
 - b. Ground all pole bases.

- B. Furnish a minimum of 2 lamps, or ten percent spare lamps of each type and wattage, whichever is greater.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install, test, and commission lighting contactor controls, motion sensors, photocell controls, astronomical time clock controls, and switches as shown on the Drawings.
- B. Replace all failed 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 and insulated to prevent galvanic corrosion between dissimilar metals.
- 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 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. Service entrance section
 - b. Standby generator
 - c. Automatic transfer switch
 - d. Main distribution panel
 - e. Motor control centers
 - f. Switchgear, low and medium voltage
 - g. Panelboards, power and lighting/receptacle
 - h. Transformers, dry type and oil filled
 - i. Feeders
 - j. Cables rated 600 volts and higher
 - k. Transfer switches, manual and automatic
 - l. Transient voltage surge suppression systems
 - m. Grounding and bonding system
 - n. Lighting fixtures and associated controls
 - o. 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, 2017 Edition
- B. NFPA 70 – National Electrical Code, 2017 Edition
- C. Incorporated by reference all Codes, Standards, and Specifications referred to in the “APPLICABLE REFERENCES” section of NETA ATS-2017.

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. Instruments shall be calibrated in accordance with the following frequency schedule:
 - 1. Field instruments: Analog, 12 months maximum. Digital, 12 months maximum
 - 2. Laboratory instruments: 12 months maximum
 - 3. Leased specialty equipment: 12 months maximum.
- E. Dated calibration labels shall be visible on all test equipment.
- F. Records, which show date and results of instruments calibrated or tested, must be kept up to date.

- G. 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 ten (10) 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 2017.
- C. Switchgear and Switchboard Assemblies
- D. Transformers, Dry Type, Air-Cooled, Low-Voltage, Small
- E. Transformers, Dry Type, Air-Cooled, Large
- F. Transformers, Liquid-Filled
- G. Cables, Low-Voltage, 600 Volt Maximum
1. Perform tests only on cables size #4 AWG and larger.
- H. Cables, Medium-Voltage and High-Voltage
- I. Metal-Enclosed Busways
- J. Switches, Air, Low-Voltage
1. Perform tests only on switches rated 100 amps or higher.
- K. Switches, Air, Medium-Voltage, Metal-Enclosed
- L. Switches, Oil, Medium-Voltage
- M. Switches, Vacuum, Medium-Voltage
- N. Switches, Cutouts
1. Perform tests only on equipment rated 100 amps or higher.

- O. 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.
- P. Circuit Breakers, Air, Medium Voltage
- Q. Circuit Breakers, Oil, Medium Voltage and High Voltage
- R. Circuit Breakers, Vacuum, Medium Voltage
- S. Circuit Switchers
- T. Network Protectors, 600 Volt Class
- U. Protective Relays
- V. Metering Devices
- W. Regulating Apparatus, Voltage, Step and Induction Voltage Regulators
- X. Regulating Apparatus, Load Tap-Changers
- Y. Grounding Systems
- Z. Ground-Fault Protection Systems, Low-Voltage
- AA. Rotating Machinery, AC Motors and Generators
 - 1. Motors provided as part of valve actuators do not require testing.
 - 2. Perform visual and mechanical inspections on all motors.
 - 3. Perform rotation tests on all motors.
 - 4. Perform electrical tests only on motors 50 horsepower and larger.
- BB. Motor Control, Motor Starters, Low-Voltage
- CC. Motor Control, Motor Starters, Medium-Voltage
- DD. Adjustable Speed Drive Systems
- EE. Direct-Current Systems, Batteries, Flooded and Valve-Regulated Lead-Acid

- FF. Direct-Current Systems, Chargers
- GG. Surge Arresters, Low-Voltage Surge Protection Devices
- HH. Surge Arresters, Medium- and High-Voltage Surge Protection Devices
- II. Capacitors and Reactors – All Types
- JJ. Outdoor Bus Structure
- KK. Emergency and Standby Power Systems, Engine Generator
- LL. Emergency and Standby Power Systems, UPS
- MM. Emergency and Standby Power Systems, Automatic Transfer Switches
- NN. Fiber-Optic Cables

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

DIVISION 17

INSTRUMENTAION

SECTION 17000
INSTRUMENTATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes

