



TOWN OF KEARNY
PHASE 2 KEARNY WATER RECLAMATION FACILITY IMPROVEMENTS

VOLUME 2 of 3:
BID DOCUMENTS
FINAL DESIGN SUBMITTAL

June 2026



EXPIRATION DATE: 09/30/27



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**TOWN OF KEARNY
WATER RECLAMATION FACILITY IMPROVEMENTS**

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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
 - 1. Influent Channel Improvements: Demolition of the existing Auger Monster, to be replaced with an in-kind Auger Monster; installation of a potable water piping to the Auger.
 - 2. River Effluent Flow Meter: Installation of a new flume flow measuring box at the AZPDES discharge to the river.
 - 3. Splitter Box Replacement: Demolition and replacement of the existing splitter box with new precast concrete splitter box.
 - 4. Aeration Blowers System Improvements: Abandonment of the existing underground air piping and installation of a new above ground stainless steel piping.
 - 5. Treatment Basin Improvements: Installation of new pneumatic butterfly valves for air piping and near aeration basin;
 - 6. Access Features Improvements: Construction of a new staircase and rotation of the existing staircase.
 - 7. Reuse Pump Station Improvements: Demolition of two existing centrifugal pumps, electrical service panels, and related components. Construction of a new reuse pump station, including valves, piping, site work, electrical panels, wiring, conduit, control panels, and associated components.
 - 8. Off-site valve assembly: Removal of the existing Cal-Val valve and two pressure gauges, to be replaced with new valves and manual check valves.
 - 9. Blower Room Improvement: Construction of walls for blower control room expansion.
- C. The American Iron and Steel Act.
 - 1. The American Iron and Steel (AIS) provision requires USDA Rural Utilities Service (RUS) Water and Environmental Programs (WEP) assistance recipients to use iron and steel products that are produced in the United States. This requirement applies to projects for the construction, alteration, maintenance, or repair of water and waste infrastructure. WEP has developed guidance on how to implement and comply with this requirement.
 - 2. The AIS provision is a requirement for all WEP projects. AIS is mandated by the Consolidated Appropriations Act of 2017, Section 746 Division A, Title VII.

1.02 LOCATION OF PROJECT

- A. The Project is located at the following addresses:
 - 1. WWTP Improvements: 501 Veterans Avenue, Kearny, AZ.

2. Offsite Valve Assembly: Near the golf course and airport, coordinates 33° 2'53.54" N, 110° 54'44.69" W.

1.03 WORK BY THE OWNER

- A. Concurrent to this Project, the OWNER will:
 1. Provide site access.
 2. Provide water needed for construction.
 3. Coordinate startup and shutdown of facilities.
 4. Coordinate for temporary pump and power to be used to pump effluent to effluent storage tank during the demolition and replacement of effluent pump station.
 5. Collect water samples after the CONTRACTOR has completed disinfection of the temporary storage tank and 0.25MG tank and conduct bacteriological tests. ENGINEER to provide De Minimus Permit for tank discharge.

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. All work must be scheduled with the OWNER to avoid interference with existing facilities. Refer to Section 01040 for additional requirements.
- B. The existing booster pump station shall remain in operation during construction of the new facilities. The Contractor shall follow a phased approach for constructing the effluent reuse pump station as follows:
 1. Divert the effluent flow to Gila river.
 2. Temporary piping to tap into effluent flow pipe at the point of installation of Parshall flume meter. This piping can be flexible piping or rigid.
 3. Demolish and replace effluent pump station and header piping with valves and appurtenances.
 4. Construct new electrical service panels, complete testing and transfer existing electrical service to new panels (shutdown to be coordinated with Owner).
 5. Demolish existing electrical panels.

6. Any damage to existing property/equipment must be replaced to original working conditions.
 7. All relocations of existing piping shall be completed first before other construction activities.
- C. The wastewater treatment plant shall remain in operation during demolition and construction of aeration piping and the influent splitter box and outlet piping.
1. Temporary air piping will be used to supply air to the treatment plant from the blowers. This piping can be flexible piping or rigid.
 2. Temporary piping will be installed before the splitter box in a manner that allows operators to direct flow to either or both treatment trains.

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 ADEQ De Minimus permits for discharge of hydrostatic test water and chlorinated water used to disinfect piping and equipment.
 2. Building and Electrical permits from Pinal County.
- B. OWNER will pay for and provide the following permits to the CONTRACTOR: Arizona Department of Environmental Quality's Approval to Construct (ATC) and Approval of Construction (AOC), if needed.

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.
- 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 interferes 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.

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 300 calendar days. CONTRACTOR shall also comply with the following interim dates of completion:

Task	Interim Completion Date (days after NTP)
	WWTP Improvements
Submit shop drawings for system components.	30
Install temp air and influent piping to the treatment plant.	40
Demolish existing facilities and install new facilities, including equipment, piping, and electrical.	270
Initiate startup and commissioning of new equipment.	295
Substantial completion.	300

- 1. CONTRACTOR shall include sufficient and complete overhead costs in base Bid for a 300 calendar day construction duration to reach substantial completion at each site as listed above. No change orders or claims for extended overhead will be considered unless the actual duration to reach substantial completion exceeds 300 calendar days and OWNER was responsible for extending the timeline:
 - a. No credit or refund will be given to CONTRACTOR if the work is substantially completed sooner than 300 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. CONTRACTOR, with input from OWNER, can identify the timeframe and duration of facility shutdowns.
 3. At no time shall CONTRACTOR or his employees modify operation of the existing facilities or start construction modifications without approval of the OWNER.
 4. CONTRACTOR shall plan his work to allow OWNER access to existing facilities to perform maintenance and repair work.
 5. 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 temporary pump and piping for MOPO.
 2. Install effluent pumps and motor.
 3. Install yard piping and conduit.
 4. Pressure test piping.
 5. Install electrical and instrumentation and controls wiring.
 6. Conduct point to point and loop check for instrumentation and controls.
 7. Disinfect piping and equipment.
 8. Conduct startup of facilities.
 9. Work with ENGINEER to conduct commissioning. Conduct training of OWNER'S staff. The trainings shall be videotaped and provided to the OWNER on a CD.
 10. Complete remaining work and punch list items.
 11. 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 (NOT REQUIRED)

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 (all similar electronic 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 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:

- | | <u>Title</u> |
|----|---|
| 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 (See Section 01340) |

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

CONTRACTORS WORK FORCE:	SUBCONTRACTORS WORK FORCE:	EQUIPMENT ON SITE:
Administrative Supervisors Carpenters Iron Workers Operators Finishers Welders Electricians Laborers _____ _____ _____	Mechanical Electrical Instrumentation Sitework Masonry Roofing Rebar Foundation Painting _____ _____ _____	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: _____

SECTION 01340

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

PART 1 - GENERAL

1.01 DESCRIPTION

- A. General:
 - 1. Section Addresses:
 - a. Mechanics of shop drawing and operation and maintenance manual submittal and review process.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 1 - General Requirements.
 - 2. Sections in Divisions 2 through 17 identifying submittal requirements.

1.02 SUBMITTALS: GENERAL

- A. Transmit all technical submittals electronically to:
 - Ken Hebert (or other designated representative)
kenhebert@ncseng.com
 - For those items that require hard copies, send to following address:
NCS Engineers,
202 E Earll Drive, Suite 110,
Phoenix, AZ 85012
- B. Utilize one copy of “Contractor’s Shop Drawing Transmittal” (Exhibit A-01340) Form to transmit all shop drawings, Operation and Maintenance Manuals, and samples. Transmittals will not be received from or returned to subcontractors.
- C. Provide submittal information defining specific equipment or materials utilized on the project. Generalized product information not clearly defining specific equipment or materials to be provided will be rejected.
- D. Calculations required in individual specification sections will be received for information purposes only and will be returned stamped “E”. Engineer’s Review Not Required” to acknowledge receipt.

- E. Assure submittals meet the following schedule:
 - 1. Shop drawings:
 - a. Submittal and approval prior to that portion of work being installed and prior to 50 percent overall completion.
 - b. ENGINEER will attempt to return all submittals to CONTRACTOR within 14 calendar days of receipt.
 - 2. Operation and Maintenance Manuals and Data Record Sheets:
 - a. Initial submittal within 45 days after date shop drawings are approved.
- F. Final payment on the project shall not be made until final approved copies of all Operation and Maintenance Manuals have been received.
- G. Provide CONTRACTOR's stamp of approval as indication of his checking and verification of dimensions and coordination with interrelated work.
- H. Provide schedule of submittals with anticipated submittal dates within two weeks after the preconstruction conference.

1.03 SUBMITTALS: SHOP DRAWINGS

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

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

1.04 SUBMITTALS: SAMPLES

- A. Identify sample as to: manufacturer, item, use, type, project designation, tag number, specification section or drawing detail reference, color, range, texture, finish and other pertinent data.
- B. Include application specific brochures, and installation instructions.
- C. Provide CONTRACTOR's stamp of approval on samples as indication of his checking and verification of dimensions and coordination with interrelated work.
- D. Resubmit samples of rejected items.
- E. Approved samples submitted or constructed, constitute criteria for judging completed work. Finished work or items not equal to samples will be rejected.

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

1.05 SUBMITTALS: OPERATION AND MAINTENANCE MANUALS

A. Transmittal Mechanics:

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

B. Transmittal Content:

1. Submission of Operation and Maintenance Manuals is applicable to but not necessarily limited to:
 - a. Equipment such as meters, valves, pumps and feed system controls, electrical panels, and instrumentation.
 - b. Equipment used with electrical motor loads (pumps).
 - c. Specialized equipment including valves and instrumentation and control system components for process systems such as meters, recorders, and transmitters.
 - d. Valves and actuators.
2. Prepare operation and maintenance manuals which include, but are not necessarily limited to the following detailed information, as applicable:
 - a. Equipment function, normal operating characteristics, limited operations.

- b. Assembly, disassembly, installation, alignment, tolerances, adjustment, and checking instructions.
- c. Operating instructions for start-up, routine and normal operation, regulation and control, shutdown, and emergency conditions.
- d. Lubrication and maintenance instructions (including schedules).
- e. Guide to “troubleshooting”.
- f. Parts list (including material of construction) and predicted life of parts subject to wear.
- g. Outline, cross-section, and assembly (exploded view) drawings; engineering data; and electrical diagrams, including elementary diagrams, wiring diagrams, connection diagrams, word description of wiring diagrams and interconnection diagrams.
- h. Test data and performance curves.
- i. A list of recommended spare parts with a price list.
- j. Copies of installation instructions, parts lists or other documents packed with equipment when delivered.
- k. Tag numbers relating the equipment back to the Contract Documents.
- l. Safety instructions.
- m. ISO identification numbers for bearings.
- n. List of specialty tools required and availability.
- o. List weight of overall assemblies and individual weights of major individual components.
- p. List of vendors and who to contact for warranty work.
- q. List of fastener grades.
- r. Copy of warranty, if applicable.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 SUBMITTALS: APPROVAL OR REJECTION

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

A - NO EXCEPTIONS TAKEN

B - FURNISH AS NOTED

C - REVISE AND RESUBMIT

D - REJECTED

E - ENGINEER’S REVIEW NOT REQUIRED

- B. Transmittals received will be initially reviewed to ascertain inclusion of CONTRACTOR's approval stamp. Drawings not stamped by the CONTRACTOR or stamped with a stamp containing language other than that specified in Paragraph 1.02 G will not be reviewed for technical content and will be returned without any action.
- C. Transmittals returned with disposition "A" or "B" are considered ready for fabrication and installation. If for any reason a transmittal that has an "A" or "B" disposition is resubmitted, it must be accompanied by a letter defining the changes that have been made and the reason for the resubmittal. The CONTRACTOR shall assure that previously approved documents are destroyed when they are superseded by a resubmittal as such.
- D. Transmittals with disposition "A" or "B" combined with Action "C" (Revise and Resubmit) or "D" (Rejected), will be individually analyzed giving consideration as follows:
 - 1. The portion of the transmittal given "C" or "D" will not be distributed (unless previously agreed to otherwise at the Preconstruction Conference). One copy or the one transparency of the "C" or "D" drawings will be marked up and returned to the CONTRACTOR. It shall be the CONTRACTOR's responsibility to ensure that these items are corrected and resubmitted.
 - 2. Items marked "A" or "B" will be fully distributed.
 - 3. If a portion of the items or system proposed are acceptable, however, the major part of the individual drawings or documents are incomplete or require revision, the entire submittal may be given "C" or "D" action. This is at the sole discretion of the ENGINEER. In this case, some drawings may contain relatively few or no comments or the statement, "Resubmit to maintain a complete package." Distribution to the OWNER, CONTRACTOR, and ENGINEER will not be made (unless previously agreed to otherwise).
- E. Failure to include any specific information specified under the submittal paragraphs of the specifications shall result in the transmittal being returned to the CONTRACTOR unapproved.
- F. In addition to calculations stamped and returned "E. Engineer's Review Not Required", other transmittals such as submittals which the Engineer considers as "Not Required" and submittal information in a transmittal which have been reviewed and approved in a prior transmittal, will be returned with action "E. Engineer's Review Not Required."

END OF SECTION

SECTION 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.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01414

EARTHMOVING AND DUST CONTROL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. CONTRACTOR shall obtain all earthmoving permits and any other permits required for earthmoving and dust generating operations related to the Work as required by the Arizona Department of Environmental Quality (ADEQ) requirements.
- B. CONTRACTOR shall not cause or allow any dust generating operation, earthmoving operation, use of property, or any other operation which causes fugitive dust emissions that exceed the 20 percent visible emission opacity limit in ADEQ requirements.
- C. If requested by the OWNER, ENGINEER, or ADEQ representative, CONTRACTOR shall conduct opacity observations for visible emissions of fugitive dust in accordance with techniques specified in USEPA Reference Method 9.
- D. In addition to earthmoving permits, CONTRACTOR shall obtain approval of CONTRACTOR developed Dust Control Plan from ADEQ. At a minimum, the Dust Control Plan shall include the following information:
 - 1. Name(s), address(es) and phone number(s) of the person(s) responsible for the preparation, submittal, and implementation of the Dust Control Plan and responsible for the dust generating operations.
 - 2. A site plan that describes the total area of land surface to be disturbed (in acres); the operations and activities to be performed on the site; actual and potential sources of fugitive dust emissions; and the delivery, transportation, and storage areas for the site (including types of materials stored and appropriate size of material stock piles).
 - 3. Description of the Reasonably Available Control Measures (RACM) to be applied during all periods of dust generating operations at all actual and potential sources of fugitive dust.
 - 4. Description of dust suppressants to be applied including product specifications; method, frequency, and intensity of application; type, number, and capacity of application equipment; and certifications related to the suppressant's appropriate and safe use.
 - 5. Description of specific surface treatment(s) or RACM used to control material track-out where unpaved or access points join paved surfaces.
 - 6. Description of at least one alternative RACM for each actual and potential fugitive dust source shall be designated as a contingency measure.

- E. CONTRACTOR shall post a copy of all earthmoving permits as well as the approved Dust Control Plan in a conspicuous location at the worksite and provide a copy of each to the ENGINEER.
- F. CONTRACTOR shall maintain a daily written log that records the actual application or implementation of the RACMS described in the approved Dust Control Plan. CONTRACTOR shall maintain this written log and supporting documentation on site and shall make available for review on request by ENGINEER, OWNER, or Maricopa County representative. CONTRACTOR shall retain copies of the Dust Control Plan, RACM implementation records, and all supporting documentation for a minimum of three years.
- G. CONTRACTOR, at a minimum, shall provide all necessary equipment and materials to apply sufficient dust suppressants (e.g., water, etc.), properly clean (sweep, etc.) all track-out areas, and provide adequate physical stabilization (e.g., gravel, recycled asphalt, etc.) to meet all requirements of the earthmoving permit and approved Dust Control Plan. CONTRACTOR shall use these methods to control fugitive dust generation from all CONTRACTOR operations on all CONTRACTOR areas including, but not limited to:
 - 1. Construction areas.
 - 2. Vehicle and equipment parking areas.
 - 3. Material storage areas.
 - 4. Office and trailer areas.
 - 5. Haul and access roadways.
 - 6. Track-out areas.
 - 7. All other areas where CONTRACTOR shall be working, storing, or parking vehicles, equipment, and materials.
- H. CONTRACTOR shall pay all fines issued ADEQ, due to violation of CONTRACTOR'S earthmoving permit and Dust Control Plan.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

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. National Sanitation Foundation 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 01500

TEMPORARY FACILITIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Furnishing, maintaining, and removing construction facilities including temporary utilities, construction aids, barriers and enclosures, security, and removal after construction.
 - 1. Requirements are of concern to OWNER and are representative of construction facilities and controls which are solely CONTRACTOR's responsibility.
 - 2. No attempt is made to set out in detail means or methods necessary to satisfy requirements:
 - a. Recognition of requirements is made to assist CONTRACTOR in the identification of necessary costs.

1.02 TEMPORARY UTILITIES

- A. Temporary Electrical Power:
 - 1. CONTRACTOR is responsible for all costs of wiring, connections, and interface with utility for temporary power supply during construction.
 - 2. CONTRACTOR to:
 - a. Provide and maintain adequate jobsite power distribution facilities conforming to applicable Laws and Regulations.
 - b. Pay for electric power for performance of the Work except for power required for the commissioning period.
 - 3. CONTRACTOR may use existing and/or new meters to obtain temporary power supply at the project sites. Costs for modifying the power supplies for temporary use by CONTRACTOR.
- B. Temporary Electrical Lighting:
 - 1. In work areas, provide temporary lighting sufficient to maintain lighting levels during working hours not less than lighting levels required by OSHA and state agency which administers OSHA regulations where Project is located.
 - 2. When available, permanent lighting facilities may be used in lieu of temporary facilities:
 - a. Prior to Substantial Completion of the Work, replace bulbs, lamps, or tubes used by CONTRACTOR for lighting.

- C. Temporary Heating, Cooling, and Ventilating:
 - 1. As needed, heat and ventilate work areas to protect the Work from damage by freezing, high temperatures, weather, and to provide safe environment for workers.

- D. Temporary Water:
 - 1. The CONTRACTOR may obtain construction water from booster pump station discharge (at booster station site) or from the storage tanks (at storage tanks site). CONTRACTOR will not be required to pay for temporary water.
 - 2. Provide and remove temporary piping and connections and restore affected portions of the facility to original condition before Substantial Completion.

- E. Temporary Sanitary Facilities:
 - 1. Provide temporary sanitary facilities for the needs of all employees and workers at the site.
 - 2. Provide suitable and adequate sanitary facilities that are in compliance with applicable Laws and Regulations.
 - 3. At completion of the Work, remove sanitary facilities and leave site in neat and sanitary condition.

- F. Temporary Fire Protection: Provide sufficient number of fire extinguishers of type and capacity required to protect the Work and ancillary facilities.

- G. First Aid: Post first aid facilities and information posters conforming to requirements of OSHA and other applicable Laws and Regulations in readily accessible locations.

1.03 CONSTRUCTION AIDS

- A. General:
 - 1. Use construction hoists, elevators, scaffolds, stages, shoring and similar temporary facilities of ample size and capacity to adequately support and move loads.
 - 2. Provide railings, kick plates, enclosures, safety devices, and controls required by Laws and Regulations and as required for adequate protection of life and property.
 - 3. Design temporary supports with adequate safety factor to assure adequate load bearing capability:
 - a. When requested, submit design calculations by professional registered engineer prior to application of loads.
 - 4. Submitted design calculations are for information and record purposes only.

- B. Accident Prevention:
 - 1. Exercise precautions throughout construction for protection of persons and property.

2. Observe safety provisions of applicable Laws and Regulations.
 3. Guard machinery and equipment, and eliminate other hazards.
 4. Make reports required by authorities having jurisdiction, and permit safety inspections of the Work.
 5. Before commencing construction Work, take necessary action to comply with provisions for safety and accident prevention.
- C. Barricades:
1. Place barriers at ends of excavations and along excavations to warn pedestrian and vehicular traffic of excavations.
 2. Provide barriers with flashing lights after dark.
 3. Keep barriers in place until excavations are entirely backfilled and compacted.
 4. Barricade excavations to prevent persons from entering excavated areas in streets, roadways, parking lots, other public or private areas, and on project site.
- D. Warning Devices and Barricades: Adequately identify and guard hazardous areas and conditions by visual warning devices and, where necessary, physical barriers.
1. Devices shall conform to minimum requirements of OSHA and State agency which administers OSHA regulations where Project is located.
- E. Hazards in Public Right-of-Way:
1. Mark at reasonable intervals, trenches and other continuous excavations in public right-of-way, running parallel to general flow of traffic, with traffic cones, barricades, or other suitable visual markers during daylight hours:
 - a. During hours of darkness, provide markers with torches, flashers, or other adequate lights.
 2. At intersections or for pits and similar excavations, where traffic may reasonably be expected to approach head on, protect excavations by continuous barricades:
 - a. During hours of darkness, provide warning lights at close intervals.
- F. Hazards in Protected Areas: Mark or guard excavations in areas from which public is excluded, in manner appropriate for hazard.
- G. Above Grade Protection: On multi-level structures, provide safety protection that meets requirements of OSHA and State agency which administers OSHA regulations where Project is located.
- H. Protect existing structures, trees, shrubs, and other items to be preserved from injury, damage or destruction by vehicles, equipment, workers or other agents with substantial barricades or other devices commensurate with hazards.

1.04 REMOVAL

- A. Remove temporary buildings and furnishings before inspection for Final Completion or when directed.
- B. Clean and repair damage caused by installation or use of temporary facilities.
- C. Remove underground installations to minimum depth of 24 inches and grade to match surrounding conditions, unless noted otherwise.
- D. Restore existing facilities used during construction to specified or original condition.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01600

PRODUCT DELIVERY, STORAGE AND HANDLING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Scheduling of product delivery.
 - 2. Packaging of products for delivery.
 - 3. Protection of products against damage from:
 - a. Handling.
 - b. Exposure to elements or harsh environments.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 1 - General Requirements.
- C. Payment:
 - 1. No payment will be made to CONTRACTOR for equipment not properly stored and insured.
 - 2. Previous payments for items will be deducted from subsequent progress estimate(s) if proper storage procedures are not observed.

1.02 QUALITY ASSURANCE

- A. Manufacturer's written directions.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 DELIVERY, STORAGE, AND HANDLING

- A. Scheduling:
 - 1. Schedule delivery of products or equipment as required to allow timely installation and to avoid prolonged storage.
- B. Packaging:
 - 1. Deliver products or equipment in manufacturer's original unbroken cartons or other containers, clearly and fully marked and identified as to manufacturer, item, installation location and instructions for assembly, use and storage.

- C. Protection:
1. Protect all materials in accordance with manufacturer's written directions:
 - a. Store products or equipment in location to avoid physical damage to items while in storage.
 - b. Handle products or equipment in accordance with manufacturer's recommendations and instructions.
 2. Protect equipment from exposure to elements and keep thoroughly dry. Store pumps, motors, electrical equipment, and other equipment having antifriction or sleeve bearings in a weathertight warehouses which are maintained at a temperature of at least 60 deg. F.
 3. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Repaint damaged painted surfaces to satisfaction of OWNER.
 4. Protect electrical equipment, controls, and insulation against moisture or water damage.

3.02 FIELD QUALITY CONTROL

- A. Inspect all products or equipment delivered to the site prior to unloading and reject all products or equipment that are damaged, used, or in any other way unsatisfactory for use on Project.
- B. Continually monitor storage area to ensure suitable temperature and moisture controls are maintained.

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 (APS).
 7. State and Federal Safety and Health Laws.
 8. National Electrical Safety Code (NESC).
 9. Amendments to Codes.
 10. AZ NPDES 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 01650

DEMONSTRATION OF SYSTEMS / COMMISSIONING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Pre-operational, Startup, and Commissioning.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 1 - General Requirements.

1.02 DEFINITIONS

- A. Pre-operational Period: The period of time after the initial installation/construction.
- B. Startup Period: A period of time (anticipated one week) immediately following the completion of the pre-operational period during which the CONTRACTOR initiates flow through the facility, starts up process equipment, calibrates and adjusts systems, completes OWNER training, and confirms the equipment is working as a system. During this period, the CONTRACTOR, manufacturer's agents, and OWNER's equipment pre-purchase suppliers verify installation requirements.
- C. Commissioning Period: A specified consecutive period of time (up to two weeks) immediately following the completion of the startup period during which the ENGINEER operates the water treatment facility with support from the CONTRACTOR and OWNER.
- D. Post Demonstration Period: The period of time after successful completion of the commissioning period but before final acceptance of Project during which the CONTRACTOR completes all punch list items and Project closeout procedures, and the OWNER has accepted ownership of the facility.

1.03 SUBMITTALS

- A. General:
 - 1. Approved Operation and Maintenance manuals prior to start of startup.
 - 2. Written request for OWNER and ENGINEER to witness each system start-up. Request to be received by OWNER minimum two weeks before scheduled training of OWNER's personnel on that system.
 - 3. Equipment installation and start-up certifications.

4. Letter verifying completion of all pre-operational testing and start-up activities including receipt of all specified items from manufacturers/suppliers as final item prior to initiation of commissioning.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 EXECUTION

A. General:

1. Demonstration of systems and commissioning of the facilities constructed under this Contract shall be performed in three phases, as indicated in Article 1.02.

B. Pre-operational Period:

1. CONTRACTOR requirements:

- a. Properly connect, align, calibrate, and adjust all system components. Check out procedures include but are not limited to:

- 1) Ring out all power, control and monitoring circuits prior to connection.
- 2) Voltage check of all circuits.
- 3) Phase sequence check.
- 4) Connecting piping system cleanliness check.
- 5) Alignment check of all connected machinery.
- 6) Pressure and vacuum testing of all closed systems.
- 7) Check of lubrication.
- 8) Calibration of all safety equipment.
- 9) Manual rotation/movement of moving parts to assure freedom of movement.
- 10) "Bump starting" of electrical motors to verify proper rotation.
- 11) Check of valving orientation and position status for manual operating mode.
- 12) Clean water testing of tankage for integrity.
- 13) Verify proper instrumentation and control signal generation, transmission, reception and response.
- 14) Check that all tagging/identification systems are in place.
- 15) Achieve successful bacteriological test for piping, equipment, and tanks.

- b. OWNER shall witness CONTRACTOR operation of each system prior to training to verify functional integrity.

- c. Provide all labor, supervision, utilities, equipment, vehicles, and required items necessary to perform work during this period.
- d. Provide certificate signed by equipment manufacturer's representative and CONTRACTOR that equipment was correctly installed and is ready for operation (as shown in Exhibit A-1650).

C. Startup Period:

- 1. CONTRACTOR Requirements:
 - a. Direct flow from the well header.
 - b. Startup equipment.
 - c. Calibrate and adjust system.
 - d. Provide training of OWNER personnel on all equipment during the startup period:
 - 1) OWNER personnel training on individual systems will not be considered as meeting the Contract requirements unless:
 - a) All pretraining deliverables are received and approved.
 - b) During training, all system malfunctions are addressed.
 - c) All provisions of field/classroom training specifications are met.
 - 2) Training not in compliance with the above will be performed again in its entirety by the manufacturer at no additional cost to OWNER.
 - 3) Training shall not be conducted until water is running through the wells and the treatment plant, and the equipment is operational.
 - e. Maintain the facilities.
 - f. During the startup period, water produced by the well shall be discharged to the header.
- 2. ENGINEER Responsibilities:
 - a. Prepare start-up plan for well pump.
- 3. OWNER Responsibilities:
 - a. Provide well water.
 - b. Provide power.
 - c. Collect water quality samples.

D. Commissioning Period for Effluent Pumps:

- 1. CONTRACTOR Responsibilities:
 - a. Complete punch list items.
 - b. Assist ENGINEER with manpower as needed to operate the pump.
 - c. Maintain the facilities.
 - d. During this period, effluent will be pumped and discharged to OWNER's Effluent Storage Tank.
- 2. ENGINEER Requirements:
 - a. Prepare commissioning plan.
 - b. Operate effluent pumps and present various operating modes.

3. OWNER Responsibilities:
 - a. Collect, and perform lab water quality tests at their cost.
 - b. Provide system water.
 - c. Assist with operations and sampling.

END OF SECTION

SECTION 01651

TRANSPORTATION AND HANDLING OF MATERIALS AND EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. CONTRACTOR shall make all arrangements for transportation, delivery and handling of equipment and materials required for prosecution and completion of the Work.
- B. Shipments of materials to CONTRACTOR or subcontractors shall be delivered to the site only during regular working hours. Shipments shall be addressed and consigned to the proper party giving name of Project, street number and city. Shipments shall not be delivered to OWNER, except where otherwise directed.
- C. If necessary to move stored materials and equipment during construction, CONTRACTOR shall move materials and equipment without any additional compensation.

1.02 PREPARATION FOR SHIPMENT

- A. When practical, factory assemble products. Matchmark or tag separate parts and assemblies to facilitate field assembly. Cover machined and unpainted parts that may be damaged by the elements with a strippable protective coating.
- B. Package products to facilitate handling and protect from damage during shipping, handling, and storage. Mark or tag outside of each package or crate to indicate its purchase order number, bill of lading number, contents by name, OWNER'S contract name and number, CONTRACTOR, equipment number, and approximate weight. Include complete packing lists and bills of materials with each shipment.
- C. Protect products from exposure to the elements and keep thoroughly dry and dust free at all times. Protect painted surfaces against impact, abrasion, discoloration, or other damage. Grease or oil all bearings and similar items.
- D. Do not have products shipped until:
 - 1. Related Shop Drawings have been approved by ENGINEER.
 - 2. Related factory test results, required in the individual Specification Sections, have been reviewed and accepted by ENGINEER.
 - 3. Required storage facilities have been provided.

1.03 DELIVERY

- A. CONTRACTOR shall arrange, with the United States Postal Service, a special address for the Project, if needed. All deliveries shall be made to that address.
- B. Arrange deliveries of products in accordance with construction schedules and in ample time to facilitate inspection prior to installation.
- C. Coordinate deliveries to avoid conflict with Work and conditions on site and to accommodate the following:
 - 1. Work of other contractors, or OWNER.
 - 2. Limitations of storage space.
 - 3. Availability of equipment and personnel for handling products.
 - 4. OWNER'S use of premises.
- D. Have products delivered to site in manufacturer's original, unopened, labeled containers. Keep ENGINEER informed of delivery of all equipment to be incorporated in the Work.
- E. Partial deliveries of component parts of equipment shall be clearly marked to identify the equipment, to permit easy accumulation of parts and to facilitate assembly.
- F. Immediately on delivery, inspect shipment to assure:
 - 1. Product complies with requirements of Contract Documents and reviewed submittal.
 - 2. Quantities are correct.
 - 3. Containers and packages are intact, and labels are legible.
 - 4. Products are properly protected and undamaged.
 - 5. Verify that the accelerometer recordings were made during shipment.
- G. Promptly remove damaged products from the Project site and expedite delivery of new undamaged products, and remedy incomplete or lost products to provide that specified, so as not to delay progress of the Work.

1.04 PRODUCT HANDLING

- A. Provide equipment and personnel necessary to handle products, including those provided by OWNER, by methods to prevent soiling or damage to products or packaging.
- B. Provide additional protection during handling as necessary to prevent scraping, marring or otherwise damaging products or surrounding surfaces.
- C. Handle products by methods to prevent bending or overstressing.

- D. Lift heavy components only at designated lifting points.
- E. Materials and equipment shall at all times be handled in a safe manner and as recommended by manufacturer or supplier so that no damage will occur to them. Do not drop, roll or skid products off delivery vehicles. Hand carry or use suitable materials handling equipment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

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, 15, 16, and 17.
- B. Equipment manufacturer operation and maintenance manuals, conforming to the requirements of Section 01340 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 suppliers' 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 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

SITWORK

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 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. Nonshrink grout:
 - a. Masterflow 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. Nonshrink Grout:
 - 1. Nonmetallic, noncorrosive and nonstaining.
 - 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:
 - 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 nonshrink 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 nonshrink 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.
- D. Salvaged Items:
 - 1. Thoroughly dry and clean all metal surfaces.
 - 2. Prime all bare metal in accordance with Section 09800.
 - 3. Dispose of items or materials not designated for OWNER's salvage or reuse. Promptly remove from site.

4. Do not store or sell CONTRACTOR salvaged items or materials on site.
- E. Clean up:
1. Transport debris and legally dispose of offsite.

END OF SECTION

SECTION 02100
SITE PREPARATION

PART 1 - GENERAL

1.01 SUMMARY

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

1.02 DEFINITIONS

- A. Clearing: Consists of removal of natural obstructions, fences, lumber, walls, stumps, brush, weeds, rubbish, trees, boulders, utility lines, and any other items which shall interfere with construction operations or are designated for removal.
- B. Grubbing: Grubbing shall consist of the removal and disposal of wood or root matter below the ground surface remaining after clearing and shall include stumps, trunks, roots, or root systems.
- C. Stripping: Stripping shall include the removal and disposal of all organic sod, topsoil, grass and grass roots, and other objectionable material remaining after clearing and grubbing from the areas designated to be stripped.

1.03 QUALITY ASSURANCE

- A. Regulatory Requirements: Verify and comply with applicable regulations regarding those governing noise, dust, nuisance, drainage and runoff, fire protection, and disposal.
- B. Pre-Construction Conference: Meet with OWNER to discuss order and method of work.

1.04 PROJECT CONDITIONS

- A. Environmental Requirements:
 - 1. For suspected hazardous materials found, comply with current applicable laws and consult OWNER for direction.
- B. Existing Conditions:
 - 1. Verify character and amount of clay, sand, gravel, quicksand, water, rock, hardpan, and other material involved and work to be performed.

1.05 SEQUENCING AND SCHEDULING

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

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

3.03 INSTALLATION

- A. Clearing:
 - 1. All exposed surfaces should be free of mounds and depressions which could prevent uniform compaction.
 - 2. Do not incorporate organic material from clearing and grubbing operations in fills and backfills.
 - 3. Contractor's Construction Facilities: Fill or remove pits, fill, and other earthwork required for erection of facilities, upon completion of the work, and level to meet existing contours of adjacent ground.
- B. Grubbing:
 - 1. Totally remove stumps and roots within area impacted by construction.
 - 2. Backfill and compact cavities left below subgrade elevation by removal of stumps or roots to density of adjacent undisturbed soil.
- C. Stripping:
 - 1. Remove soil material containing sod, grass, or other vegetation to depth of 6 inches from areas to receive fill or pavement and from area within 5 feet outside foundation walls.
 - 2. Deposit stripped material in accordance with following requirements:
 - a. At locations as requested by ENGINEER.

END OF SECTION

SECTION 02200

EARTHWORK

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Loosening, excavating, filling, grading, borrow, hauling, preparing subgrade, compacting in final location, wetting, and drying, and operations pertaining to structures.
 - 2. Backfilling and compacting around structures.

1.02 REFERENCES

- A. Associated General Contractors (AGC):
 - 1. Manual of Accident Prevention in Construction (Section 9).
- B. American Society for Testing and Materials (ASTM):
 - 1. C 117 - Standard Method for Materials Finer Than 75- μ m (No. 200) in Mineral Aggregate by Washing.
 - 2. C 131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - 3. C 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - 4. D 698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³).
 - 5. D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
 - 6. D 2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
 - 7. D 6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
 - 8. D 4318 - Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
- C. Institute of Makers of Explosives (IOMOE).
- D. Occupational Safety and Health Act (OSHA).
- E. American Association of State Highway & Transportation Officials (AASHTO).

1.03 DEFINITIONS

- A. Excavation: Consists of satisfactory loosening, removing, loading, transporting,

depositing, and compacting in final location materials, wet and dry, necessary to be removed for purposes of construction, or as required for ditches, grading, roads, structures, and such other purposes as are indicated on the Drawings.

- B. Backfill Adjacent to Structures: Backfill within volume delimited by exterior surfaces of structures, surface of undisturbed soil in excavation around structures, and finish grade around structure.
- C. In-Place Density of Compacted Backfill: Density determined in accordance with ASTM D 698, and with ASTM D 6938.
- D. Maximum Density: Is density obtained in laboratory when tested in accordance with ASTM D 698.
- E. Definitions Related to Compaction of Coarse Fill:
 - 1. One Pass: Defined as one movement of roller over area being compacted.
 - 2. Measurement Of Pass Width: Measure width of pass between centers of outside tires or outside edge of roller wheel.

1.04 SYSTEM DESCRIPTION

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

1.05 SUBMITTALS

- A. Property owner's Permission Agreements: Submit copy of property owner's agreements to allow dumping surplus material on their private property.
- B. Product Data: Submit material source, gradation, moisture density curve, and

testing data for all imported materials.

1.06 QUALITY ASSURANCE

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

1.07 SEQUENCING AND SCHEDULING

- A. Schedule earthwork operations to meet requirements as provided in this Section for excavation and uses of excavated material.
- B. If necessary, stockpile excavated material in order to use it in specified locations.
- C. Excavation and Filling: Perform excavation and filling, during construction, in manner and sequence that provides drainage at all times.

PART 2 - PRODUCTS

2.01 MATERIALS FOR FILL AND BACKFILL

- A. Water For Compacting Fills: Use water from source acceptable to OWNER.
- B. Fill and Backfill Materials:
 - 1. General:
 - a. Native soils are considered suitable for fill and backfill material.
 - b. Obtain material for fills from cut sections or from borrow source.
 - c. For fill and backfill materials covered under 2.01.B provide material having maximum particle size not exceeding 4 inches and that is free from frozen material, leaves, grass, roots, stumps, and other vegetable matter.
 - d. Materials derived from processing demolished or removed asphalt concrete are not acceptable.
 - 2. Drain Rock:
 - a. Consist of hard, durable particles of stone or gravel, screened or crushed to specified size and gradation.

- b. Free from frozen material vegetable matter, lumps or balls of clay, or other deleterious matter.
- c. Crush or waste coarse material and waste fine material as required to meet gradation requirements.
- d. Durability Index: Percentage of wear not greater than 40 percent when tested in accordance with ASTM C131.
- e. Conform to size and grade within the limits as follows when tested in accordance with AASHTO T-27 or ASTM C 136:

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

3. Gravel:
- a. Consist of hard, durable particles or fragments of stone or gravel, screened or crushed to specified sizes and gradations.
 - b. Free from frozen material vegetable matter, lumps or balls of clay, alkali, adobe, or other deleterious matter.
 - c. When sampled and tested in accordance with specified test methods, material shall comply with following requirements:
 - 1) Durability Index: Percentage of wear not greater than 40 percent after 500 revolutions when tested in accordance with ASTM C 131.
 - 2) Plasticity Index: Not greater than 5 when tested in accordance with ASTM D 4318.
 - 3) Liquid Limit: Not greater than 25 percent when tested in accordance with ASTM D 4318.
 - d. Conform to sizes and grade within the limits as follows when tested in accordance with ASTM C136 and ASTM C 117.