1. Provide complete instrumentation and control systems as indicated on the Drawings, in the Specifications, and as required by other contract documents. These documents include descriptions of functional operation and performance, as well as standards, but do not necessarily enumerate detailed specifications for all components and devices which are necessary. However, all components and devices shall be furnished and installed as required to provide complete and operable systems for accomplishing the functions and meeting the performance requirements.
2. Scope of work includes the following as shown on the drawings:
 - a. Provide all instruments.
 - b. Provide all control panels, PLC panels, SCADA consoles.
 - c. Provide all communication equipment required to make the control system fully operational including but not limited to radios, antennas, switches, routers, hubs, protocol converters, communication cables, and communication racks and power supplies.
 - d. Provide all conduit, conductors, enclosures, materials, and labor to fully interconnect and make operational all control system components.
 - e. Provide power at proper voltage and ampacity to all system components.
 - f. Provide startup and commissioning assistance.
 - g. Train Owner's personnel on proper use and maintenance of the control systems.
 - h. Other equipment, materials, and work as necessary to achieve a fully tested and operational control system.

B. Products Supplied But Not Installed Under This Section

1. None

C. Products Installed But Not Supplied Under This Section

1. Instruments and controls provided loose for field installation by packaged equipment or skid-mounted equipment vendors.
2. Existing equipment to be relocated as shown on the drawings.

D. Related Sections

1. All Division 16 specifications provided for this project.
2. All Division 17 specifications provided for this project.
3. Other division specifications provided for this project as they relate to submittals, concrete, structural, piping/plumbing, mechanical, and HVAC systems.

E. Allowances

1. Not applicable this section.

- F. Unit Prices
 - 1. Not applicable this section.
- G. Measurement Procedures
 - 1. Not applicable this section.
- H. Special Payment Procedures
 - 1. Not applicable this section.
- I. Alternates/Alternatives
 - 1. ENGINEER must approve all alternates, alternatives, or proposed substitutions of materials or equipment.

1.02 REFERENCES

1.03 DEFINITIONS

- A. The word “provide” means “furnish and install”.
- B. PLC means Programmable Logic Controller.
- C. SCADA means Supervisory Control and Data Acquisition System.

1.04 SYSTEM DESCRIPTION

- A. Design Requirements
 - 1. Using sound engineering principals and current best design practices, provide engineering drawings and design documents specifying system components and detailing their interconnection and installation.
- B. Performance Requirements
 - 1. The instrumentation and control systems shall be furnished and installed complete and ready to operate, including all necessary interconnections and connections to sources of electrical power, air, water, drains and vents, with all required valves, switches and accessories as specified or as recommended for best operation by the manufacturer of the equipment furnished.

1.05 SUBMITTALS

- A. General
 - 1. Submittals for the equipment shall be provided in accordance with Section 16000, and as required elsewhere in the Contract Documents.
- B. Product Data
 - 1. Detailed catalog information for all system components in sufficient detail so that ENGINEER has sufficient information to determine if the equipment is acceptable for the intended purpose. Minimum information shall be:
 - a. Instrument or Equipment tag number

- b. Manufacturer
 - c. Model number
 - d. Materials of construction
 - e. Materials in contact with process fluids
 - f. Dimensional information
 - g. Weight
 - h. Power consumption with required voltage and ampacity
 - i. Heat dissipation if greater than 200 watts
 - j. Process connection information detailing connection size, type (threaded, flanged, socket weld, etc...)
 - k. Recommended mounting details
 - l. Recommended spare parts for one year of operation
 - 2. Instrument Data Sheets in ISA S20 format for all instruments.
- C. Shop Drawings
- 1. For complex control systems consisting of mechanical, electrical, and control components, provide the following:
 - a. A Piping and Instrument Diagram in ISA format
 - b. Electrical load calculations with conduit and conductor sizing
 - 2. For integrated control panels or control assemblies, provide the following:
 - a. Dimensioned layout of the control enclosure and mounted equipment and instruments.
 - b. Full bill of material for all components with detailed catalog information on all components.
 - c. 11"x17" fully developed schematic diagram(s) showing power and control wiring, terminal block assignments, and identifying field and enclosure wiring. Provide a drawing index and symbols and legend sheet with all schematics. Show all I/O card details including rack, slot, channel numbers, field termination points, and control power wiring. Label all conductors and identify conductor size and color. Identify all field devices by tag number and by description. Provide over current protection in accordance with NEC requirements.
 - d. 11"x17" instrument loop drawings in ISA format for all analog control loops. Alternatively, multiple loops may be combined on a single analog input or analog output I/O card schematic diagram.
 - e. Nameplate legend
 - f. Paint color and type for painted assemblies
 - 3. Any special installation details.
- D. Samples
- 1. Not applicable for this section
- E. Quality Assurance/Control Submittals
- 1. Design Data, Test Reports
 - a. Submit calibration sheets for all field instruments containing the following information:
 - 1) Instrument tag number.
 - 2) Instrument manufacturer and model number.
 - 3) Person who performed the calibration.