Sieve Size (Square Openings)	Percent By Weight	
	Type A	Type B
3 inch	100	—
1-1/2 inch	—	100
Number 4	30 - 75	30 – 70

Number 8	20 - 60	20 – 60
Number 30	10 - 40	10 – 40
Number 200	0 - 12	0 – 12

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

2.02 SLUDGE DRYING BED BEDDING MATERIALS

- A. Sand for Sludge Drying Bed: Clean granular sand free of clay, shale and deleterious material shall be delivered to the site and placed as noted on the plans. Sand shall be compacted to 95% of maximum density at optimum water content per ASTM D-1557 unless otherwise noted on the plans. The material shall conform to a sand equivalent of 30 or greater. The maximum amount of material passing the Number 100 Sieve shall be 2 percent. The maximum amount of material passing the Number 200 sieve shall be 2 percent. The sand shall conform to the following gradation percentages:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/8"	100
No. 4	95-100
No. 8	80-100
No. 16	50-85
No. 30	25-60
No. 50	5-30
No. 100	0-2
No. 200	0-2

- B. The Contractor shall supply a five-gallon sample of sand material to the material testing laboratory within four (4) days after the Notice to Proceed is issued. The Gradation, Maximum Density, and Sand Equivalent of the sand bedding material shall be determined. The test results shall be forwarded to the Engineer for approval prior to the delivery of the material to the construction site. The cost of the testing shall be incurred by the Contractor.
- C. Fine Gravel for Sludge Drying Bed: Clean fine gravel free of clay, shale and deleterious material shall be delivered to the site and placed as noted on the plans. Fine gravel shall be compacted with a plate compactor with one pass in maximum

1 foot lifts. Additional lifts shall not be added until previous lifts shall have been passed over by the plate compactor. The maximum amount of material passing the ¼” Sieve shall be 2 percent. The fine gravel shall conform to the following gradation percentages:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/8”	100
¼”	0-2

D. The Contractor shall supply a five-gallon sample of fine gravel material to the material testing laboratory within four (4) days after the Notice to Proceed is issued. The Gradation and Maximum Density of the fine gravel material shall be determined. The test results shall be forwarded to the Engineer for approval prior to the delivery of the material to the construction site. The cost of the testing shall be incurred by the Contractor.

E. ¾-Inch Crushed Rock for Sludge Drying Bed: Clean ¾-inch crushed rock free of clay, shale and deleterious material shall be delivered to the site and placed as noted on the plans. ¾-inch crushed rock shall be compacted with a plate compactor with one pass in maximum 1 foot lifts. Additional lifts shall not be added until previous lifts shall have been passed over by the plate compactor. The maximum amount of material passing the ½” Sieve shall be 2 percent. The ¾-inch crushed rock shall conform to the following gradation percentages:

<u>Sieve Size</u>	<u>Percent Passing</u>
¾”	100
½”	0-2

F. The Contractor shall supply a five-gallon sample of fine gravel material to the material testing laboratory within four (4) days after the Notice to Proceed is issued. The Gradation and Maximum Density of the fine gravel material shall be determined. The test results shall be forwarded to the Engineer for approval prior to the delivery of the material to the construction site. The cost of the testing shall be incurred by the Contractor.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions:
1. Character and Amount of Material:
 - a. Verify character and amount of rock, gravel, sand, silt, water, and other inorganic or organic materials to be encountered in work to be performed.
 - b. Determine gradation and shrinkage of excavation and fill material, and suitability of material for use intended in work to be performed.

- c. Determine quantity of material, and cost thereof, required for construction of excavations and fills, whether from on-site excavations, borrow areas, or imported materials.
- d. Include wasting of excess material, if required, in cost of work to be performed under this Contract.

3.02 PREPARATION

A. Surface Preparation:

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

3.03 APPLICATION

A. General:

1. The CONTRACTOR shall assume responsibility and expense of disposing of excavated materials which are not required or unsuitable for fill and backfill in lawful manner.
2. Do not dump surplus material on private property unless written permission agreement is furnished by owner of property. Submit copies of such agreements.
3. Obtain material required for fills in excess of that produced by excavation from borrow areas as specified herein.
4. Rocks, Broken Concrete, or Other Solid Materials Larger Than 4 Inches in Greatest Dimension: Do not place in fill areas but remove from project site at no additional cost to the Contract.
5. Stabilization of Subgrade: Provide materials used or perform work to stabilize subgrade so it can withstand loads which may be placed upon it by CONTRACTOR's equipment at no additional cost to Contract.
6. Engineered fill under structure foundations and slabs on grade shall consist of native material and imported material that is conditioned and compacted as specified in this Section. See Paragraph 2.01.B.
7. Backfill around all structures that require hydrostatic testing shall not be completed until after hydrostatic testing is completed, and the structures have passed the hydrostatic test.

8. Undermining footings/slabs after they have been cast-in place is prohibited.

B. Excavation:

1. Excavations for Structures:

- a. As shown on the Drawings, the site expansion shall be over-excavated from existing ground surface down to elevation shown on drawings, and material removed from the site
- b. Where soil of Unsuitable Bearing Value is Encountered: The CONTRACTOR may direct in writing that excavation be carried to elevations above or below those indicated on the Drawings.
- c. Unless directed by the ENGINEER, excavations shall not be carried below elevations indicated on the Drawings.
- d. Where excavations are made below elevations required for the foundation, adjust elevations of excavations in accordance with requirements following:
 - 1) Under Slabs: Restore to proper elevation in accordance with procedure specified for backfill in this Section.
 - 2) Under Footings: Select one of the following:
 - a) Increase heights of walls or footings.
 - b) Refill space with Class C concrete, as specified in Section 03300, at no additional cost to the Contract.
 - c) Excavation Width: Extend excavations at least 24 inches clear from walls and footings to allow for placing and removal of forms, installation of services, and inspection. Undercutting of slopes will not be permitted.
- e. Bottom of Excavations For Structures: Consist of native material with top 8 inches compacted to 98 percent of maximum density and graded to conform to outside limits of structures as indicated on the Drawings, except where otherwise indicated on the Drawings or specified.
- f. Difficulty of Excavation: No extra compensation will be made for removal of rock or any other material due to difficulty of excavation.
- g. Location of Structures on Different Substrates: Where structure will be located partially on fill and partially on undisturbed or natural material, over-excavate entire area to depth of 12 inches below the structure and re-compact to 95 percent maximum density.

2. Excavation of Ditches and Gutters:

- a. Cutting: Cut ditches and gutters accurately to cross sections and grades indicated on the Drawings.
- b. Excavation: Take care not to excavate ditches and gutters below grades indicated on the Drawings.
- c. Over Excavation: Back fill excessive ditch and gutter excavation to grade with suitable thoroughly compacted material to form adequate gutter paving.
- d. Depositing Of Material Adjacent To Ditches: Do not deposit any material within three feet of edge of ditch unless otherwise indicated on the Drawings.

3. Necessary Over Excavation:
 - a. General:
 - 1) Where it becomes necessary to excavate beyond normal lines of excavation in order to remove boulders or other interfering objects, backfill voids remaining after removal as specified below in “Backfilling Of Voids,” or as acceptable to the ENGINEER.
 - 2) With ENGINEER’s approval, perform necessary excavation beyond normal lines as specified in Subparagraph above and backfill such voids. Cost of such work shall be considered as included in price bid for the work.
 - 3) Backfilling of Voids:
 - a) Fill voids with suitable material acceptable to the OWNER, placed in manner and to same uniform density as surrounding material.

C. Compaction:

1. Compacted Fills:
 - a. Lines and Grades:
 - 1) Construct fills, embankments, and backfills, designated herein as fills, at locations and to lines and grades indicated on the Drawings.
 - 2) Borrow sources are not available within project site. Where required, CONTRACTOR shall provide necessary imported fill material from outside sources.
 - b. Compacted Fill Shape and Sections: Provide completed fill that corresponds to shape of typical sections indicated on the Drawings or that meets requirements for particular case.
 - c. Preparation of Areas Designated to Receive Fill Material: Scarify to minimum depth of 8 inches, unless otherwise indicated on the Drawings, and recompact to density of fill material as specified in following Article.
 - d. Fills and Backfills and Upper 6 Inches in Cuts: Compact to percentage of maximum density as follows:
 - 1) Backfill Adjacent to Structures: 98 percent.
 - 2) Under Present and Future Structures: 98 percent.
 - 3) Under Roadways (aggregate base course, and dirt), Parking, Curbs and Sidewalks: 98 percent.
 - 4) Aggregate Base Below Pavement 98 percent.
 - 5) Aggregate Base other than Below Pavement: 98 percent.
 - 6) Landscaped Areas: 98 percent unless otherwise noted.
 - 7) Compacted Embankments: 98 percent.
 - 8) Spoil Areas Indicated on the Drawings: No minimum required.
 - e. Placing Compacted Fills:
 - 1) Placement: Place loose material in successive layers that do not exceed 8 inches before compaction.

- 2) Moisture Content: Bring each layer to optimum moisture content for maximum density before compaction by rolling.
- 3) Defective Compacted Fills:
 - a) Remove and replace any placed material that does not have correct moisture content.
 - b) Remove and replace fills with suitable material when any one of the following 2 conditions exist as they shall serve as sufficient evidence, without further testing, that moisture content is not correct:
 - i. Soft, spongy, or stringy material causing areas that “pump” when heavy loads pass over.
 - ii. Dry material that will not “ball.”
- f. Mechanical Spreading and Rolling Layers of Fills:
 - 1) Spreading: Spread each layer uniformly by use of road machine or other accepted device.
 - 2) Rolling: Roll with acceptable tamping roller, heavy pneumatic roller, or power roller until thoroughly compacted to not less than specified density.
 - 3) Fill Required to be Compacted That is Inaccessible to Rollers: Compact with pneumatic, vibrating, or other tamping equipment.
 - 4) Use of Other Equipment: Use of trucks, carryalls, scrapers, tractors, or other heaving hauling equipment is not considered as rolling in lieu of rollers, but distributed traffic of such hauling equipment over fill in such manner as to make use of compaction by use of rollers.
2. Compaction of Coarse Fill:
 - a. When Materials Are Coarsely Graded Such That Performance of Field Density Tests Are Impossible:
 - 1) Placement and Compaction: Place material in lifts so as to obtain compacted thickness of 6 inches and roll with pneumatic roller or power roller.
 - 2) Moisture Content: Provide moisture content of fraction of material passing 3/4 inch sieve within plus or minus 2.0 percent of optimum moisture as determined in accordance with ASTM D 1557.

3.04 FIELD QUALITY CONTROL

- A. Tests:
 1. Confirmation Tests:
 - a. CONTRACTOR’s Responsibilities:
 - 1) Accomplish specified compaction for backfill, fill, and other earthwork.
 - 2) Control operations by confirmation tests to verify and confirm that compaction work complies, and is complying at all times, with requirements specified in this Section concerning compaction, control, and testing.

- 3) Copies of Confirmation Test Reports: Submit promptly to the OWNER and ENGINEER.
 - b. Frequency of Confirmation Testing:
 - 1) Perform testing not less than as follows:
 - a) For Structural and Engineered Fill and Backfill: One every 30 cubic yards, or each day's production whichever is more frequent.
 - b) In Embankment or Fill: One every 200 cubic yards.
 - c) Base Material: One every 50 cubic yards.
 - d) Subgrade of Structures, Footings, Structural Slabs in cut situation: once per foundation area.
 - 2. Retesting:
 - a. Costs of Retesting: Costs of retesting required to confirm and verify that remedial work has brought compaction within specified requirements shall be borne by the CONTRACTOR.
 - b. CONTRACTOR's Confirmation Tests During Performance of Remedial Work:
 - 1) Performance: Perform tests in manner acceptable to the ENGINEER.
 - 2) Frequency: Double amount specified for initial confirmation tests.
- B. Tolerances:
- 1. Finish Grading of Excavations, Backfill and Fills:
 - a. Perform fine grading under concrete structures such that finished surfaces are never above established grade or approved cross section and are never more than 0.10 feet below.
 - b. Provide finish surface areas outside of structures that are not more than 0.10 feet above or below established grade or accepted cross section.
 - 2. Of Areas which are not Under Structures, Concrete, Asphalt, Roads, Pavements, Walks, Dikes, and Similar Type Items:
 - a. Provide finish graded surfaces of either undisturbed natural soil, or cohesive material not less than 6 inches deep.
 - b. Intent of preceding is to avoid sandy or gravelly areas.
 - 3. Finished Grading Surfaces:
 - a. Reasonably smooth, compacted, and free from irregular surface changes.
 - b. Provide degree of finish that is ordinarily obtainable from blade grader operations, except as otherwise specified.
 - c. Uniformly grade areas which are not under concrete.
 - d. Finish gutters and ditches so that they drain readily.

3.05 ADJUSTING

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

3.06 PROTECTION

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

3.07 DISPOSAL OF EXCAVATED MATERIAL

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

END OF SECTION

SECTION 02223

TRENCH EXCAVATING AND BACKFILLING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Excavating and backfilling for utilities from outside edge of buildings or other concrete facilities.
- B. "Pipe zone" backfill.
- C. Trench sub-base stabilization.
- D. Removal and disposal of unsatisfactory materials.

1.02 RELATED SECTIONS

- A. Section 02200 – Earthwork
- B. Division 15 - Mechanical

1.03 REFERENCES

- A. AASHTO T180 - Moisture-Density Relations of Soils Using a 10 lbs (4.54 Kg) Rammer and an 18 inch (457 mm) Drop
- B. ASTM C 136 - Method for Sieve Analysis of Fine and Coarse Aggregates
- C. ASTM D 698 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures, Using 5.5 lbs (2.49 Kg) Rammer and 12-inch (304.8 mm) Drop
- D. ASTM D 1556 - Test Method for Density of Soil in Place by the Sand-Cone Method
- E. ASTM D 1267 - Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
- F. ASTM D 2321 - Underground Installation of Flexible Thermoplastic Sewer Pipe
- G. ASTM D 2774 - Underground Installation of Thermoplastic Pressure Piping
- H. ASTM D 2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by

Nuclear Methods (Shallow Depth)

- I. ASTM D 3017 - Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures

1.04 DEFINITIONS

- A. Utility: Any buried pipe, conduit, or cable.
- B. Rigid Pipe: All concrete pipe, steel pipe, ductile iron pipe.
- C. Flexible Pipe: All thermoplastic pipe such as PVC, PE.
- D. Pipe Zone: The area 4 inches under the pipe, the trench width, and 6 inches (12 inches for pipes 24-inch diameter or larger) over the pipe.
- E. Unclassified Excavation: Includes all materials encountered regardless of their nature or the manner in which they are removed.
- F. Trench Width: The outside diameter (OD) of the pipe, not including joints, plus 12 inches each side of the pipe.

1.05 SUBMITTALS

- A. Submit under provisions of Section 01340 – Technical Submittals.
- B. Submittals are required for all "pipe zone" materials.

1.06 JOB CONDITIONS

- A. Pipeline lengths indicated on drawings are for information only. Furnish pipeline lengths as required to complete the Project.
- B. Embankment Areas: Perform no work in areas receiving fill until embankment or fill has been completed to at least two feet above the top of the pipe grade, and has been properly compacted.
- C. Do not change pipe size, material, or class without securing written approval of the ENGINEER.
- D. Unsuitable Weather Limitations: Do not place, spread, or roll any fill material during unsuitable weather conditions. Do not resume operations until moisture content of material is satisfactory.
- E. Weather Softened Subgrade: Remove and replace at no additional cost to OWNER.

- F. Protection of Graded Areas: Protect from traffic and erosion. Keep free of trash and debris. Repair and reestablish grades in settles, eroded, and rutted areas to specified tolerances.
- G. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or unsuitable weather, scarify surface, reshape, and compact to required density prior to further construction at no additional cost to OWNER.

PART 2 - PRODUCTS

2.01 MATERIALS FOR OVER EXCAVATING

- A. Materials as specified in Section 02200

PART 3 - EXECUTION

3.01 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Protect bench marks, existing structures, fences, sidewalks, paving, and curbs from excavation equipment and vehicular traffic.
- C. Maintain and protect above and below grade utilities which are to remain.
- D. Provide grading to prevent surface water from flowing into trenches or other excavations. Promptly remove any ponded water.
- E. Provide free access to all fire hydrants, water valves, and meters, and leave clearance to enable free flow of storm water in all gutters, conduits, and natural water courses.
- F. Asphalt coat aluminum pipe to prevent direct contact with concrete.
- G. Insulate dissimilar metals from direct contact with each other, using neoprene gaskets or asphalt coatings.
- H. Lay pressure lines to eliminate high points in line. Notify ENGINEER of any unavoidable high points for possible installation of air relief valves.
- I. Lay gravity pipe upgrade, beginning at lower end.
- J. Handle pipe in accordance with accepted practices and according to manufacturer's

recommendations.

- K. Do not lay pipes in water.
- L. Do not lay pipe when trench conditions or weather are unsuitable.
- M. Use approved equipment, as recommended by the pipe manufacturer, to cut pipes.
- N. Secure ENGINEER'S approval to deflect pipe from true line and grade. Do not exceed deflection recommended pipe manufacturer.

3.02 EXCAVATION

- A. Excavate trenches for pipes to the lines and grades called for regardless of the type of material encountered.
- B. Limit the trench width in the "pipe zone" to the width as defined in ADEQ Standard Specifications.
- C. Hand trim excavation, removing loose matter.

3.03 SUBGRADE PREPARATION

- A. If sub-grade is not readily compatible secure authorization for extra excavation and backfill with materials as specified in Section 02200.
- B. All unnecessary over-excavation shall be avoided. Backfill of over-excavated areas shall be with bedding materials as specified in Section 02200. Backfill of unnecessary over- excavation will be at no cost to the OWNER.

3.04 DEWATERING

- A. Keep trenches free from water during pipe laying and joining by methods approved by the ENGINEER. Trench dewatering will be considered incidental to the cost of pipe laying, and no additional compensation will be allowed.

3.05 SHORING AND BRACING

- A. Provide all shoring, bracing, or trench boxes as needed to protect the work, existing property, utilities, pavement, etc., and to provide safe working conditions in the trench in accordance with current State and Federal (OSHA) regulations.

3.06 EXISTING UTILITIES

- A. Notify utilities according to provision of Section 01030 - Summary of Work.

- B. Accept responsibility for repair of utilities damaged during construction whether shown on the Drawings or not. Damaged utilities are not to be covered until repairs are verified by utility and ENGINEER.

3.07 "PIPE ZONE" CONSTRUCTION

A. GENERAL

1. Backfill trench only after installation has been approved by ENGINEER.
2. Trench backfill in the "pipe zone" is termed bedding.
3. Changes in bedding can only occur with written approval by ENGINEER.
4. Protect pipes during bedding.
5. Allowable pipe deflections limits from manufacturers will be enforced.
6. Round bottom of "pipe zone" so that at least the bottom quadrant of the pipe rests firmly on compacted bedding for the entire length of barrel.

B. BEDDING

1. All pipes shall have a minimum thickness of bedding material below the barrel of the pipe as specified. Bedding material shall be placed in the bottom of the trench, leveled and compacted.
2. Bell holes shall be excavated at each pipe joint to permit proper inspection and uniform bearing of pipe on bedding material.
3. After the pipe has been laid to alignment and grade, unless otherwise specified, additional bedding material shall be placed in layers the full width of the trench and compacted up to the specified level. Bedding shall be placed simultaneously on both sides of the pipe, keeping the level of backfill the same on each side. The material shall be carefully placed and compacted around the pipe to ensure that the pipe barrel is completely supported and that no voids or uncompact areas are left beneath the pipe. CONTRACTOR shall use particular care in placing material on the underside of the pipe to prevent lateral movement during backfilling.

3.08 BACKFILL

A. INITIAL BACKFILL

1. After pipe has been properly bedded, Contractor shall place and compact initial backfill consisting of Class 2 Permeable material as defined in Section 02200, from top of bedding to pipe springline. Initial backfill shall be compacted according to the requirements listed in Section 02200.

B. SUBSEQUENT BACKFILL

1. GENERAL: Backfill material, placement and compaction above the pipe zone shall be as specified in Section 02200. Backfill above the pipe zone shall not commence until initial backfill has been inspected and accepted by the ENGINEER.

END OF SECTION

SECTION 02235

AGGREGATE BASE COURSE

PART 1 - GENERAL

1.01 SUMMARY AGENCY

- A. Section Includes: Aggregate base course for applications as specified and shown on the Drawings.

1.02 REFERENCES

- A. American Society of Testing and Materials (ASTM):
 1. C 117 - Standard Test Method for Material Finer than 75 μ M (Number 200) Sieve in Mineral Aggregate by Washing.
 2. C 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 3. D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.03 SUBMITTALS

- A. Product Data:
 1. Source, gradation, and testing data for aggregate base course.
- B. Field Quality Control:
 1. Test Reports.
 2. Certificates of Compliance

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Protection: Protect from segregation and excessive moisture during delivery, storage, and handling.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Aggregate Base Course:
 1. Consist of hard, durable particles or fragments of stone or gravel, screened or crushed to required size and grading and free from frozen material, vegetable matter, lumps or balls of clay, alkali, adobe, or other deleterious matter.
 2. Materials derived from processing demolished, removed asphalt concrete, or Portland cement aggregate are not acceptable.

3. When sampled and tested in accordance with specified test methods, material shall comply with following requirement:
 - a. Plasticity Index: Not be more than 5 when tested in accordance with ASTM D 4318.
 - b. Liquid Limit: Not be more than 25 percent when tested in accordance with ASTM D 4318.
4. Aggregate Base Course for Structures:
 - a. Consist of crushed or fragmented particles.
5. For other than aggregate base course for site roads, grade within the following limits when tested in accordance with ASTM C 136 and ASTM C 117:

Sieve Sizes1 (Square Openings)	Percent by Weight Passing Sieve
1-1/8 inch	100
Number 4	38-65
Number 8	25-60
Number 30	10-40
Number 200	3-12

6. Aggregate shall have a percentage of fifty or less at 500 revolutions when tested in accordance with AASTHO T96.
7. Aggregate base course for roads and parking areas shall comply with Section 702 of the Uniform Standard Specifications for Public Works Construction, Maricopa Association of Governments (1998 with revisions through 2010). Aggregate base course shall be compacted to a minimum of 98% of maximum density as determined by ASTM D-698.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Examine conditions upon which the work specified in this Section depends for defects that may influence installation and performance.
- B. Do not proceed with installation unfit unsatisfactory conditions have been corrected

3.02 PREPARATION

- A. Sub-grade Preparation: Per Maricopa Association of Governments (MAG) Standard Specifications.

3.03 INSTALLATION

- A. Furnish, spread, and compact aggregate base course material to the lines, grades, and dimensions indicated on the Drawings.
 - 1. Spreading: Spread in accordance with sections of MAG Subdivision Infrastructure Design Manual
 - 2. Compacting: Compact in accordance with MAG Subdivisions and Infrastructure Design Manual.
 - a. Below asphalt concrete pavement: 100%
 - b. Below concrete pads and driveways: 95%
 - c. All areas not subjected to vehicular traffic: 85%

3.04 FIELD QUALITY CONTROL

- A. Tests: CONTRACTOR to perform compaction tests every 50 cubic yards or each day's placement, whichever is more frequent.

END OF SECTION

SECTION 02242

STABILITY OF EXCAVATIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Stability of excavations.

1.02 REFERENCES

- A. American Institute of Steel Construction, Inc., (AISC):
 - 1. Manual of Steel Construction (MSC).

1.03 DEFINITIONS

- A. General Engineering Design Practice: General engineering design practice in area of the Project, performed in accordance with recent engineering literature on subject of shoring and stability of mass excavations.
 - 1. Where general engineering design practice is specified, provide drawings and signed calculations and have design performed by civil or structural engineer registered in State where the Project is located:
 - a. Provide design calculations that clearly disclose assumptions made, criteria followed, and stress values used for various materials.
 - b. Furnish acceptable references substantiating appropriateness of design assumptions, criteria, and stress values.
- B. Shoring: A temporary structural system designed to support vertical faces of soil or rock for purposes of excavation. Shoring includes cantilevered sheet piling, internally braced sheet piling, slurry walls, soldier piles and lagging, and other similar shoring systems. Sloping of the soil is not shoring.

1.04 SYSTEM DESCRIPTION

- A. Design Requirements:
 - 1. Design means for safe and stable excavations in accordance with general engineering design practice.
 - 2. Design steel members in accordance with AISC MSC.
 - 3. Design shoring involving materials other than steel in accordance with International Building Code.
 - 4. Perform design in accordance with soil characteristics and design recommendations contained in the geotechnical report issued by the OWNER
 - 5. When electing to design with material stresses for temporary construction higher than allowable stresses prescribed in the reference publications, increase in such stresses shall not exceed 10 percent of value of prescribed stresses.

- B. Performance Requirements:
1. General:
 - a. Support faces of excavations and protect structures and improvements in vicinity of excavations from damage and loss of function due to settlement or movement of soils and alterations in ground water level caused by such excavations, and related operations.
 - b. Herein Specified Provision:
 - 1) Complement, but do not substitute or diminish, obligations of CONTRACTOR for the furnishing of a safe place of work pursuant to provisions of the Occupational Safety and Health Act of 1970 and its subsequent amendments and regulations and for protection of the Work, structures, and other improvements.
 - 2) Represent minimum requirement for:
 - a) Number and types of means needed to maintain soil stability.
 - b) Strength of such required means.
 - c) Methods and frequency of maintenance and observation of means used for maintaining soil stability.
 2. Provide safe and stable excavations by means of sheeting, shoring, bracing, sloping, and other means and procedures, such as draining and recharging groundwater and routing and disposing of surface runoff, required to maintain the stability of soils.
 3. Provide support for trench excavations for protection of workers from hazard of caving ground.
 4. Provide Shoring:
 - a. Where, as result of excavation work and analysis performed pursuant to general engineering design practice, as defined in this Section:
 - 1) Excavated face or surrounding soil mass may be subject to slides, caving, or other types of failures.
 - 2) Stability and integrity of structures and other improvements may be compromised by settlement or movement of soils.
 - b. For trenches 5 feet and deeper.
 - c. For trenches less than 5 feet in depth, when there is a potential for cave-in.
 - d. Where indicated on the Drawings.
 5. For safe and stable excavations, use appropriate design and procedures for construction and maintenance to minimize settlement of supported ground and to prevent damage to existing structures and other improvements, including:
 - a. Using stiff support systems.
 - b. Following appropriate construction sequence.
 - c. Preventing soil loss through or under support system:
 - 1) Provide support system that is tight enough to prevent loss of soil and extend deep enough to prevent heave or flow of soils from supported soil mass into the excavation.
 - 2) Where sheet piling is used, drive sheet piles in interlock.

1.05 SUBMITTALS

- A. Shop Drawings and Calculations:
 - 1. Perform design pursuant to general engineering design practice.
 - 2. For excavations other than trenches, submit, in advance of excavation work, design calculations as performed pursuant to general engineering design practice, as specified in this Section, and detail drawing showing means for safe and stable excavations. In design calculations and detail drawing, cover, and as a minimum:
 - a. Excavations adjacent to structures, and
 - b. Excavations 5 feet or more in depth, or less than 5 feet in depth when there is potential for cave-in, at other locations.

- B. Control Points and Schedule of Measurements:
 - 1. Submit location and details of control points and method and schedule of measurements in accordance with requirements of this section.
 - 2. Promptly upon constructing control points and making measurements and such control points, as specified in this Section, submit copy of field report with such measurements.

- C. Detailed Sequence of Installation and Removal of Shoring:
 - 1. Address the sequence of installation and removal of shoring in design calculations.
 - 2. Consider effects of ground settlement in the sequence of installation and removal of shoring.

1.06 SEQUENCING AND SCHEDULING

- A. For excavation, including trenching, do not begin until excavation submittals have been accepted by Engineer and until materials necessary for installation are on site.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 INSTALLATION AND REMOVAL

- A. Install means for providing safe and stable excavations as indicated in the submittals.
- B. Remove shoring by completion of the Work. Pressure preservative treated wood lagging may be left in place when acceptable to the ENGINEER.

3.02 MAINTENANCE

- A. Where loss of soil occurs, plug gap in shoring and replace lost soil with fill material acceptable to ENGINEER.
- B. Where measurements and observations indicate possibility of failure of excavation support, determined in accordance with general engineering design practice, take appropriate action

immediately.

3.03 CONTROL POINTS

- A. Establish control points on shoring and on structures and other improvement in vicinity of excavation for measurement of horizontal and vertical movement:
 - 1. Set Control Points on Support System:
 - a. Set points at distances not exceeding 25 feet at each support level.
 - b. Support levels shall be levels of tie-backs, whales, bottom of excavation, and other types of supports.
 - 2. Set control points in corners of structures and on curbs, manholes, and other locations indicated on the Drawings.
- B. Provide plumb bobs with horizontal targets indicating original position of plumb bobs in relation to shoring at control points and at locations indicated on the Drawings.
- C. Perform horizontal and vertical measurements of control points at least once every week.

END OF SECTION

SECTION 02260

FINISHED GRADING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Cutting, grading, filling, rough contouring, finish contouring, and compacting site for site improvements.

- B. Related Sections:
 - 1. Section 02200 - Earthwork
 - 2. Section 02235 – Aggregate Base Course
 - 3. Section 02360 – Soil Treatment
 - 4. Division 15 - Mechanical

1.02 REFERENCES

- A. American Association of State Highway and Transportation Officials:
 - 1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

- B. ASTM International:
 - 1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - 2. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - 3. ASTM D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
 - 4. ASTM D2434 - Standard Test Method for Permeability of Granular Soils (Constant Head).

- C. Geotechnical Evaluation Report:
 - 1. Geotechnical Evaluation Report prepared by Ninyo & Moore, dated November 8, 2016.

1.03 QUALITY ASSURANCE

- A. Perform Work in accordance with ASTM C136, ASTM D2419, and ASTM D2434.

- B. Perform Work in accordance with ADEQ.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.01 PREPARATION

- A. Call Local Utility Line Information service at (602) 659-7521 not less than two working days before performing Work.
 - 1. Request underground utilities to be located and marked within and surrounding construction areas.
- B. Identify required lines, levels, contours, and datum.
- C. Notify utility company and ENGINEER to remove and relocate utilities.
- D. Protect utilities indicated to remain from damage.
- E. Protect plant life, lawns, rock outcropping, and other features remaining as portion of final landscaping.
- F. Protect bench marks, survey control point, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

3.02 FILLING

- A. Fill areas to contours and elevations with unfrozen materials.
- B. Place material in continuous layers as follows:
 - 1. Subsoil Fill: In accordance with ADEQ.
 - 2. Structural Fill: In accordance with Section 02200.
- C. Maintain optimum moisture content of fill materials to attain required compaction density.
- D. Make grade changes gradual. Blend slope into level areas.
- E. Repair or replace items indicated to remain damaged by excavation or filling.

3.03 TOLERANCES

- A. Top Surface of Subgrade: Plus or minus 1/10 (0.10) foot from required elevation.
- B. Size of Surface Material: All material placed within three inches of the subgrade surface shall pass the 3/4-inch sieve.

3.04 FIELD QUALITY CONTROL

- A. Perform laboratory material tests in accordance with ASTM D698.

- B. Perform in place compaction tests in accordance with the following:
 - 1. Density Tests: In accordance with ADEQ.
 - 2. Moisture Tests: In accordance with ADEQ.
- C. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest.
- D. Frequency of Tests: One for each lift.

END OF SECTION

SECTION 02360

SOIL TREATMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Soil treatment for control of unwanted plant life. Apply treatment in all disturbed areas for both sites.

1.02 SUBMITTALS

- A. Product Data: Include for each material to be used, composition by percentage, dilution schedule, rate and volume calculations, intended application rate; current EPA-approved labels and Material Safety Data Sheets for each product used.
- B. Manufacturer's Instructions: Complete handling, mixing, application, cleanup, and safety instructions.

1.03 ASSURANCE QUALITY

- A. Qualifications of Applicator: Licensed applicator in the State where project is located.

1.04 PROJECT CONDITIONS

- A. Environmental Requirements:
 - 1. Do not apply treatment materials when soil or fill is excessively wet in order to avoid surface flow of material from application site.

1.05 SEQUENCING AND SCHEDULING

- A. Treatment:
 - 1. Notification:
 - a. Notify Engineer in advance so that ENGINEER may be present during application.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Vegetation Control: Soil sterilization type. One of the following or equal:
 - 1. DuPont, Karmex 80W.
 - 2. Drexel Chemical Corp.'s, Diuron 4L.

PART 3 - EXECUTION

3.01 APPLICATION

A. Vegetation Control:

1. 1. Provide vegetation control material for unwanted plant life under structures, sidewalks, and pavements, within site perimeter wall, and as indicated in the plans or directed by the OWNER.
2. 2. CONTRACTOR shall make two applications of the soil treatment, with the second application no less than 14 calendar days following the first treatment.
3. 2. Apply each of the two vegetation control material applications in accordance with manufacturer's installation instructions.

END OF SECTION

DIVISION 3
CONCRETE WORK

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 sufficient number of forms so that the work may be performed rapidly and present uniform appearance in form patterns and finish.
 - 4. Use forms that are clean and free from dirt, debris, concrete, and similar type items. Coat with acceptable form release oil if required, prior to use or reuse.

1.04 QUALITY ASSURANCE

- A. Qualifications of Formwork Manufacturers: Use only forming systems manufactured by manufacturers having minimum 5 years experience, except as otherwise specified.
- B. Regulatory Requirements: Install work of this Section in accordance with local, state, and federal regulations.

1.05 PROJECT CONDITIONS

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

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Form Ties:
 - 1. General:
 - a. Provide form ties for forming system selected that are manufactured by recognized manufacturer of concrete forming equipment.
 - b. Do not use wire ties or wood spreaders of any form.
 - c. Provide ties of type that accurately tie, lock, and spread forms.
 - d. Provide form ties of such design that when forms are removed, they locate no metal or other material within 1-1/2 inches of the surface of the concrete.
 - e. Do not allow holes in forms for ties to allow leakage during placement of concrete.
 - 2. Cone-Snap or Flat Bar Form Ties:
 - a. Cone-snap ties shall form a cone shaped depression in the concrete with a minimum diameter of 1 inch at the surface of the concrete and 1-1/2 inches deep.
 - b. Provide neoprene waterseal washer which is located near the center of the concrete.
 - 3. Taper Ties:
 - a. Neoprene Plugs for Taper Tie Holes: Size so that after they are driven, plugs are located in center third of wall thickness.
 - b. Drypack Mortar for Filling Taper Tie Holes:
 - 1) Consist of mix of one part of Portland Cement to one part of plaster sand.
 - 2) Amount of water to be added to cement-sand mix is to be such that mortar can be driven into holes and be properly compacted.
 - 3) Admixtures or additives: Are not to be used in drypack mortar.
- B. Built-Up Plywood Forms:
 - 1. Built-up plywood forms may be substituted for prefabricated forming system following minimum requirements:
 - a. Size and Material:
 - 1) Full size 4 by 8 feet plywood sheets, except where smaller pieces are able to cover entire area.
 - 2) Sheet Construction: 5-ply plywood sheets, 3/4 inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.
 - b. Wales: Minimum 2 by 4 inch lumber.
 - c. Studding And Wales: Contain no loose knots and be free of warps, cups, and bows.

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

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

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

- A. Forms and Accessories:
 - 1. Vertical Forms:
 - a. Remain in place minimum of 24 hours after concrete is placed.
 - b. If, after 24 hours, concrete has sufficient strength and hardness to resist surface or other damage, forms may be removed.
 - 2. Other Forms Supporting Concrete And Shoring: Remain in place as follows:
 - a. Sides of Footings: 24 hours minimum.
 - b. Vertical Sides of Beams, Girders, And Similar Members: 48 hours minimum.

- c. Slabs, Beams, and Girders: Until concrete strength reaches specified strength or until shoring is installed.
 - d. Shoring for Slabs, Beams, and Girders: Shore until concrete strength reaches specified strength.
 - e. Wall Bracing: Until concrete strength of beams and slabs laterally supporting wall reaches specified strength.
- B. Form Ties:
- 1. Cone-Snap Rod and Bar Ties: Tie forms together at not more than 2 foot centers vertically and horizontally. After forms are removed from wall, fill tie holes as follows:
 - a. Remove form ties from surfaces.
 - b. Roughen cone shaped tie holes by heavy sandblasting before repair.
 - c. Dry pack cone shaped tie holes with drypack mortar as specified in Section 03600.
 - 2. Taper Ties:
 - a. Neoprene Plug in Taper Tie Holes: After forms and taper ties are removed from wall, plug tie holes with neoprene plug as follows:
 - 1) Heavy sandblast and then clean tie holes.
 - 2) After cleaning, drive neoprene plug into each of taper tie holes with steel rod. Final location of neoprene plug shall be in center third of wall thickness. Bond neoprene plug to concrete with epoxy.
 - 3) Locate steel rod in cylindrical recess, made in plug, during driving:
 - a) At no time are plugs to be driven on flat area outside cylindrical recess.
 - b. Dry Pack of Taper Tie Holes: After installing plugs in tie holes:
 - 1) Coat tie hole surface with epoxy bonding agent and fill with drypack mortar as specified in Section 03600.
 - a) Drypack Mortar: Place in holes in layers with thickness no exceeding tie hole diameter and heavily compact each layer.
 - b) Drypack the outside of the hole no sooner than 7 days after the inside of the hole has been dry packed.
 - c) Wall surfaces in area of drypacked tie holes: On the water side of water containing structures and the outside of below grade walls:
 - i. Cover with minimum of 10 mils of epoxy gel.
 - ii. Provide epoxy gel coating on wall surfaces that extend minimum of 2 inches past drypack 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 on center.
 - b. Closer spacing may be required depending upon strength requirements of the forms, in order to prevent any bulging surfaces on faces of finished concrete work.
 - c. Install studs perpendicular to grain of exterior ply's 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. Tolerances:
1. Finish concrete shall conform to shapes, lines, grades, and dimensions indicated on the Drawings.

2. The maximum deviation from true line and grade shall not exceed tolerances listed below at time of acceptance of project.
3. General: Comply with ACI 117, paragraphs 2.0 through 2.2 and paragraphs 4.0 through 4.5, except as modified in following:
 - a. Slabs:
 - 1) Slope: Uniformly sloped to drain when slope is indicated on the Drawings.
 - 2) Slabs Indicated to be Level: Have maximum deviation of 1/8 inch in 10 feet without any apparent changes in grade.
 - b. Inserts: Set inserts to tolerances require for proper installation and operation of equipment or systems to which insert pertains.
 - c. Maximum Tolerances: As follows:

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

END OF SECTION

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Concrete reinforcement.
- B. Related Sections:
 - 1. Section 03100 - Concrete work.

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 separate letter submitted with shop drawings any changes of requirements indicated on the drawings for reinforcing steel.
 - 2) Such changes will not be acceptable unless the ENGINEER has accepted such changes in writing.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Packing And Shipping:
 1. Deliver bars bundled and tagged with identifying tags.
- B. Acceptance At Site:
 1. Reinforcing Bars: Deliver reinforcing bars accompanied by manufacturer's guarantee of grade.
- C. Storage:
 1. All rebar shall be stored on dunnage.

1.06 SEQUENCING AND SCHEDULING

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

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Reinforcement:
 1. General: Provide reinforcing steel that is new material, of quality specified, free from excessive rust or scale or any defects affecting its usefulness.
- B. Reinforcing Bars:
 1. Reinforcing Bars to be Embedded in Concrete or Masonry: Grade 60 deformed bars conforming to ASTM A 615 except as specified in the next subparagraph.
 2. Reinforcement resisting earthquake-induced flexural and axial forces in concrete frame members and in concrete wall boundary members shall comply with low alloy ASTM A 706. ASTM A 615 Grade 60 reinforcement may be used in these members if the following requirements are met:
 - a. The actual yield strength based on mill tests does not exceed the specified yield strength by more than 18,000 pounds per square inch (retest shall not exceed this value by more than an additional 3,000 pounds per square inch).
 - b. The ratio of the actual ultimate tensile stress to the actual tensile yield strength is not less than 1.25.
 3. Hot-Dip Galvanized Reinforcing Bars:

- a. When reinforcing bars are indicated on the Drawings to be hot-dip galvanized, perform such galvanizing in accordance with ASTM A 767 and ATM A 143.
 - b. Galvanizing: Galvanize bars in conformance with Class 1 coating and perform galvanizing after fabrication and shearing.
4. Thread Bars:
- a. Provide thread bars having continuous rolled-in patten of thread-like deformations along entire length.
 - b. Provide hex nuts and couplers for the thread bars that develop 125 percent of yield strength of bar.
 - c. Thread Bars:
 - 1) Conform to ASTM A 615 Grade 60.
 - d. Do not substitute cut threads on regular reinforcing bars for thread bars.
- C. Bar Supports:
- 1. Reinforcement Support Chairs:
 - a. Hot-dip galvanized steel. Provide hot-dip galvanized steel with plastic tips at surfaces which will be exposed to view. Use unless otherwise indicated on the Drawings.
 - b. Stainless Steel where indicated on the Drawings.
 - c. Provide concrete adobe blocks to support rebar associated with building foundation slabs.
 - d. Other suitable material approved by ENGINEER.
- D. Tie Wires: Annealed Steel.