- 4) Manufacturer, model, and serial number of the calibrating device.
- 5) Date that calibrating device was last calibrated.
- 6) For analog instruments, process range and associated analog signal in at least 5 increments (For example: 4.00 maDC/0 psig, 8.00 maDC/25 psig, 12.00 maDC/50 psig, 16.00 maDC/75 psig, 20.00 maDC/100 psig).
- 7) For switches, process values at which the switch changes state and at which the switch resets.
- 8) For instruments calibrated by manufacturer, manufacturer's calibration report is acceptable as proof of calibration.
- b. Factory acceptance test reports on all fabricated control panels or assemblies containing the following information:
 - 1) Date of test.
 - 2) Test participants.
 - 3) Visual inspection of components.
 - 4) Successful application of power.
 - 5) Validation of all internal wiring.
 - 6) Validation of correct control operation.
 - 7) Validation of screen graphics or alarm operation (if applicable).
 - 8) Validation of program installation into PLC's and that I/O is functioning properly (if applicable).
2. Certificates, Manufacturer's
 - a. UL 508 certification for all assembled control panels and assemblies
3. Instructions, Manufacturer's Field.
 - a. Furnish a complete Operations and Maintenance Manual for all assembled control panels and assemblies.
4. Reports
 - a. Not applicable to this section.

F. Closeout Submittals

1. Furnish Operations and Maintenance Manuals in 3-ring binders complete with the following:
 - a. On front and spine of binders provide the project name, owners name and project number.
 - b. Within the binder, identify the contractor and provide contact information
 - c. Inside binders, provide a volume index and table of contents for each binder. Each instrument or control component tag number must be cross referenced to a specific binder tab.
 - d. Furnish manufacturers complete operations and maintenance manuals for all discrete instruments and controls.
 - e. Furnish custom Operations and Maintenance section for each custom control system, control panel, or fabricated assembly.
 - f. Furnish "As-Built" loop and wiring diagrams.
 - g. Furnish the written warranty.
2. Turn over all spare parts to owner with documentation showing which instrument or control system the spare parts are for.

- G. Schedule
 - 1. Submit a detailed work schedule showing start/finish dates, task duration, task sequencing, critical path, and available float. Identify task predecessors and identify coordination activities with other trades.
- H. Startup and Commissioning Plan
 - 1. Submit a detailed startup and commissioning plan for review by Owner and Engineer. Plan should include the following information:
 - a. The order in which the various plant systems will be started up.
 - b. What work must be performed prior to the startup.
 - c. What documentation will be maintained by the contractor and provided to the owner validating that the startup was performed in a safe and efficient manner.

1.06 QUALITY ASSURANCE

- A. Qualifications
 - 1. Contractor performing the work shall have a minimum 5 years' experience performing similar work in similar industries. All contractors' personnel shall be trained and experienced in best current construction practices.
- B. Regulatory Requirements
 - 1. Perform all work in accordance with all applicable national and local codes.
- C. Certifications
 - 1. Not applicable this section.
- D. Field Samples
 - 1. Not applicable this section.
- E. Mock-Ups
 - 1. Not applicable this section.
- F. Pre-Installation Meetings
 - 1. Not applicable this section.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Packing, Shipping, Handling, and Unloading
 - 1. Perform these activities in a manner which assures instruments and equipment will arrive undamaged and in proper working order. Replace any instrument or equipment damaged upon arrival at no additional cost to owner.
- B. Acceptance at Site
 - 1. Maintain a comprehensive log by instrument or equipment tag number of all received instruments or equipment.

- C. Storage and Protection
 - 1. Store all instruments and equipment as recommended by manufacturer. Protect from physical damage, moisture, dirt/dust, or extremes of temperature.

1.08 PROJECT/SITE CONDITIONS

- A. Environmental Requirements
 - 1. Follow any and all environmental requirements pertaining to the site.
 - 2. Maintain a safe and clean job site.
 - 3. Dispose of all trash and construction debris in an approved manner.
- B. Existing Conditions
 - 1. Contractor is to examine the site and be thoroughly familiar with any site requirements which may affect the work or storage of instruments or equipment.

1.09 SEQUENCING

- A. Coordinate all work with other trades.

1.10 SCHEDULING

- A. Provide and maintain a detailed schedule for performance of the work identifying start/finish dates, durations, required preceding activities, and coordination with other trades. Organize procurement, deliveries, and staff labor to meet the overall construction schedule and to assure that other trades are not delayed.

1.11 WARRANTY

- A. Instrumentation
 - 1. One year from system acceptance by owner for all discrete instrumentation, control devices, or equipment. During this period, replace any defective or malfunctioning device with 15 working days after notification by owner.
 - 2. One year from system acceptance by owner for the performance of the overall control system. Correct the defect within 15 working days after notification by owner. Warranty repair work includes but is not limited to the following:
 - a. Improper sequencing or interlocking of equipment control systems.
 - b. Wiring errors or omissions.
 - c. Improper calibration of field instruments.
 - d. Improper operation of programmable logic controllers or operator interface terminals
 - e. Improper operation of communications systems installed as part of the overall control system
 - f. Unsafe operations or maintenance conditions..
 - g. Other system malfunctions which prevent or impair the plant from operating at design capacity, requires excessive operator intervention, or results in unsafe operating conditions.

1.12 SYSTEM STARTUP/COMMISSIONING

A. General

1. Provide labor, tools, and equipment to start up the facility in a safe and efficient manner.
2. Plant shall be started up by system. A system is defined as a collection of mechanical, electrical, and controls equipment configured to perform a specific function or purpose. Examples may be a UV disinfection system, a dissolved oxygen blower system, a grit removal system, etc... The order in which the systems will be started shall be submitted by contractor in the startup plan and approved by owner and engineer. Any variance in this schedule must be approved by owner and engineer.
3. Unless approved otherwise by owner and engineer, contractor is to follow the startup sequence detailed below. The following work must be complete prior to beginning the startup:
 - a. All mechanical equipment installed and tested in accordance with manufacturers recommendations.
 - b. All motors must have been rotation checked.
 - c. Electrical power is available and wired to all mechanical equipment
 - d. All instruments must have been calibrated and installed in accordance with the manufacturer's recommendations.
 - e. Control system communication systems are installed and fully operational. This includes DH+ networks, Modbus+ networks, Ethernet networks, radio telemetry systems, telephone systems, etc...
 - f. All power and control wiring must be installed, rung out, and validated to be in accordance with approved construction drawings.
 - g. Programmable logic controllers, SCADA computers, and Operator Interface Terminals all are installed, have their programs installed, and these devices are fully operational and functioning in their design configuration.

B. System Startup Sequence

1. By manipulation of the instrument or direct signal injection at the instrument, verify that the control signal (discrete or analog) is received at the programmable logic controller or by the hard wired control circuit.
2. For motorized equipment, disconnect the power leads at the starter, VFD, or solid state motor controller.
3. Completely exercise the control circuit in Manual, Remote, and Automatic modes and verify that all interlocks and permissives are functioning correctly.
4. Verify that the programmable logic controller can start and stop the motor in Auto or Remote. Motors may be "bumped" by forcing PLC outputs but these program forces must be removed immediately afterward.
5. Verify that run status, signal levels, and alarms display properly on the OIT and the SCADA screens.
6. Reconnect the motor power leads.
7. Verify PID loop operating correctly (either direct or reverse) and adjust gain constants to achieve critically damped operation.
8. Configure the mechanical system for normal operation and leave system ready for normal operation.