2.02 FABRICATION

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

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

- A. Surface Preparation:
 - 1. Reinforcing Bars: Thin coating of red rust resulting from short exposure will not be considered objectionable. Thoroughly clean any bars having rust scale, 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 in sufficient number to prevent sagging and to support loads during construction, but in no case less than quantities and at locations as indicated in ACI 315.
 - b. Support reinforcing for concrete 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 (does not apply to dowel lap splices or to bars shorter than 4 feet, unless necessary for rigidity).
 - 4. Tie slab bars at every intersection around periphery of slab.
 - 5. Tie wall bar and slab bar intersections other than around periphery at not less than every fourth intersection, but at not greater than following maximum spacing:

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

6. After tying wire ties, bend ends of wire ties in towards the center of the concrete section. Wire ties shall conform to the cover requirements of the reinforcing bars.
- D. Lap Splices of Reinforcing Bars:
1. Where bars are to be lapped spliced at joints in concrete, ensure bars project from concrete first placed, minimum length equal to lap splice length indicated on the Drawings.
 2. Where lap splice length is not indicated on the Drawings, then provide lap splice length as specified in ACI 318 and this Division.
- E. Welded Wire Fabric Reinforcement:
1. Install necessary wiring, spacing chairs, or supports to keep welded wire fabric in place while concrete is being placed.
 2. Bend fabric as indicated on the Drawings or required to fit work.
 3. Unroll or otherwise straighten fabric to make perfectly flat sheet before placing in the Work.
 4. Lap splice welded wire fabric as indicated on the Drawings.
 5. If lap splice length is not shown on the Drawings, splice fabric in accordance with ACI 318.

END OF SECTION

SECTION 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 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 inject 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 samples 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 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 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. Cast in place concrete shall be in accordance with MAG standard specification section 725.
- B. Nonslip Abrasive:
 - 1. Type: Aluminum oxide abrasive of size 8/16, having structure of hard aggregate, homogenous, nonglazing, 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.
- C. 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.
- D. Conduit Encasement Coloring Agent:
- 1. Color: Red color concrete used for encasement of electrical ducts, conduits, 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.
- E. Keyway Material: Steel, plastic, or lumber.
- F. 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.
- G. 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. Concrete mixing shall be in accordance with MAG Standard Specification Section 725.7.

2.03 MIXES

- A. Mixes shall be in accordance with MAG Standard Specification Section 725.6.

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 waterstops and that waterstops 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 MAG Standard Specification Section 729.
 - 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 so as 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 coming in contact with such concrete or winds causing excessive drying.
 6. Keep sufficient protective covering on hand at all times for protection of concrete.
 7. After acceptance, adhere to proposed sequence of placing concrete, except when specific changes are requested 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. Keep sufficient vibrators on hand at all times to vibrate concrete as placed.
 - b. In addition to vibrators in actual use while concrete is being placed, have on hand minimum 1 spare vibrator in serviceable condition.
 - c. Do not place concrete until it has been ascertained that all vibrating equipment, including spares, are in serviceable condition.
 5. Take special care to place concrete solidly against forms so as 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 or 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 keep concrete surfaces moist at all times for 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 any and all points after drying for at least 24 hours.

- k. The CONTRACTOR is cautioned that 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 and also similar adjacent area with specified compound in specified manner for comparison:
 - 1) If proposed sample is not equal or better, in opinion of the ENGINEER, in all features, proposed substitution will not be allowed.
- 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 in regard to 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 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 of 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, 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 equals:
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 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 necessary limited to, Work that is directly related to this Section.

1.02 QUALITY ASSURANCE

- A. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown and specified.
1. ASTM 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. Finish shall be black.
 3. Product and Manufacturer: Provide inserts by one of the following:
 - a. Figure 282, manufactured by ITT Grinnell.
 - b. No. 380, as manufactured by Hohmann and Barnard, Incorporated.
 - c. Or equal.
- D. Toggle Bolts:
1. Provide spring-wing toggle bolts, with two-piece wings.
 2. Provide carbon steel bolts with zinc coating in accordance with Federal Specification FF-S-325.
 3. Product and Manufacturer: Provide toggle bolts by one of the following:
 - a. The Rawlplug Company, Incorporated.

- b. Haydon Bolts, Incorporated.
 - c. Or equal.
- E. Stud Type Expansion Anchors:
 - 1. Product and manufacturer
 - a. Kwik-Bolt 3.
 - b. Or equal.
- F. Powder activated fasteners and other types of bolts and fasteners not specified herein shall not be used.

PART 3 - EXECUTION

3.01 INSPECTION

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

3.02 INSTALLATION

- A. Assure that embedded items are protected from damage and are not filled in with concrete.
- B. Use concrete inserts for pipe hangers and supports for the pipe size and loading recommended by the insert manufacturer.
- C. Use toggle bolts for fastening brackets and other elements onto masonry units.
- D. For the epoxy adhesive anchors and adhesive material, CONTRACTOR shall comply with the manufacturer's installation instructions on the hole diameter and depth required to fully develop the tensile strength of the adhesive anchor or reinforcing bar. Contractor shall properly clean out the hole utilizing a wire brush and compressed air to remove all loose material from the hole, prior to installing adhesive capsules or material.

3.03 CLEANING

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

END OF SECTION

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 07411 – Preformed Metal Roof Panels: Gutters and downspouts
- C. Section 09900 - Painting and Coating: Paint finish.

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 01300 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 09900.

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 09800 - Special Coatings.
 - 3. Section 09900 - Painting.

- 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 Toeboards.

- 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 with 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 A 570	–
Coil (plate)	A 635	–
Structural plate, bars, rolled shapes, and	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 indicated on the Drawings or specified elsewhere. Fabricate and install in accordance with the best practices of the trade.

2.06 LADDERS

- A. General:
 - 1. Type: Safety type conforming to local, State, or Occupational Safety and Health Administration standards as minimum. Furnish guards for ladder wells.
 - 2. Size: Minimum 16 inches wide between side rails of length, size, shape, detail, and location indicated on the Drawings.
- B. Aluminum Ladder:
 - 1. Material shall be 6061-T6 Aluminum and anodized.
 - 2. Ladder shall conform to OSHA Standard 1910.27.
 - 3. Rungs shall have serrated surface for slip resistance.
 - 4. 1-1/4" solid serrated safety rung designed to meet loading standards which are 4 times that which is recommended by OSHA Standard #1910.27.
 - 5. Ladder Up Safety Post where shown: Factory assembled telescoping post, designed for mounting fixed ladder, complete with brackets, hardware, and fasteners.
 - a. Material Finish: Aluminum mill finish.
 - b. Product and Manufacturer: Model LU-4, The Bilco Company or approved equal.

2.07 RAILING

- A. General: Design and fabricate assemblies to conform to current local, State, and Occupational Safety and Health Administration standards and requirements.
- B. CONTRACTOR shall provide aluminum or stainless steel railing.
- C. Aluminum Railings (Nonwelded Pipe):
 - 1. Rails, Posts, and Fitting-assembly Spacers:
 - a. ASTM B 429, 6063-T5, minimum Schedule 40, extruded aluminum pipe of minimum 1.89 inch outside diameter and 0.14-inch wall thickness.
 - b. Alloy 6063-T6 may be used for pieces requiring bending only.
 - c. Railing shall be attached to concrete structure with sleeve or side mount brackets, as indicated on Drawings.
 - 2. Kick Plates: 6061-T6 aluminum alloy.
 - 3. Fastening and Fasteners: As recommended or furnished by the manufacturer.

4. Other Parts: 6063 extruded aluminum, or F214 or F514.0 aluminum castings.
 - a. Fabrications: ASTM B 209 or ASTM B 221 extruded bars.
 - 1) Bases: 6061 or 6063 extruded aluminum alloy.
 - b. Plus Screws or Blind Rivets: Type 305 stainless steel.
 - c. Other Parts: Type 300 series stainless steel.
5. Finish of Aluminum Components:
 - a. Anodized finish, 0.7 mil thick, applied to exposed surfaces after cutting. Aluminum Association Specification M32-C22-A41.
 - b. Pretreat aluminum for cleaning and removing markings before anodizing.
6. Fabrication and Assembly:
 - a. Fabricate posts in single, unspliced pipe length.
 - b. Perform without welding.
 - c. Do not epoxy bond the parts.
 - d. Maximum clear opening between assembled railing components as indicated on the Drawings.
7. Manufacturers: One of the following or equal:
 - a. Moultrie Manufacturing Company, Wesrail.
 - b. Julius Blum and Company, Inc., Connectorail.
 - c. Craneveyor Corporation Enerco Metals, C-V Rail.
 - d. Or approved equal.

D. Stainless Steel Pipe Railing:

1. Manufacturers: One of the following or equal:
 - a. R & B Wagner, Inc.
 - b. Julius Blum and Company.
 - c. Or approved equal.
2. General: Prefabricated shop-assembled type, field welded type, or mechanically joined type.
3. Materials: Type 304 or Type 316 stainless steel posts, rails, brackets, and accessory parts.
 - a. Railings and Posts: Nominal 1-1/2 inch, Schedule 5 pipe with minimum 1.900 inch outer diameter and 0.065 inch wall thickness,
 - b. Post Insert Reinforcing for All Posts: 1.750 inch outside diameter pipe, of 0.083 inch wall thickness, and 26 inches long.
 - c. Fasteners, Connection Plates, Splice Bars, and Fittings: Type 304 or Type 316 stainless steel.
 - d. Stainless Steel Finish: Number 4 NAAMM finish.
4. Fabrication:
 - a. Fabricate rails and posts to be in same plane.
 - b. Fabricate posts in single, unspliced pipe length.
 - c. Make railing sections between splices 20 feet maximum.
 - d. Form bends in pipe without use of fittings where practical. Form with internal mandrels on power benders.
 - e. Where railing is welded, make intersections and joints with continuous 360 degree welds and grind welds smooth.

- f. Where railing is mechanically joined, make joints with mechanical connections utilizing stainless steel machine screws with lock washers and threaded tubular rivets.
- E. Fastenings and Fasteners: As recommended or furnished by railing manufacturer for use with this system.

2.08 GRATING

A. General:

1. Fabricate grating to cover areas indicated on Drawings. Grating manufacturer shall obtain and review drawings, and pricing shall include grating design in drawings and these specifications.
2. Unless otherwise indicated on Drawings, grating over an opening shall cover entire opening.
3. Make cutouts in grating where required for equipment access, piping or protrusion, including valve operators or stems, and gate frames.
4. Band ends of grating and edges of cutouts in grating:
 - a. End Banding: 1/4 inch less than height of grating, with top of grating and top edge of banding flush.
 - b. Cutout Banding: Full-height of grating.
 - c. Use banding of same material as grating.
 - d. Panel Layout: Enable installation and subsequent removal of grating around protrusions or piping.
 - e. Openings 6 inches and Larger: Lay out grating panels with edges of 2 adjacent panels located on centerline of opening.
 - f. Openings Smaller than 6 inches: Locate opening at edge of single panel.
 - g. Where an edge requires more than 1 grating section to cover area, clamp adjacent grating sections together at 1/4 points with fasteners acceptable to ENGINEER.
 - h. Fabricate grating in units of maximum 50 pounds each.
5. When requested by ENGINEER, test 1 section of each size grating for each span length involved on the job under full load:
 - a. Furnish a suitable dial gauge for measuring deflections.
6. Grating shall be aluminum, unless otherwise specified or indicated on the Drawings:
 - a. Aluminum Grating:
 - 1) Materials for Gratings, Shelf Angles, and Rebates: 6063-T6 aluminum alloy, except cross bars may be 6063-T5 aluminum alloy.
 - 2) Shelf Angle Concrete Anchors: Type 304 or Type 316 stainless steel.
 - 3) Grating Rebate Rod Anchors: 6063-T6 aluminum alloy.
 - 4) Fabrication:
 - a) Bar Size and Spacing: As determined by manufacturer to enable grating to support a minimum of 180 pounds per square foot uniform live load on entire grating area, using an extreme fiber stress of 12,000 pounds per square inch maximum.
 - b) Maximum Deflection Under specified Loading: 1/4 inch of grating clear span maximum.

- c) Spacing of Main Grating Bars: 7/16 inch clear between bars.
- d) Minimum Grating Height: See Drawings.
- 5) Manufacturers:
 - a) McNichols Co.
 - b) Or approved equal.

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION, 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 7
THERMAL AND MOISTURE PROTECTION

SECTION 07212

BOARD AND BLANKET INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Board insulation and integral vapor retarder at perimeter foundation wall.
- B. Blanket insulation in exterior ceiling and roof construction.
- C. Foam insulation for filling perimeter window and door shim spaces and crevices in exterior wall and roof assemblies.

1.02 RELATED REQUIREMENTS

- A. Section 09260 - Gypsum Board Assemblies: Metal studs receiving blanket insulation and acoustic insulation.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M-17 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- B. ASTM C578-19 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
- C. ASTM C665-17 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
- D. ASTM C1136-17a - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
- E. ASTM E84-19a - Standard Test Method for Surface Burning Characteristics of Building Materials.
- F. ASTM E96/E96M-16 - Standard Test Methods for Water Vapor Transmission of Materials; 2005.
- G. ASTM E136-19 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate the installation of perimeter insulation with size, location, and

installation of service utilities.

- B. Scheduling: Install board insulation at exterior masonry walls prior to installation of gypsum board assemblies.

1.05 SUBMITTALS

- A. See Section 01340 for submittal procedures.
- B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.
- C. Manufacturer's Installation Instructions: Include information on special environmental conditions required for installation and installation techniques.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the work of this section with minimum 3 years documented experience.

1.07 MOCK-UP

- A. Provide the following thermal insulation components part of a multiple-component wall assembly mock-up:
 - 1. Board insulation.
 - 2. Blanket insulation.
- B. Locate where directed.
- C. Mock-up may not remain as part of the Work.
- D. Accepted mock-ups shall be a comparison standard for the remaining Work.
- E. Remove rejected mock-ups. Replace rejected mock-ups with new mock-ups until mock-up is accepted by Engineer.

1.08 FIELD CONDITIONS

- A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

1.09 DELIVERY, STORAGE, AND PROTECTION

- A. Deliver products in manufacturer's original containers, dry, undamaged, with seals and labels intact.
- B. Store products in weather protected environment, clear of ground and moisture.

- C. Protect foam insulation from direct exposure to sunlight.

PART 2 - PRODUCTS

2.01 APPLICATIONS

- A. Refer to Schedule at the end of this Section.

2.02 BOARD INSULATION MATERIALS

- A. Extruded Polystyrene Board Insulation: ASTM C 578, Type IV; Extruded polystyrene board with either natural skin or cut cell surfaces; with the following characteristics:
 1. Flame Spread Index: 75 or less, when tested in accordance with ASTM E 84.
 2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E 84.
 3. Board Size: 24 x 96 inch.
 4. Board Edges: Shiplap.
 5. Environmental Data: Hydrochlorofluorocarbon (HCFC) free with zero ozone-depletion
 6. Thermal Resistance (R-Value at 25 degrees F, per 1-inch thickness): 5.0, minimum.
 7. Compressive Resistance: 30 psi.
 8. Board Density: 1.6 lbs/cu ft.
 9. Water Absorption, maximum: 0.7 percent, volume.
 10. Recycled Content: 25 percent, minimum.
 11. Product and Manufacturer: Styrofoam Brand SM, Dow Chemical Co: www.dow.com or approved equal.

2.03 BLANKET INSULATION MATERIALS

- A. Blanket Insulation: ASTM C 665; preformed blanket; conforming to the following:
 1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E 84.
 2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E 84.
 3. Surface Burning Characteristics: Flame spread index of 25 or less; smoke developed index of 450 or less, when tested in accordance with ASTM E 84.
 4. Combustibility: Non-combustible, when tested in accordance with ASTM E 136.
 5. Formaldehyde Content: Zero.
 6. Recycled Content: 40 percent, minimum.
 7. Thermal Resistance: As indicated.

2.04 ACCESSORIES

- A. Sheet Vapor Retarder: 6 mil thick reinforced foil, which meets ASTM E 84.
 1. Construction: Foil/Scrim/Kraft (FSK).
 2. Weight: 24 lbs/ 1000 square feet.
 3. Tensile Strength: 55 lbf., per ASTM C 1136.
 4. Perm Rating: 0.02, per ASTM E 96 Method A.
 5. Flame Spread/Smoke Developed: 0/10 (Foil); 25/10 (Kraft); Class A, in accordance with ASTM E 84.

6. Product and Manufacturer: R-3035 HD, Lamtec Corporation: www.lamtec.com or approved equal.
- B. Tape: Bright aluminum self-adhering type, mesh reinforced, 3 inch wide.
- C. Insulation Fasteners: Impaling clip of unfinished steel with washer retainer and clips, to be adhered to surface to receive insulation, length to suit insulation thickness and substrate, capable of securely and rigidly fastening insulation in place; with nylon safety point covers.
- D. Nails or Staples: Steel wire; electroplated, or galvanized; type and size to suit application.
- E. Foam Insulation: Latex polymer, low-expanding, paintable.
 1. Product and Manufacturer: DAPtex, DAP, Inc.; www.dap.com or approved equal.
- F. Fasteners: Self-Drilling, Self-Tapping Screws, and Washers, ASTM A 123/A 123M, hot dip galvanized to 1.3 oz/sq ft.
- G. Wire Mesh: Galvanized steel, hexagonal wire mesh.
- H. Support Wire: 16 gage steel wire.
- I. Steel Straps: 3/4 inch by 26 gage galvanized steel bands.
- J. Plastic Netting: Lightweight plastic net, 1 x 2 inch openings.
 1. Product and Manufacturer: NT Series Netting, S.F. Products: www.sfproducts.com or approved equal.
- K. Adhesive: Type recommended by insulation manufacturer for application.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.
- B. Verify substrate surfaces are flat, free of irregularities.
- C. Verify that masonry joints are struck flush.

3.02 PREPARATION

- A. Remove concrete fins and mortar projections that interfere with placement of insulation boards.

3.03 BOARD INSTALLATION AT FOUNDATION PERIMETER

- A. Insulation Boards: Extruded polystyrene board, bead adhesive application.
- B. Apply adhesive to back of boards:
- C. Install boards horizontally on foundation perimeter.
 - 1. Place boards to maximize adhesive contact.
 - 2. Install in running bond pattern.
 - 3. Butt edges and ends tightly to adjacent boards and to protrusions.
- D. Extend boards over expansion joints, unbonded to foundation on one side of joint.
- E. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.04 BLANKET INSTALLATION

- A. Install insulation and vapor retarder in accordance with manufacturer's instructions.
- B. Install in exterior wall and roof spaces without gaps or voids. Do not compress insulation.
- C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
- D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.
- E. Install continuous vapor retarder membrane facing warm side of building spaces.
- F. Blankets installed against concrete masonry: Retain insulation blankets in place with spindle fasteners at 12 inches on center.
- G. Tape seal butt ends, lapped flanges, and tears or cuts in membrane.
- H. Tape seal tears or cuts in vapor retarder.

3.05 FOAM INSULATION INSTALLATION

- A. Install insulation in accordance with manufacturer's instructions.
- B. Use foam insulation at voids which cannot be filled tightly with board and blanket insulation.
- C. At window and door frames install in spaces between frame and wall framing without gaps or voids.
- D. Trim cured foam as required to avoid conflicts with installation of finish materials.

3.06 PROTECTION

- A. Do not permit installed insulation to be damaged prior to its concealment.

3.07 SCHEDULE

- A. Perimeter Insulation: Extruded polystyrene board, bead adhesive application to warm side of foundation walls and footings.
 - 1. R-Value: R-10, minimum.
 - 2. Thickness: 2 inches.
 - 3. Locations: From finish floor elevation to bottom of footing, as indicated.
- B. Concealed crevices and gaps on interior side of building which cannot be filled by blanket or board insulation: Foam insulation.

3.08 CLEAN-UP

- A. Remove and dispose of excess insulation, wrappings, and other waste materials.

END OF SECTION

DIVISION 8
DOORS AND WINDOWS

SECTION 08110

STEEL DOORS AND FRAMES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Steel frames for wood doors.
- B. Sound-rated steel doors and frames.
- C. Accessories, including glazing.

1.02 RELATED REQUIREMENTS

- A. Section 08710 - Door Hardware.
- B. Section 09900 - Paints and Coatings: Field painting.

1.03 REFERENCE STANDARDS

- A. ANSI/ICC A117.1-2017 - American National Standard for Accessible and Usable Buildings and Facilities; International Code Council.
- B. ANSI A250.8-201x, Specifications for Standard Steel Doors and Frames (SDI -100).
- C. ANSI A250.10-201x, Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
- D. ASTM A653/A653M-18 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- E. ASTM C1363-11 - Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus.
- F. ASTM E90-09(2016) - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- G. ASTM E413-16 - Classification for Rating Sound Insulation.
- H. BHMA A156.115-2016 - Hardware Preparation in Steel Doors and Steel Frames.
- I. DHI A115 Series - Specifications for Steel Doors and Frame Preparation for Hardware; Door and Hardware Institute; 2000 (ANSI/DHI A115 Series).
- J. NAAMM HMMA 840 - Guide Specifications for Installation and Storage of Hollow Metal

Doors and Frames; The National Association of Architectural Metal Manufacturers; 2007.

1.04 SUBMITTALS

- A. See Section 01340 for submittal procedures.
- B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes.
- C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and identifying location of different finishes, if any.
- D. Certificates:
 - 1. Provide evidence of manufacturer's membership in the Steel Door Institute or the Hollow Metal Manufacturer's Association.
- E. Installation Instructions: Manufacturer's published instructions, including any special installation instructions relating to this project.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years documented experience.
- B. Manufacturer Qualifications: Provide all products from a single manufacturer who is a member of the Hollow Metal Manufacturer's Association or the Steel Door Institute.
- C. Where indicated provide door and frame assemblies tested and certified by the manufacturer in accordance with ASTM E90 to provide an STC rating of 50 or better.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Store in accordance with NAAMM HMMA 840.
- B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion.

PART 2 - PRODUCTS

2.01 DOORS AND FRAMES

- A. Requirements for All Doors and Frames:
 - 1. Accessibility: Comply with ANSI/ICC A117.1.
 - 2. Door Top Closures: Flush with top of faces and edges.
 - 3. Door Edge Profile: Beveled on both edges.
 - 4. Door Texture: Smooth faces.

5. Glazed Lights: Non-removable stops on non-secure side; sizes and configurations as indicated on drawings.
 6. Hardware Preparation: In accordance with BHMA A156.115, with reinforcement welded in place, in addition to other requirements specified in door grade standard.
 7. Mortar Grout Guards: Provide mortar guard boxes for hardware cut-outs and glazing stop fasteners in frames to be installed in masonry or to be grouted.
 8. Galvanizing at Doors and Frames Indicated: All components hot-dipped zinc-iron alloy-coated (galvannealed), A40/ZF120.
 9. Finish: Factory primed, for field finishing.
- B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with all the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.02 STEEL FRAMES

- A. General:
1. Comply with the requirements of grade specified for corresponding door, except:
 - a. Frames for Wood Doors: Comply with frame requirements specified in ANSI A250.8 for Level 2
 2. Finish: Factory primed, for field finishing.
 3. Provide mortar guard boxes for hardware cut-outs in frames to be installed in masonry or to be grouted.
 4. Frame Anchors: Manufacturer's standard anchoring devices for indicated opening types, minimum six per frame, with anchoring device accessories specified in manufacturer's installation instructions.
 - a. Provide frame anchors of type and at locations recommended by manufacturer for frame size and substrate material.
 - b. Door Frames: Provide 3 anchors minimum for each jamb for frames up to 78 inches in height; 4 anchors up to 96-inch jamb height; one additional anchor each 24 inches or fraction thereof over 96-inch jamb height.
 - 1) Door frame anchor locations: Provide anchors on each jamb at hinge and strike levels.
 - c. Window frame anchor locations: One anchor for each 30 inches of frame height or fraction thereof.
 5. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inches high to fill opening without cutting masonry units.
 6. Frames Wider than 48 Inches: Reinforce with steel channel fitted tightly into frame head, flush with top.
 7. Frames Installed Back-to-Back: Reinforce with steel channels anchored to floor and overhead structure.
- B. Exterior Door Frames: Fully welded.
1. Galvanizing: All components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with A40/ZF120 coating.
 2. Weatherstripping: Separate, see Section 08710.

- C. Interior Door Frames: Fully welded type.
- D. Sound-Rated Door Frames: Knock-down type.
- E. Frames for Interior Glazing or Borrowed Lights: Construction and face dimensions to match door frames, and as indicated on drawings.

2.03 ACCESSORY MATERIALS

- A. Silencers: Resilient rubber, fitted into drilled hole; 3 on strike side of single door, 3 on center mullion of pairs, and 2 on head of pairs without center mullions.
- B. Temporary Frame Spreaders: Provide for all factory- or shop-assembled frames.

2.04 FINISH MATERIALS

- A. Primer: Rust-inhibiting, complying with ANSI A250.10, door manufacturer's standard.
- B. Bituminous Coating: Asphalt emulsion or other high-build, water-resistant, resilient coating.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Verify connections for electrical hardware are available before starting work.

3.02 PREPARATION

- A. Coat inside of frames to be installed in masonry or to be grouted, with bituminous coating, prior to installation.

3.03 INSTALLATION

- A. Install in accordance with the requirements of the specified door grade standard and NAAMM HMMA 840.
- B. Coordinate frame anchor placement with wall construction.
- C. Grout frames in masonry construction, using hand trowel methods; brace frames so that pressure of grout before setting will not deform frames.

- D. Coordinate installation of hardware.
- E. Coordinate installation of glazing.
- F. Coordinate installation of electrical connections to electrical hardware items.

3.04 TOLERANCES

- A. Clearances Between Door and Frame: As specified in ANSI A250.8.
- B. Diagonal Distortion: 1/16 in Max measured with straight edge, corner to corner.

3.05 ADJUSTING

- A. Adjust for smooth and balanced door movement.
- B. Adjust sound control doors so that seals are fully engaged when door is closed.

END OF SECTION

SECTION 08710

DOOR HARDWARE

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Hardware for hollow steel doors.
- B. Thresholds.
- C. Weatherstripping, seals and sweeps.

1.02 RELATED SECTIONS

- A. Section 08110 - Steel Doors and Frames.

1.03 REFERENCES

- A. ANSI/ICC A117.1-2017 – American National Standard for Accessible and Usable Buildings and Facilities; International Code Council.
- B. BHMA A156.3-2014 - American National Standard for Exit Devices; Builders Hardware Manufacturers Association (ANSI/BHMA A156.3).
- C. BHMA A156.13-2017 - American National Standard for Mortise Locks; Builders Hardware Manufacturers Association (ANSI/BHMA A156.13).
- D. BHMA A156.18-2016 - American National Standard for Materials and Finishes; Builders Hardware Manufacturers Association, Inc. (ANSI/BHMA A156.18).
- E. BHMA A156.21-2014 - American National Standard for Thresholds; Builders Hardware Manufacturers Association (ANSI/BHMA A156.21).
- F. DHI (LOCS) - Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames; Door and Hardware Institute; 2004.
- G. NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association; 2019.

1.04 SUBMITTALS

- A. See Section 01340 for submittal procedures.

- B. Shop Drawings:
 - 1. Indicate locations and mounting heights of each type of hardware, schedules, and catalog cuts.
 - a. Hardware Schedule: Number each set independently, matching the same numbering system listed in the Hardware Schedule at the end of this Section. Include quantities, model numbers, finishes, and other characteristics as indicated.
- C. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention.
- D. Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.
- E. Keys: Deliver with identifying tags to Owner by security shipment direct from hardware supplier.
- F. Warranty: Submit manufacturer's warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 10 years of documented experience.
- B. Hardware Supplier Qualifications: Company specializing in supplying commercial door hardware with 10 years of documented experience.

1.06 DELIVERY, STORAGE, AND PROTECTION

- A. Package hardware items individually; label and identify each package with door opening code to match hardware schedule.

1.07 COORDINATION

- A. Coordinate the work with other directly affected sections involving manufacture or fabrication of internal reinforcement for door hardware.
- B. Furnish templates for door and frame preparation.
- C. Coordinate Owner's keying requirements during the course of the Work.

1.08 WARRANTY

- A. Provide a five-year warranty for door closers.

1.09 MAINTENANCE PRODUCTS

- A. Provide special wrenches and tools applicable to each different or special hardware component.
- B. Provide maintenance tools and accessories supplied by hardware component manufacturer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Hinges:
 - 1. Bommer Industries, Inc. (BOM): www.bommer.com.
 - 2. Hager Companies (HAG): www.hagerhinge.com.
 - 3. McKinney Products Company (MCK): www.mckinneyhinge.com
 - 4. Stanley Hardware (STA): www.stanleyworks.com.
- B. Mortise Locks:
 - 1. Schlage Lock Company (SCH): www.schlage.com.
 - 2. Sargent & Company (SAR): <http://www.sargentlock.com>
 - 3. Yale-Corbin U.S. (YAL): www.yalesecurity.com.
 - 4. Medeco (MED): www.medeco.com
- C. Closers:
 - 1. DORMA Group North America (DOR): www.dorma-usa.com.
 - 2. LCN (LCN): www.lcnclosers.com.
 - 3. Norton, Division of Yale-Corbin U.S. (NOR): www.yalesecurity.com.
 - 4. Sargent & Company (SAR): <http://www.sargentlock.com>.
- D. Weatherstripping, Seals and Door Gaskets:
 - 1. National Guard Products, Inc. (NAT): www.ngpinc.com.
 - 2. Pemko Manufacturing Company (PEM): www.pemko.com.
 - 3. Reese Enterprises, Inc. (REE): www.reeseusa.com
 - 4. Zero International, Inc. (ZER): www.zerointernational.com.
- E. Stops, Holders and Door Trim:
 - 1. Hager Companies (HAG): www.hagerhinge.com.
 - 2. H. B. Ives, A Harrow Company (IVE)
 - 3. Rockwood Manufacturing Company (ROC): www.rockwoodmfg.com
 - 4. Triangle Brass Manufacturing Company (TRI): www.trimcobbw.com.
 - 5. Glynn-Johnson (GLY): www.glynnjohnson.com.
- F. Thresholds:
 - 1. National Guard Products, Inc. (NAT): www.ngpinc.com.
 - 2. Pemko Manufacturing Company (PEM): www.pemko.com.
 - 3. Reese Enterprises, Inc. (REE): www.reeseusa.com.
 - 4. Zero International, Inc (ZER): www.zerointernational.com.

2.02 GENERAL REQUIREMENTS FOR DOOR HARDWARE PRODUCTS

- A. Provide products that comply with the following:
 - 1. Applicable provisions of Federal, State, and local codes.
 - 2. ANSI/ICC A117.1, American National Standard for Accessible and Usable Buildings and Facilities.

- B. Finishes: Identified in schedule at end of section.
 - 1. Finish designations used in schedule indicates hardware finishes listed in ANSI/BHMA A156.18 including coordination with the traditional U.S. finishes shown by certain manufacturers for their products.

- C. Fasteners: Provide flat-head Phillips screws for installation with each hardware item to match hardware finish except as otherwise indicated or as otherwise required by manufacturer.
 - 1. Provide concealed fasteners for hardware components exposed when door is closed; Provide sleeves for each thru bolt or use hex screw fasteners.
 - 2. Anchors: Provide stud type zinc plated carbon steel expansion anchor with a single piece wedge for hardware connected to concrete.

2.03 KEYING

- A. Door Locks: Master keyed.
 - 1. Include construction keying and control keying with removable core cylinders.
 - a. Construction cores: Metallic (not plastic).
 - 2. Permanent change keys and lock cores: Shipped by manufacturer directly to Owner by registered mail after substantial completion.
 - a. Equip locksets with cylinders for interchangeable-core pin tumbler inserts. Locks from manufacturers must be provided with cores as manufactured by the following:
 - 1) Medeco.
 - b. Tag each key with a label which identifies the Room Name (or, in the case of master keys, the type of master key).
 - c. Key Material: Provide keys of nickel silver only.

- B. Comply with Owner's instructions for master keying.

- C. Key Material: Provide keys of nickel silver only.

- D. Supply keys in the following quantities:
 - 1. 5 master keys.
 - 2. 3 construction master keys.
 - 3. 5 keys for each lock.

- E. Tag each key with a label which identifies the Room Name (or, in the case of master keys, the type of master key).

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that doors and frames are ready to receive work, and dimensions are as indicated on shop drawings.

3.02 INSTALLATION

- A. Install hardware in accordance with manufacturer's instructions and applicable codes.
- B. Use templates provided by hardware item manufacturer.
- C. Install hardware on fire-rated doors and frames in accordance with code and NFPA 80.
- D. Mounting heights for hardware from finished floor to center line of hardware item:
 - 1. For steel doors and frames: Comply with DHI "Recommended Locations for Architectural Hardware for Steel Doors and Frames."
- E. Hinge Pins: Except as otherwise noted, provide hinge pins as follows:
 - 1. Out-Swing Exterior Doors: Nonremovable Pins (NRP).
 - 2. Out-Swing Corridor Doors with Locks: Nonremovable pins (NRP).
 - 3. Interior Doors: Nonrising pins.
 - 4. Tips: Flat button and matching plug, finished to match leaves, except where hospital tip (HT) indicated.
- F. Set thresholds for exterior doors in full bed of sealant complying with Section 07900.

3.03 ADJUSTING

- A. Adjust hardware for smooth operation.

3.04 PROTECTION OF FINISHED WORK

- A. Do not permit adjacent work to damage hardware or finish.

3.05 HARDWARE SCHEDULE

- A. Provide hardware for each door to comply with the requirements for design, grade, function, finish, size, and other characteristics of each type of finish hardware as indicated in the following Hardware Schedule.
- B. Hardware sets indicate quantity, item, manufacturer and product designation, size, and finish or color, as applicable.
- C. Hardware Set HW-1 (Store Room Function):
 - 1. (6 ea) Hinges (IVE) 5BB1 4.5" x 4.5" x NRP x 630
 - 2. (2 ea) Manual Flush Bolt (IVE) FB458-12" x 626

3. (1 ea) Dust Proof Strike (IVE) DP2 x626
4. (1 ea) Storeroom Lockset (BES) 93K7D 15 3/4" throw latch bolt x 626
5. (1 ea) Latch Guard (DON) BLP-107 x 630
6. (1 ea) Surface Closer (LCN) 4111 EDA x ST-2730 x thru-bolt x 689
7. (2 ea) Overhead Stop (GLY) 900S X SNB x 630
8. (2 ea) Kick Plate (IVE) 8400 10" x 2" less door with x 630
9. (1 ea) Threshold (NGP) 425E x door width x AL
10. (2 ea) Door Sweep (NGP) 200NA x door width x CL
11. (1 ea) Door Seals (NGP) 160S x door size x AL
12. (1 ea) Astragal (NGP) 139SP X 5050B X D.H. x 600
13. (1 ea) Drip Cap (NGP) 16A x door width plus 4" x CL

D. Hardware Set HW-2 (Entrance Function):

1. (3 ea) Hinges (IVE) 5BB1 4.5" x 4.5" x NRP x 652
2. (1 ea) Entrance Lockset (BES) 93K7 AB 15D x 626
3. (1 ea) Surface Closer (LCN) 4111 EDA x thru-bolt x 689
4. (1 ea) Kick Plate (IVE) 8400 10" x 2" less door width x 630
5. (1 ea) Wall Stop (IVE) WS407CVX x 630
6. (1 ea) Threshold (NGP) 425E x door width x AL
7. (1 ea) Door Sweep (NGP) 200NA x door width x CL
8. (1 ea) Door Seals (NGP) 160S x door size x AL

E. Hardware Set HW-3 (Storeroom Function):

1. (3 ea) Hinges (IVE) 5BB1 4.5" x 4.5" x NRP x 652
2. (1 ea) Storeroom Lockset (BES) 93K7D 15D x 626
3. (1 ea) Latch Guard (DON) BLP-107 x 630
4. (1 ea) Surface Closer (LCN) 4111 EDA x ST-2730 x thru-bolt x 689
5. (1 ea) Overhead Stop (GLY) 900S X SNB x 630
6. (1 ea) Kick Plate (IVE) 8400 10" x 2" less door width x 630
7. (1 ea) Threshold (NGP) 425E x door width x AL
8. (1 ea) Door Sweep (NGP) 200NA x door width x CL
9. (1 ea) Door Seals (NGP) 160S x door size x AL
10. (1 ea) Drip Cap (NGP) 16A x door width plus 4" x CL

F. Hardware Set HW-4 (Privacy Function):

1. (3 ea) Hinges (IVE) 5BB1 4.5" x 4.5" x 652
2. (1 ea) Privacy Lockset (BES) 93K0L 15D x 626
3. (1 ea) Wall Stop (IVE) WS407CVX x 630
4. (3 ea) Silencer (IVE) SR64 gray

G. Hardware Set HW-5 (Storeroom Function):

1. (3 ea) Hinges (IVE) 5BB1 4.5" x 4.5" x 652
2. (1 ea) Storeroom Lockset (BES) 93K7D 15D x 626
3. (1 ea) Surface Closer (LCN) 4111 x thru-bolt x 689
4. (1 ea) Kick Plate (IVE) 8400 10" x 2" less door width x 630
5. (1 ea) Wall Stop (IVE) WS407CVX x 630
6. (3 ea) Silencer (IVE) SR64 gray

END OF SECTION

DIVISION 9

FINISHES

SECTION 09260

GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Metal stud framing.
- B. Z-furring system.
- C. Metal channel ceiling framing.
- D. Acoustic insulation.
- E. Gypsum board.
- F. Joint treatment and accessories.
- G. Textured finish system.
- H. Metal studs used for seismic bracing of suspended ceiling systems.

1.02 REFERENCES

- A. ASTM C475/C475M-17 - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
- B. ASTM C635/C635M-17 - Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings.
- C. ASTM C645-18 - Standard Specification for Nonstructural Steel Framing Members.
- D. ASTM C665-17 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
- E. ASTM C754-18 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
- F. ASTM C840-19 - Standard Specification for Application and Finishing of Gypsum Board.
- G. ASTM C1002-18 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
- H. ASTM C1047-14a - Standard Specification for Accessories for Gypsum Wallboard and

Gypsum Veneer Base.

- I. ASTM C1396/C1396M-17 - Standard Specification for Gypsum Board.
- J. ASTM E72-15 - Standard Test Methods of Conducting Strength Tests of Panels for Building Construction.
- K. ASTM E84-19a - Standard Test Method for Surface Burning Characteristics of Building Materials.
- L. GA-216 – Application and Finishing of Gypsum Board; Gypsum Association; 2010.

1.03 SUBMITTALS

- A. See Section 01340 for submittal procedures.
- B. Product Data: Provide data on metal framing, gypsum board, accessories, Z-furring components, accessories, and joint finishing system.
- C. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.
- D. Test Reports: For all stud framing products that do not comply with ASTM C 645 or C 754, provide independent laboratory reports showing maximum stud heights at required spacings and deflections.
- E. Samples: Submit three samples of gypsum board finished with proposed texture application, 12 by 12 inches in size.
 - 1. Finish Samples: Provide one sample each of "orange peel" spray-applied texture, in extra fine, fine, and medium gradations; Upon approval, Engineer will select one texture for use throughout the entire project.

1.04 QUALITY ASSURANCE

- A. Perform in accordance with ASTM C 840.

1.05 REGULATORY REQUIREMENTS

- A. Conform to applicable code for seismic bracing of suspended ceiling systems as indicated on drawings.

PART 2 - PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C 840 and GA-216.
 - 1. See PART 3 for finishing requirements.

2.02 METAL FRAMING MATERIALS

- A. Framing System Components: ASTM C 645; galvanized sheet steel, of size and properties necessary to comply with ASTM C 754 for the spacing indicated, with maximum deflection of wall framing of L/240 at 5 psf.
1. Exception: The minimum metal thickness and section properties requirements of ASTM C 645 are waived provided steel of 40 ksi minimum yield strength is used, the metal is continuously dimpled, the effective thickness is at least twice the base metal thickness, and maximum stud heights are determined by testing in accordance with ASTM E 72 using assemblies specified by ASTM C 754.
 2. Studs: "C" shaped with flat or formed webs.
 - a. Size and Gage: As indicated.
 3. Track: U shaped, depth and gage to match studs.
 4. Ceiling Channels: C-shaped.
 5. Main Ceiling Channels: Cold rolled, C shaped, 16 gage, 3/4 inches deep
 6. Braces: C shaped, depth and gage as indicated.
 7. Hat-shaped Furring Channels: Roll-formed, corrosion-resistant steel, hat-shaped sections, minimum depth of 7/8 inch.
 - a. Gage: As indicated. If not indicated, match gage of metal stud substrate.
 - b. Product and Manufacturer: Big "D" Furring Channel FCE, Dietrich Industries, Inc.: www.dietrichindustries.com or equal.
- B. Deep Leg Track:
1. Deep Leg Track: Gage and size to match partition studs; Provide at partition head to structure connections. Fasten to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short.
 - a. Product and Manufacturer: SLP-TRK Slotted Track, Dietrich Metal Framing: www.dietrichindustries.com or equal.
 2. Spacing Bars: Formed 20 gage galvanized angles, engineered to resist deflection and stud rotation at the deep leg track of stud walls, prenotched to match stud spacing and rigidly hold studs in place without fasteners.
 - a. Product and manufacturer: Spazzer 9300 Spacing Bar, Dietrich Industries, Inc.: www.dietrichindustries.com or equal.
- C. Z-Furring System: Z-shaped furring sections and furring reinforcing angles designed to mechanically attach gypsum panels and rigid insulation to interior side of monolithic concrete and masonry walls.
1. Z-Furring Section: 20 gage corrosion resistant coated steel; with slightly toed, 1-1/4 inch holding leg designed for a positive grip on the insulation; with 3/4 inch flange for attachment to substrate; Furring depth: 2 inch.
 - a. Product and Manufacturer: Z-F Series, Z-Furring, Dietrich Industries, Inc.: www.dietrichindustries.com or equal
 2. Z-Furring System Insulation Board:
 - a. Extruded Polystyrene Board Insulation: ASTM C 578, Type X; Extruded polystyrene board with either natural skin or cut cell surfaces; with the following characteristics:
 - 1) Board Size: 23-7/8 x 96 inch.

- 2) Board Thickness: 2 inches.
- 3) Board Edges: Square.
- 4) Thermal Resistance (R-Value at 25 degrees F, per 1-inch thickness): 5.0, minimum.
- 5) Compressive Resistance: 15 psi.
- 6) Board Density: 1.3 lbs/cu ft.
- 7) Water Absorption, maximum: 0.1 percent by volume.
- 8) Surface Burning Characteristics: Flame spread/Smoke developed index of 5/165, when tested in accordance with ASTM E 84.
- 9) Product and Manufacturer: Styrofoam Z-Mate, Dow Chemical Co: www.dow.com or equal.

2.03 GYPSUM BOARD MATERIALS

- A. Gypsum Wallboard: ASTM C 1396/C 1396M. Sizes to minimize joints in place; ends square cut.
 1. Regular Type:
 2. Thickness: 5/8 inch.
 3. Edges: Tapered.
- B. Moisture-Resistant Gypsum Board: ASTM C 1396; ends square cut.
 1. Application: Vertical surfaces of walls containing plumbing piping and other locations as indicated.
 2. Core Type: Regular, as indicated.
 3. Thickness: 5/8 inch.
 4. Edges: Tapered.

2.04 ACCESSORIES

- A. Acoustic Insulation: ASTM C 665; preformed glass fiber, friction fit type, unfaced. Thickness: 3-1/2 inch.
 1. Surface burning characteristics when tested in accordance with ASTM E 84:
 - a. Maximum flame spread: 15 or less.
 - b. Maximum smoke developed: 10 or less.
- B. Clip Angles: Formed angles from galvanized steel or rolled zinc sheets, gage to match studs; of configuration indicated.
- C. Trim, Cornerbead, and Finishing Accessories: ASTM C 1047, galvanized steel or rolled zinc, unless otherwise indicated.
 1. Types: As detailed or required for finished appearance.
 2. Special Shapes: In addition to conventional cornerbead and control joints, provide L-bead and LC-bead at exposed panel edges.
- D. Flute Cover Plates: Flanged 18 gage plates of same material and finish of metal deck, conforming to the profile of the steel deck flute.

- E. Control Joints: Casing beads on either side of joint; void filled with sealant.
- F. Joint Materials: ASTM C 475 and as recommended by gypsum board manufacturer for project conditions.
 - 1. Tape: 2 inch wide, creased paper tape for joints and corners, except as otherwise indicated.
 - 2. Ready-mixed vinyl-based joint compound.
- G. Textured Finish Materials: Vinyl-based compound; plain.
- H. Screws: ASTM C 1002; self-piercing tapping type.
- I. Anchorage Device(s): Powder actuated, Drilled expansion bolts, and Screws with sleeves.
- J. Anchorage to Substrate: Secure framing components to substrate with tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.
- K. Hanger Wire: ASTM A 641, Class 1 zinc coating, soft temper, pre-stretched.
 - 1. Size: Provide wire diameter so that its stress at 3 times the hanger design load (ASTM C 635, Table 1, Direct Hung) will be less than the yield stress of wire, but provide not less than 12 gage diameter wire.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that project conditions are appropriate for work of this section to commence.

3.02 FRAMING INSTALLATION

- A. Metal Framing: Install in accordance with ASTM C 754 and manufacturer's instructions.
- B. Suspended Ceilings and Soffits: Space framing and furring members at 12 inches on center.
 - 1. Laterally brace entire suspension system.
 - a. Provide seismic bracing as indicated.
- C. Studs: Space studs at 16 inches on center.
 - 1. Extend partition framing above ceilings as indicated.
 - 2. Partitions Terminating at Structure: Attach deep leg top runner to structure, maintain clearance between top of studs and structure, and brace both flanges of studs with continuous bridging.
 - 3. Unless indicated otherwise, extend stud framing above finish ceiling. Provide 45 degree bracing system consisting of same stud type spaced 48 inches on center, fastened to stud framing approximately 6 inches above ceiling and anchored to structural framing members above ceiling.
 - 4. Attach ceiling runner securely to substrate in accordance with manufacturer's instructions.

- D. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.
- E. Z-Furring System: Install at masonry walls scheduled to receive gypsum board; Secure Z-furring sections in place on flange at 24 inches on center.
 - 1. Z-Furring Orientation: Vertical; Extend full height of masonry unless indicated otherwise.
 - 2. Z-Furring System Insulation: Provide boards continuous, between Z-furring flanges.

3.03 ACOUSTIC ACCESSORIES INSTALLATION

- A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.

3.04 GYPSUM BOARD INSTALLATION

- A. Comply with ASTM C 840. Install to minimize butt end joints, especially in highly visible locations.
- B. Single-Layer Non-Rated: Install gypsum board perpendicular to framing, with ends and edges occurring over firm bearing.
- C. Installation on Metal Framing: Use screws for attachment of all gypsum board.
- D. Installation on Z-Furring System: Use screws for attachment of all gypsum board.
- E. Moisture Protection: Treat cut edges and holes in moisture resistant gypsum board with sealant.

3.05 INSTALLATION OF TRIM AND ACCESSORIES

- A. Control Joints: Place control joints consistent with lines of building spaces and as follows:
 - 1. Not more than 30 feet apart on walls over 50 feet long.
- B. Corner Beads: Install at external corners, using longest practical lengths.
- C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials and as indicated.

3.06 JOINT TREATMENT

- A. Paper Faced Gypsum Board: Use paper joint tape, bedded with ready-mixed vinyl-based joint compound and finished with ready-mixed vinyl-based joint compound.
- B. Finish gypsum board in scheduled areas in accordance with levels defined in ASTM C 840

and as scheduled below.

1. Above Finished Ceilings Concealed From View: Level 1.
 2. Utility Areas and Areas Behind Cabinetry: Level 2.
 3. Walls to Receive Textured Wall Finish: Level 3.
- C. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
1. Feather coats of joint compound so that camber is maximum 1/32 inch.
 2. Taping, filling, and sanding is not required at surfaces behind adhesive applied ceramic tile and fixed cabinetry.

3.07 TEXTURE FINISH

- A. Apply finish texture coating by means of spraying apparatus in accordance with manufacturer's instructions.
- B. Texture Required: Provide as follows:
1. Walls: Match approved sample.

3.08 TOLERANCES

- A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

END OF SECTION

SECTION 09800

SPECIAL COATINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Field applied high performance coatings. All surfaces of equipment, piping, supports interior and exterior surfaces shall be coated, unless specifically stated otherwise.
- B. See Drawings.

1.02 REFERENCES

- A. NSF International (NSF):
 - 1. 61 - Drinking Water System Components - Health Effects.
- B. American National Standards Institute (ANSI):
 - 1. A159.1 - Surface Preparation Specifications.
- C. American Society for Testing and Materials (ASTM):
 - 1. D 16 - Terminology Relating for Paint, Related Coatings, Materials, and Applications.
 - 2. D 4417, Standard Test Methods for Field Measurement of Surface Profile of Blast Cleaned Steel.
 - 3. E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- D. American Water Works Association (AWWA):
 - 1. D102 - Coating Steel Water-Storage Tanks
- E. The Society for Protective Coatings (SSPC):
 - 1. SP 1 - Solvent Cleaning.
 - 2. SP 2 - Hand Tool Cleaning.
 - 3. SP 3 - Power Tool Cleaning.
 - 4. SP 6 - Commercial Blast Cleaning.
 - 5. SP 10 - Near White Metal Blast Cleaning.
 - 6. SP 11 - Power Tool Cleaning to Bare Metal.
 - 7. Steel Structures Painting Manual, Volumes 1 and 2.
 - 8. VIS 1 - Guide and Reference Photographs for Steel Surfaces Prepared by Dry Abrasive Blast Cleaning.
 - 9. VIS 3 - Guide and Reference Photographs for Steel Surfaces Prepared by Hand and Power Tool Cleaning.
 - 10. PA1 - Shop, Field, and Maintenance Painting of Steel, latest revision.

11. PA2 Level 3- Procedure for Determining Conformance to Dry Coating Thickness Requirements.
 12. PA10-Guide to Safety and Health Requirements.
 13. Guide 6-Guide for Containing Surface Preparation Debris Generated During Paint Removal Operations.
 14. Guide 12-Guide for Illumination of Industrial Painting Projects.
- F. National Association of Corrosion Engineers (NACE International)
1. SP0188-Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
 2. Publication 6D-173-A Manual for Painter Safety.

1.03 DEFINITIONS

- A. Submerged Metal: Steel or iron surfaces below tops of channel or structure walls which will contain water even when above expected water level.
- B. Dry Film Thickness (DFT): Thickness of fully cured coating, measured in mils (1/1000 inch).
- C. Volatile Organic Compound (VOC): Content of air polluting hydrocarbons in uncured coating products measured in units of grams per liter or pounds per gallon.
- D. Rust Spot: Rusted surface with area smaller than 0.05 SQ.FT.
- E. Installer or Applicator: Installer or applicator is the person actually installing or applying the product in the field at the Project site. Installer or applicator are synonymous. Installer or Applicator may be the CONTRACTOR.
- F. Inaccessible Areas: Areas of the finished structure that, by virtue of the configuration of the completed structure, cannot be accessed to perform surface preparation or coating application (with or without the use of scaffolding, rigging, or staging). Inaccessible areas include such areas as the contact surfaces of roof plate lap joints, underside of roof plates where they cross supporting members, top surface of rafters directly supporting roof plates, contact surfaces of bolted connections, underside of column base plates, contact surfaces of mating parts not intended to be removed or disassembled during routine operation or maintenance of the tank, and underside of the tank bottom for ground-supported flat-bottom tanks.
- G. Holiday: A void, crack, thin spot, foreign inclusion, or contamination in the coating film that significantly lowers the dielectric strength of the coating. May also be identified as a pinhole.
- H. The term “coating” and “lining” as used herein are considered interchangeable and mean coating systems materials, including any applicable resinous primers and finish coats that function to provide protection of steel substrates.

- I. Touch-Up Coating: The application of a coating on areas of coated surfaces to repair marks, scratches, and areas where the coating has deteriorated to restore the coating film to an unbroken condition.
- J. Shop Coat: One or more coats applied in a shop or plant prior to shipment to the site, where the field or finishing coat is applied.
- K. Wet Film Thickness (WFT): Thickness of wet coating measured in mils.

1.04 PERFORMANCE REQUIREMENTS

- A. Coating materials for metal surfaces shall be especially adapted for use in potable water purposes.
- B. Coating materials that come into contact with potable water shall be certified to NSF Standard 61.

1.05 SUBMITTALS

- A. Product Data: Submit in accordance with Section 01340. Include description of physical properties of coatings including solids content and ingredient analysis, VOC content, temperature resistance, typical exposures and limitations, and manufacturer's standard color chips.
- B. Certificates: Submit in accordance with requirements for Product Data.
- C. Manufacturer's Instructions: Submit in accordance with requirements for Product Data. Include:
 - 1. Special requirements for transportation and storage.
 - 2. Mixing instructions.
 - 3. Shelf life.
 - 4. Pot life of material.
 - 5. Precautions for applications free of defects.
 - 6. Surface preparation.
 - 7. Method of application.
 - 8. Recommended number of coats.
 - 9. Recommended thickness of each coat.
 - 10. Recommended total thickness.
 - 11. Drying time of each coat, including prime coat.
 - 12. Required prime coat.
 - 13. Compatible and non-compatible prime coats.
 - 14. Recommended thinners, when recommended.
 - 15. Limits of ambient conditions during and after application.
 - 16. Time allowed between coats.
 - 17. Required protection from sun, wind, and other conditions.
 - 18. Touch-up requirements and limitations.
 - 19. Material Safety Data Sheet.

D. Certification: Certify that applicable pigments meet the specifications.

1.06 QUALITY ASSURANCE

A. Qualifications of CONTRACTOR and Applicator:

1. All work of this Contract shall be done in a workmanlike manner, by skilled personnel experienced in the particular type of work being performed. The coating shall be performed in a manner satisfactory to the ENGINEER and using approved methods, acceptable tools, and practices.
2. CONTRACTOR is completely responsible to insure that applicator personnel are completely trained and experienced in the proper use of all specified/submitted coating and lining materials, surface preparation and application equipment being used for the project.

B. Regulatory Requirements: Comply with requirements regarding the following:

1. Volatile organic compound limitations.
2. Coatings containing lead compounds.
3. NSF certification of coatings for use in potable water supply systems.
4. Abrasives and abrasive blast cleaning techniques, and disposal.

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

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

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

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

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

H. Pre-Application Meetings:

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

I. Coating Application Log:

1. Coating Application Log shall be maintained on a daily basis for all areas where the Work is being performed. The Paint Application Log shall be turned over to the

ENGINEER by 9:00 a.m. on the day following the day that the work was performed. The log shall include the following:

- a. Date.
- b. Time.
- c. Weather condition (at work location).
- d. Air temperature (at work location).
- e. Surface temperature (at work location).
- f. Dew point (at work location).
- g. Humidity (at work location).
- h. Wind direction, wind speed, and surface temperature a minimum of three (3) times per day for each day the CONTRACTOR is on site completing the work. The CONTRACTOR shall also record the interior metal surface temperatures on sides of tanks that are shaded and not shaded from the sun.
- i. Material temperature Before (Separately) and Mixed (Combined).
- j. Location/area square footage of area coated.
- k. Description of work performed.
- l. Materials used, colors and batch numbers, quantity of materials used (not including waste).
- m. Application/surface preparation equipment and personnel.
- n. WFT/surface profile measurements.
- o. Comments, quality control procedures.
- p. Signature/title.

1.07 PROJECT CONDITIONS

- A. Proceed with surface preparation and coating application only when air and surface temperatures are above the manufacturers' recommended minimum surface temperature and below 100 degrees Fahrenheit, and surface temperature is at least 5 degrees above dew point air temperature reading. Coating shall not be applied to dusty, wet, or damp surfaces, and shall not be applied in rain, snow, fog, or mist, or when relative humidity exceeds 85 percent. No coating shall be applied when it is expected that the relative humidity will exceed 85 percent or when the air temperature will drop below 40 degrees Fahrenheit within 8 hours after the application of the coating. If working conditions are questionable, the ENGINEER shall make the decision, and the CONTRACTOR shall accept ENGINEER'S interpretation as final and binding.
- B. Provide adequate continuous ventilation and sufficient heating facilities to maintain minimum 45 degrees Fahrenheit for 48 hours before, during, and 72 hours after application of finishes.
- C. Provide fans, heating devices, dehumidification, or other means recommended by coating manufacturer to prevent formation of condensate or dew on surface or substrate, intermediate coats, and within curing time following application of last coat.
- D. No surface preparation or coating application work shall be done under unfavorable weather conditions, unless the work is adequately protected, and then only with the specific approval of the ENGINEER and inspection.

- E. Before coating is started in any area, all surfaces to be coated and floors shall be cleaned of all dust using commercial vacuum-cleaning equipment equipped with high-efficiency particulate air filters (HEPA filters) and dust containment systems. Just blowing down surface is not acceptable.
- F. Apply coatings to dust free surfaces. To test surfaces, apply strip of clear adhesive tape provided in OTB-SCATT test kit to surface and rub onto surface with finger or supplied roller. When removed, compare the tape to the supplied OTB-SCATT SC PERCENTAGES chart. Visual observations (without magnification) should show a rating of SC-1(1%) or less, i.e., little or no dust, blast abrasive, or other contaminant. Attach tape test strip to the middle rating sheet. Reject contaminated surfaces, clean by vacuum cleaning, and retest. Randomly test surfaces at rate of 8 tests for the first 1000 square feet. Afterwards conduct one test for each additional 1000 square feet. Provide two additional tests for each failed test or questionable test. Submit test tapes results with Daily Inspection Reports. OTB-SCATT can be obtained at OTB Technologies Inc. 5401 E. Becklane Scottsdale, AZ 85254 or www.OTBTECH.NET, or approved equal.
- G. Provide lighting for all work areas as prescribed in SSPC Guide 12.

1.08 MAINTENANCE

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

1.09 PRODUCTS DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products in accordance with Sections 01651 and 01661.
- B. Remove unspecified and unapproved paints from Project site immediately.
- C. Deliver containers with labels identifying the manufacturer's name, brand name, product type, batch number, date of manufacturer, expiration date or shelf life, color, mixing and reducing instructions, and batch identification number/code.
- D. Store coatings in well-ventilated facility that provides protection from the sun weather, and fire hazards. Maintain ambient storage temperature between 45 and 90 degrees Fahrenheit, unless otherwise recommended by the manufacturer.
- E. Take precautions to prevent fire and spontaneous combustion.

1.10 PROTECTION

- A. During application of exterior coating of booster pump, the CONTRACTOR shall take any and all necessary precautions to avoid coating fallout on and the consequent damage to any

works, improvements, or properties either of the OWNER or of other parties, wherever located. The CONTRACTOR shall be responsible for all damage resulting from the coating.

- B. Furnish sufficient drop cloths, shields, and protective equipment to prevent spray or droppings from fouling surfaces not being painted and in particular, surfaces within storage and preparation area.
- C. Place cotton waste, cloths and material which may constitute fire hazard in closed metal containers and remove daily from site.
- D. Remove electrical plates, surface hardware, fittings, and fastenings, prior to coating operations. Carefully store, clean, and replace on completion of coating in each area. Do not use solvent or degreasers to clean hardware that may remove permanent lacquer finish.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. General:
 - 1. P = prime coat. I = intermediate coat. F = finish coat. Finish color to be selected by OWNER.
 - 2. All coatings and products for each coating system shall be the product of a single coating manufacturer.
 - 3. All materials brought to the jobsite shall be subject to inspection by ENGINEER.
 - 4. Only full kits of approved coating shall be mixed. No partial kits will be saved or mixed at a later time.
 - 5. All coating materials used must not contain more than 3.5 LBS/GAL VOC as applied (in a thinned state).
 - 6. Coating thicknesses specified are minimum dry mil thicknesses.
- B. Acceptable Manufacturers
 - 1. Following are acceptable coating manufacturers:
 - a. AkzoNobel International Protective (Devco) Coatings.
 - b. Tnemec Coatings
 - c. Carboline
 - d. Or Approved Equal
- C. Coating Systems:
 - 1. System No. 1: Two coat Polyamide Epoxy and Acrylic Aliphatic Polyurethane coating system: For ferrous metals and metals exterior surface coating (except galvanized steel and pre-primed steel). Items include but are not limited to hypopneumatic tank exterior surface, both water storage tanks' exterior roof surfaces including handrails, roof hatches, roof vents, exterior surfaces of all exposed steel and ductile iron piping, equipment and pipe supports.
 - a. Surface Preparation: Per Section 3.01.E.
 - b. Following are acceptable coating systems:

Devoe Epoxy/Urethane System

P1 = Bar-Rust 235 (Gray), 1 coat, 4-6 mils DFT.

I = Bar-Rust 235 (Off White), 1 coat, 4-6 mils DFT.

F1E = Devthane 378H (color choice by OWNER), 1 coat, 3-4 mils DFT.

Tnemec Epoxy/Urethane System

P1 = Series 66 (Gray), 1 coat, 4-6 mils DFT.

I = Series 66 (White), 1 coat, 4-6 mils DFT.

F1E = Series 1075U (color choice by OWNER) 1 coat, 3-4 mils DFT.

Carboline Epoxy/Urethane System

P1 = Carboguard 60 (Gray), 1 coat, 4-6 mils DFT.

I = Carboguard 60 (White), 1 coat, 4-6 mils DFT.

F1E = Carbothane 134 HB (color choice by OWNER) 1 coat, 3-4 mils DFT.

c. For all new piping and appurtenances, prime coat shall be shop applied and finish coat shall be field applied.

2. System No. 2 – 100% Solids Polyurethane (EPA/NSF) Coating System: Items included but are not limited to hydropneumatic tank interior surface, tank floor, and interior shell surfaces of both water storage tanks including columns, ladders, shell manways, and other interior appurtenances.

a. Surface Preparation: Per Section 3.01.G.

b. Coating system shall be NSF approved.

c. Following are acceptable coating systems:

Polibrid Polyurethane (Devoe) System

F1E = Polibrid 705 (Buff), 1 coat, 30-40 mils DFT, 100% Solids, Zero VOC.

Carboline Polyurethane Hybrid

F1 = Reactamine 760, 1 Coat, 30-40 mils DFT, 100% Solids, Zero VOC

Sherwin Williams Polyurethane

F1 = Poly-Cote, 115 Series, 1 Coat, 30-40 mils DFT, 100% Solids, Zero VOC

3. System No. 3: Epoxy-Polyurethane: For overcoating, both water storage tanks' exterior surface. Items include but are not limited to entire existing exterior tank surface, exterior ladders and shell manways/hatches, rust spots, conduits, and piping.

a. Surface Preparation: Per Section 3.01.F.

b. Following are acceptable coating systems:

Carboline

Spot Prime = Carbomastic 615, 1 coat, 2-4 mils DFT. (for rust spots only)

F1E = Carbothane 133HB (color choice by OWNER), 1 coat, 3- 4 mils DFT.

Devoe

Spot Prime = Bar-Rust 233H, 1 coat, 2-4 mils DFT. (for rust spots only)

F1E = Devthane 378H (color choice by OWNER), 1 coat, 3- 4 mils DFT.

Tnemec

Spot Prime = Series 135 Chembuild, 1 coat, 2-4 mils DFT. (for rust spots only)

F1E = Series 1075U (color choice by OWNER), 1 coat, 3- 4 mils DFT.

4. System No. 4: Polyamide Epoxy-Polyurethane: For exposed PVC and CPVC piping.

a. Following are acceptable coating systems:

Carboline

P1 = Carboguard 893 SG Epoxy, 1 coat, 4-6 mils DFT.

F1E = Carbothane 133HB (color choice by OWNER), 1 coat, 3- 4 mils DFT.

Devoe

P1 = Bar-Rust 233H, 1 coat, 4-6 mils DFT.

F1E = Devthane 378H (color choice by OWNER), 1 coat, 3- 4 mils DFT.

Tnemec

P1 = Series N69 Hi-Build Epoxoline II, 1 coat, 3-4 mils DFT.

F1E = Series 1075 Endura-Shield II (color choice by OWNER), 1 coat, 3-4 mils DFT.

5. System No. 5 - Two Coat Epoxy (EPA/NSF) - For both water storage tanks' interior roof surface and center column top plates. Items also include but are not limited to rafters, roof vents, and roof hatches.

a. Surface Preparation: Per Section 3.01.G.

b. Following are acceptable coating systems:

Carboline

P1 = Carboguard 61 (Gray), 1 coat, 6-8 mils DFT.

F1 = Carboguard 61 (White), 1 coat, 6-8 mils DFT.

Devoe

P1 = Bar-Rust 233H (Gray), 1 coat, 6-8 mils DFT.

F1 = Bar-Rust 233H (White), 1 coat, 6-8 mils DFT.

Tnemec

P1 = Series N140 (Gray), 1 coat, 6-8 mils DFT.

F1 = Series N140 (White) 1 coat, 6-8 mils DFT.

D. Blast Abrasive:

1. Use proper equipment and abrasives when blast cleaning to produce the mil profile as recommended by the coating manufacturer. Do not reuse abrasives.
2. CONTRACTOR shall use only garnet for blasting purposes. The garnet abrasive used shall be of the type that is graded as to proper size, shape, and hardness. It shall be free of contaminants and shall not embed itself in the blasted surface. Garnet type abrasives shall be chemically washed, dried, dust, dirt, and fines free, resistant to fracture (shattering), and contain no leachable contaminants. The use of reduced or dust free abrasive blasting is required. Prior to mobilization to the field, samples of the CONTRACTOR's selected abrasive and/or abrasive/admixture shall be submitted to the ENGINEER for testing and review. Random field testing of the

abrasive shall be done by the CONTRACTOR, as directed by the ENGINEER to ensure the abrasive used complies with these requirements.

3. Acceptable abrasives:
 - a. Garnet.
 - b. Green Diamond.
 - c. Pre-approved equal.

PART 3 - EXECUTION

3.01 GENERAL PREPARATION

- A. Prepare surfaces in accordance with coating manufacturer's instructions unless more stringent requirements follow.
- B. Protect following surfaces from abrasive blasting in accordance with Paragraph 1.10, by masking, or other means:
 1. Surfaces to be assembled against gaskets.
 2. Field instruments like pressure gauges, pressure sensors, flow meters, or electrical panels.
- C. Protect installed equipment, and adjacent coated equipment from abrasive blasting to prevent damage caused by entering sand or dust.
- D. For both water storage tanks, the existing interior and exterior coatings shall be handled as hazardous waste. During surface preparation of both interior and exterior surfaces that require removal of the existing coatings to the bare metal, the CONTRACTOR shall take necessary measures for safely removing, collecting, and disposing of the coating debris as a hazardous waste. The coating debris shall be handled, stored, transported, and disposed as a hazardous waste. The CONTRACTOR shall be responsible for any third party claims involved in removing the hazardous coating. In performing this Work CONTRACTOR shall comply with the following provisions:
 1. CONTRACTOR shall utilize services of a properly licensed hazardous waste handling and disposal vendor in performing this work.
 2. CONTRACTOR shall submit the coatings removal and disposal plan prior to performing the Work, for ENGINEER's review and approval. This shall detail the approach used and the method for handling and disposal and the parties involved.
 3. CONTRACTOR shall take care to ensure that all coating waste that is removed is contained using a proven approach that contains waste particles properly prior to disposal.
 4. CONTRACTOR shall comply with all State and Federal Resource Recovery and Recovery Act and Air Quality (ADEQ) regulations applicable to this work. All manifests shall be submitted to OWNER for necessary signatures and proper filing when work is completed.

- E. Surface Preparation for Exterior Surface New Coating:
 - 1. The exterior surface shall be abrasive blasted in accordance with SSPC SP-6 or better to remove rust, scale, and welding slag and spatter, and to provide roughened angular surface profile as recommended by the coating manufacturer.

- F. Surface Preparation for Exterior Surface Overcoating:
 - 1. Unless specified otherwise, the water storage tanks' exterior shell surface shall be pressure washed (minimum 3,500psi with rotating tip) to remove all chalk, dirt, debris, and contaminants followed by SSPC SP-3 Power Tool Cleaning on any areas where there is visible rust, bare metal, or loose coating. CONTRACTOR shall coordinate with ENGINEER to determine the areas that require power tool cleaning.
 - 2. For bidding purposes, CONTRACTOR shall include 100 rust spots for each existing water storage tanks.
 - 3. CONTRACTOR shall be responsible for all third party claims for over spray.

- G. Surface Preparation for Interior Surface Coating:
 - 1. Remove grease and oil in accordance with SSPC SP-1.
 - 2. Unless specified otherwise, abrasive blast in accordance with SSPC SP-10 or better to remove rust, scale, and welding slag and spatter, and to provide roughened angular surface profile as recommended by the coating manufacturer. Where not possible to abrasive blast, power tool clean surfaces again to remove rust and discoloration.
 - 3. Do not coat surfaces before abrasive blasting.
 - 4. When metal surfaces are exposed because of coating damage, abrasive blast surfaces before touching-up.
 - 5. Include containment sheets over the tank openings to prevent airborne spreading of the blast material.

3.02 GENERAL PROTECTION

- A. Protect adjacent surfaces not to be coated from weld spatter and droppings with drop cloths and other coverings.
- B. Mask off surfaces of items not to be coated or remove items from area.

3.03 GENERAL APPLICATION REQUIREMENTS

- A. Apply coatings in accordance with manufacturer's most current written instructions.
- B. Verify metal surface preparation immediately before applying coating in accordance with the specified cleanliness standard for that area.
- C. Allow surfaces to dry, except where coating manufacturer requires surface wetting before coating.
- D. Spot prime exposed metal of shop primed surfaces before applying intermediate or finish coating over entire surface.

- E. Apply minimum number of specified coats.
- F. Apply coats to thicknesses specified.
- G. Apply additional coats when necessary to achieve specified thicknesses, especially at edges and corners.
- H. Coat surfaces without runs, drops, ridges, waves, holiday, laps, or brush marks.
- I. Remove spatter and droppings after completion of coating.
- J. When multiple coats of same material are specified, tint prime coat and intermediate coats with suitable pigment to distinguish each coat.
- K. Dust coatings between coats: Lightly sand and dust surfaces to receive high gloss finishes, unless instructed otherwise by coating manufacturer.
- L. Spray Application:
 - 1. When using spray application, apply coating to thickness not greater than that suggested in coating manufacturer's instructions.
 - 2. Use airless spray method unless air spray method is required by coating manufacturer's instruction or these Specifications.
 - 3. Conduct spray coating under controlled conditions. Protect adjacent construction and property from coating mist or spray.
- M. Drying and Recoating:
 - 1. Limit drying time to that required by coating manufacturer's instructions.
 - 2. Do not allow excessive drying time or exposure which may impair bond between coats.
 - 3. Recoat within time limits recommended by coating manufacturer.
 - 4. When time limits are exceeded, re-prepare surface according to the coating manufacturer's most current written recommendations before applying another coat.
 - 5. When limitations on time between abrasive blasting and coating cannot be met before attachment of components to surfaces which cannot be abrasive blasted, coat components before attachment.
 - 6. Ensure primer and intermediate coats of coating are unscarred and completely integral at time of application of each succeeding coat.
 - 7. Touch up suction spots between coats and apply additional coats where required to produce finished surface of solid, even color, free of defects.
 - 8. Check for discontinuities on steel immersion surfaces using holiday detector (NACE SP0-188). Any discontinuities located shall be corrected in according to with the coating manufacturer's most current written recommendations/guidelines. All corrected discontinuities shall be re-tested according to (NACE SP0-188) until compliant.
 - 9. Sand and recoat scratched, contaminated, or otherwise damaged coating surfaces so damages are invisible to naked eye.

- N. DFT readings shall be recorded in accordance with SSPC PA2- Level 3.
- O. No coating work shall be performed on weekends.

3.04 FIELD QUALITY CONTROL

- A. Inspection will be performed by the ENGINEER prior to and following the abrasive blasting and following each coat. Strip and remove defective coats, prepare surfaces, and recoat. Successive coats shall only be applied following approval of previous coat or surface preparation.
- B. Control and check dry film thicknesses and integrity of coatings.
- C. Measure dry film thickness with calibrated thickness gauge.
- D. Dry film thickness reading equipment to be used must be certified and still within certification during the inspection process.
 - 1. Ferrous and Non-Ferrous substrates - Type 1 or Type 2 dry film thickness gauges, manufactured by Elcometer, Delfelsko or equal.

3.05 SCHEDULE OF ITEMS NOT REQUIRING COATING

- A. Nameplates.
- B. Caution signs
- C. Serial number tags.
- D. Control panels and instruments.
- E. Hardware (galvanized or stainless steel)
- F. Shop painted items

3.06 CLEANING

- A. As work proceeds and upon completion, promptly remove coating where spilled, splashed, or spattered.
- B. During progress of work, keep premises free from unnecessary accumulation of tools, equipment, surplus materials, and debris.
- C. Upon completion of work leave premises neat and clean.
- D. Disinfection of systems as per specifications.

3.07 DISINFECTION

- A. CONTRACTOR shall be responsible for disinfection. Disinfection shall conform to all applicable requirements of AWWA C652, and as specified below.
- B. The OWNER shall take a bacteria test of the water after disinfecting. If the water is considered not safe after testing, additional disinfecting and testing shall be performed by the CONTRACTOR at his expense until the pipe is tested safe for use as part of a potable water supply system.
- C. The OWNER shall take a taste and odor test of the water after disinfecting to detect the presence of any volatile organic compounds (VOC's) imparted by the coating. If the water is not considered safe or acceptable after testing, further work shall be performed by the CONTRACTOR at his expense until the pipe is tested safe and acceptable for use as part of a potable water supply system.
- D. Water for initial disinfection and filling and for any additional disinfection during the initial disinfection procedure to obtain satisfactory bacteriological samples, will be furnished by the OWNER. CONTRACTOR shall be responsible for all disinfection chemical required.
- E. If the pipe must be emptied, re-sprayed, flushed and refilled to obtain satisfactory bacteriological samples, the OWNER will furnish additional water for the Work at the expense of CONTRACTOR. Additional disinfection chemical required costs shall belong to CONTRACTOR.
- F. Supply all necessary pumps, hoses, and other required equipment each time the pipe needs to be emptied.

END OF SECTION

SECTION 09900

PAINTING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Field applied paint and related materials for normal exposures.
- B. Related Sections:
 - 1. Section 09800 - Special Coatings

1.02 DEFINITIONS

- A. Paints: Manufacturer's best ready-mixed coatings, except when field catalyzed, with fully ground pigments having soft paste consistency and capable of being readily and uniformly dispersed to complete homogenous mixtures, having good flowing and brushing properties, and capable of drying or curing free of streaks or sags.
- B. Volatile Organic Compound (VOC): Content of air polluting hydrocarbons in uncured coating products measured in units of grams per liter or pounds per gallon.

1.03 SUBMITTALS

- A. Shop Drawings: Submit in accordance with Section 01340. Include schedule of where and for what use coating materials are proposed in accordance with requirements for Product Data.
- B. Product Data: Submit in accordance with Section 01340. Include description of physical properties of coatings including solids content and ingredient analysis, VOC content, temperature resistance, typical exposures and limitations, and manufacturer's standard color chips.
- C. Samples: Submit in accordance with Section 01340. Include 8 inch square draw-downs or brush-outs of topcoat finish when requested. Identify each sample as to finish, formula, color name and number and sheen name and gloss units.
- D. Manufacturer's Instructions: Submit in accordance with requirements for Product Data. Include:
 - 1. Special requirements for transportation and storage.
 - 2. Mixing instructions.
 - 3. Shelf life.
 - 4. Pot life of material.
 - 5. Precautions for applications free of defects.
 - 6. Surface preparation.
 - 7. Method of application.

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

1.04 QUALITY ASSURANCE

- A. Products: First line or best grade.
- B. Materials for Each Paint System: By single manufacturer.
- C. Applicator Qualifications: Applicator of products similar to specified products with minimum 3 years experience.
- D. Regulatory Requirements: Comply with by using paints that do not exceed governing agency's VOC limits or do not contain lead.
- E. Field Sample: Paint one complete surface of each color scheme to show colors, finish texture, materials, and workmanship. Obtain approval before painting other surfaces.

1.05 PRODUCTS DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle products in accordance with Section 01651.
- B. Remove unspecified and unapproved paints from Project site immediately.
- C. Deliver containers with labels identifying the manufacturer's name, brand name, product type, batch number, date of manufacturer, expiration date or shelf life, color, and mixing and reducing instructions.
- D. Store coatings in well ventilated facility that provides protection from the sun weather, and fire hazards. Maintain ambient storage temperature between 45 and 90 degrees Fahrenheit, unless otherwise recommended by the manufacturer.
- E. Take precautions to prevent fire and spontaneous combustion.

1.06 ENVIRONMENTAL CONDITIONS

- A. Do not paint or coat:
 1. Under dusty conditions.

2. When light on surfaces measures less than 15 foot-candles.
 3. When ambient or surface temperature is less than 45 degrees Fahrenheit.
 4. When relative humidity is higher than 85 percent.
 5. When surface temperature is less than 5 degrees Fahrenheit above dew point.
 6. When surface temperature exceeds the manufacturer's recommendation.
 7. When ambient temperature exceeds 90 degrees Fahrenheit unless manufacturer allows a higher temperature.
 8. Apply clear finishes at minimum 65 degrees Fahrenheit.
- B. Provide fans, heating devices, or other means recommended by coating manufacturer to prevent formation of condensate or dew on surface or substrate, coating between coats and within curing time following application of last coat.
- C. Provide adequate continuous ventilation and sufficient heating facilities to maintain minimum 45 degrees Fahrenheit for 24 hours before, during, and 48 hours after application of finishes.

1.07 PROTECTION

- A. Protect adjacent surfaces from paint and damage. Repair damage resulting from inadequate or unsuitable protection.
- B. Furnish sufficient drop cloths, shields, and protective equipment to prevent spray or droppings from fouling surfaces not being painted and in particular, surfaces within storage and preparation area.
- C. Place cotton waste, cloths and material which may constitute fire hazard in closed metal containers and remove daily from site.
- D. Remove electrical plates, surface hardware, fittings, and fastenings, prior to painting operations. Carefully store, clean, and replace on completion of painting in each area. Do not use solvent or degreasers to clean hardware that may remove permanent lacquer finish.