9. Utilize colored tagging scheme to identify startup condition. Red is not ready for startup, yellow is mechanically and electrically ready but not yet tested or started up, and green is fully tested and ready for normal operation. Place these tags on all mechanical, electrical, instrumentation, and control components of each system.
10. As plant systems are started up, coordinate and remedy any coordination or interface issues between systems.

C. Remedies for Damages

1. Contractor is liable for any and all damage done to mechanical or electrical equipment due to improper startup procedures and shall repair or replace any damaged equipment at owner's discretion without additional cost to owner.
2. Contractor is forbidden to jumper around any process or safety interlock either with wiring or within a PLC program without the express written permission of both the owner and engineer. All jumpers, hardwired and programmed, must be maintained in a log book. Entries shall include:
 - a. Name of person placing the jumper.
 - b. Date of installation.
 - c. Reason for installation.
 - d. Approval of owner and engineer.
 - e. Date of removal.
 - f. Name of person removing the jumper.

1.13 OWNER'S INSTRUCTIONS

- A. Not applicable this section.

1.14 MAINTENANCE

- A. Extra Materials
1. Not required this section.
- B. Maintenance Service
1. Not required this section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Approved manufacturers are listed in the other Electrical and Instrument Specification Sections.

2.02 EXISTING PRODUCTS

- A. Not applicable this section.

2.03 MATERIALS

- A. All materials are to be new and the manufacturers most current model.

2.04 MANUFACTURED UNITS

- A. Manufactured units are to be fully assembled and tested at the point of manufacture and delivered to the job site ready for installation and start-up.
- B. Regulated dc power supplies for instrument loops shall be designed and arranged so that loss of one supply does not affect more than one instrument loop or system. Power supplies shall be suitable for an input voltage variation of plus or minus 10 percent, and the supply output shall be fused or short circuit protected. Output voltage regulation shall be as required by the instrumentation equipment being supplied. Multi-loop, or multi-system power supplies, will be acceptable if backup power supply units are provided which will automatically supply the load upon failure of the primary supply. The backup supply systems shall be designed so that either the primary or backup supply can be removed, repaired, and returned to service without disrupting the instrument system operation.
- C. The power distribution from multi loop supplies shall be selectively fused such that a fault in one instrument loop will be isolated from the other loops being fed from the same supply. Fuses shall be clearly labeled and located for easy access. Multi loop supply systems shall be oversized for an additional 10 percent future load. Failure of a multi loop supply shall be indicated on the respective instrument panel or enclosure.

2.05 EQUIPMENT

- A. All equipment is to be new and the manufacturers most current model. All instruments and control devices and assemblies shall be standard devices constructed of corrosion-resistant materials enclosed in a water and dust proof case and mounted as specified in the individual application. Enclosures shall be manufacturer's standard color unless specified otherwise.

2.06 COMPONENTS

- A. Not applicable this section.

2.07 ACCESSORIES

- A. Not applicable this section.

2.08 MIXES

- A. Not applicable this section.

2.09 FABRICATION

- A. Shop Assembly
 - 1. Fabricate assemblies in accordance with approved drawings. Notify engineer and owner at least 5 working days prior to start of testing so that they may witness the testing if they choose to do so.

2.10 FINISHES

A. General

1. Finishes for all components, equipment, and fabricated assemblies must take into account the environment in which they will be installed. NEMA ratings must be appropriate for the environment. Ratings for corrosive areas must be NEMA 4X, for outdoor areas NEMA 4 or 3R, indoor dusty areas may be NEMA 12.

B. Shop Finishing

1. Where called for in other sections, sandblast, prime, and paint assemblies.

2.11 SOURCE QUALITY CONTROL

A. Fabrication/Tolerances

1. In accordance with generally accepted manufacturing standards.

B. Tests, Inspections

1. In accordance with generally accepted manufacturing standards.

C. Verification of Performance

1. Not applicable this section.

PART 3 - EXECUTION

3.01 ACCEPTABLE INSTALLERS

- A. Contractors having a minimum 5 years' experience in the design, procurement, and construction of industrial water/wastewater instrumentation and control systems.

3.02 EXAMINATION

A. Site Verification of Conditions

1. Visit job site and ascertain any environmental or physical conditions which may affect the performance of the work or the equipment requirements.