1.08 EXTRA MATERIALS

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

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

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

2.02 ARCHITECTURAL FINISHES

Exterior Materials	Primer or First Coat	Second Coat	Third Coat	Fourth Coat
Galv. Metal Alkyd Gloss	Galva-Etch GE-123	Versaprime 42-44	Syn-Lustro 10 Series	Syn-Lustro 10-Series
Ferrous Metal Alkyd Gloss	Corrobar 43-5	Syn-Lustro 10 Series	Syn-Lustro 10 Series	Syn-Lustro 10 Series
Masonry 100% Acrylic Flat	Concrete Block Filler W-315	Acri-Flat W704	Acri-Flat W704	If semi-gloss, use Permasheen W901 in lieu of W704
	Level 2 - Backroll blockfiller. Fill all voids. Notify A/E to inspect block filling before proceeding with finish coats.			
Stucco 100% and Gypsum Board and Wood Acrylic Flat	Acrylic Stucco Primer/Sealer W-6232	Acri-Flat W704	Acri-Flat W704	If semi-gloss, use Permasheen W901 in lieu of W704

2.03 ANTI-GRAFFITI COATING

- A. Existing integrally colored concrete masonry unit site walls and new integrally colored concrete masonry unit site walls shall receive two flood coats of Tnemec Dur A Pell GS Series V626 or pre-approved or equal, silicone rubber water repellent and graffiti protectant.

PART 3 - EXECUTION

3.01 INSPECTION

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

- B. Start painting when unsatisfactory conditions have been corrected.

3.02 PREPARATION OF SURFACES

- A. Prepare surfaces in accordance with paint manufacturer's instructions or when none, the following.
- B. Canvas and Cotton Insulation Coverings: Remove dirt, grease, and oil.
- C. Concrete: Remove dirt, loose mortar, scale, powder, and other foreign matter. Remove oil and grease with solution of tri-sodium phosphate. Remove stains caused by weathering of corroding metals with solution of sodium metasilicate. Rinse well and allow to thoroughly dry. Spot prime exposed metal with alkyd primer.
- D. Integrally colored concrete masonry unit site walls:
 - 1. For existing walls: power wash with water at minimum 4,000 psi. The OWNER has prepared an approximate 5 foot wide test strip of masonry wall with a water power wash at 4,000 psi on the east wall of the site; aesthetic appearance of cleaned wall shall at minimum match the OWNER's test strip.
 - 2. For new walls: remove oil, grease, dirt, efflorescence, mortar, and all coatings.

3.03 APPLICATIONS

- A. Apply each coat at proper consistency.
- B. Tint each coat of paint slightly darker than preceding coat.
- C. Sand lightly between coats to achieve required finish.
- D. Do not apply finishes on surfaces that are not sufficiently dry.
- E. Allow each coat of finish to dry before following coat is applied, unless directed otherwise by manufacturer.
- F. Application of silicone rubber repellent and graffiti protectant.
 - 1. Surfaces must be clean and dry. For surfaces that have been power washed, allow minimum of 72 hours drying time. After rain, allow 48 hours drying time.
 - 2. Newly constructed surfaces shall cure for 28 days before application begins.
 - 3. Caulking should be completed and cured prior to application.
 - 4. All repointing and repairs shall be completed prior to beginning application.
 - 5. To test for aesthetics of anti-graffiti coatings on site walls, apply to a small area of existing south site wall prior to beginning application to entire site wall.

3.04 CLEANING

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

- B. During progress of work keep premises free from unnecessary accumulation of tools, equipment, surplus materials, and debris.
- C. Upon completion of work leave premises neat and clean.

END OF SECTION

DIVISION 11
EQUIPMENT

SECTION 11005

EQUIPMENT: GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes
 - 1. Requirement of this Section apply to all equipment provided on the Project, including that found in Divisions 11, 13, 15 and 16, even if not specifically referenced as a related section in those Specifications.
 - 2. Premium efficiency motors shall be supplied.
- B. Related sections include, but are not necessarily limited to:
 - 1. Division 1 - General Requirements.
 - 2. Section 09800 - Special Coatings.
 - 3. Individual equipment specifications in Divisions 11 through 15.
- C. American Iron and Steel Act Requirements – comply with requirements of American Iron and Steel Act per Supplementary Conditions (C-800).

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 01340 - 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, range-ability, 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 01340.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. Motors:
 - a. US Motors
 - b. GE
 - c. Emerson
 - d. Baldor
 - e. 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 Deg C ambient. Design in accordance with NEMA standards for Class F insulation with Class B temperature rise above 50 Deg C ambient on continuous operation or intermittent duty at nameplate horsepower.
 - 5. Design for full or reduced voltage starting, as appropriate.
 - 6. Design bearing life based upon actual operating load conditions imposed by driven equivalent.
 - 7. Size for altitude of Project.
 - 8. Size so that, under maximum continuous load imposed by driven equipment, motor nameplate horsepower for continuous operation is minimum of 15 percent more than driven load.
 - 9. Provide encapsulated windings in wet/corrosive and for outdoor applications.
 - a. Provide encapsulation using a silicone or epoxy seal after the windings have been dried to less than 1 percent moisture.
 - 10. Furnish with clamp-type grounding terminals inside motor conduit box.
 - 11. Furnish with oversized external conduit boxes.
 - 12. Furnish with stainless steel nameplates with information to include all data as required by paragraph 430-7 of the National Electric Code, NFPA 70.
 - 13. 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 09800.

PART 3 - EXECUTION

3.01 ERECTION/INSTALLATION/APPLICATION

- A. Install equipment as shown on Drawings and in accordance with manufacturer's directions.
- B. Utilize templates for anchorage placement for slab mounted equipment.
- C. For equipment having drainage requirements such as seal water, provide 3/4-inch PVC or clear plastic tubing from equipment base to nearest floor or equipment drain. Route clear of major traffic areas and as approved by OWNER.
- D. Extend all non-accessible grease fittings using stainless steel tubing to a location which allows easy access of fittings.
- E. Construct subbases, either concrete, steel or cast iron, level in both directions. Particular care shall be taken at hold-down bolt locations, so these areas are flat and level.
- F. Machine Base:
 - 1. Mount machine bases of rotating equipment on subbases in manner that they are level in both directions according to machined surfaces on base. Use machinist level for this procedure.
 - 2. Level machine bases on subbases and align couplings between driver and driven unit using steel blocks and shims.
 - a. Size blocks and shims to provide solid support at each anchor bolt location. Area size of blocks and shims shall be approximately 1-1/2 times area support surface at each anchor bolt point.
 - b. Provide blocks and shims at each anchor bolt. Blocks and shims shall be square shape with "U" cut out to allow blocks and shims to be centered on anchor bolts.
 - c. After all leveling and alignment has been completed and before grouting, tighten anchor bolts to proper torque value.
 - d. Do not use nuts below the machine base on anchor bolts for base leveling.
- G. Grouting:
 - 1. After machine base has been shimmed, leveled, couplings aligned and anchor bolts tightened to correct torque value, a dam or formwork shall be placed around base to contain grouting. Dam or formwork shall extend at least 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. Field coat in accordance with Section 09800.

3.02 WIRING CONNECTIONS AND TERMINATION

- A. Clean wires before installing lugs and connectors.
- B. Coat connection with oxidation eliminating compound for aluminum wire.
- C. Terminate motor circuit conductors with copper lugs bolted to motor leads.
- D. Tape uninsulated conductors and connectors with electrical tape, 150 percent of insulation value of conductor.
- E. Connections to carry full ampacity of conductors without temperature rise.
- F. Terminate spare conductors with electrical tape.

3.03 FIELD QUALITY CONTROL

- A. Furnish equipment manufacturer services as specified in the individual equipment specifications.
- B. Inspect wire and connections for physical damage and proper connection.
- C. Check rotation of motor before connection to driven equipment before couplings are bolted or belts installed. Before motor is started to check rotation, determine that motor is lubricated.

END OF SECTION

SECTION 11201

STOP GATES

PART 1 – GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Related Sections:
 - 2. Section 01340: Technical Submittals
 - 3. Section 11005: Equipment: General Requirements
 - 4. Section 15050: Basic Process Piping Materials and Methods
 - 5. Division 5: Metals
 - 6. Division 16: Electrical
 - 7. Section 02200: Earthwork
 - 8. Section 02100: Site Preparation

1.02 SECTION INCLUDES

- A. Furnish and install complete, tested and operating, the equipment as shown on the Drawings and as specified herein.
- B. Work Included in This Section:
 - 1. Stop Gates with operators.

1.03 SUBMITTALS

- A. Shop Drawings: Submit shop drawings in the Product Review category for the stop gates and associated operators. Submit construction details, dimensions, and construction materials. Include sufficient data to show that equipment conforms to Specification requirements. Submit shop drawings as a complete initial package.
- B. Manuals: Furnish manufacturer's installation, lubrication, and maintenance manuals, bulletins, and spare parts lists.
- C. Affidavits: Furnish affidavits from the manufacturer stating that the gates and operators have been properly installed and tested and are ready for full time operation.

1.04 QUALITY ASSURANCE

- A. All equipment furnished under this Section shall be of a manufacturer who has been regularly engaged in the design and manufacture of the equipment for at least 5 years. Demonstrate to the satisfaction of the Engineer that the quality is equal to equipment made by those manufacturers specifically named herein.

1.05 SEISMIC CERTIFICATION

- A. Seismic anchorage certifications and descriptions are required.

PART 2 – PRODUCTS

2.01 STOP GATES

- A. General: Provide aluminum stop gates complete with slide guides, seals, and all appurtenances to provide complete operational stop gate as shown in the Stop Gate Schedule and as specified herein.
 - 1. The complete system comprising the gate, slide, guides, and appurtenances shall be furnished by the gate manufacturer, who shall be responsible for the compatibility of components and functional integrity. The size of each stop gate shall be suitable for the clear opening shown on the Drawings.
 - 2. The stop gates as a whole and all their components shall be suitable for service in raw sewage. The gates shall be designed for manual operation with heads as shown in the Stop Gate Schedule.
 - 3. Stop gates shall conform to AWWA C561 except as modified herein.
- B. Stop Gate Type: The stop gate shall be of the manually operated, surface mounted, self-contained type. The gate shall be by Halliday, Series N1C, Rodney Hunt; Waterman; or equal.
- C. Stop Gate Construction:
 - 1. Frame and guides: The gate frame shall be a Halliday, type 203, or equal. The frame shall be a rigid unit made of plates and structural shapes. The frame shall be a one-piece 1/4" 6061-T6 aluminum extrusion, with a continuous mounting flange for in-channel mounting as required. The extruded aluminum frame shall be mitered and welded continuously and shall incorporate a one-piece extruded polymer channel liner.
 - 2. Gate: The gate shall be 1/4" thick 6061-T6 aluminum, reinforced to deflect no more than 1/360th of the span. The bottom edge of the gate shall be beveled for positive seating. Unit shall be guaranteed against defects in material and/or workmanship for a period of 3 years.
 - 3. Fasteners and anchor bolts: ASTM F593/594, Type 316 CW stainless steel.
 - 4. Stop gates shall be unpainted.
- D. Isolation Coatings
 - 1. All aluminum components in direct contact with concrete shall be coated with bituminous mastic per Specification Section 05500 Metal Fabrications.

2.02 MANUAL OPERATORS

- A. Manually operated gates shall have a standard “R” handle as shown in the Stop Gate Schedule.

PART 3 – EXECUTION

3.01 INSTALLATION

- A. Equipment shall be installed in strict conformance with the manufacturer's installation instructions. Installation of stop gates shall be in accordance with the requirements of AWWA C560 and C561 and as amended herein. The manufacturer of the stop gates shall furnish all gates, suitably designed, so that anchorage to the headworks channel can be performed at the designed locations.

3.02 FIELD SERVICE

- A. The manufacturer of the gates shall supply a competent field service engineer to thoroughly check and inspect the stop gates after installation, place the gates in operation, and make necessary adjustments, and instruct plant personnel in proper operating and maintenance procedures.

3.03 FIELD PAINTING

- A. Painting shall be done in accordance with Section 09900. Submerged surfaces need not be field painted but shall be touched up if required.

3.04 FIELD LEAKAGE TESTS

- A. All stop gates shall be given a field leakage test under the head conditions listed in the gate schedules on the Drawings or in these specifications. A qualified representative of the manufacturer shall be present to direct any adjustments required to reduce leakage to the specified amounts.
- B. Allowable Leakage:
 - 1. The permitted leakage for stop gates shall not exceed allowable leakage per AWWA 501-C standards.
- C. For individual gates, the absence of a leakage test requirement for either seating or unseating head in the Schedule or the fact that the test heads are lower than the expected operating heads shall not relieve the requirement for satisfactory functioning at operating conditions. The tests and test levels are limited by expected limitations on water levels that will be available at the time the tests must be performed.

D. Gate Schedule

STOP GATE SCHEDULE

Gate Designation	Location	Dia (inches)	Height (inches)	Operator		Head	
				Type	Mounting	Seating (feet)	Unseating (feet)
SG-1	Splitter Box	1	48	H	SC	N/A	N/A
SG-2	Splitter Box	1	48	H	SC	N/A	N/A

1. The dimensions of stop gate are based on the dimension provided by the vendor supplied drawings of the splitter box.

Legend:

Type of operator: H - Handle
 HC - Hand crank
 HW - Handwheel
 Type of operator mounting: S - Slab or Deck
 WB - Wall Bracket
 SC - Self Contained

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. Division 13 - Special Constructions.
 - 3. Section 01340 - Technical Submittals.
 - 4. Section 01650 - Demonstration of Systems/Commissioning.
 - 5. Section 01715 - Equipment Operation and Maintenance Instructions.
 - 6. Section 09800 - Special Coatings.
 - 7. Section 11005 - Equipment: General Requirements.
 - 8. Section 11218 - End of Suction Centrifugal Pumps.
- 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.

1.03 DEFINITIONS

- A. NPSHR - Net Positive Suction Head Required.
- B. NPSHA - Net Positive Suction Head Available.
- C. VFD - Variable Frequency Drive.
- D. Pump Service Category - Pump or pumps having identical names (not tag numbers) used for specific pumping service.

1.04 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 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

6. Ratio of rotative speed to critical speed of a unit or components thereof less than 0.8 or more than 1.3.
7. 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 approved by the NEC code.

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 09800.
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 11218

END SUCTION CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.01 SUMMARY

- A. General work included in this Section:
 - 1. Horizontal close coupled end suction centrifugal pumps.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 1.
 - 2. Section 09800 - Special Coatings.
 - 3. Section 11005 - Equipment General Requirements.
 - 4. Section 11210 - Pumping Equipment: General Statement.
 - 5. Division 16 - Electrical.
- C. American Iron and Steel Act Requirements – comply with requirements of American Iron and Steel Act per Supplementary Conditions (C-800).

1.02 QUALITY ASSURANCE

- A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
 - 1. Standards of the Hydraulic Institute.
 - 2. National Electric Code.
 - 3. Standards of National Electrical Manufacturers Association.
 - 4. Institute of Electrical and Electronic Engineers.
 - 5. American National Standards Institute.
 - 6. Standards of American Water Works Association.
 - 7. Anti-Friction Bearing Manufacturer's Association (AFBMA).
 - 8. American Iron and Steel Institute (AISI):
 - 9. Steel Products Manual.
 - 10. American Society for Testing and Materials (ASTM):
 - a. A48, Standard Specification for Gray Iron Castings.
 - b. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
 - 11. Hydraulic Institute Standards for Centrifugal, Rotary, and Reciprocating Pumps (HI).
 - 12. American National Standards Institute (ANSI).
 - 13. NEMA Standards.
 - 14. OSHA Rules and Regulations.
- B. Shop Tests:
 - 1. Pump casings shall be hydrostatically tested to twice the discharge head or 1 ½ times the shutoff head, whichever is greater.

2. Running Test: Test set up and apparatus shall be in accordance with Hydraulic Institute Standards. Pump assembly shall be operated from zero to maximum capacity as shown on the approved curve. Results of the test shall be shown in a plot of test curves showing head, flow, horsepower, efficiency, and current. Readings shall be taken at a minimum of five evenly spaced capacity points including shut-off, design point and minimum head for which pump is designed to operate.
3. Tests shall be conducted in conformance with applicable methods described in Hydraulic Institute Standards. Provide 4 copies of certified pump performance curves and test report signed by a professional engineer to ENGINEER.
4. Pumps shall not be shipped until the Engineer has approved the test reports.

C. Qualifications:

1. All water pumps, motors, and mounting accessories shall be furnished by the same manufacturer.

1.03 SYSTEM DESCRIPTION

- A. Reuse Pump: Two reuse pumps (TAG Nos. PMP-301 and PMP-302) shall pump 360 GPM from the water storage tank to the golf course. One pump is to operate while the other remains on standby. Both pumps shall be identical, and one complete pump assembly, including motor, couplings, and connections as spares. The pumps shall be provided as part of a packaged water pump station. Refer to Section 11220.

1.04 SUBMITTALS

- A. Shop Drawings:
1. Comply with requirements in Sections 11005, 11210 and 01340.
- B. Shop tests.
- C. Operation and Maintenance Manuals:
1. Comply with requirements in Section 01340.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. All pumps (horizontal close-coupled):
1. Grundfos
 2. Price Pump
 3. Fairbanks Morse
 4. Goulds
 5. Or approved equal.

2.02 MATERIALS

- A. Pump casing: Casing shall be of ASTM A48, Class 30 cast iron, and be vertically split, with the discharge flange on the same centerline as the pump shaft.
- B. Suction and discharge connections shall be 125# class ANSI flanges. Pump casings shall have 3" suction and discharge connections. Casing shall be drilled and tapped for priming and gauge connections.
- C. Sealing of the pump cavity shall be accomplished with a mechanical shaft seal. Mechanical seal shall be furnished with a carbon seal ring, silicon carbide mating, viton elastomers and 316 stainless steel metal parts. Mechanical seal shall be rated for 250 PSIG pressure. The elastomers shall be rated for temperatures ranging from -20 °F to 400°F.
- D. Impeller shall be of the single suction enclosed type made entirely of ASTM B584-875, die cast bronze finished smooth all over and of ample strength and stiffness for maintaining the maximum capacity of the unit. Impeller shall be statically and dynamically balanced and shall be keyed to the shaft and securely held in axial position on the shaft by means of a 304 stainless steel impeller screw and washer. Balance holes on the back of the impeller shall be provided to reduce thrust with the hydraulic balancing of pressure. Spot and plug balancing will not be acceptable.
- E. Pump shaft and sleeve: Bronze. The pump / motor shaft shall be made of high-quality alloy steel type AISI 1141, and engineered to transmit full drive horsepower with a liberal safety factor and minimum deflection.
- F. The shaft shall be protected where it passes through the stuffing box with a bronze shaft sleeve. The sleeve shall be sealed with an O-ring to prevent contamination from pumpage or external liquids.
- G. Motors: The pump shall be close-coupled to a premium efficiency, NEMA JM frame, TEFC, AC electric motor rated for 40-HP, 3600-RPM, 460-Volt, 3-Phase, 60-Hertz. Motor bearings shall be grease lubricated and sized for minimum of 20,000 hours, B10 life, which is equivalent to 100,000 hours average bearing life.
- H. Wearing Rings: Pumps shall be provided with bronze wear rings.
- I. Acceptable level of vibration: Per Hydraulic Institute Standards.
- J. Pump and motor base plate: Steel base plate welded to concrete equipment support pad.

2.03 EQUIPMENT PERFORMANCE

- A. Pumps shall be specially designed, constructed, and installed for the service intended and shall comply with the following minimum conditions. The requirements in this section shall govern for pump performance compliance. (Hydraulic Institute's tolerance for testing and hydraulic efficiency are not applicable).

- B. For the effluent pumps:
 - 1. Type of Drive: constant speed/soft start
 - 2. Design capacity (gpm): 360 gpm
 - 3. Design head (ft): 260 ft
 - 4. Volts/Phase/Frequency: 460V/3ph/60hz
 - 5. Rotative speed (rpm), maximum: 3600
 - 6. Driver horsepower: 40

2.04 ACCESSORIES FOR PUMPS

- A. Three Pressure regulating valves with 6 – isolation butterfly valves and 2 airy vents.

2.05 SOURCE QUALITY CONTROL

- A. Inspection and Factory Tests:
 - 1. Each centrifugal pump furnished under these specifications shall be tested at the factory to verify individual performance (VIP). Certified copies of all test reports shall be submitted to the Engineer for approval prior to shipment. Each unit shall be hydrostatically tested in accordance with the Hydraulic Institute Standards.
- B. Installation:
 - 1. The pumping units shall be installed in accordance with the instructions of the Manufacturer and as shown on the Drawings by the potable water pump station supplier.
 - 2. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the Manufacturer's recommendations.

2.06 TOOLS, SPARE PARTS, AND MAINTENANCE MATERIALS

- A. All pumps shall be furnished with the following:
 - 1. One Gasket.
 - 2. One Shaft Sleeve, with O-Ring.
 - 3. Impeller Screw.
 - 4. Impeller Key.
 - 5. Impeller Washer.
 - 6. Deflector.
 - 7. One Mechanical Seal.
- B. Spare parts shall be packed in sturdy containers with clear indelible identification marking and shall be stored in a dry, warm location until transferred to the OWNER at the conclusion of the project.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installation shall be in complete accordance with Manufacturer's instructions.

3.02 FIELD QUALITY CONTROL

- A. The pump Manufacturer shall be required to be present for the pre-startup inspection of the installation.
- B. The Manufacturer shall also be represented at actual startup.
- C. See also Section 11210.

3.03 ADJUSTING

- A. Before being placed into operation, the pumps shall be given a final adjustment as regards to the alignment of the shafts and other necessary adjustments.

3.04 START UP AND TRAINING

- A. Start up and training services are specified in Section 11210. Also see Section 01650.

END OF SECTION

SECTION 11220

PACKAGE WATER PUMP STATION

PART 1 - GENERAL

1.01 SUMMARY

A. Scope:

1. Equipment Supply:
 - a. The Supplier shall supply a complete package water pump station (PWPS) including pumps, motors, drives, pressure reducing valves, controls, electrical wiring, control panel, piping, valves, pipe supports, and all other necessary equipment needed for a fully functional pump station.
 - b. The PWPS shall include two pumps with jockey pump. The piping system, electrical, and controls shall be designed for these pumps.
 - c. The PWPS shall be shipped in sections to be assembled in the field, as necessary. All labor to field erect the pump station shall be the responsibility of either the CONTRACTOR or equipment Supplier, and shall be included in the CONTRACTOR'S bid.
 - d. The PWPS shall follow the general arrangement and intent shown on the Drawings, and fit within the indicated enclosure dimensions. Vendor may make minor adjustment in the enclosure dimensions. Design details will be confirmed during the shop drawing review process.
 - e. See Drawings.
2. Include in the Bid a list of three installations and contacts, which demonstrates experience in the design of wastewater effluent pump stations as described in these specifications. Qualifications of the supplier and proposed personnel shall be provided.

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

1. Division 1 - General Requirements
2. Section 01340 – Technical Submittals
3. Section 01715 – Equipment Operations and Maintenance Instructions
4. Section 09800 – Special Coatings
5. Division 11 – Equipment
6. Section 11005 – Equipment General Requirements
7. Section 11218 – End Suction Centrifugal Pumps
8. Division 13 – Special Construction
9. Section 13329 – Field Instruments
10. Division 15 – Mechanical
11. Section 15050 – Basic Process Piping Materials and Methods
12. Section 15062 - Ductile Iron Piping
13. Section 15112 – Butterfly Valves, Operators and Appurtenances
14. Section 15114 – Check Valves
15. Division 16 - Electrical

16. Division 16010 Electrical – Basic Requirements
17. Section 16123 600 Volt Class Cable
18. Section 16124 – Instrumentation Class Cable
19. Section 16161 Control Panels
20. Section 16195 Electrical Identification
21. Section 16476 Low Voltage Circuit Breakers
22. Section 16477 600V Fuses
23. Section 16482 Solid State Motor Controllers
24. Section 16902 Electrical Controls, Relays and Alarms
25. Section 16920 Electrical Acceptance Testing
26. Division 17 – Instrumentation and Controls
27. Section 17000 Instrumentation
28. Section 17001 Programming
29. Section 17111 Float Switches
30. Section 17120 Pressure Transmitters
31. Section 17121 Pressure Switches
32. Section 17124 Submersible Level Transmitter
33. Comply with the requirements of above Sections.

- C. General: It is the intent of this Section to provide general descriptions and minimum requirements of the major components and accessories of the water pump station. It is the Supplier's responsibility to provide a complete, properly functional, and reliable pump station which will meet these Specifications. A complete system including all components, equipment, services, and appurtenances shall be provided by the Supplier. All equipment provided as part of this Section, Section 11218, Section 13329, Section 15112, and Section 15114 must be supplied by a single Supplier, who shall assume complete system responsibility.

1.02 QUALITY ASSURANCE

- A. Tests by Independent Regulatory Agencies: Electrical material and equipment shall be new and shall bear the label of the Underwriter's Laboratories, Inc., or other nationally-recognized, independent testing laboratory, wherever standards have been established and label service consistently applies. All power and control wiring, cable, conduit, and appurtenances shall meet the requirements of the NEC code.
- B. Reference Standards: The SUPPLIER shall ensure that the water pumping station complies with all the latest applicable provisions and recommendations of the societies, associations and institutes referenced throughout these specifications and below, except as otherwise specified.
1. American National Standards Institute (ANSI).
 2. American Society for Testing and Materials (ASTM).
 3. American Water Works Association (AWWA).
 4. Institute of Electrical and Electronics Engineers (IEEE).
 5. National Electrical Manufacturer's Association (NEMA).
 6. National Electrical Code.

7. National Fire Protection Association.
 8. Standards of the Hydraulic Institute.
 9. NSF International.
- C. Codes: All equipment and work shall comply with all local, state, and federal codes, standards, laws, ordinances, and regulations having jurisdiction in the area where the goods and equipment shall be installed. See Section 01610. Where conflicts exist between the specified standards and the codes, the Supplier shall bring it to the attention of the ENGINEER. The Supplier shall make necessary tests and inspections to ensure all ordinances, codes and regulations are met.

1.03 SUBMITTALS

- A. Engineering Design Drawings and Shop Drawings: The Supplier shall submit for approval complete detailed engineering design and shop drawings and descriptions of the proposed equipment including:
1. Full set of mechanical drawings including skid framing, connection dimensions, and piping and equipment layout, all to scale. The drawings shall show size of all piping, valves, and appurtenances.
 2. Full electrical schematic, including wiring diagrams, conduits, three line power schematic and ladder logic.
 3. Complete instrumentation and control schematics, wiring diagrams, and terminal strip information. All panels to be provided by the Supplier shall be factory pre-wired.
 4. Instrumentation and control description detailing start-up and shutdown, procedures, operation, control, and monitoring.
 5. Pump curves which include pumping system internal losses, manufacturer's name, pump model number, and motor type, RPM, and horsepower.
 6. Properly marked cut sheets for each component of the pumping system, both mechanical and electrical.
 7. Submit shop drawings for each of the items and equipment showing all dimensions, weights, parts, construction details, and materials required to demonstrate compliance with these specifications. Submit the shop drawings considering water pump station as a whole.
 8. A list of any and all parameters, ratings, or other characteristics where the proposed water pump station equipment deviates from the requirements set forth in the Specifications.
 9. Water pump station plan and piping drawings including all ancillary facilities.
- B. Operation and Maintenance Manual: Operation and maintenance manuals shall be submitted in accordance with Section 01340 - Technical Submittals.

1.04 PRODUCT DELIVERY AND HANDLING

- A. Deliver materials to the site to ensure uninterrupted progress of the work.

1.05 WARRANTY

- A. The manufacturer shall warrant that the water pumping system shall be free of defects in workmanship for a period of one year from date of substantial completion, but not to exceed eighteen months from date of shipment.
- B. Manufacturer shall furnish and install replacement parts or components during the warranty life. Upon request, manufacturer shall provide advice for trouble shooting of a defect during the warranty period.
- C. Complete documentation describing installation, operation, programming, and simple field maintenance shall be available in paper format and on CD-ROM.

1.06 UNIFORMITY OF EQUIPMENT

- A. To assure complete compatibility of all components and to provide uniform responsibility, all components of the system shall be furnished by one supplier. Said supplier shall assume full and undivided responsibility.

PART 2 - PRODUCTS

2.01 SUPPLIER

- A. Provide complete wastewater effluent pumping system as designed and assembled by one of the following:
 - 1. Premier Flows
 - 2. Or approved equal.

2.02 PACKAGED WATER PUMP STATION COMPONENTS

- A. Structural Support: The pump station shall be built on a structural steel base with panels that provide a walking surface. The base shall supply adequate support for the pumps, motors, and piping. Where suction and discharge piping and other conduit pass through the base, removable access panels shall be provided.
- B. Pumping Equipment: The pumps shall be horizontal close coupled end suction centrifugal pumps designed for heavy-duty service. See Sections 11218. And for jockey pump with vertical multistage pump.
Design parameters for jockey pumps:
Flow(gpm): 50 gpm
Head(ft): 260
Horse power (Hp): 5
Power: 460V/3ph/60Hz

- C. Piping:
1. Provide epoxy coated carbon steel or ductile iron piping.
 2. All piping supports shall cover 120 degrees of arc under the piping and support the weight of the piping and the water it contains. Pipe supports shall be provided to keep weight of piping and water off pumps.
 3. Thrust shall be resisted by proper use of mechanical restraint joints as needed, and through proper anchoring of the pump station and pipe to the foundation slab according to manufacturer's recommendations. Thrust blocks are not allowed.
 4. Comply with Section 15050 - Basic Piping Materials and Methods, unless otherwise specified in this Section.
- D. Valves and Fittings:
1. All valves shall comply with the AWWA standards.
 2. Provide AWWA C504 butterfly valves with levers on the suction and discharge of each pump as shown in the Drawings and sized per Valve Schedule. Valves shall have electric actuators as shown on the Drawings. Refer to Section 15112 - Butterfly Valves, Operators, and Appurtenances.
 3. Silent check valves shall be provided on the discharge of each pump and sized per Valve Schedule. Refer to Section 15114 - Check Valves for detailed specifications.
 4. Pressure transducers shall be provided on the suction and discharge side of the pumps.
 5. Pressure gauges shall be 2-1/2" NPT thread at all pump suction and discharge locations.
- E. Station Base:
1. Pumping system shall be a completely skid mounted pumping system built by a single manufacturer.
 2. All equipment including, but not limited to pumps, motors, valves, instrumentation and controls, shall be mounted on a common structural steel base to form a complete operating pumping system.
 3. The pumping system base shall be designed and fabricated to provide proper structural support for all attached equipment.
 4. The base shall supply sufficient rigidity to withstand the stresses of reasonable and competent transportation to site, off-loading, installation, and operation.
 5. All structural members shall be constructed from heavy weight structural tubing.
 6. Provisions shall be made in the station base for off-loading and handling the station at the site of installation.
 7. Base shall include skid resistant deck plate over all the skid, and structural steel plate mounted under pumps and motors.
 8. All deck and structural plate shall be 100% seal welded to peripheral structural members, and skip welded on the bottom to internal structural members.
 9. The station base, pipe supports, and all metal surfaces shall receive epoxy coating system per Specification Section 09800. Contractor to touch up damaged areas of coating prior to turn over to OWNER.
- F. Electrical System:
1. All electrical work shall comply with the National Electrical Code.

2. All electrical control wiring and conduit necessary for working stations shall be supplied and prewired by Supplier. Provide GRC or LFMC conduit for all wiring within pump station.
3. Power Supply to the PWPS: As shown on the Drawings, a new 480V, 3 Phase, 60 Hz single utility power feed shall be provided to the PWPS power center.
4. Provide transformers to step down from 460V, 3 Phase to 120V, 1 Phase for light fixtures, or electrical receptacles.
5. The PWPS shall include power distribution for all electrical demands in the Project. Refer to Drawings for one line diagram.
6. Refer to Division 16- Electrical for additional requirements.
7. Design and provide electrical system for a total of 2 pumps.

G. Facility Control Panel:

1. All instrumentation and controls shall conform to this Section.
2. The control panel shall contain all failsafe controls required by the SUPPLIER to protect the pumping equipment installed and requirements in this Section.
3. The control panel shall be UL rated and be a NEMA 4 steel standing control cabinet
4. All products shall be designed, manufactured, and tested in accordance with recognized UL, C-UL, CSA, IEC, and CE mark industrial standards. The system shall be operational during and after testing.
5. The manufacturer shall have a fully operational quality assurance and quality control program in place and shall comply with ISO9001 standards for "Quality Systems - Model for Quality Assurance in Design/Development, Production, Installation, and Servicing."
6. Terminals shall be provided for all connections between additional control panels, junction boxes, and other electrical components. All control panels and electrical enclosures shall be NEMA 4.
 - 1- Delta DVP, micro-PLC controller
 - a. Flash Main Memory
 - b. SD memory for all user variables
 - c. Real time clock
 - d. Multi-level password security
 - e. 32bit controller
 - f. MODBUS RTU, SMS, GPRS
 - g. USB programing portRS-232,485 Ethernet communication ports
 - h. 1-7" Color, touch screen HMI
 - i. PV-VB Self Tuning pressure sequencing (ASHRAE 90.1 compliant)
 - j. Suction and System discharge pressure read out in PSI
 - k. Individual pump run indication
 - l. Hand-off-auto selection
 - m. ETM's (Elapsed Time Meters)
 - n. Automatic alternation
 - o. 100 Event Log
 - p. Low Suction alarm with TDR delay
 - q. Low System Alarm with TDR delay
 - r. High System alarm with TDR delay

- s. High Suction Energy Saving Mode
 - t. 1-120V fused transformer
 - u. 2 sets of common Auxiliary Alarm Contacts
 - v. 3- Thru – the - door disconnects with individual motor circuit protection
 - w. 3-Individual motor starters with overload protection
 - x. 2- 4-20MA, stainless steel pressure transducers, header mounted suction, and discharge
- 7. Refer to Division 16 - Electrical for additional requirements.
 - 8. Design and provide control panel for two pumps.
 - 9. The panel is anticipated to be 3 feet wide. If the supplier determines a 4-foot wide panel is needed, a double door shall be provided.

H. Air Release Valve

- 1. Two air release valves with wet switches will be installed on each pump station discharge line as shown in the drawings.

2.03 COATING

- A. All equipment shall receive coating system prior to shipment per Section 09800.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Prior to installation, one site visit and up to 4 hours of time on-site by the Supplier's representative shall be provided for the following services:
 - 1. Ensure that the equipment shipped to the job-site has been handled according to the Supplier's recommendations and has arrived in good working order.
 - 2. Ensure that all equipment has been stored and protected according to the Supplier's recommendations.
- B. Inspect and verify that structures or surfaces on which the equipment will be installed have no defects which would adversely affect the installation.
- C. The Supplier shall promptly report, in writing, defects which may affect the Work to the ENGINEER. A copy of the Supplier's field report shall be provided to the ENGINEER.

3.02 SUPPLIER'S FIELD SERVICES

- A. Suppliers shall furnish all required oil, grease, hydraulic fluids, and chemicals required for initial operation and supervise the installation of these lubricants, fluids, and chemicals.
- B. The Supplier shall check and approve the installation during construction and prior to initial operation. Prior to initial start-up, a written statement shall be provided by the Supplier stating the equipment has been installed in accordance with the Drawings, Specifications, and shop drawings and is ready to be placed into operation. The Supplier shall test operate

the system in the presence of the OWNER and shall verify the equipment conforms to the specified requirements. The Supplier shall re-visit the job-site as often as necessary until all deficiencies are corrected and the installation and operation is satisfactory to the ENGINEER.

- C. The Supplier shall provide 16 hours (2 days) training to OWNER in accordance with the requirements of Section 01715, Equipment Operation and Maintenance Instructions.

3.03 FIELD ACCEPTANCE TEST

- A. OWNER will conduct a 5-day pump system field acceptance test following completion of start-up, with support from CONTRACTOR and Supplier. Suppliers shall provide on-site support services for two days during this test period. Suppliers shall provide test protocols.
- B. In the event that the water pumping station does not meet the requirements of the Specifications during the field acceptance test, the Supplier will be permitted to make changes to the equipment and methods of operation at his own expense. The re-adjustments shall be made as soon as practicable within a period not to exceed 10 calendar days. Following the re-adjustments, the OWNER will make a second test run similar to the first. Additional testing of any equipment that has been repaired, modified, or replaced shall be conducted in accordance with the procedure for the initial acceptance test described above. Conformance with the hydraulic requirements must be achieved before the water pumping system will be deemed acceptable. A maximum of two retests shall be allowed to show conformance with the Performance Requirements. However, after initial start-up, the OWNER shall have the right to use the equipment as needed to pump water until accepted or, if rejected, until acceptable replacement equipment, or system is available for use.
- C. Satisfactory completion of the field acceptance tests does not release the Supplier from other guarantees required by the Contract Documents or provided by law.

END OF SECTION

SECTION 11330

VERTICALLY MOUNTED HEADWORKS SCREENING

PART 1 – GENERAL

1.01 SUMMARY

- A. The CONTRACTOR shall install, place into satisfactory operation, and warrant the vertically mounted headworks screening system for receiving, separating, washing, dewatering and transporting screenings material to the designated collection container, as shown on the Drawings and described by the Specifications. The OWNER shall furnish the headworks screenings system as described in this Specification.
- B. All items detailed in this section were provided by the same manufacturer.
- C. Related Sections:
1. Section 11005: Equipment: General Requirements
 2. Section 15050: Basic Process Piping Materials and Methods
 3. Division 5: Metals
 4. Division 16: Electrical
 5. Section 02200: Earthwork
- D. Equipment Identification: Vertically mounted headworks screening equipment to be installed are identified in the Drawings and Specifications as follows:

<u>Equipment Name</u>	<u>Identifier</u>
Auger Monster	AM101

1.02 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM) A536-84: Standard Specification for Ferritic Ductile Iron Castings
- B. American Society for Testing and Materials (ASTM) A48-83: Standard Specification for Grey Iron Casting
- C. American National Standards Institute (ANSI) B16.42-1979, Class 150 Flanges
- D. American Iron and Steel Institute (AISI) 303 Stainless Steel
- E. American Iron and Steel Institute (AISI) 304 Stainless Steel
- F. American Iron and Steel Institute (AISI) 316 Stainless Steel
- G. American Iron and Steel Institute (AISI) 4130 Heat Treated Alloy Steel

- H. American Iron and Steel Institute (AISI) 4140 Heat Treated Alloy Steel
- I. American Iron and Steel Institute (AISI) 17-4 Stainless Steel
- J. Controllers shall, as applicable, meet the requirements of the following Regulatory Agencies:
 - 1. National Electrical Manufacturer's Association (NEMA) Standards
 - 2. National Electrical Code (NEC)
 - 3. Underwriters Laboratory (UL and cUL)
 - 4. International Electrotechnical Commission (IEC)

1.03 SUBMITTALS

- A. Shop Drawings and Product Data: Submit the following as a single complete initial submittal in accordance with Section 01340:
 - 1. Product data fully describing all items proposed for use to demonstrate that the equipment conforms to the plans and specifications.
 - 2. A copy of this specification section, with addenda updates, with each paragraph check marked to show specification compliance or marked to show deviations.
 - 3. Performance data demonstrating the equipment can operate at the required solids load.
 - 4. Manufacturer's catalog data and operating literature on equipment used.
 - 5. Specifications, performance data and calibration curves for fan, motor, and auxiliary components.
 - 6. System layouts and/or schematics.
 - 7. Elementary and connection wiring diagrams clearly showing external connections to other equipment.
 - 8. Motor designation and horsepower.
 - 9. NEMA starter sizes and overload types/sizes.
 - 10. Enclosure type with interior and exterior elevations with dimensions.
 - 11. Control transformer ratings.
 - 12. Circuit breaker (or fuse) sizes.
 - 13. Auxiliary contacts.
 - 14. Control devices being utilized.
 - 15. Point-to-point wiring diagram by an approved system integrator.
 - 16. Bill of material including spare parts being furnished.
 - 17. Warranty.
- B. Performance Testing: Submit certified non-witnessed factory performance test results. Receive favorable reviews of test results prior to shipping the equipment.
- C. Manuals: Furnish manufacturer's installation, lubrication, operation and maintenance manuals, bulletins, and spare parts list.
- D. Affidavits: Submit affidavits from the manufacturer stating that the equipment has been properly installed, adjusted, and tested and is ready for full-time operation.