3.03 PREPARATION

A. Protection

1. Not applicable this section.

B. Surface Preparation

1. Not applicable this section.

3.04 ERECTION

- A. Provide 4-inch-tall reinforced concrete housekeeping pads for all control panels and floor

mounted fabricated control assemblies and consoles. Dowel into concrete base and extend a minimum of 2" past edges of equipment.

- B. Provide Unistrut or fabricated structural supports for heavy equipment or assemblies. Prime and paint supports so that they are unaffected by the environment in which they are installed.
- C. Securely fasten all panels and assemblies to their housekeeping pads or structural supports.
- D. All interconnecting wiring shall be run in conduit in accordance with the division 16 sections requirements.

3.05 INSTALLATION

- A. Install all instruments and controls in accordance with manufacturer's recommendations and all applicable electrical codes and standards. Connect all required utilities including electrical power, air, hydraulics, water, and communications as required.
- B. Provide stainless steel tags for each instrument engraved with instrument tag number. Attach to instrument with stainless steel wire.
- C. Provide engraved nameplates for all panel mounted instruments. Attach to panel with stainless steel screws.

3.06 APPLICATION

- A. Not applicable this section

3.07 CONSTRUCTION

- A. Special Techniques
 - 1. In accordance with manufacturers recommended installation procedure.
- B. Interface with Other Work
 - 1. Coordinate with all other trades.
- C. Sequences of Operation
 - 1. Not applicable this section.
- D. Site Tolerances
 - 1. Not applicable this section.

3.08 REPAIR/RESTORATION

- A. Repair any damages caused by the installation or erection to original condition.

3.09 RE-INSTALLATION

- A. Not applicable this section.

3.10 FIELD QUALITY CONTROL

- A. Site Tests
 - 1. Test and calibrate instrumentation in accordance with other parts of this section.
- B. Inspection
 - 1. Not required this section.
- C. Manufacturer's Field Services
 - 1. If recommended by manufacturer, have equipment/control systems inspected, tested, and started up by manufacturer's representative.

3.11 ADJUSTING

- A. Not required this section.

3.12 CLEANING

- A. Remove and dispose of construction debris daily. Wipe down and vacuum out all enclosures.

3.13 DEMONSTRATION/TRAINING

- A. In accordance with the Startup part of this section.
- B. Provide training of personnel in the operation and maintenance of the furnished control systems.
- C. Training shall be provided as required elsewhere in the Contract Documents, but shall consist of at least eight hours, in a single, or multiple sessions, to accommodate the personnel schedules.
- D. Coordinate with the Engineer, and the Owner, to schedule the training sessions at least 5 workdays in advance.

3.14 PROTECTION

- A. Protect instrumentation and control equipment from environmental damage and from damage by other trades.

3.15 SCHEDULES

- A. Not applicable this section.

END OF SECTION

SECTION 17052

RADAR LEVEL TRANSMITTER

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. This section covers Radar Level Transmitters to be provided where indicated on the Drawings.
- B. Related work specified elsewhere includes, but is not limited to section 16000 Electrical. Also, refer to requirements of Contract Documents for testing, adjusting and balancing of systems.

1.02 QUALITY ASSURANCE

- A. Equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacture of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functioning of the work.

1.03 SUBMITTALS

- A. The following material shall be submitted to the Engineer prior to installation, in accordance with Section 16000, and as required elsewhere in the Contract Documents:
 - 1. Where applicable, provide complete manufacturer's part number, identifying scaling, operating range, housing and wetted parts materials, NEMA rating, product options, consumable materials, and other pertinent information.
 - 2. Prior to Final Acceptance of the work, the Contractor shall provide Operations and Maintenance Manuals, in accordance with the Contract Documents.

PART 2 - PRODUCTS

2.01 RADAR LEVEL TRANSMITTER

- A. The radar level controller system shall be comprised of a transmitter and integral transducer housed in a NEMA 4X housing. The system shall be of the non-contact type for continuous measurement and control of liquid and solid levels.
- B. The transmitter shall include a front panel mounted, 4 line (min.) LCD display.
- C. The transmitter shall have a 2-wire, 4-20 mA HART enabled output that is proportional to level.