- E. If requested by the ENGINEER or OWNER, manufacturer shall provide a list of reference sites for similar equipment for verification.

1.04 QUALITY ASSURANCE

- A. The products furnished under this section were by a manufacturer that has been regularly engaged in manufacturing the equipment and has a minimum of 5 years' experience in design, fabrication, and testing of vertically mounted headworks screenings systems. Demonstrate to the satisfaction of the ENGINEER that the quality is equal to equipment made by those manufacturers named herein.
- B. Upon completion of the installation each piece of equipment in each system shall be tested for satisfactory operation without excessive noise, vibration, or overheating. Compliance shall be as required in the Contract Documents and all applicable codes and standards. All equipment shall be adjusted and checked for misalignment, clearances, supports, and adherence to safety standards.
- C. The CONTRACTOR shall be responsible for the successful startup and testing of headworks screenings system. The manufacturer shall provide supervisory assistance, instrumentation and testing services required during this phase of the work.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Place materials in area protected from weather immediately upon delivery to the job site. Use non-marring slings for loading, unloading, and handling units to prevent rope or cable damage to surfaces and protective wrappings.
- B. Equipment shall remain in the packaging provided by the supplier until it is installed.
- C. Equipment shall be stored in a dry environment between 40 degrees F and 100 degrees F.

1.06 WARRANTY

- A. CONTRACTOR shall provide a written warranty for the entire system, both in material and workmanship for a period of eighteen months (18) months from the date of Substantial Completion.
- B. The equipment shall be warranted to be free from defects in workmanship, design, and materials. If any part of the equipment should fail during the warranty period, it shall be repaired or replaced and the complete system restored to service at no expense to the OWNER.
- C. Manufacturer shall provide a written warranty.

1.07 WARNING SIGNS

- A. Each piece of driven machinery which can be started manually by any control station not within 15 feet of the machine, or which can be controlled automatically by any means, shall be identified with a warning sign inscribed:

CAUTION

THIS MACHINE IS REMOTELY CONTROLLED
AND MAY START AT ANY TIME

The word “CAUTION” shall be in yellow block letters on black panel at the tip of the sign which shall have yellow background and text in black block letters. Signs shall be fabricated from 30-gauge copper-bearing steel and finish shall be high-baked enamel; the finished signs shall be weather resistant. Signs shall be 10 inches wide by 7 inches high. Signs shall be located in prominent locations at machines and shall be fastened to surfaces previously specified for nameplates.

PART 2 – PRODUCTS

2.01 GENERAL

- A. The system shall comprise the following major components:
1. Wall Mount Frame.
 2. Vertical Auger.
 3. Auger Locator Supports.
 4. Wash Water Control Assembly.
 5. Discharge Chute.
 6. Level Probe.
 7. Motor Controller.
 8. Factory Finishing.
 9. The headworks screenings system shall be Model ALV01-285 by JWC Environmental, LLC, or pre-approved equal.
- B. The system shall be designed for continuous, automatic operation and also be capable of manual operation. Access ports shall be provided to allow access to the internals of the system. The system shall be designed to withstand ambient temperatures up to 130 degrees F. The system and all accessories shall be factory mounted, piped, and wired to the maximum extent possible.

2.02 PERFORMANCE AND DESIGN CRITERIA

- A. The vertically mounted headworks screenings system shall receive wastewater flow into a wet well or vault, collect and remove captured solids from the waste stream and effectively wash, transport, compact, de-water and discharge the solids to a collection container. The system shall incorporate wall-mounted frame assembly and vertical auger with perforated screen segment, transport segment, dewatering discharge segment, drive segment, and rotating spiral. The system shall be configured to permit installation of a future grinder pump that precedes the auger.

- B. The system shall meet the following minimum criteria unless otherwise pre-approved by the ENGINEER:
1. Number of vertical headworks screening systems: 1
 2. Number of motor controllers: 1
 3. Capacity per system: 500 GPM
 4. Wet well diameter: 6 ft
 5. Nominal screen height: 28 in
 6. Screen perforation size: 1/4"
 7. Minimum perforated screen thickness: 11 gauge
 8. Minimum screen open area: 58%
 9. Automatic screen cleaning with pressurized wash water with explosion-proof solenoid valve.
 10. Nominal rotor diameter: 11-1/4"
 11. Nominal rotor RPM: 60 (drive), 44 (driven)
 12. Environment rating in wet well: Class 1, Div. 1, Groups C & D
 13. Supply power characteristics: 460 volt / 3 phase
 14. Auger installed horsepower: 2 hp
 15. Future grinder: 5 hp minimum.
 16. Auger motor type: TEFC
 17. Auger motor service factor: 1.15
 18. Auger min. motor efficiency (at full load): 84%
 19. Auger min. motor power factor (at full load): 72%
 20. Motor controller enclosure rating: NEMA 4X
 21. Selector switch, push button & pilot lamp type: 22 mm, LED (pilot lamp)
 22. Programmable Logic Controller type: Siemens S7-1200
 23. Human Machine Interface type: Siemens KTP-400 Comfort
 24. Level probe: Endress & Hauser FMU 40-series

2.03 MATERIALS

- A. General: The system shall be fabricated from the following materials unless otherwise pre-approved by the ENGINEER:
1. Grinder Housing: Epoxy-coated ductile iron
 2. Grinder Cutters & Spacers: Hardened 4130 alloy steel
 3. Grinder Shafts: 4140 alloy steel
 4. Auger Trough and Screen: 304 stainless steel
 5. Spiral and Transport Shaft: Alloy steel
 6. Spray Wash Assembly: 304 stainless steel
 7. Control Enclosure: 304 stainless steel
 8. Fasteners, Hardware: 304 or 316 stainless steel

2.04 SYSTEM COMPONENTS

- A. Wall Mounted Frame
1. General: Frame shall be wall-mounted to suit the wetwell diameter listed in Performance and Design Criteria and provide a method for supporting the vertical auger. Frame shall contain and guide wastewater flow through the equipment for

processing. An overflow barscreen shall be incorporated into the frame to allow coarse screening of wastewater during high-flow events.

2. Components: Frame shall be of material type listed in Materials. Frame shall incorporate a flange feature to allow for anchoring to the wall of a round or flat wall wet well. Frame shall incorporate a pocket for mounting a future in-channel grinder. Frame shall incorporate a guide feature to accommodate a removable slide gate-style interface adapter for mounting the auger. Frame shall be designed to support the static and dynamic loads of both the grinder and the vertical auger. Frame shall incorporate an overflow barscreen.

B. Vertical Auger

1. General: Vertical auger shall include a perforated screen trough with flanged inlet and spray wash manifold, transport segment, discharge segment with dewatering feature, rotor assembly, and drive assembly.
2. Components:
 - a. Perforated Screen Trough: Screen trough shall be constructed of stainless steel of type listed in Performance and Design Criteria and electro-polished to remove burrs. Perforations shall be of diameter listed in Performance and Design Criteria. Screen trough shall be cylindrical and have a 12" diameter flanged inlet pipe. Spray water manifold with nozzles shall be mounted to the screen trough to apply water spray to help promote transport and washing of solids.
 - b. Auger Interface & Support Assembly: A slide gate-style auger interface and separate flange-mounted support shall be fabricated from stainless steel of type listed in Performance and Design Criteria and connected to both the screen trough inlet flange and upper screen trough flange. Auger interface shall guide wastewater flow from wall-mounted frame to perforated screen trough. Along with the auger interface, the support assembly shall transfer all vertical loads from the vertical auger to the wall-mount frame.
 - c. Transport Segment: Transport casings shall be fabricated of stainless steel sheet of type listed in Materials. Minimum material thickness shall be 10 gauge. Transport casings shall be fitted with a minimum of six (6) 1/2" x 1-1/2" anti-rotation or wear bars to bear the radial loads from the auger. Wear bars shall be fabricated from 17-4PH stainless steel. Individual transport casings 39" and longer shall have removable inspection covers. At least one flange of the transport segment shall be fitted with an auger locator flange bracket for connection to the auger locator supports.
 - d. Dewatering Discharge Segment: Discharge segment shall be fabricated of stainless steel sheet of type listed in Materials. Minimum material thickness shall be 10 gauge. Discharge segment shall be fitted with a minimum of six (6) 1/2" x 1-1/2" anti-rotation or wear bars to bear the radial loads from the auger. Wear bars shall be fabricated from 17-4PH stainless steel. Discharge segment shall incorporate a dewatering feature including 0.12" holes, spray wash manifold with high-impact spray nozzles, collection tray and gasketed shroud assembly. Discharge segment shall have a radial discharge.

- e. Auger Rotor: Rotor shall be constructed of high-strength alloy steel suitable for forming a centerless spiral consisting of a main spiral and an insert spiral. Material shall have a minimum hardness of 215 BHN. Rotor shall be fitted with a center pipe to inhibit material fallback. The diameter of the spiral shall have a tolerance of no more than +/- 1%. A portion of the rotor shall be fabricated with a ½-inch x ½-inch circumferential groove for mounting and positioning of a brush. The groove shall be milled directly into the main spiral bar. Grooves fabricated from separate spiral elements shall not be acceptable. A coil-wound brush shall seat into groove and be secured with set screws to inhibit snagging. Brush shall be a continuous helical design with stainless steel backing, nylon bristles, and stainless steel anchor wire.
- f. Lifting Brackets: Two lifting brackets shall be mounted to the drive end of the vertical auger. Lifting brackets shall be fabricated from material type listed in Materials. Lifting brackets shall be designed to bear to full weight of the vertical auger, including any material that may not have been cleared from the unit.
- g. Packing Gland and Housing: Packing shall be constructed of four (4) PTFE impregnated cords. Packing housing shall be constructed of 4140 steel.
- h. Speed Reducer: Reducer shall be manufactured by Nord Gear Corporation or pre-approved equal. Reducer shall be helical-parallel and shaft mounted with nominal 160:1 reduction.
- i. Motor: Motor shall be manufactured by Baldor Electric Company or pre-approved equal. Motor horsepower, power characteristics, service factor, power factor, and efficiency shall be listed in Performance and Design Criteria.

C. Auger Locator Supports

- 1. General: Supports shall be provided above the wall-mounted frame to keep the auger properly located. One auger locator support shall be provided for each 13 feet of vertical auger above the wall-mount frame.
- 2. Components: Supports shall be constructed of stainless steel of type listed in Materials and designed to accommodate horizontal loads only.
 - a. A bolted-style locator support shall be provided as close as possible to the top of the wet well. Support shall use a beam for connection to the locator flange mounted on the auger transport segment. Side wall brackets or front wall beam supports shall be used to maintain the position of the beam.
 - b. Any additional locator supports provided below the bolted-style locator support shall not require human contact to disconnect. A female locator flange bracket shall be mounted on the auger transport segment. A corresponding male locator shall be mounted on a beam. Side wall brackets or front wall beam supports shall be used to maintain the position of the beam.

D. Wash Water Control Assembly

- 1. General: Wash water control assembly shall provide screenings and flow control of spray water for washing and transport of the captured solids, as well as cleaning of the perforations of the dewatering discharge segment.
- 2. Components
 - a. Basket strainer shall be of material type listed in Materials and include a 20-mesh 304 stainless steel screen.

- b. Y-strainer shall be of material type listed in Materials above and include an 80-mesh 304 stainless steel screen.
 - c. Electrically actuated water control valves shall be of type listed in Performance and Design Criteria above.
 - d. Ball valves shall be manual and constructed of 316 stainless steel and allow the wash water to be regulated or shut off.
 - e. An integral mounting bracket shall be provided to attach the assembly to a wall or a floor.
- E. Discharge Chute
- 1. General: A discharge chute shall connect to the radial discharge of the discharge segment and guide the ground, washed and dewatered wastewater solids to a collection container.
 - 2. Components
 - a. Discharge chute and supports shall be fabricated from stainless steel sheet of type listed in Materials.
 - b. Discharge chute shall be removable to facilitate inspection and maintenance.
 - c. Additional supports shall be provided for discharge chutes allowing more than 36" of horizontal transport.
- F. Level Probe
- 1. General: A level probe shall be mounted on the frame upstream of the headworks intake. Level probe shall produce an analog output signal representative of the level of the liquid contained in the frame. Analog signal shall be passed to the motor controller.
 - 2. Components: Level probe shall be rated NEMA 6P for temporary immersion and in accordance with the environment rating listed in Performance and Design Criteria. Level probe shall have 1-1/2" NPT process connection. Level probe shall be of make and model listed in Performance and Design Criteria.
- G. Motor Controller
- 1. General: Controller shall provide programmable operation of the Vertically Mounted Headworks Screening. Controller shall have switches, indicator lights, and other control devices. Operating parameters shall be adjustable via a Human Machine Interface (HMI). Controller shall be designed to suit the supply power and motor characteristics listed in Performance and Design Criteria.
 - 2. Components:
 - a. Enclosure shall be of rating and material type listed in Materials. Enclosure shall house motor starter, PLC, and control devices, and shall be latched and lockable.
 - b. Pilot shall be of type listed in Performance and Design Criteria, rated equal or better than the enclosure. Lights shall indicate Power On, Compactor Run and Fail.
 - c. Selector switches shall be rated equal to or better than the enclosure. Auger selector switch shall be three-position and indicate On-Off-Auto.
 - d. Pushbuttons shall be rated equal to or better than the enclosure. Reset push button shall be momentary type and indicate Reset. Emergency stop pushbutton shall be maintained type and indicate Emergency Stop.

- e. Motor starters shall be full-voltage reversing with 120-volt operating coils. Overload relays shall be adjustable and sized to full load amperes (FLA) of the motor.
- f. Current transducer shall have a discrete output. Current transducer shall have selectable amperage range input and output contact.
- g. Control transformer shall produce 120-volt AC power from the supply power. Transformer shall be sized and fused in accordance with code to accommodate the control power requirements.
- h. Disconnect switch in addition to existing disconnect switch shown on Drawing E-04 shall be provided to completely disconnect the motor controller from all phases of the supply power.
- i. Short-circuit protection shall be in accordance with the Electrical Drawings.
- j. Programmable Logic Controller (PLC) shall be of type listed in Performance and Design Criteria.
- k. Human Machine Interface (HMI) shall be of type listed in Performance and Design Criteria. HMI shall display alarms and statistical counters, and provide controls for adjusting operating parameters. HMI devices exposed to direct sunlight shall be protected with a thermal insulating cover.

3. Operation

- a. Vertical auger control shall be in accordance with the setting of the auger ON-OFF-AUTO selector switch. In the OFF position the auger shall not run. In the ON position, the auger shall run forward continuously. In the AUTO position, the auger shall operate as controlled by the status of the HMI programmable run cycle settings.
- b. HMI shall display operational messages, alarms, and statistical counters, and provide controls for adjusting operating parameters.
- c. RESET push button shall clear active alarms.
- d. EMERGENCY STOP pushbutton shall de-energize PLC output circuits powering motor starter, run indicator lamps, and wash water control valves. Once the emergency stop push button is reset, the RESET pushbutton shall be pressed to clear active alarms.
- e. When a vertical auger jam condition occurs while the system is operating, the controller shall de-energize the auger, then reverse the auger rotation to clear the obstruction. If the jam is cleared, the controller shall return the auger to normal operation. If two reversals occur within a 30-second interval, the controller shall de-energize the auger motor and activate the FAIL indicator and de-energize the FAIL relay (fail-safe).
- f. When a motor overload, motor over-temperature or emergency stop condition occurs, to motor shall be de-energized, the FAIL indicator lamp shall be illuminated, and the FAIL relay shall be de-energized (fail-safe).
- g. When a power failure occurs while the system is operating, the system shall return to normal operation when power is restored.
- h. When a power failure occurs while the auger is in a “fail” condition, the system shall return to a fail state when power is restored. The fail state shall not be cleared until reset.

- H. Factory Finishes
 - 1. Passivation: Stainless steel components shall be cleaned and passivated to remove surface contaminants and re-establish the corrosion-resistant passivation layer.
 - 2. Paint Coatings (Ferrous Materials): Ferrous metal surfaces shall be prepared to SSPC-SP6 (Commercial Blast Cleaning) and coated with minimum 6-8 mils TDFT (total dry film thickness) paint of type and color listed in Materials.

2.05 SPARE PARTS

- A. At a minimum, the following spare parts shall be supplied with the equipment:
 - 1. One (1) set of fuses, one (1) for each fuse rating.
 - 2. One (1) set of bearings.
 - 3. Any other spare parts recommended by the Manufacturer.
- B. The supplier shall identify and submit any applicable spare parts. Spare parts shall be clearly labeled and packed for long-term storage.

PART 3 – EXECUTION

3.01 SITE PREPARATION

- A. Prepare the site in accordance with Section 02100.

3.02 FACTORY ACCEPTANCE TEST

- A. Electrical control panel shall be inspected prior to shipping for conformance to the following:
 - 1. NEMA rating according to this specification.
 - 2. PLC program shall be tested for proper communication and functionality.
 - 3. PLC digital and analog inputs shall be electrically tested to ensure input recognition in the proper area of the PLC program.
 - 4. All wiring between panel components and terminal strips shall be checked for proper labeling and connection.
- B. All water panel piping and/or other pre-installed piping shall be tested prior to shipping for conformance to the following:
 - 1. System shall have no leaks when subjected to a pressure test at 1.5 times the maximum operating pressure for a minimum of 1 hour.
 - 2. All installed instruments, sensors, pumps, actuated valves, and other electrical components shall be tested for proper operation.
 - 3. All wiring from terminal strips to all electrical components shall be tested to ensure proper wiring.

3.03 INSTALLATION & EQUIPMENT STARTUP

- A. Installation of all equipment shall be in accordance with Manufacturer's written installation and startup instructions and by workers experienced in the handling of similar equipment

and materials, electrical work, plumbing, and instrumentation. The final installation shall be certified by the Manufacturer as complete and correct.

- B. The Manufacturer shall provide the CONTRACTOR with required clearances, tolerances, and limitations, such as smoothness/flatness of concrete pad.
- C. The CONTRACTOR shall coordinate installation of the compactor and controller in accordance with the manufacturer's installation instructions, Drawings, and related Specification sections, and in accordance with all OSHA, local, state, and federal codes, and regulations.
- D. Once the installation has been certified by the Manufacturer, the CONTRACTOR, with supervision from the Manufacturer, shall provide startup services of the system.
- E. Any special tools or instruments required for this startup/acclimation period shall be provided by the Manufacturer.
- F. After satisfactory startup and the corresponding switch over to normal operation, the CONTRACTOR shall conduct the performance test as detailed below.

3.04 FIELD COATING & CORROSION PROTECTION

- A. If painted surfaces are damaged during shipment, off-loading or installation, as long as the damage is surface only and in no way affects the integrity of the equipment or its ability to perform, these blemishes, scratches or other imperfections shall be touched up by the CONTRACTOR in accordance with instructions from the Manufacturer. Materials used shall be compatible with the original coating material in quality and color.

3.05 FIELD PERFORMANCE TESTING

- A. Performance testing shall not commence until the Manufacturer and OWNER agree that the system has been satisfactorily started-up.
- B. After the vertically mounted headworks screening system has been satisfactorily started-up, the CONTRACTOR shall demonstrate that the system will perform as specified.
- C. The CONTRACTOR shall provide the ENGINEER with a written test protocol for approval prior to conducting testing.
- D. The CONTRACTOR shall supply, install, and operate all equipment, sensors and instrumentation required to complete the performance testing.
- E. The CONTRACTOR shall conduct testing of the compactor to demonstrate correct alignment, smooth operation and freedom of excessive vibration and noise. Testing shall demonstrate accurate measurement of sensors and function of the operating parameters.

3.06 MANUFACTURER'S SERVICES

- A. Start-up assistance, testing, and training: Manufacturer's factory trained representative for one (1) separate trip unless otherwise pre-approved by the ENGINEER.
- B. Performance testing assistance: Manufacturer's factory trained representative for one (1) separate trip unless otherwise pre-approved by the ENGINEER.
- C. The Manufacturer shall provide the services of a field technician to inspect the equipment for proper installation, apply power for the first time, and check for proper motor rotation, oversee the initial introduction of material into the system, and configure the equipment operating parameters to optimize performance based on site-specific requirements.
- D. Field training shall be provided for OWNER's operations, maintenance, and supervisory staff members. Field instruction shall cover key components of the equipment, operating and maintenance requirements and troubleshooting techniques.

3.07 EQUIPMENT NAME PLATES

- A. Each separate piece of equipment shall be furnished with a unique name plate identifying the Manufacturer, model & serial number, date of manufacture and, if applicable, capacity and any performance limitations. The nameplates shall be engraved stainless steel and firmly affixed to the exterior surface of the equipment and in a location that is accessible and easily read.

END OF SECTION

SECTION 11410

PARSHALL FLUME

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Furnish and install complete, tested and operating, the equipment shown on the Drawings and as specified herein.
- B. Work Included in This Section: 3-inch Parshall flumes
- C. Related Sections: Include but are not necessarily limited to:
 - 1. Division 1: General Requirements
 - 2. Section 11005: Equipment – General Requirements

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. A 193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
 - 2. D 256 - Standard Test Method for Determining the Izod Pendulum Impact Resistance of Plastics.
 - 3. D 570 - Standard Test Method for Water Absorption of Plastics.
 - 4. D 638 - Standard Test Method for Tensile Properties of Plastics.
 - 5. D 695 - Standard Test Method for Compressive Properties of Rigid Plastics.
 - 6. D 696 - Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C with a Vitreous Silica Dilatometer.
 - 7. D 790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - 8. D 792 - Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
 - 9. D 1056 - Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
 - 10. D 2583 - Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
 - 11. D 2584 - Standard Test Method for Ignition Loss of Cured Reinforced Resins.
- B. International Organization for Standardization (ISO) 1438 - Open Channel Flow Measurement.
- C. Composition of the Parshall flume laminate shall be in accordance with the recommendations shown in the Quality Assurance Report for Reinforced Thermoset Plastic (RTP) Corrosion Resistant Equipment prepared under the sponsorship of the Society of the Plastics Industry, Inc. (SPI), and the Material Technology Institute (MTI) of the Chemical

Process Industry for “Hand Lay-Up Laminates,” and shall meet the specifications for Type I, Grade 10 laminates shown in Appendix M-1 of said report.

1.03 OPERATING CONDITIONS

- A. Flow: 15-830 gpm.
- B. Fluid: Reclaimed Wastewater Effluent

1.04 SUBMITTALS

- A. Product Data: List of materials and coatings used.
- B. Shop Drawings: Submit for approval the following:
 - 1. All critical dimensions and wall thickness.
 - 2. Principal parts and materials including fittings, attachments, bolts, and gasket materials.
- C. Operation and Maintenance Manual:
 - 1. Submit instructions for installation, operation, and maintenance instructions for the flumes including bulletins and spare parts lists.
 - 2. The manual shall include magnified views, maintenance details, etc.

1.05 QUALITY ASSURANCE

- A. Equipment provided under this section shall be fabricated, assembled, and transported in full conformity with Drawings, Specifications, and engineering data.
- B. Manufacturer shall be experienced in the design and manufacture of Parshall flumes and accessories for a minimum period of 10 years.
- C. Manufacturer must provide warranty for 25 years against failure due to corrosion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. Plastifab
 - 2. Tracom
 - 3. Approved equal.
- B. The flume fabrication, engineering and customer support shall all be provided by the same company
- C. To assure quality control and single source accountability, the same manufacturer shall fabricate and fully assemble the flume and all components.

2.02 MATERIALS

- A. Flume body shall be engineered composite fiberglass reinforced plastic (FRP) molded in one piece to create a seamless corrosion barrier impervious to moisture.
- B. FRP resin shall be vinyl ester.
- C. Flume hardware, where applicable shall be T-316L stainless steel.

2.03 CONFIGURATION AND CONSTRUCTION

- A. Flume
 1. Flume throat size shall be 3-inches.
 2. Flume body shall be totally manufactured of fiberglass reinforced polyester.
 3. Each flume shall be molded individually to the exact dimensions specified.
 4. Thickness of the walls and floor of flumes 48-inches and smaller shall not be less than 1/4" (6 mm) thick.
 5. Flume inside surface shall be smooth, isophthalic gelcoat of 10-12 mil (0.25 - 0.51 mm) thickness for UV resistance.
 6. The surface shall be free of exposed reinforcing fibers, and the minimum glass content shall be 30% exclusive of gelcoat surfaces.
 7. The flume shall be reinforced with box section stiffeners down the sides and across the bottom.
 8. The stiffeners shall be joined at the knee to form a rigid dimensionally stable flume.
 9. Reinforcing shall be designed to provide structural support throughout the length and width of the flume floor.
 10. Flume shall be structurally designed to maintain dimensional integrity with a full head of water while being free standing.
 11. Flume shall have a molded-in head gage with dual graduation in "gpm" on the left and "inches" on the right side.
 12. Stiffeners across the top shall be permanent FRP pultruded angle/channel or temporary wood spreaders as required for the job, and shall provide sufficient strength and structural support to resist the stresses that occur during shipping and proper installation of the flume.
- B. Accessories:
 1. Wing walls.
 2. Bulkheads.
 3. Sectioning.
 4. Low profile.
 5. T-304 adjustable stainless steel ultrasonic mounting bracket.

2.04 PHYSICAL PROPERTIES

- A. Structural Characteristics:
 1. The structural characteristics for a 1/8" (3 mm) glass mat laminate shall meet the following minimum physical properties:

Tensile Strength	15,000 psi
Flexural Modulus	1,000,000 psi
Flexural Strength	20,000 psi
Compressive Strength	22,000 psi
Impact Strength	9.0 ft-lbs/in.
Water absorption	0.13% (in 24 hours)

B. Dimensions:

1. The flume shall conform to the physical dimensions listed in Figure 19 of the U.S. Department of Interior, Water Measurement Manual, latest edition. Dimensional tolerance for flumes 4-inches and larger shall be plus or minus 1/8" (3 mm) maximum in the throat, and plus or minus 1/4" (6 mm) maximum elsewhere.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Verify that dimensions are correct and project conditions are suitable for installation. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Thoroughly clean and remove all shipping materials prior to setting.
- C. Install products in accordance with plans, general comments below and the Manufacturer's recommendations.
- D. Care should be taken in the handling, storage, and placement of the flume in preparation for installation. The top spreaders shall be left on the flume until after installation is complete. They may be removed after the grout has been cured, if desired.
- E. The flume shall be installed level end-to-end and side-to-side, and must remain level throughout installation. Flume assembly should be set into a pre-poured block-out/channel.
- F. The contractor shall provide sufficient shoring and bracing of the floor and sidewalls to prevent lifting, floating, buckling or bulging of the sides and bottom during installation. The side locking clips are not intended to be used as anchorage points. Their function is to key the flume into the grout or concrete.
- G. Concrete shall be poured in successive lifts of not more than 6" to 8" per lift. Extra care should be exercised during the first pour to ensure that grout flows smoothly under the floor, and an even fill is achieved. The first lift shall be allowed to set so that excessive hydraulic forces are not transferred to the bottom of the flume by later lifts.

3.02 ADJUSTMENT AND STARTUP

- A. Check flume for being level both directions, meeting dimensional requirements and cleaned per manufacturer's instructions.
- B. Startup/calibration of ultrasonic flow sensor, see section 13329.

END OF SECTION

SECTION 11951

HYDROPNEUMATIC SYSTEM AND AIR COMPRESSOR

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Air compressors, filters, air system appurtenances, and integrated control panel and related instruments for the entire hydropneumatic system (plant water pump, hydropneumatic tank, and air compressor) at the location indicated on Drawings.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 01340 - Technical Submittals.
 - 2. Section 09800 - Special Coatings.
 - 3. Section 11005 - Equipment: General Requirements.
 - 4. Section 11405 - Surge Tank and Hydropneumatic Tank.
 - 5. Division 16 - Electrical.
- C. Supplier shall review all reference sections and Drawings when developing pricing.
- D. The Supplier of the control system shall have unit responsibility for this Section.

1.02 SYSTEM DESCRIPTION

- A. Furnish all materials, equipment, and incidentals required to install, start-up, test, and place into operation the hydropneumatic system including the plant water pump, air compressor and hydropneumatic tank as shown on the Drawings and as specified within.

1.03 QUALITY ASSURANCE

- A. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
 - 1. National Electric Code.
 - 2. Standards of National Electrical Manufacturers Association.
 - 3. Institute of Electrical and Electronic Engineers.
 - 4. American National Standards Institute.
 - 5. Anti-Friction Bearing Manufacturer's Association (AFBMA).
 - 6. American National Standards Institute (ANSI)
 - 7. NEMA Standards.
 - 8. OSHA Rules and Regulations.

1.04 SUBMITTALS

- A. Product Data and Shop Drawings Include:
 - 1. Material List.
 - 2. Literature and drawings describing equipment performance and construction, including parts list, materials, and details of construction and installation.

3. Schematic electrical wiring diagrams and other data as required for complete system.
- B. Equipment Data:
1. Manufacturer.
 2. Dimensional data.
 3. Model.
 4. Motor information.
 5. Site capacity, actual cubic feet per minute.
 6. Discharge pressure, psi.
 7. Weight.
- C. Operation and Maintenance Manuals.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
1. Minimum 3 years' experience in manufacturing similar equipment utilized in water and wastewater treatment plants.
 2. Supply accessories required for compressors (including motors), air filter, and receiver at each well site.
 3. Assume responsibility for compatibility of components furnished.
 4. Furnishing services of factory representatives with complete knowledge of proper installation, operation, and maintenance of equipment to inspect and approve final installation and supervise test runs of equipment.

1.06 ENVIRONMENTAL CONDITIONS

- A. Compressed air supply systems shall be suitable for continuous service. Air compressor should be suitable for outdoor installation.
- B. Typical site conditions are as follows:
1. Elevation is 5,604 feet above sea level
 2. Ambient Temperature:
 - a. Maximum - 85 degrees Fahrenheit.
 - b. Minimum - 30 degrees Fahrenheit.

1.07 SPARE PARTS

- A. Furnish one set of special tools with equipment when required for normal operation and maintenance of air compressor.
- B. Spare Parts:
1. Compressor equipment, including the following:
 - a. Four complete sets of air intake filters.
 - b. Two complete sets of gaskets.
 - c. Two sets of drive belts.
 - d. Four quarts of synthetic lubricant designed for air compressors.

1.08 WARRANTY

- A. The equipment manufacturer shall warrant the OWNER against defects in workmanship and materials including parts and labor for a period of one year.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Pulsco.
- B. Or equal.

2.02 AIR COMPRESSOR

- A. The air compressor system shall include a rotary screw air compressor. Capacity of the air compressor - 92 cfm at standard pressure rated at 42 TO 110 psi.
 - 1. The air compressors should be Charge Air 2000 Model CA 2000.
 - 2. Or equal.
- B. A totally enclosed, fan cooled (TEFC) motor shall drive the compressor and shall be adequate to drive the compressor continuously at full-rated output. The motor should be 25 hp for compressor and comply with electrical specifications. Power supply shall be 230 volts, single phase, 60 Hz.
- C. Baseplate for air compressors:
 - 1. Provide folded mild steel baseplate protected from corrosion with a high grade of powder coated paint finish. The baseplate shall support all the components within the air compressor package.
 - 2. The baseplate shall be provided with fork truck slots to enable easy handling.
- D. Air compressor shall be capable of adjusting water level in hydropneumatic tank in 4 minutes.
- E. Compressor Air Filter/ Regulator/ Gauge:
 - 1. Performance: Remove 99.9% of 0.1-micron particles and oil aerosols.
 - 2. Maximum working pressure: 160 psig.
 - 3. Filter shall be piped into the system with bypass piping for changing the element without shutting down the air system.
 - 4. Accessories: Provide with filter:
 - a. Diaphragm type of gauge.
- F. Each air compressor should be provided with manufacturer's silencer to reduce noise level.

2.03 CONTROL SYSTEM

- A. Provide an integrated control panel for entire hydropneumatic system. Panels should control and monitor air compressors, plant water pumps and hydropneumatic tank. This control

system need not be the same supplier as the air compressor supplier.

- B. Hydropneumatic System Control Panel with the following features:
 - 1. NEMA 12 enclosure - wall mount.
 - 2. Magnetic motor starters for air compressors and plant water pumps.
 - 3. Induction relays.
 - 4. Control relays.
 - 5. Time delay relays.
 - 6. High- and low-level alarm lights.
 - 7. Dry contacts for alarms.

- C. Control Panel shall receive interface with the following instruments:
 - 1. Hydropneumatic tank - elevated level, low level, and low-low water level from the 9-ft long probe bottle as shown on the Drawings. Refer to Section 13329 for specifications on level probe; Mercoïd pressure switch.
 - 2. Air compressor - on/off control relays and motor overload (fault)
 - 3. Plant water pump - on/off control relays and motor overload (fault)

- D. Control System Description:
 - 1. Mercoïd switch on hydropneumatic tank will have a high and low water pressure setpoint to maintain a predetermined pressure range in the air system and the hydropneumatic tank.
 - 2. Based on the pressure setpoints, relay from the switch to the air compressor motor will cause the air compressor to start or stop.
 - 3. Control Panel will be equipped with a HOA selector switch for the plant water pump and manual "START" and "STOP" pushbuttons:
 - a. "HAND" mode will allow manual control of the pump using the START/STOP pushbuttons at the local control panel.
 - b. "OFF" mode will disconnect the manual pushbutton controls and the hard-wire relay from the mercoïd pressure switch.
 - c. "AUTO" mode will cause the compressor to be controlled by the relay from the mercoïd pressure switch.
 - 4. Capacitance probes on the air compressor will have a high and low level setpoint to maintain a predetermined water level range in the hydropneumatic tank.
 - 5. Based on the level setpoints, relaying from the switch to the compressor motor will cause the plant water pump to start or stop.
 - 6. The plant water pump will be shut off (locked out) when the high pressure set point is activated.
 - 7. Control Panel will be equipped with a HOA selector switch and manual "START" and "STOP" pushbuttons:
 - a. "HAND" mode will allow manual control of the plant water pump using the START/STOP pushbuttons at the local control panel.
 - b. "OFF" mode will disconnect the manual pushbutton controls and the hard-wire relay from the capacitance probes.
 - c. "AUTO" mode will cause the service water pump to be controlled by the relay from the capacitance probes.
 - 8. Digital output from the control panel to the Well 23 WTF PLC shall indicate the following outputs. Output is a status indicator only:

- a. Air compressor “RUN” status
 - b. Air compressor “FAIL” status
 - c. Hydropneumatic tank low level alarm
 - d. Hydropneumatic tank high level alarm
 - e. Plant water pump “FAIL” status.
- E. Provide fused disconnects at panel for the air compressor and the plant water pump.
- F. Refer to Section 11005 for additional control panel requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install per manufacturer’s instructions.

3.02 MANUFACTURER’S SERVICES

- A. The Supplier shall provide the services of a qualified, factory trained representative of the manufacturer to check and approve the installation before it is placed in service, supervise initial operation, and testing in the presence of the ENGINEER. The Supplier’s representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.
- B. The Supplier shall provide the services of a qualified, factory trained representative of the manufacturer to instruct the OWNER’S personnel in operation and maintenance of the equipment. Four (4) hours of training will be provided. The 4 hours may not be consecutive if more than one training session is necessary.

END OF SECTION

DIVISION 13
SPECIAL CONSTRUCTION

SECTION 13110

CATHODIC PROTECTION SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope:

1. Provide all labor, equipment, materials, and incidentals as shown on the Drawings, and specified herein. CONTRACTOR shall furnish, install, and place into satisfactory operation one new cathodic protection system for the tank. All work furnished shall be in accordance with AWWA D104 and features included in this specification.
2. The new cathodic protection system shall consist of the following:
 - a. Furnish and install anode and reference electrode assemblies inside the tank with all necessary mounting and conducting cables.
 - b. Furnish and install rectifier, cable, and conduit as necessary for the system.
3. Furnish and install electrical power conduit, wiring and connections to rectifier. All wiring and conduits required for completion of the work is included under this Section.
4. American Iron and Steel Act Requirements – comply with requirements of American Iron and Steel Act per Supplementary Conditions (C-800).

B. See Drawings.

1.02 QUALITY ASSURANCE

A. Manufacturer's/Installer's Qualifications:

1. Manufacturer/Installer shall have a minimum of 5 years' experience of producing substantially similar equipment, and shall be able to show evidence of at least 5 installations in satisfactory operation for at least 5 years.

B. Manufacturer's/Installer's Responsibility: All equipment required under this Section shall be supplied by a single supplier or manufacturer who shall assume responsibility for the adequacy and performance of all the equipment and completeness of the system. The manufacturer shall identify those components furnished by him which are not of his manufacture.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

1. ANSI/NSF 61, Drinking Water System Components - Health Effects.
2. ASTM D1248, Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
3. AWWA D104, Automatically Controlled, Impressed-Current Cathodic Protection for the Interior Submerged Surfaces of Steel Water Storage Tanks.

4. Recommended Practice RP-01-69, National Association of Corrosion Engineers (NACE).
 5. UL-6, Rigid Metal Electrical Conduit.
 6. UL-651, Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
- D. All equipment and material shall be the latest design, and of the highest quality standard product of manufacturers regularly engaged in the production of such equipment and material.

1.03 SUBMITTALS

- A. Shop Drawings: Submit for approval the following in accordance with the Section 01340:
1. Fabrication, assembly and installation drawings, and manufacturer's literature for the following components:
 - a. Rectifier.
 - b. Anode support assembly.
 - c. Anode (titanium with a mixed metal oxide coating) to lead cable connection.
 - d. Tank roof connections, mounting details, and system layout.
 - e. Copy of ANSI/NSF 61 Certification for all system components located within the tank.
 - f. Manufacturer's catalog cuts for the conduit, fittings, supports, conduit identification tags, orange electrical ID tape, and warning ribbon proposed for use. Provide engraved samples of conduit identification tags.
 2. Wiring diagrams.
 3. Submit design calculations signed and sealed by a Registered Professional Engineer in Arizona or National Association of Corrosion Engineers certificated Cathodic Protection Specialist with proven experience of not less than five years in design of cathodic protection systems.
 4. System design shall be based on not less than 25 percent coating failure of submerged surfaces. A current requirement of not less than 0.002 amp per square foot of coating failure surface shall be used in design calculations.
- B. Operation and Maintenance Manuals:
1. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation and spare parts information.
 2. Submit Operation and Maintenance Manuals according to the Section 01340.
- C. Manufacturer's/Installer's Installation Inspection Report:
1. Submit to ENGINEER within 30 days after the manufacturer makes his final inspection of the equipment installation.
 2. Include the following in the report:
 - a. List of deficiencies found.
 - b. Recommended corrective action for all deficiencies.
 - c. Certification that the equipment is properly installed and adjusted, except as noted.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Materials shall be of the latest standard design of manufacturers regularly engaged in the production of such materials. All materials shall meet or exceed the standards established in these Specifications.
- B. All materials in contact with potable water or exposed to the interior of the tank shall be classified in accordance with ANSI/NSF 61.

2.02 DESIGN

- A. Rectifier:
 - 1. General:
 - a. Capacity: Adequate to meet the required protection of the tank.
 - b. Serviceability: Fully field serviceable.
 - c. Rated Temperature: 50C ambient.
 - d. Overall Efficiency: Minimum 65 percent.
 - e. Power Factor: Minimum 90 percent at full load.
 - f. Input power: 120 volt, 1 phase, 60 Hertz.
 - g. Enclosure: Waterproof 16 gauge (minimum) steel cabinet in accordance with NEMA 4 suitable for mounting on brackets. Provide provisions for locking and suitable mounting brackets to attach to the pad mounted Unistrut supports.
 - h. An AC magnetic type circuit breaker properly rated for the rectifier shall be furnished within the rectifier.
 - i. Lightning, surge, and overload protection shall be provided.
 - j. Power cable, conduits, and disconnect switches for rectifier units shall conform to the requirements of this Section. The cathodic protection work shall include connecting AC wiring furnished to the AC input terminals of rectifier unit from the existing power distribution panel.
 - 2. Isolation Transformer:
 - a. The transformer shall have primary and secondary windings and shall allow for not less than 20 equal steps from 0 to 100 percent of power unit rating.
 - b. Enclosed in an air-cooled housing.
 - c. Coating: Three coats of moisture and atmosphere-resistant electric varnish.
 - 3. Type:
 - a. Rectification shall be of the silicon type.
 - b. Rectifier stacks shall be air-cooled with cooling fins.
 - 4. Controls:
 - a. Automatic operation - The automatic controller shall be AWWA D104, Type A and shall adjust current output to compensate for changes in water level, temperature of water, water chemistry, and cathodic polarization, and shall include the following provisions:
 - 1) Utilize long-life solid matrix copper-copper sulfate reference electrode(s) mounted within the tank.
 - 2) Monitor the tank-to-water potential, free of IR drop error.
 - 3) Operate within 25MV of preset value.

- 4) Automatically limit current to a preset value.
 - 5) Utilize potential meter(s) to display tank-to-water potential, free of IR drop.
 - 6) The potential meter shall be an analog type having a 2-inch or larger scale with a full scale reading of 1.5 volts.
5. Control Panel:
- a. DC Amp meters shall be furnished to indicate output of the rectifier.
 - 1) Meters shall be provided for each anode circuit.
 - 2) Meter full scale reading shall not exceed 125 percent of the rating of the power unit.
 - 3) Meter shall be marked with a red line to indicate the power unit rating.
 - 4) Meter shall be analog type having a 2-inch or larger scale.
 - b. Each DC Volt circuit shall have a separate ammeter. Each anode circuit shall be protected by a cartridge type fuse with a rating not exceeding that of the power unit plus 20 percent.
 - 1) Shall be provided to monitor the power unit operating voltage.
 - 2) Meter full scale reading shall not exceed 125 percent of the rating of the power unit.
 - 3) Meter shall be marked with a red line to indicate the power unit rating.
 - 4) Meter shall be analog type having a 2-inch or larger scale.
6. Lightning Protection and Surge Protection:
- a. Each rectifying element shall be equipped with a surge protection device, such as a metal oxide varistor, to eliminate voltage surges across the rectifying elements.
 - b. AC input shall be equipped with a lightning arrester.
 - c. DC output shall be equipped with a lightning arrester.
7. Cable and Conduit:
- a. All DC conductors No. 8 and test leads shall be stranded, single conductor copper with black high molecular weight polyethylene insulation extruded to a thickness of no less than 7/64-inch. The polyethylene shall conform to ASTM D 1248, Type I, Class C, Grade 5.
 - b. Conduit routing shown on the Drawings is schematic in nature. Responsibility to establish single line, riser and interconnection diagrams, belongs to CONTRACTOR. Provide for the proper installation of all conduits for the system.
 - c. The conduit types and the installation methods shall conform to the following:
 - 1) Galvanized rigid steel conduit for exposed exterior conduit runs.
 - 2) PVC coated rigid steel conduit for non-encased underground conduit.
 - d. Reference Standards: Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
 - 1) UL Standard No. 6, Rigid Metal Electrical Conduit.
 - 2) UL Standard No. 651, Schedule 40 and 80 Type EB and A Rigid PVC Conduit and Fittings.
 - 3) ANSI C80.4, Fittings for Rigid Metal Conduit and Electrical Metal Tubing
 - 4) NEMA RN 1, Polyvinyl Chloride (PVC) Externally Coated Rigid Steel Conduit and Intermediate Metal Conduit.

- e. Galvanized Rigid Steel Conduit, Elbows and Couplings:
 - 1) Material: Rigid, heavy wall, mild steel, hot dip galvanized, smooth interior, tapered threads, and carefully reamed ends; 3/4-inch NPS minimum size.
 - 2) Manufacturer: Provide conduit and fittings of one of the following:
 - a) Allied Tube and Conduit.
 - b) Republic Steel Corporation.
 - c) Or pre-approved "Or Equal."
- f. PVC Coated Rigid Steel Conduit, Elbows and Couplings:
 - 1) Material: Rigid, heavy wall, mild steel, interior coating of 2-mil thick urethane, tapered threads, carefully reamed ends, 3/4-inch NPS minimum size for exposed, 1 inch for embedded, encased, or otherwise inaccessible, with a factory exterior coating of 40-mil thick polyvinyl chloride.
 - 2) Color: All PVC coated materials shall be standard dark gray.
 - 3) Tools: Power drives, chucks, z-wrenches, vises, and cutting or bending tools shall follow recommendations for tooling in manufacturer's installation guide. Use touch-up compounds recommended by the manufacturer for repair of minor damage to interior urethane or exterior PVC factory coatings.
 - 4) Manufacturer: Provide conduit and fittings of one of the following:
 - a) Robroy Industries, "Perma-Cote."
 - b) Robroy Industries, "Plasti-Bond."
 - c) OCAL Inc.
 - d) Or pre-approved "Or Equal."
- g. Metallic Conduit Fittings and Outlet Bodies:
 - 1) Material and Construction: Cast gray iron alloy, cast malleable iron bodies, and covers. Outdoor units to be gasketed and water-tight. Gaskets shall be of an approved type designed for the purpose. Improvised gaskets are not acceptable. All units shall be threaded type with five full threads. Material shall conform to ANSI C80.4 and be listed by UL. Do not use "LB" fittings. Use type "LBD" fittings wherever the use of fittings is unavoidable.
 - 2) Manufacturer: Provide conduit fittings and outlet bodies of one of the following:
 - a) Crouse-Hinds Company.
 - b) Appleton Electric Company.
 - c) Or pre-approved "Or Equal."
- h. PVC Coated Conduit Fittings and Outlet Bodies:
 - 1) Material and Construction: Cast gray iron alloy, cast malleable iron bodies, and covers with a factory coating of 40-mil thick polyvinyl chloride, an interior coating of 2-mil thick urethane and Form 8 tongue-in-groove V-seal gasket on sizes 1/2" through 2". Conduit or fittings having areas with thin or no coating shall be unacceptable. Do not use "LB" fittings for conduit sizes of 1 1/4" or larger. Use type "LBD" fittings wherever the use of fittings for conduit sizes of 1 1/4" or larger is unavoidable. All units shall be threaded type with five full threads. Material shall conform to ANSI C80.4.
 - 2) Provide PVC coated conduit fittings and outlet bodies in all corrosive locations.

- 3) Manufacturer: Provide PVC coated conduit fittings and outlet bodies of one of the following:
 - a) Robroy Industries, "Perma-Cote."
 - b) Robroy Industries, "Plasti-Bond."
 - c) OCAL Inc.
 - d) Or pre-approved "Or Equal."
- i. Metallic Conduit Hubs:
 - 1) Material: Threaded conduit hub, vibration proof, weather proof with captive O-ring seal, zinc metal with insulated throat and bonding screw.
 - 2) Manufacturer: Provide one of the following:
 - a) Myers Electrical Products Company.
 - b) Thomas and Betts.
 - c) Or pre-approved "Or Equal."
- j. PVC Coated Conduit Hubs:
 - 1) Material: Threaded conduit hub, vibration proof, weatherproof with captive O-ring seal, zinc metal with insulated throat and factory coating of 40-mil thick polyvinyl chloride and smooth urethane interior coating.
 - 2) Use: Provide for all PVC coated conduit terminations to boxes, cabinets and other enclosures located in all areas.
 - 3) Locknuts are not allowed. Use hubs only.
 - 4) Manufacturer: Provide one of the following:
 - a) Robroy Industries, "Perma-Cote."
 - b) Robroy Industries, "Plasti-Bond."
 - c) OCAL Inc.
 - d) Or pre-approved "Or Equal."
- k. Conduit Bushings:
 - 1) Insulated Bushings: Malleable iron body with plastic liner. Threaded type with steel clamping screw. Provide with bronze grounding lug, as required.
 - 2) Use: Provide for all conduit terminations to boxes, cabinets, other enclosures, and raceways not requiring a hub.
 - 3) Manufacturer: Provide one of the following:
 - a) O-Z/Gedney.
 - b) Appleton Electric Company.
 - c) Thomas and Betts.
 - d) Or pre-approved "Or Equal."

B. Anode Assembly, Anode Handhole, Anode Header Cable, Reference Electrode and Splices:

1. General:
 - a. Anodes shall be vertically mounted within the structure and adjacent to the new handholes.
 - b. Anodes and anode header cable shall be individually supported to the underside of the roof via porcelain pin type insulator, mounted on a 3/8-inch NC thread plated stud bolted through the roof of the tank.
 - c. The pin insulators shall be designed to support a weight of not less than 25 pounds.

2. Anodes:
 - a. Anodes shall be not less than 0.062-inch diameter titanium mixed metal oxide.
 - b. Anode lead wires shall be not less than AWG No. 10 HMW/PE.
 - c. Anode to anode lead wire connection shall be made in a proven manner for this type of submerged application.
 - d. Anode material quantities shall be such as to have a system design life of in excess of 20 years' operating at system rated output.
 - e. Enough anode material shall be provided to ensure a total system circuit resistance of not less than two ohm at full system rated output.
3. Anode Handholes:
 - a. New anode handholes shall be located within 6-inches of each anode assembly, see Drawings.
 - b. New anode handholes shall be 5-inch in diameter, cut into the tank roof prior to coating, all edges shall be ground smooth.
 - c. New handhole covers shall be not less than 6-inch in diameter consisting of galvanized cover plate, full face rubber gasket, PVC clamping bar, and 1/2-inch by 1-1/2-inch 316 stainless steel clamping bolt with peened end.
4. Anode Header Cable:
 - a. Anode header cable shall be run full circle without breaks in the conductor.
 - b. Anode header cable shall be not less than AWG No. 10 HMW/PE.
 - c. Cable shall be run with enough slack to allow the splices to be pulled though the handhole above the tank, not less than 12-inches.
5. Reference Electrodes:
 - a. Two reference electrodes shall be provided.
 - 1) One cell to be located 6-inches above the tank floor, next to tank shell.
 - 2) One cell to be located 10 feet above the tank floor, next to tank shell.
 - b. The reference electrodes shall be a copper-copper sulfate electrode which is of the solid matrix design.
 - c. Manufactured to remain stable with a minimum stable design life of 20 years.
 - d. The reference electrode shall be factory assembled with not less than an AWG No. 14 HMW/PE. The wire to copper core connection shall be encapsulated to prevent water migration.
6. Splices:
 - a. All splices shall be made via appropriately sized crimp connectors. Split bolts shall NOT be used.
 - b. Encapsulation of splices shall be not less than two wraps of ½ lap rubber filler tape covered with two wraps of ½ lap vinyl electric tape suitable for high moisture application and environments.

C. Product and Manufacturer: Provide the following:

1. Accurate Corrosion Control, Inc.
2. Corrpro Companies, Inc.
3. Peak Corrosion Control, Inc.
4. Or pre-approved "Or Equal."

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All electrical work shall conform to the requirements of the National Electrical Code.
- B. CONTRACTOR shall coordinate with CP system manufacturer/installer for all tank work required to install the new CP system.
- C. Anodes and reference electrodes shall be installed from the roof of the tank in a vertical position and shall not require tank draining or refilling.
- D. Handholes, 6-inch diameter galvanized steel with gasketed cover, and a PVC clamping bar shall be provided at the roof next to each anode and reference electrode assembly. The holes shall be cut and ground smooth prior to coating of the tank.
- E. Wire shall run in galvanized rigid steel conduit, 3/4-inch minimum, from the rectifier to the anode circuits. The conduit shall be secured to the tank shell, see Drawings. Wire shall be Type HMW-PE or THWN. The conduits shall be installed after coating of the tank.
- F. Negative lead from the rectifier shall be securely grounded to the tank.
- G. The installation of handhole covers, pin insulators, and electrical connections shall be done with care so as to minimize damage to the paint on the tank.
- H. Install the rectifier as shown on the Drawings.
- I. Galvanized and PVC Coated Rigid Steel Conduits:
 - 1. Install in strict accordance with manufacturer's recommendations and installation manual.
 - 2. Install with manufacturer's installation tools and compounds to prevent damage to the PVC coating.
 - 3. Repair minor damage to interior urethane and exterior PVC coating with manufacturers recommended touch-up compound.
 - 4. Install parallel or perpendicular to structural members or walls.
 - 5. Provide support at manufacturer's recommended distances, or at every eight feet minimum.
 - 6. Locate clear of interferences.
 - 7. Install vertical runs plumb. Unsecured drop length not to exceed feet.
 - 8. Plug or cap conduit ends at time of installation to prevent entrance of moisture or foreign materials.
 - 9. Make conduit connections watertight by applying PVC touch-up compound at the sealing sleeve joints.
 - 10. Terminate with threaded hubs. Do not use bushings or locknuts.

- J. Underground Conduits:
1. Install individual underground conduits a minimum of 24-inches below grade, unless otherwise shown on the Drawings or as required to avoid existing obstructions.
 2. Perform all excavation, bedding, backfilling, and surface restoration including pavement replacement, where required.
 3. Install a warning ribbon 12-inches below finished grade over all conduits carrying cables of 120 volts and higher.
 4. Make conduit connections watertight.

3.02 FIELD TESTING

- A. Corrosion Engineering Firm: Employ a qualified corrosion engineering firm, to perform field testing for the cathodic protection systems.
1. All tests shall be witnessed by the ENGINEER.
 2. The experienced corrosion field engineer performing the field tests shall perform the work under the general supervision of a Registered Professional Corrosion Engineer and/or a Cathodic Protection Specialist as accredited by the National Association of Corrosion Engineers (NACE).
 3. Notify the ENGINEER at least 48 hours in advance before the performance of field tests.
 4. The corrosion field engineer shall be directly responsible to CONTRACTOR and, when requested, shall make daily reports to the ENGINEER.
- B. Testing the completed cathodic protection systems:
1. The completed cathodic protection systems shall be tested by the corrosion field engineer to verify compliance with the applicable requirements of NACE Standard SP-0196-11. These tests shall include all measurements considered necessary to verify proper operation of the systems.
 2. The submerged cathodic protection systems shall be tested using an independent electrode. Potential shall be measured at representative selection of points throughout the structure. Potentials measured with the current applied shall range from -0.85 to -1.1 volt DC.

3.03 MANUFACTURER'S SERVICES

- A. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of 2 visits, minimum 2 hours on-site for each visit to the site. The first visit shall be for assistance in the installation of equipment. The second visit shall be for checking the completed installation and start-up of the system, and training. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the cathodic protection system conforms to requirements. Representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

- B. All costs, including travel, lodging, meals and incidentals, shall be considered as included in CONTRACTOR'S bid price.

END OF SECTION

SECTION 13329

FIELD INSTRUMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. CONTRACTOR shall provide labor, materials, equipment, and incidentals according to:
 - a. Section 11005 - Equipment General Requirements,
 - b. Section 01715 - Equipment Operation and Maintenance Instructions,
 - c. Section 01600 - Product Delivery, Storage, and Handling and as shown in this Section.
 - d. The above requirements are necessary to furnish, install, calibrate, test, adjust and place all the field instruments into satisfactory operation as specified in the above-mentioned sections and this Section.
2. The functional and general construction requirements of the field instruments shall be illustrated and specified clearly in the Contract documents. All the necessary components including components, piping, wiring, accessories, and labor required for a complete, workable, and integrated system shall be provided by the CONTRACTOR.
3. Provide taps in the process piping systems for installation of flow and pressure sensing instruments.
4. The CONTRACTOR shall coordinate the installation of all items specified herein and shall be required to ensure the complete and proper interfacing of all the instruments.

B. Related Work Specified Elsewhere:

1. Division 1: General Requirements.
2. 01340 – Technical Submittals.
3. 01715 - Equipment Operation and Maintenance Instructions.
4. 11005 - Equipment General Requirements.
5. 01600 – Product Delivery, Storage, and Handling.

1.02 REFERENCES

- A. National Electrical Manufacturer's Association (NEMA).
- B. ICS 6, Enclosures for Industrial Controls and Systems.

1.03 QUALITY ASSURANCE

- A. All the field instruments shall be in compliance with the requirements of Section 11005, Equipment General Requirements.

- B. Manufacturers' Acceptable:
 - 1. Named manufactures or other manufacturers who supply approved equal equipment shall be the acceptable manufactures to furnish the field instruments.
 - 2. The named manufacturers are those who have been specified to establish the standard of quality and performance of the equipment to be supplied.
 - 3. All the field instruments of a given type shall be obtained from the same manufacturer.

- C. Manufacturers' Responsibilities:
 - 1. The design and manufacture of the field instruments shall be in accordance with the applicable general requirements specified in Section 11005 - Equipment General Requirements, and the detailed specifications herein.
 - 2. The manufacturer shall be responsible for conducting field supervision, inspection, and start-up operations along with the CONTRACTOR.

- D. CONTRACTOR'S RESPONSIBILITIES:
 - 1. CONTRACTOR shall assume the responsibilities specified below:
 - a. The design and implementation of the field instruments shall be in accordance with the Contract Documents.
 - b. Supervise, check, and approve the installation of all system components and wiring connections prior to placing the instruments into operation.
 - c. Calibrate the instruments, check the operation functions, and test the final control actions.
 - d. The CONTRACTOR shall furnish to the ENGINEER certified calibration reports for field instruments, as soon as calibration is completed.
 - 1) Receipt of any calibration certificate shall in no way imply acceptance of any Work or instrument.
 - 2) The calibration certificate forms shall be prepared and furnished by CONTRACTOR and shall contain the information shown on the sample calibration certificate included at the end of this Section.
 - 3) Each calibration certificate shall be signed and dated by an authorized representative of CONTRACTOR.
 - e. CONTRACTOR shall furnish ENGINEER two (2) copies of an installation inspection report certifying that all equipment has been installed correctly and is operating properly. The report shall be signed by an authorized representative of CONTRACTOR.
 - f. CONTRACTOR to provide O & M manuals for all field instruments.

1.04 EQUIPMENT DELIVERY, STORAGE AND HANDLING

- A. All the field equipment shall be delivered and handled according to the requirements specified in Section 01600, Product Delivery, Storage and Handling.

- B. The field instruments shall not be delivered to the site until all product information and system Shop Drawings for instruments have been approved.

1.05 SUBMITTALS

- A. Submittals shall be in accordance with Section 01340 - Technical Submittals and as specified in this Section.
- B. Shop Drawing submittals shall be in accordance with the requirements of the Contract Documents.
- C. Three (3) copies of each completed calibration certificate shall be submitted to ENGINEER.
- D. Two (2) copies of an installation inspection report shall be submitted to the OWNER.
- E. Field Instruments Shop Drawing Submittal Requirements:
 - 1. Product information for all field instruments, including the following:
 - a. Manufacturer's product name and complete model number.
 - b. Instrument tag number from Contract Documents.
 - c. Manufacturer's data sheets and catalog literature.
 - d. Description of construction features.
 - e. Performance and operation data.
 - f. Installation and mounting details, instructions, and recommendations.
 - g. Service requirements.
 - h. Dimensions.
 - i. Range of each device and calibration information.
 - j. A complete list of all field instruments to be provided shall be part of the submittal. All ranges and setpoints shall be coordinated during the submittal review process. The CONTRACTOR shall provide suggested ranges based on the actual tank sizes, flow, and pressure of equipment to be installed. If changes are required due to a change in the installed equipment, the associated change in the instrument shall be provided at no extra cost.
 - 2. Complete fabrication, assembly and installation drawings and operation, maintenance, and storage instructions, together with detailed specifications and data covering materials used, parts, devices and other accessories forming a part of the equipment furnished.
 - 3. Descriptions of enclosures and materials of constructions of all parts and a listing of NEMA ratings for all equipment.
 - 4. Detailed mounting and installation instructions for each piece of equipment furnished under this Section.

PART 2 - PRODUCTS

2.01 PRESSURE SWITCHES

- A. Type: Bourdan Tube actuating a Snap Action Switch for sensing gage or differential pressure.
- B. Bourdan Tube Material: Stainless Steel\
- C. General Features:
 - 1. Adjustable Operating Range: As per Drawings.
 - 2. Fixed Deadband: Depends on the operating range and is factory set.
 - 3. Switch: Fixed Deadband, Fully Automatic, Single Adjustment Snap Action Switch.

4. Visible operation with On/Off indication.
5. Repeatability: ± 1 of full scale.
6. Snap Action Switch is SPDT rated 15 amp resistive at 120 VAC.
7. Process Connection: 1/4-inch NPT.

D. Control Features:

1. Weather-Proof.
2. Diaphragm Seal.
3. Watertight, Dust-tight NEMA 4X Enclosure.

E. Acceptable Manufacturers:

1. Tri-point SA, SB, SC, SD, and SE Series, as manufactured by ASCO.
2. Mercoid
3. Ashcroft
4. Or equal.

2.02 FLOW SWITCH

A. Type: A vane operated flow switch to actuate an electric switch at a predetermined flow rate.

B. Materials:

1. Vane: 316 Stainless Steel.
2. Body: 316 Stainless Steel standard.
3. Magnet Keeper: 430 SS standard.

C. General Features:

1. Leak proof body.
2. Weatherproof and designed to meet NEMA 4 standards.
3. Pressure Limit: See Equipment Schedule.
4. Required Pipe Diameter: As per diameter of pipes in Drawings and vane combinations provided by the manufacturer.

D. Electrical Features:

1. Electrical Connections:
 - a. UL and CSA models: 16 AWG, 6" long.
 - b. ATEX and SAA unit: Terminal block.
2. Conduit connection: 3/4" female NPT.
3. Process Connection: 1-1/2" male NPT.

E. Acceptable Manufacturers:

1. Flotech by Dwyer Instruments Inc.
2. Or equal.

2.03 ULTRASONIC LEVEL SWITCH/SENSOR

A. Type: The ultrasonic level controller system shall be comprised of a transmitter, an ultrasonic transducer, and cable. The system shall be of the non-contact type for continuous

measurement and control of liquid and solid levels.

B. Performance Requirements:

1. Level Setpoints: (to be determined by the Owner).
2. Electrode Tag Numbers per Drawings.

C. Required Features:

1. The transmitter shall include a front panel mounted, 4-digit LCD indicator, scalable in engineering units. The LCD shall provide messages for loss of echo, and cabling trouble.
2. The transmitter shall provide a 4-20 mA DC analog output signal which is proportional to level.
3. The unit shall also have 5 form-'C'-SPDT relays assignable for level control, totalizing, sampling, and alarming.
4. Transmitter Temperature Range: The transmitter shall be designed to operate from -20 degrees C to +50 degrees C.
5. The transducer shall be encapsulated in chemical and corrosion resistant material, such as Kynar, Teflon, or TEFZEL.
6. Transducer Temperature Range: The transducer shall be capable of operating from -40 degrees C to +73 degrees C. The unit shall be ambient temperature compensated.
7. The transducer shall be compatible with the level range as indicated on the Plans, and shall operate with up to 1200 feet of separation from the transmitter.
8. Measurements Range: The transducer shall be capable of measuring a span of up to 35 feet. The span and range shall be set in the field. Accuracy shall be +/-0.25 percent of range.
9. Power Requirements: The system shall operate on 120 VAC.
10. Enclosures: NEMA 4X for field mounted locations; NEMA 1 for interior panel mounted installations

D. Product Manufacturer: Provide one of the following:

1. Siemens Energy and Automation, c/o Process Dynamics, Inc.
2. Milltronics HydroRanger
3. Or approved equal.

2.04 PRESSURE GAUGES - ASHCROFT TYPE 1279 OR EQUAL

- A. 304 SS Wetted Parts
- B. 4.5" full-size bourdon tube.
- C. Welded tube construction.
- D. "Rounded Cap Tip" construction.
- E. Self-locking micrometer pointer.

- F. Burn-resistant phenol turret case.
- G. Exclusive Teflon coated 400-series stainless steel rotary movement.
- H. Epoxy-coated system.
- I. Pressure Range: 0-150 psi.

2.05 PRESSURE TRANSDUCERS - ROSEMOUNT MODEL 2088 OR EQUAL

- A. Polysicilon pressure sensor with a 316 SS isolating diaphragm and process connector.
- B. Process Connections: ½ - 14 NPT female.
- C. Electronic Housing: NEMA 4X.
- D. Cover O-rings: Buna-N.
- E. Includes one 4-20 mA signal from the pressure transmitter to a central monitoring location.
- F. Pressure Range: 0 - 150 psi.
- G. Units shall have LCD display with a cover for protection.

2.06 CHLORINE ANALYZERS; ENDRESS AND HAUSER.

- A. Analyzer: Model M CCM223/253. One analyzer can be used to transmit readings from 3 sensors.
 - 1. Provide one analyzer for CA 1 <<EDIT THESE AS NECESSARY>>.
 - 2. Provide one analyzer for CA 2, CA 3, and ORP 1.
- B. Sensors: Model CCS140 (Chlorine).
 - 1. Provide three sensors - CA 1, CA 2, CA 3.
- C. Chlorine sensor has a measuring range of 0.05-20 mg/L chlorine.
- D. Sensor shall be mounted in a flow fit WCCA250 model flow assembly. Body of the flow assembly is made of plexiglass and contains a need valve, flow meter, and proximity switch.
- E. Provide cable length as needed between the sensor and analyzer.

END OF SECTION

CALIBRATION CERTIFICATE

Tag Number: _____

Loop Description: _____

Instrument Location: _____

Manufacturer: _____

Model Number: _____

Adjustable Range: _____

Calibrated Range: _____

Remarks: _____

Installation Per Manufacturer's Requirements?	Yes	No
Installation Per Contract Documents?	Yes	No
If "No", explain: _____		

Calibration Test:

	<u>Input (Units)</u>	<u>Output (Units)</u>	<u>Accuracy</u>
0%	_____	_____	_____
10%	_____	_____	_____
25%	_____	_____	_____
50%	_____	_____	_____
75%	_____	_____	_____
90%	_____	_____	_____
100%	_____	_____	_____

Switch Test:

	<u>Setting</u>	<u>Deadband</u>	Switch Point <u>Upscale</u>	Switch Point <u>Downscale</u>
Setpoint 1	_____	_____	_____	_____
Setpoint 2	_____	_____	_____	_____
Setpoint 3	_____	_____	_____	_____
Setpoint 4	_____	_____	_____	_____

CALIBRATION CERTIFICATE (cont.)

I hereby certify that the above information is correct and accurate, to the best of my knowledge, and that the instrument indicated above has been supplied, installed, calibrated, and testing in accordance with the manufacturer's recommendations and the Contract Documents, unless otherwise noted.

Receipt of this Calibration Certification shall in no way imply acceptance of any Work or instrument supplied as a part of this Contract.

CONTRACTOR's Signature: _____ Date: _____

END OF SECTION

SECTION 13334

MAGNETIC FLOW METERS

PART 1 - GENERAL

1.01 SUMMARY OF SECTION

- A. Provide magnetic flowmeters as shown on the Drawings.
- B. Related Sections include, but are not necessarily limited to:
 - 1. Division 1 - General Requirements.
 - 2. Section 01340 - Technical Submittals.
 - 3. Section 01600 - Product Delivery, Storage, and Handling.
 - 4. Section 01715 - Equipment Operation and Maintenance Instructions.
 - 5. Section 11005 - Equipment: General.
 - 6. Division 16 - Electrical.

1.02 REFERENCES

- A. National Electrical Manufacturer's Association (NEMA).
- B. ICS 6, Enclosures for Industrial Controls and Systems.

1.03 SUBMITTALS

- A. Shop Drawings:
 - 1. Product data sheets, including dimensions and material specifications.
 - 2. Documentation to demonstrate compliance with specifications.
 - 3. Manufacturers installation instructions.
 - 4. Flow ranges and levels of accuracy.
 - 5. Electrical power requirements and wiring diagrams.
 - 6. Provide manufacturer's certification that meter operates within specified ranges of accuracy for the given lengths of straight pipe runs upstream and downstream of flow meter.
- B. Operations and Maintenance Manuals:
 - 1. See Section 11005 - Equipment, General Statement.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Krohne Enviromag 2000.

- B. Or approved equal.

2.02 MATERIALS

- A. Body: Carbon Steel.
- B. Liner: Polyurethane.
- C. Electrodes: Stainless steel.

2.03 DESIGN/FABRICATION

- A. Pulsed DC type sensor.
- B. Provide integral flow transmitter mounted with NEMA 4 enclosure for flow meters inside the treatment building.
- C. Solid state circuitry with adjustable span, zero and output signal damping.
- D. Power Supply: Transmitter shall operate at 120 V ac, 60 Hz.
- E. Flow Rate Ranges: Units shall operate under flow conditions specified in Meter Schedule on Drawings with an accuracy of $\pm 0.5\%$ under all conditions.
- F. Outputs: Provide with amplifiers, noise suppression circuitry, signal converting circuitry to produce an isolated 4-20 mA signal and a totalizer pulse signal transmitted to the main control panel.
- G. Include local LCD display calibrated for instantaneous and totalized display.
- H. Flanged end connections rated for 150 psi.
- I. Accessories:
 - 1. Provide all ancillary devices required for a complete installation including grounding rings, signal isolators, cables, and hardware.
 - 2. Meter body and electrical connections shall be suitable for indoor use.

PART 3 - EXECUTION

- A. Installation: As per drawings and manufacturer's installation instructions.
- B. Project Conditions:
 - 1. Environmental Requirements: The instrument selected shall be suitable for the following conditions:
 - a. Humidity: 0–50% relative humidity.
 - b. Ambient temperature limit: 60 to 100 °F with local display.

- C. Manufacturer's Representative shall conduct checkout of equipment installation and provide two hours of training per site.

END OF SECTION

DIVISION 15
MECHANICAL

SECTION 15050

BASIC PROCESS PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Basic piping materials and methods.

1.02 REFERENCES

- A. American Society of Testing and Materials (ASTM):
 1. A106/A106M-19a - 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 09800 for coating requirements for exterior of exposed piping.
- E. American Iron and Steel Act Requirements – comply with requirements of American Iron and Steel Act per Supplementary Conditions (C-800).

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 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 for 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 in 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 above ground 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 evaluated 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 at 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 plates 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 pipes.
 - 2. General Requirements.
 - a. Sleeves 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 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. Couplings 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 for 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 in 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. Evaluating 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 the 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 the manufacturer. Dimensions, size spacing, 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.

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 1/2" 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 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 in 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 stress 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 joint piping, thoroughly clean and wipe joint contact surfaces and then properly dress and make joints.
 4. Immediately prior to pressure testing, clean and remove grease, metal cuttings, dirt, or other foreign materials which may have entered the system.
 5. At completion of work and prior to final acceptance, thoroughly clean work installed under these Specifications. Clean equipment, fixtures, pipe, valves, and fittings of grease, metal cuttings, and sludge which may have accumulated by operation of system, from testing, or from other causes. Repair any stoppage or discoloration or other damage to parts of building, its finish, or furnishings, due to failure to properly clean piping system, without cost to Owner.
 6. Clean chlorine piping by pulling a cloth saturated with trichloroethylene or other suitable chlorinated solvent through each length of pipe. Disassemble valves and

clean with suitable solvent. All surfaces which may come in contact with chlorine shall be thoroughly dry, and free of oil or grease before placing in service.

B. Cleaning Potable Water Piping:

1. Flush and disinfect potable water piping in accordance with Section 15495.

3.06 FIELD QUALITY AND CONTROL

A. General:

1. Upon completion of piping, prior to application of insulation on exposed piping or covering concealed/buried piping, evaluate all piping systems.
2. Evaluate all piping systems at 150 psi for 2 hours, unless otherwise indicated. Pressure shall stabilize within 2% of 150 psi.
3. Isolate equipment which may be damaged by the specified pressure test conditions.
4. Perform pressure test using calibrated pressure gauges and calibrated volumetric measuring equipment to determine leakage rates. Select each gauge so that the specified test pressure falls within the upper half of the gauge's range. Notify the OWNER 24 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 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 systems 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. Evaluate 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 pipelining and coating.

1.02 REFERENCES

- A. American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME):
 - 1. B 16.1 - Grey Iron Pipe Flanges and Flanged Fittings - Classes 25, 125, and 250.
- B. American Society for Testing and Materials (ASTM):
 - 1. A 47 - Standard Specification for Ferritic Malleable Iron Castings.
 - 2. A 183 - Standard Specification for Carbon Steel Track Bolts and Nuts.
 - 3. A 536 - Standard Specification for Ductile Iron Castings.
 - 4. A 674 - Standard Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids.
 - 5. D 792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
 - 6. D 4976 - Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.
- C. American Water Works Association (AWWA):
 - 1. C 104 - Standard for 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.
 - 4. C 111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - 5. C 115 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
 - 6. C 150 - Thickness Design of Ductile-Iron Pipe.
 - 7. C 151 - Ductile-Iron Pipe, Centrifugally Cast.
 - 8. C 600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
 - 9. C 900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. Through 60 in.
- D. National Sanitation Foundation (NSF) 61 - Drinking Water Components - Health Effects.
- E. American Iron and Steel Act Requirements – comply with requirements of American Iron and Steel Act per Supplementary Conditions (C-800).

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 to 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 pipelining 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. Typical: AWWA C 150 and AWWA C 151 with minimum Class 350 wall thickness.
- 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 Flanged 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. Provide gaskets with inserted 13-ounce nylon fabric cloth for pipes 20 inches or larger.
 - 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. Provide Protecto 404 Epoxy interior coating for DIP in wastewater applications per manufacturer's instructions.

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 following 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 15103

STAINLESS STEEL PIPE

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install stainless steel pipe and fittings.
- B. Related Sections: CONTRACTOR shall coordinate the requirements of the Work in this Section along with the requirements of the Sections listed below which include, but is not necessarily limited to, Work that is directly related to this Section.
 - 1. Section 01600 - Product Delivery, Storage, and Handling.
 - 2. Section 01340 - Technical Submittal.
 - 3. Section 05052 - Anchor Bolts, Toggle Bolts, and Concrete Inserts.
 - 4. Section 09800 - Special Coatings.

1.02 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 - 1. Manufacturers of stainless-steel pipes and fittings shall have a minimum of five years of experience producing stainless steel pipes and fittings, and shall be able to show evidence of at least five installations in satisfactory operation.
- B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
 - 1. ANSI B2.1, Pipe Thread.
 - 2. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
 - 3. ANSI B16.11, Forged Steel Fittings, Socket Welding and Threaded.
 - 4. ANSI B36.19, Stainless Steel Pipe.
 - 5. ASTM A 182, Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
 - 6. ASTM A 193, Specification for Alloy Steel and Stainless-Steel Bolting Materials for High-Temperature Service.
 - 7. ASTM A 194, Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
 - 8. ASTM A 240, Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels.
 - 9. ASTM A 276, Specification for Stainless Steel Bars and Shapes.
 - 10. ASTM A 312, Specification for Seamless and Welded Austenitic Stainless-Steel Pipes.
 - 11. ASTM A 320, Specification for Alloy Steel Bolting Materials for Low-Temperature Service.
 - 12. ASTM A 403, Specification for Wrought Austenitic Stainless Steel Piping Fittings.

13. ASTM A 409, Specification for Welded Large Diameter Austenitic Steel Pipe for Corrosive or High Temperature Service.
 14. ASTM A 480, Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
 15. ASTM A 774, Specification for As-Welded Wrought Austenitic Stainless-Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
 16. ASTM A 778, Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
 17. AWS D1.1, Structural Welding Code.
- C. Field Verification: Verify and, if required, correct indicated dimensions and sizes of pipe connections by field measurement prior to preparation of design drawings and fabrications of shop fabricated pipe.

1.03 SUBMITTALS

- A. Shop Drawings: Submit for approval the following:
1. Detailed drawings and data on pipe, fittings, gaskets, and appurtenances. Submit these with Shop Drawings required under Section 01340.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices, which are to be embedded in cast in place concrete in ample time not to delay that Work.
- B. Store materials to permit easy access for inspection and identification. Keep steel members off the ground, using pallets, platforms, and other supports. Protect steel members and packaged materials from corrosion and deterioration.
- C. Store all mechanical equipment in covered storage off the ground and prevent condensation.

PART 2 - PRODUCTS

2.01 REQUIREMENTS

- A. Fabricated Stainless-Steel Pipe:
1. Pipe:
 - a. Type: Pipe and fittings less than 3-inch diameter shall be seamless. Pipe 3-inch diameter and larger may be electrically welded or seamless. Spiral welded pipes are not acceptable.
 - b. Material: ASTM A 240, Type 316L stainless steel.
 - c. Diameter: Pipe diameters shown on the Drawings shall mean the nominal outside diameter of the pipe, except for pipes specified with schedule numbers for wall thickness which shall conform to ANSI.
 - d. Wall Design Criteria:

- 1) Provide a piping system designed to meet the fabrication, installation and service conditions shown on the Drawings and specified.
 - 2) Support weight of pipe fittings and valves using the support system shown on the Drawings or specified.
 - 3) Minimum Wall Thickness:
 - a) Exposed and Submerged Pipe shall be Schedule 5.
 - b) All stainless-steel piping less than 6-inches in diameter shall be Schedule 40.
- e. Fabrication:
- 1) Longitudinal Seams: Maximum of two per section.
 - 2) Girth Seams: Not less than six feet apart, except at fittings and specials.
 - 3) Pipe Ends: Perpendicular to longitudinal axis.
 - 4) Roundness: 1/16-inch.
 - 5) Straightness: 1/8-inch in ten feet.
 - 6) Edges: All joint edges shall be true so as not to leave a shoulder on the inside of the pipe.
- f. Welding:
- 1) Longitudinal Welds: Tungsten Inert Gas or Metal Inert Gas.
 - 2) Circumferential Welds: Heliarc or metallic air process.
 - 3) Grinding: All interior welds shall be ground smooth to provide an internal bead of 1/16-inch or less.
- g. Factory Finish:
- 1) All pipes and fittings shall be pickled after manufacture by immersion in acid bath until all weld discoloration and iron pickup are removed.
 - 2) Passivate all piping welds after fabrication.
 - 3) Thoroughly wash all pipe and fittings with clear water after pickling.
2. Joints:
- a. General:
- 1) Provide flanged joints at valves and equipment.
 - 2) Provide flanged joints for field assembly of exposed and submerged piping.
 - 3) Provide flexible stainless steel expansion joints, where shown on the Drawings.
 - 4) All joints shall be shop welded, unless otherwise shown on the Drawings or specified.
 - 5) Stainless steel pipe fabricated into spool pieces shall have shop-welded circumferential butt-welded joints or flanges.
- b. Flanged Joints:
- 1) Two-part flange:
 - a) Slip-on rolled angle face rings of 1/8-inch stainless for pipe less than 16-inches in diameter and 3/16-inch thick for pipe 16-inches and larger. The angle face ring thickness shall be equal to or greater than the wall of the pipe or fitting to which it is welded and it shall be continuously welded on both sides to the pipe or fitting. The angle leg shall not interfere with the flange bolt holes.
 - 2) Gaskets:

- a) Comply with the manufacturer's recommendations for service conditions as shown in the Drawings.
 - 3) Bolts and Nuts:
 - a) Exposed: Type 316 stainless steel.
 - b) Submerged: Type 316 stainless steel.
 - 3. Fittings:
 - a. Type: Welded or flanged as shown on the Drawings, all stainless steel.
 - b. Construction:
 - 1) Stainless steel fittings, 2-1/2-inch and smaller, shall be ASTM A 403, of the same material and pressure rating as the pipe, threaded, long radius with dimensions conforming to ANSI B16.11.
 - 2) Unless otherwise specified, stainless steel fittings 3-inch and larger shall be of the same material and of the same thickness as the pipe. Long radius elbows up to 24-inches in diameter shall be smooth flow. All short radius, special radius and reducing bends and long radius bends greater than 24-inches in diameter shall be of mitered construction. Reducers shall be tapered, cone type. Tees, crosses, laterals, and wyes shall be shop-fabricated pipe.
 - c. Wall Thickness: Not less than the pipe wall thickness.
 - d. Base Fitting: Provide Type 316L stainless steel.
 - 4. Field Assembly of Piping:
 - a. Field welding of pipe is not permitted.
 - b. Connect exposed and submerged piping with flanges.
 - 5. Threaded Connections: Threaded pipe, gage, or instrument connections shall be made using stainless steel, 150-pound, threaded half-couplings conforming to ASTM A 182 or ASTM A 276, shop welded to the pipe at the locations specified or shown on the Drawings.
- B. Specials:
- 1. Taps:
 - a. Provide taps were shown on the Drawings or required for small pipe and instrument connections.
 - b. Connections shall be welded, forged threaded Type 316L stainless steel boss.
 - 2. Pipe Adapters: Where necessary to join pipe of different type, provide necessary adapters. Ends shall conform to Specifications for the appropriate type of joint.
- C. Product and Manufacturers: Provide one of the following:
- 1. Alaskan Copper.
 - 2. Felker Brothers Corporation.
 - 3. Or approved equal.