- D. Transmitter shall have a switch output that has programmable switch-on and switch-off points.
- E. Transmitter shall have a minimum operating temperature range of -20 degrees C to +70 degrees C.
- F. Enclosure shall be die cast aluminum, powder coated, NEMA 4X rated.
- G. Shall be equipped with a weather protective cover in all outdoor installations where transmitter will be exposed to sunlight or adverse weather conditions.
- H. The transducer shall be capable of measuring a span of up to 98 feet. The span and range shall be set in the field.
- I. Shall have a minimum accuracy of +/- 3mm.
- J. The system shall be 24VDC loop powered.
- K. Shall be an Endress + Hauser Micropilot FMR56 or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Equipment and materials specified in this section shall be installed and connected as specified, and as shown on the Drawings and in accordance with manufacturers recommendations. The Contractor shall coordinate the installation with the other trades, to insure proper installation of the transducer, transmitter, and associated conduit and cables.
- B. The Contractor shall calibrate the instruments to the proper ranges, as required by the Owner and the Engineer. Where analog signals are connected to local, or remote monitoring equipment, the Contractor shall verify that the calibrated ranges and scaling of the local and remote indicators are correct.

3.02 ACCEPTANCE

- A. Prior to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation under the conditions set forth in these specifications. This requirement is in addition to the manufacturer's guarantee.

3.03 SPARE PARTS

- A. Provide Owner with a list of the manufacturers' recommended spare parts.

END OF SECTION

SECTION 17111

FLOAT SWITCHES

PART 1 - GENERAL

1.01 SCOPE

- A. This section includes furnishing all float switches as indicated on the drawings and specified herein.
- B. Related work specified elsewhere includes, but is not limited to, Section 16000, Electrical. Also refer to requirements of Contract Documents for testing, adjusting and balancing of systems.

1.02 QUALITY ASSURANCE

- A. Equipment to be furnished under this section shall be the product of firms regularly engaged in the design and manufacture of this type of equipment. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functioning of the work.

1.03 SUBMITTALS

- A. The following material shall be submitted to the Engineer prior to installation, in accordance with Section 16000, and as required elsewhere in the Contract Documents:
 - 1. Where applicable, provide complete manufacturer's part number, identifying scaling, operating range, housing and wetted parts materials, NEMA rating, product options, consumable materials, and other pertinent information.
 - 2. Prior to Final Acceptance of the work, the Contractor shall provide Operations and Maintenance Manuals, in accordance with the Contract Documents.

PART 2 - PRODUCTS

2.01 BALL TYPE FLOAT SWITCH (MERCURY FREE) AND ATTACHED CABLE.

- A. Float switch shall be direct acting and be constructed of a Teflon-coated, 20 gauge, 316 type stainless steel housing measuring not less than 5 ½ inches in diameter.
- B. A long life, high reliability, potted SPST magnetic reed switch rated for not less than 100VA at up to 250V shall be mounted inside the float and connected to a multi-stranded, 2 conductor plus ground, 16 gauge, CPE jacketed cable. The cord shall have fine strand conductors made especially for heavy flexing service.
- C. The cable connection point shall be potted in epoxy providing a strong bond to the float and

reed switch forming a water/moisture tight connection.

- D. A flexible neoprene sleeve, not less than 1/8" thick, shall be provided over the CPE jacketed cable standing not less than 5 inches from the top of the mounting bracket extending down through the cable mounting bracket hinge point to the top of the float switch body providing cable stress point relief and extended operational life.
- E. A 316 stainless steel flanged cable mounting clamp assembly shall be supplied that allows either pipe or cable mounting.
- F. Float cable length shall be as required based upon specific project installation requirements.
- G. Float switch assembly shall have a minimum operating temperature range of -35 deg. C to 90 deg.
- H. Float switches shall be a Siemens Model 9G-EF, or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Equipment and materials specified in this section shall be installed and connected as specified and as shown on the drawings. Contractor shall coordinate with Mechanical and Structural for optimum location of float switches.

3.02 ACCEPTANCE

- A. Prior to final acceptance of the work, the Contractor shall certify the equipment and installation included under this section to be free of defects, and suitable for trouble-free operation under the conditions set forth in these specifications.

END OF SECTION