2.02 IDENTIFICATION

- A. All pipeline materials shall be stamped, marked, or identified with the following:
- 1. Name of manufacturer.
 - 2. Date of manufacture.
 - 3. Operating design pressure at operating design temperature.

4. Type of service.
5. Manufacturer's part number.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Inspect all piping to ensure that piping is free of defects in material and workmanship.

3.02 INSTALLATION

- A. For piping installation, refer to 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.
- B. American Iron and Steel Act Requirements – comply with requirements of American Iron and Steel Act per Supplementary Conditions (C-800).

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. A126 - Standard Specification for Gray Iron Casting for Valves, Flanges, and Pipe Fittings.
 - 2. A48 - Standard Specification for Gray Iron Castings.
 - 3. A536 - Standard Specification for Ductile Iron Castings.
- B. American Water Works Association (AWWA):
 - 1. C111 - Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
 - 2. C504 - Rubber Seated Butterfly Valves, 3 In. Through 72 In.
 - 3. C508 - Swing Check Valves for Waterworks Service, 2-In. through 24-In. NPS.
 - 4. C110 - Ductile-Iron and Grey-Iron Fittings.
 - 5. C207 - Steel Pipe Flanges for Waterworks Service, Sizes 4 In. Through 144 In.
- 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 - Health Effects.

1.03 DESIGN REQUIREMENTS

- A. Pressure Rating: 150 psi.
- B. Valve to Piping Connections:
 - 1. Valves 3-inch nominal size and larger: Flanged ends unless otherwise specified on the Drawings.

2. Valves less than 3-inch nominal size: Screwed ends.

1.04 SUBMITTALS

- A. Product Data: Submit detailed technical information relating to the valve including description of component parts, materials of construction, performance, dimensions, and weights.
- B. Manufacturer's Published Instructions:
 1. Submit instructions for installation, operation, and maintenance of valves.
 2. Furnish bound sets of installation, operation, and maintenance instructions for each type of valve 3-inch nominal size and larger.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 1. Valves: Manufactured by manufacturers whose valves have had successful operational experience in comparable service.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Underground Bolts: Low-alloy steel in accordance with AWWA C111.
- B. Bronze And Brass Alloys: Use bronze and brass alloys with not more than 6 percent zinc and not more than 2 percent aluminum in the manufacturing of valve parts.
- C. Interior Protective Coating:
 1. Epoxy coat interior non-working surfaces, except stainless steel surfaces.
 2. Coating Types:
 - a. Powder Epoxies:
 - 1) Manufacturers: One of the following or equal:
 - a) 3-M Company, ScotchKote 134; certified to NSF 61 for drinking water use.
 - b) Michigan Chrome and Chemical Company, Micron 650 or 651.
 - c) Or pre-approved equal.
 - b. High Solids Polyamine Cured Epoxy:
 - 1) Manufacturers: One of the following or equal:
 - a) Tnemec: Series 140N Pota Pox
 - b) Ameron: Amercoat 395
 - c) Carboline: Carboguard 891
 - d) Devoe: Bar Rust 223H
 - e) Or pre-approved equal
 3. Clean surfaces to meet SSPC-SP-10, near-white metal blast cleaning, with grit of size recommended by epoxy manufacturer.

4. Apply in accordance with manufacturer's published instructions:
 - a. High Solids Polyamine Cured Epoxy:
 - 1) Not less than 2 coats to the specified thickness.
 5. Coating Thickness: 12 mils except that:
 - a. Coating thickness in grooves for gaskets: 5 mils.
 - b. Do not coat seat grooves in valves with bonded seat.
 6. Quality Control:
 - a. Coating Thickness: Measured with a nondestructive magnetic type of 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 tests.
 - 2) Repair pinholes in accordance with manufacturer's published recommendations.
- D. Underground Valves:
1. Provide underground valves with flanged, mechanical, or other types of joints 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 Operators:
1. Open counterclockwise.
 2. Provide valves located below operating level or deck with extensions for key operation or floor stands and handwheels.
 3. Provide manually operated valves and gates located not more than 6 feet above the operating level with levers, tee handles, wrenches, or handwheels, as shown on Drawings.
 - a. Make the valve operator more conveniently accessible by rolling valves, located more than 5 feet but less than 6 feet above the operating level, toward the operating side.
 - b. Secure tee handles and wrenches to the valve head or stem, except where a handle or wrench so secured constitutes a hazard to personnel; in which case, stow handle or wrench immediately adjacent to the valve on or in a suitable hanger, bracket, or receptacle.
 4. Fit valves located more than 6 feet above operating level with chain operated handles or valve wheels:
 - a. Chains: Sufficient length to reach approximately 4 feet above the operating level.
 - b. Where chains constitute a nuisance or hazard to operating personnel, provide holdbacks or other means for keeping the chains out of the way.

- F. Air Release Valve:
1. Manufacturer: Vent-O-Mat, Series RBXb, APCO, or Pre-approved equal.
 2. Orifice: 5/16".
 3. Size: See Drawings.
 4. Body: stainless steel.
 5. Float: HDPE.
 6. Seat: Buna-N (soft seat).
 7. Float Guide: stainless steel.
 8. O Ring Seat: EPDM rubber.
 9. Other internal parts: stainless steel.
 10. Pressure rating: 150 psi.
 11. Provide isolation valve upstream of air release valve.
- G. Valves equal to and larger than 6-inches and/or throttling service valves shall include hand crank and worm gear actuators. Valves located 60-inches or higher above finished floor level shall include chainwheel actuators. Chains shall hang down within 36-inches of the finished floor level.

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 shall 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 they handle 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 15112

BUTTERFLY VALVES, OPERATORS, AND APPURTENANCES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Metal body lugged butterfly valve, operators, and appurtenances.
- B. Related Sections:
 - 1. Section 09800 - Special Coatings.
 - 2. Section 15110 - Valves.
- C. Where valves are connected to electric actuators, the entire valve and actuator assembly shall be supplied by same Manufacturer/Supplier.
- D. American Iron and Steel Act Requirements – comply with requirements of American Iron and Steel Act per Supplementary Conditions (C-800).

1.02 REFERENCES

- A. American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME):
 - 1. ANSI/ASME B16.1 – Gray Iron Pipe Flanges and Flanged Fittings, Classes 25, 125 and 250.
 - 2. ANSI/ASME B16.5 – Pipe Flanges and Flanged Fittings, NPS ½ through NPS 24 Metric/Inch Standard.
- B. American Society for Testing and Materials (ASTM):
 - 1. A 126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - 2. D 429 - Standard Test Methods for Rubber Property - Adhesion to Rigid Substrates.
- C. American Water Works Association (AWWA):
 - 1. C 110 – Ductile-Iron and Gray-Iron Fittings.
 - 2. C 504 – Rubber-Seated Butterfly Valves.
- D. National Sanitation Foundation (NSF) 61 - Drinking Water Components - Health Effects.

1.03 SYSTEM DESCRIPTION

- A. Design Requirements:
 - 1. General Purpose Butterfly Valves:
 - a. Design Standard: In accordance with AWWA C 504 as modified and complemented herein.

- b. Class: AWWA Class 150B, when not otherwise specified or indicated in the Drawings.
 - 2. Design Requirements for General Purpose Butterfly Valves:
 - a. Design valves and actuators for maximum operating torque, in accordance with and using safety factors required in AWWA C504 and using the following values:
 - 1) Maximum Water Velocity: 16 feet per second with valve fully open.
 - 2) Maximum pressure differential across the closed valve in accordance with AWWA Class designation, or as indicated on the Valve Schedule.
 - b. System head loss characteristic, exclusive of valve, and proportional to the velocity head.
 - c. Coefficient for seating and unseating torque, dynamic torque, and bearing friction in accordance with valve manufacturer's published recommendations.
 - 3. Valve Disc: Seat in at angular position of 90 degrees to the pipe axis and rotate at angle of 90 degrees between fully open and closed positions.
 - a. Do not supply valves with stops or lugs cast with or mechanically secured to the body of the valve for limiting the disc travel.
 - b. Unacceptable Thrust Bearings: Do not provide valves with thrust bearings exposed to the fluid in the line, consisting of a metal bearing surface in rubbing contact with an opposing metal bearing surface.
- B. Performance Requirements:
 - 1. General Purpose Butterfly Valves:
 - a. Tight shut off at the AWWA rated class with flow in either direction.
 - 2. Suitable for the following service conditions:
 - a. Throttling.
 - b. Frequent operation.
 - c. Operation after long periods of inactivity.
 - d. Installation in any position and flow in either direction.

1.04 SUBMITTALS

- A. Shop Drawings: Include certified drawings and material specifications in accordance with AWWA C504, Sections 1.4 and 1.5.
 - 1. Include description of the method of attachment of the edge to the valve disc.
 - 2. Provide size and dimensions of operator/actuators.
- B. Product Data: Include manufacturer's published recommendations for seating and unseating torque coefficient, dynamic torque, and bearing friction for calculation of maximum operating torque.
- C. Provide valve tags for the butterfly valves included in the shop drawing.
- D. Test Reports: Records of tests performed in accordance with AWWA C504.
- E. Certificates: Affidavit of compliance specified in AWWA C504, Section 1.7.

PART 2 - PRODUCTS

2.01 GENERAL PURPOSE BUTTERFLY VALVES

- A. Manufacturers: One of the following:
 - 1. Dezurik
 - 2. VSI
 - 3. Or Approved Equal.

- B. Valve Body:
 - 1. Material: Cast-iron ASTM A 126, Class B.
 - a. Flanges: 150-pound ANSI/ASME B16.1.
 - b. Mechanical Joint Ends: In accordance with AWWA C 110.
 - 2. Body Design:
 - a. Provide short body or long body valves at CONTRACTOR's option, subject to:
 - 1) Location in the piping system so that when the valve is operated, its operation will not interfere with, nor be impaired by, adjacent fittings, valves, equipment, or other installations.
 - 3. Valve body including all internals shall be rated as shown on the Valve Schedule.

- C. Disc Materials:
 - 1. For Liquid Service: Stainless steel or nickel-chrome mating edge on a cast-iron or ductile iron disc. For high pressure applications (see Drawings), only ductile iron is allowed.
 - 2. For Low Pressure Air Service: Stainless steel.

- D. Shaft and Bearings:
 - 1. Shaft: Type 304 or 316 stainless steel.
 - 2. Thrust Bearings: Self-lubricating, sleeve type; Teflon lined with fiberglass backing, or polytetrafluoroethylene (PTFE) with phenolic or stainless-steel backing.
 - 3. Valves in Low Pressure Air Systems and Systems with Operating Temperatures of 250 Degrees Fahrenheit or Higher: Provide valves with Teflon lined bearings with fiberglass backing.
 - 4. Valves in Other Service Applications: Provide valves with polytetrafluoroethylene with phenolic or stainless-steel backing.

- E. Disc Pins: Secure valve disc to shaft by means of solid, smooth-sided, Type 316 stainless steel or Monel, taper, or dowel pin.
 - 1. Extend pins through shaft and mechanically secure in place.

- F. Seats:
 - 1. For valves less than 24 inches Nominal size, bond or vulcanize seats into the valve body.
 - 2. For valves 24 inches Nominal size and larger, mechanically retain seats in the valve body:
 - a. Achieve retaining effect by an epoxy injection method that expands the seat into the body, or by segmented clamping tee lock ring with adjusting screws.

- b. Provide means to prevent nuts and screws used to retain rubber seats from loosening due to vibration or cavitation.
 - c. Seat Retainers: Type 316 stainless steel.
 - 3. Do not provide valves with seats retained by a snap ring.
 - 4. Seat Materials:
 - a. Liquid Service: Buna N, Acrylonitrile Butadiene, natural rubber.
 - b. Low Pressure Air Service: Synthetic rubber suitable for continuous operation at 250 degrees Fahrenheit.
- G. Valve Packing:
 - 1. Valves 4 inches to 48 inches in Nominal Size: Self-adjusting V-type packing or chevron type packing.
 - 2. Valves 54 inches in Nominal Size and Larger: Adjustable V-type packing with bronze packing gland or self-adjusting V-type packing.

2.02 BUTTERFLY VALVE OPERATORS

- A. Type of Actuator is shown in the Valve Schedule.
- B. Manual Operators for Valves less than 8 Inch Diameter: Hand lever type with a locking device so that the valve can be locked in any position with a wing nut.
- C. Provide underground valves 6 inches in nominal size and larger with an enclosed worm gear operator mounted on the valve:
 - 1. Valve Shaft: Extend from the valve to the operator and be as specified for valve shafts.
 - 2. Operator: Gasketed for water tightness.
- D. Manual Operators on Aboveground Butterfly Valves Larger than 8 Inches in Nominal Size: Worm geared; valves 10 inches in nominal size and smaller on low pressure air service may be lever operated.
- E. Fit exposed butterfly valves not specified to have geared operators with ell or tee wrenches, or speed handles for operation.
- F. Where handwheels are specified in Valve Schedule in Drawings, provide speed crank.

2.03 FABRICATION

- A. Shop coat interior and exterior ferrous metal surfaces of valves and accessories, except as follows:
 - 1. Finished surfaces.
 - 2. Bearing surfaces.
 - 3. Stainless steel components.
- B. Surface Coatings:
 - 1. Unfinished Surfaces:
 - a. Interior Surfaces:

- 1) High solids polyamine cured epoxy.
 - b. Exterior Surfaces:
 - 1) Submerged Valves: High solids polyamine epoxy.
 - 2) Buried Valves, Valves in Manholes and Vaults: Coal tar.
 - 3) Other Valves: Rust-inhibitive primer.
 - 2. Polished and Machined Surfaces: Rust-preventive compound.
 - 3. Actuators and Accessories: Rust-inhibitive primer.
- C. Coating Materials:
 - 1. High Solids Polyamine Cured Epoxy:
 - a. Application: Shop apply to iron and steel surfaces, except stainless steel.
 - b. Product: As specified in Section 09800.
 - c. Quality Control: After coating is cured, check coated surface for porosity with a holiday detector set at 1,800 volts.
 - d. Repair holidays and other irregularities and retest coating.
 - 1) Repeat procedure until holidays and other irregularities are corrected.
 - e. Additional field coating, other than touchup coating of damaged surfaces, will not be required.
 - 1) Perform touchup coating within the recoat time recommended by the paint manufacturer.
 - 2) When touchup coating is required after expiration of the recoat time, precede coating by blast cleaning or other surface preparation recommended by manufacturer of the coating material for satisfactory adhesion between coats.
 - 2. Rust-Inhibitive Primer:
 - a. Rust-inhibitive Primers: Compatible with the piping systems coating specified in Section 09800.
 - b. Surface Preparation: As specified in Section 09800.
 - c. Rust-Preventive Compound: One of the following or pre-approved equal:
 - 1) Houghton, Rust Veto 344.
 - 2) Rust-Oleum, R-9.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install valves with valve shafts horizontal, unless a vertical shaft is required to suit a particular installation, and unless a vertical shaft is indicated on the Drawings.
- B. Install pipe spools or valve spacers in locations where butterfly valve disc travel may be impaired by adjacent pipe lining, pipe fittings, valves, or other equipment.

3.02 SCHEDULE

- A. See Drawings.

END OF SECTION

SECTION 15114

CHECK VALVES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes: Silent check valves.
- B. American Iron and Steel Act Requirements – comply with requirements of American Iron and Steel Act per Supplementary Conditions (C-800).

1.02 REFERENCES

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

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. Or pre-approved equal.
 - 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.

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 15115

GATE VALVES AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope:
 - 1. Provide all labor, materials, equipment, and incidentals required to furnish and install all gate valves and appurtenances complete and operational as shown on the Drawings and as specified.
- B. Coordination:
 - 1. Review installation procedures under other Sections and coordinate with the Work which is related to this Section.
- C. Related Sections: CONTRACTOR shall coordinate the requirements of the Work in this Section along with the requirements of the Sections listed below which include, but is not necessarily limited to:
 - 1. Division 1 - General Requirements
 - 2. Section 09800 - Special Coatings.
- D. See Drawings.
- E. American Iron and Steel Act Requirements – comply with requirements of American Iron and Steel Act per Supplementary Conditions (C-800).

1.02 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 - 1. Manufacturers shall have a minimum of five years' 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.
 - 2. Gate valves shall be the product of one manufacturer.
- B. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
 - 1. ANSI B16.1 - Gray Iron Pipe Flanges and Flanged Fittings, Classes 25, 125, and 250.
 - 2. AWWA C 110 - Ductile-Iron and Gray-Iron Fittings.
 - 3. ASTM A 48 – Standard Specification for Gray Iron Castings.
 - 4. ASTM A 126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
 - 5. ASTM A 307 – Standard Specification for Carbon Steel Bolts, Studs and Threaded Rod 60,000 psi Tensile Strength.

6. ASTM A 354 - Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners.
7. ASTM A 436 – Standard Specification for Austenitic Gray Iron Castings.
8. ASTM A 536 – Standard Specification for Ductile Iron Castings.
9. ASTM B 62 – Standard Specification for Composition Bronze or Ounce Metal Castings.
10. AWWA C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
11. AWWA C515 - Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
12. AWWA C550 - Protective Interior Coatings for Valves and Hydrants.
13. American Gear Manufacturers Association (AGMA) Standards.
14. National Electrical Manufacturer’s Association (NEMA).
15. NSF 61 - Drinking Water System Components - Health Effects.

1.03 SUBMITTALS

- A. Shop Drawings: Submit for approval the following:
 1. Manufacturer’s literature, illustrations, paint certifications, specifications, detailed drawings, data and descriptive literature on all valves and appurtenances.
 2. Deviations from Contract Documents.
 3. Engineering data including dimensions, materials, size, and weight.
 4. Fabrication, assembly, and installation diagrams.
 5. Certificates of compliance with AWWA Standards, where applicable.
 6. Corrosion resistance information to confirm suitability of the valve materials for the application. Information on chemical resistance of elastomers shall be furnished by the elastomer manufacturers.
 7. Complete nameplate data of valves.
 8. Special tools list.
 9. Cv values and headloss curves.
- B. Operation and Maintenance Manuals:
 1. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation, and spare parts information.
 2. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01340.
- C. Shop Tests:
 1. Hydrostatic tests shall be performed, when required by the valve specifications included herein.
- D. Certificates: Where specified or otherwise required by ENGINEER, submit test certificates.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the site to ensure uninterrupted progress of the Work.
- B. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the

site. CONTRACTOR shall notify ENGINEER if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition, in accordance with manufacturer's instructions.

- C. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General:

1. Valves shall have manufacturer's name and working pressure cast in raised letters on valve body.
2. Manual valve operators shall turn clockwise to close, unless otherwise specified. Valves shall indicate the direction of operation.
3. The gear actuator and the valve components shall be able to withstand a minimum pull of 200 pounds on the manual operator and an input torque of 300-foot pounds to an actuator nut. Manual operators include handwheel, chains, cranks, lever, and a T-handle wrench.
4. Buried valves shall have mechanical joint ends. All bolts shall be Type 316 stainless steel.
5. Buried valves shall be provided with adjustable two-piece valve boxes and provided with extension stems, operating nuts and covers, unless otherwise shown on the Drawings or specified. Extension stems shall terminate 12-inches below finished grade.
6. Iron body valves shall be provided with screwed-on seat rings. Buried or submerged gate valves shall be of the non-rising stem type. Exposed gate valves shall be rising stem type. Rising stem valves and brass non-rising stem valves shall be provided with O-ring stem seals.
7. For stainless steel bolting, except where Nitronic-60 nuts are required, use anti-seize compound, graphite free, to prevent galling. Strength of the joint shall not be affected by the use of anti-seize compound.
8. All other bolts, nuts and studs shall, unless otherwise approved, conform to ASTM A 307, Grade B; or ASTM A 354.
9. Bolts and nuts shall have hexagon heads and nuts.
10. All materials of construction of the valves shall be suitable for the applications as shown in the Drawings.
11. Protect wetted parts from galvanic corrosion due to contact between two different metals.
12. Buried service valves shall be provided with grease filled actuators with position indicators.
13. Gasket material and installation shall conform to manufacturer's recommendations.

14. Identification: Identify each valve 4-inches and larger with a stainless-steel nameplate stamped with the approved designation. Nameplate shall be permanently fastened to valve body at the factory. Stenciled designations are acceptable for buried valves.
15. All valves shall meet NSF 61 requirements.

B. Gate Valves:

1. Buried, 3-inch Diameter and Larger:
 - a. Standard: AWWA C515.
 - b. Type: Resilient seat, non-rising stem.
 - c. Construction:
 - 1) Body and Bonnet: Ductile Iron, ASTM A 536, coated inside and out with fusion bonded epoxy.
 - 2) Gate: Ductile Iron, ASTM A 536, symmetrically and fully encapsulated with an elastomer having a minimum 1/8-inch thickness suitable for the service intended.
 - 3) Stem: low zinc bronze stem.
 - 4) Stem Seal: "O"-Ring.
 - 5) Stuffing box and Bonnet bolts and nuts: Steel; Bolts – SAE J429 Grade 2; Nuts – ASTM A-563 Grade A – Plated to ASTM F1941 Class Fe/Zn 12c.
 - 6) Provide position indicators for non-rising stem valves.
 - 7) Stuffing Box: Ductile iron, ASTM A-536.
 - d. Pressure Rating: Gate valves shall have the following minimum pressure ratings unless otherwise specified in the Valve Schedule.
 - 1) 3-inch through 16-inch diameter valves: 250 pounds per square inch.
 - 2) 16-inch and larger diameter valves: 150 pounds per square inch.
 - e. End Connection: Unless otherwise shown on the Drawings or specified, valves shall be mechanical joint ends conforming to AWWA C111.
 - f. Interior Coating:
 - 1) All valves shall be coated inside. The steel, cast-iron and ductile iron surfaces, except machined surfaces, shall be epoxy coated in accordance with AWWA C550.
 - g. Testing:
 - 1) Test all valves in conformance with AWWA C515.
 - h. Gear Actuators for Manually Operated Valves:
 - 1) Provide valves with gear actuators conforming to AWWA C515.
 - 2) Size gear actuators for the following maximum differential pressures:
 - a) Maximum Differential Pressure Across Closed Valve: 100 psi.
 - i. Product and Manufacturer: Provide one of the following:
 - 1) Mueller Company.
 - 2) American Flow Control, American-Darling, Series 2500.
 - 3) VSI
 - 4) M&H
 - 5) Clow.

2.02 APPURTENANCES FOR BURIED VALVES

- A. Wrench Nuts:
 - 1. Provide wrench nuts on all buried valves of nominal 2-inch size conforming to AWWA C515.
 - 2. Arrow indicating direction of opening the valve shall be cast on the nut along with the word "OPEN."
 - 3. Material: Ductile iron.
 - 4. The nut shall be secured to the stem by mechanical means.

- B. Extension Stems for Non-Rising Stem Valves and Quarter Turn Buried Valves:
 - 1. Provide extension stems to bring the operating nut to 6-inches below the valve box cover.
 - 2. Minimum Size and Material: Same as valve stem.
 - 3. Maximum Unsupported Length: Three feet.
 - 4. Provide top nut and bottom coupling of ductile iron with pins and set screws of Type 316 stainless steel.

- C. Valve Boxes:
 - 1. Valve boxes shall be as shown on the Drawings and as required.
 - 2. Type: Heavy duty, suitable for highway loading, 2-piece telescopic, and adjustable. Lower section shall enclose operating nut and stuffing box and rest on bonnet.
 - 3. Material: Cast or ductile iron.
 - 4. Coating: Two coats of asphalt varnish conforming to Federal Specification TT-C-494.
 - 5. Marking: As required for service.

2.03 TOOLS AND SPARE PARTS

- A. Provide the following T-Handle Operating Wrenches for Buried Valves:
 - 1. T-handle operating wrench of suitable length and size for each valve that is not readily accessible to direct operation.
 - 2. Quantity: Provide one of each length and size required.

2.04 SURFACE PREPARATION AND PAINTING

- A. Valves, appurtenances, etc., shall receive shop primer and shop finish coating conforming to the requirements of Section 09800, Special Coatings. If any damage to the paint system occurs, the equipment shall be repainted as directed by the OWNER.

- B. Surface preparation and painting shall conform to the requirements of Section 09800, Special Coatings.

- C. All gears, bearing surfaces, machined surfaces and other surfaces which are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. This coating shall be maintained during storage and until the equipment is placed into operation.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install all valves and appurtenances in accordance with the manufacturer's instructions and recommendations, and MAG Standard Specification 610.7 and Avondale Supplemental MAG Detail A1310.
- B. Conform to appendices of AWWA Standards, where applicable.
- C. For buried valve installations, set valve boxes plumb and centered, with soil carefully tamped to a lateral distance of four feet on all sides of the box, or to the undisturbed trench face if less than four feet.

3.02 FIELD TESTS AND ADJUSTMENTS

- A. Adjust all parts and components as required to provide correct operation of the valves.
- B. Conduct a functional field test on each valve in the presence of the ENGINEER to demonstrate that each valve operates correctly.
- C. Test ten percent valves of each type by applying 200 pounds effort on the manual operators. There shall be no damage to the gear actuator or the valve.

3.03 MANUFACTURER'S SERVICE

- A. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of one visit, eight hours on site for each visit to the site. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the valves conform to requirements. Manufacturer's representative shall revisit the job site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.
- B. All manufacturer service costs, including travel, lodging, meals and incidentals, shall be considered as included in CONTRACTOR's bid price.

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.
- B. American Iron and Steel Act Requirements – comply with requirements of American Iron and Steel Act per Supplementary Conditions (C-800).

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 in 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 pipes, 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 appear, the strictest 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 may only 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 at 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 photocells 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 16001

PACKAGED SYSTEMS AND CONTROL PANELS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish and install, ready to use the complete Package Control System as indicated on the Drawings and the Contract Documents.
- B. If any contradictions or inconsistencies appear, the strictest criteria noted and the collective requirements in any and all of the Contract Documents shall apply.

1.02 DEFINITION

- A. Packaged Systems are those equipment(s) which are noted as such in the Contract Documents, the Contractor is providing those equipment(s) to function as a system, or the nature of the operation indicates so.
- B. The Packaged Systems may include, but are not limited to the following:
 - 1. Centrifuges
 - 2. Centrifuge Motor Operated Valves
 - 3. Hydraulic Power Packs and Cake Pumps
 - 4. Thickened Sludge Pumps
 - 5. Primary Sludge Pumps
 - 6. Polymer Blending Units
 - 7. Polymer Solution Feed Pumps
 - 8. Augers and Hopper Valves
 - 9. Sludge Grinders
 - 10. Sludge Mixing Tank Grinders
 - 11. UV Treatment Systems
 - 12. Scrubbers
 - 13. HVAC Chillers
 - 14. Air Handling Units
 - 15. Compressors/Dryers
 - 16. NaOH Pumps
 - 17. Decant Pumps
 - 18. Sludge Transfer Pumps
 - 19. Ferric Chloride Feed Pumps

1.03 SUBMITTALS

- A. Provide submittals for the Packaged Control Panels in accordance with Division

16000 and the Contract Documents.

1.04 RELATED SECTIONS

- A. Related sections may include, but are not limited to the following:
 - 1. Section 16000 - General Electrical Requirements
 - 2. Section 16111 - Conduits
 - 3. Section 16123 - 600 Volt Class Conductors
 - 4. Section 16124 - Instrumentation Class Conductors
 - 5. Section 16130 – Outlet, Pull and Junction Boxes
 - 6. Section 16143 - Terminal Blocks
 - 7. Section 16160 - Enclosures
 - 8. Section 16161 – Control Panels
 - 9. Section 16195 - Electrical Identification
 - 10.
 - 11.
 - 12.
 - 13. Section 16476 - Low Voltage Circuit Breakers
 - 14. Section 16477 - 600 Volt Fuses
 - 15. Section 16902 - Electrical Control and Relays
 - 16. Section 16482 - Solid State Motor Controllers

PART 2 - PRODUCTS

2.01 REFER TO THE EQUIPMENT SPECIFICATIONS FOR FURTHER INFORMATION.

2.02 THE CONTROL SYSTEMS SHALL HAVE THE FOLLOWING AS A MINIMUM:

- A. Main disconnecting means (The main disconnecting means shall be a main circuit breaker or a fused disconnect switch).
- B. Motor circuit protectors and starters for each motor.
- C. Automatic motor alternation with manual override and lead selection. (If the system has more than one motor)
- D. Capability to interface with other related systems/devices as described in the Contract Documents.
- E. Control, delay, timer, and other relays as required.
- F. Push buttons and switches as follows:
 - 1. Start/Lock-Out-Stop
 - 2. Manual-Off-Auto
 - 3. Slow/Fast (if applicable)
 - 4. Forward/Reverse (if applicable)
 - 5. Emergency Stop
- G. Pilot lights as follows:
 - 1. On/Off status
 - 2. Manual/Auto Status

3. Slow/Fast Status (if applicable)
 4. Forward/Reverse Status (if applicable)
 5. Alarm (General malfunction)
 6. Alarms (Individual malfunctions)
 7. The Packaged Control Panel shall incorporate devices to visually represent all information needed to diagnose the individual malfunction alarm cause. The Contractor shall review and confirm all requirements with manufacturer(s) in order to bid a complete working package.
- H. Indicators as follows:
1. Speed LCD display (if VFD controlled)
 2. Running time meters for each motor.
- I. Enclosures
1. Refer to Section 16160 for more information.
- J. The Packaged Systems shall be supplied for a single source of power (480V, 3 phase, or 120/240V, 1 phase). All power and control transformers shall be provided as required. Transformers shall be sized and protected by fuses as required by NEC as a minimum.
- K. The Packaged Systems shall include transient voltage surge suppressors.
- L. The Packaged Systems shall include auxiliary relays, amplifiers, and connections needed for transmission of specified information to the remote location. Auxiliary relays shall also be provided for control and status communication above and beyond the standard Control Panel.

PART 3 - EXECUTION

3.01 GENERAL

- A. Electrical Power and Control
The Contractor shall provide electrical power for all the packaged units including, but not limited to all equipment, instruments, devices, controls, alarms, and lights, as recommended by the equipment manufacturer(s) installation instructions and recommendations, and the Contract Documents.
- B. The Contractor shall review, verify, and confirm all requirements with the manufacturer in order to bid a complete working package and system. This includes, but is not limited to, package control panel, power distribution panel, transformer(s), conductors, inter/intra connections, and all other work needed for a complete working system.
- C. In the situation that a system is not specified and/or the Contractor is proposing an

equal system, the Contractor shall provide all necessary equipment, instruments, devices, controls, alarms, lights, conduits, conductors, and inter/intra connections, in order to provide a complete system. These requirements are above and beyond what is shown in the Drawings and/or specified in the Specifications. The Contractor shall be fully responsible for any and all work resulting from changes requiring more than what is indicated on the Contract Documents.

- D. The Contractor shall refer to Civil, Structural, Architectural, Mechanical, Electrical, P&ID drawings, control descriptions, and all collective Contract Documents for complete information, requirements, implementations, and coordination in order to determine the system control logic.

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 pre-purchased 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. The 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 submitting 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, 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, 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. Contractors 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 selector switches, pushbuttons, pilot lights, starters, and other components.
- C. Control Wire Markers: Install at both ends of each control wire interconnecting between such items as control panels, sensors, and control devices, and each end of control wires within control panels, and other such enclosures. Wiring markers shall correspond to control wire numbers on approved wiring diagrams.

END OF SECTION

SECTION 16111

CONDUITS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. Furnish and install conduits as required, and as shown on the Drawings. Materials employed shall be as shown on the Drawings.

1.02 SUBMITTALS

- A. Submit product 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. Liquid-tight flexible metal conduit shall be liquid and vapor tight, oil and ultraviolet ray resistant and manufactured in accordance with UL 360 standards. Liquid-tight 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, liquid-tight 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 liquid-tight 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 XHHW Type 2 stranded copper, rated for 90 degrees C. All circuit conductors, #6 or smaller shall be "THWN" stranded copper. All other conductors sizes between #2 and #4 shall be "XHHW" 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 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 classifications.

- 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 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 (Mersen), 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 Conductors.
- 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, Vent 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 16161

CONTROL PANELS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Control panels.
 2. Products shall be submitted for review in accordance with Section 16000, and elsewhere in the Contract Documents, prior to installation.

1.02 QUALITY ASSURANCE

- A. Referenced Standards:
1. American Society for Testing and Materials (ASTM):
 - a. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
 2. Joint Industrial Council (JIC): 111
 - a. EMP 1, Mass Production Equipment.
 3. National Electrical Manufacturers Association (NEMA):
 - a. ICS 4, Terminal Blocks for Industrial Use.
 - b. ICS 6, Enclosures for Industrial Controls and Systems.
 - c. 250, Enclosures for Electrical Equipment (1000 V Maximum).
 4. National Fire Protection Association (NFPA):
 - a. National Electric Code (NEC).
 5. Underwriters Laboratory (UL)
 - a. UL 508A, Standard for Industrial Control Panels
- B. Miscellaneous:
1. Prior to placement of conduit feeds, assure approved control panel layouts are available.
 2. Assure completely matching color tones for any individual color specified.
 3. Provide panel with the required NEMA rating per NEMA Publication No. 250 to meet classifications shown on drawings or specifications.
 4. Control panels shall be UL 508A listed and labeled by the panel shop or manufacturer.

1.03 SUBMITTALS

- A. Shop Drawings:
1. Scaled panel face and subpanel face instrument and nameplate layout drawings.
 2. Panel and subpanel materials of construction.

3. Panel and subpanel dimensions and weights.
 4. Panel access openings.
 5. Conduit and wiring access locations.
 6. Internal wiring and terminal block drawings.
 7. Nameplate text.
 8. Scaled layouts of any graphic panels.
- B. Operation and Maintenance Manuals.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Enclosures:
 - a. nVent Hoffman
 - b. Rittal
 - c. Hammond
 - d. Or equal.
- B. Submit requests for substitution in accordance with the Contract Documents.

2.02 MATERIALS

- A. Front Panel, Subpanel or Front Door: Steel.
- B. Frame and Bottom Angles: Steel.
- C. Top, Sides, Back, and Back Door: Steel.
- D. Hinges: Stainless steel.
- E. Nameplates: Phenolic.
- F. Filler Panels: Steel.

2.03 ACCESSORIES

- A. Control Panels:
1. Single function pilot lights.
 - a. Flush, non-protruding.
 - b. Heavy duty lights with glass lenses.
 - c. Colors:
 - 1) Red: "ON" or "RUNNING."

- 2) Blue: "REQUIRED" or "STAND BY."
- 3) Amber: "Alarm."
- 4) Green: "OFF" or "STOPPED."
- d. Lens type with LED illumination.

B. Panel Nameplates and Identification:

- 1. Identify each item on the control panel with rectangular nameplates.
- 2. Provide nameplates with black letters on white background.
- 3. Minimum letter height is 1/2 IN for instrument description and 1/4 IN height for instrument tag number.
- 4. For all panels which have a panel identification number, provide 2 IN high white nameplate with black, 1 IN high lettering with panel identification number.

2.04 FABRICATION

A. General:

- 1. Fabricate panels with instrument arrangements as shown on the Drawings.
- 2. Prime control panels with rust inhibitive shop applied primer and paint with two coats of UV resistant white water-based paint.
- 3. Finish interior of panel with epoxy glass white.
- 4. Provide control panel which meets the following requirements:
 - a. Panel depth per JIC EMP 1 1967, E7.1.4.
 - b. Door opening per JIC EMP 1 1967, E7.1.5.
 - c. Data pocket per JIC EMP 1 1967, E7.1.6.
 - d. Rigidity per JIC EMP 1 1967, E7.1.7.
 - e. Door alignment and reinforcement per JIC EMP 1 1967, E7.1.8.
 - f. Panel holes and openings per JIC EMP 1 1967, E7.3.2, E7.3.3, and E7.3.4.
 - g. Doors per JIC EMP 1 1967, E7.5.
 - h. Clear panel mounting space per JIC EMP 1 1967, E8.2.9.
 - i. Panel mounted control device location per JIC EMP 1 1967, E8.3.4.
 - j. Clearances in enclosures per JIC EMP 1 1967, E8.4.

B. Free Standing Panels:

- 1. Minimum construction thicknesses:
 - a. Front panel, subpanel, or front door with cutouts: 0.123 IN.
 - b. Top, sides, back, filler plates and side or doors with no cutouts: Minimum thickness per, NEMA ICS 6.
- 2. Welded construction.
- 3. Completely enclosed, self-supporting, and gasketed dust tight.
- 4. Edges turned back minimum of 2 IN.
- 5. Seams and corners welded and ground smooth to touch and smooth in visual appearance.
- 6. Arrange control panel faces continuous and flush with face of adjacent electrical motor control centers.

7. Provide filler panels where necessary to close gaps between panels or back of panel and wall. Provide full length flush pan doors.
8. Provide full length piano hinges rated for 1.5 times door plus instrument weight.
9. Furnish doors with keyed alike locking handles and three point catch.
10. Provide appropriate conduit, wiring, and instrument openings in accordance with best panel design.
11. After cutouts have been made, finish opening edges to smooth and true surface condition.
12. Provide each panel with lifting eyebolts. Furnish hot dipped galvanized steel base channels.
13. Slotted bolt holes in base, 1 1/2 long for field adjustment.

C. Wall Mounted Panels:

1. Minimum construction thicknesses:
 - a. Front panel, subpanel, or door with cutouts:
 - 1) Width or height not exceeding 42 IN: 0.093 IN.
 - 2) Width or height exceeding 42 IN: 0.123 IN.
 - b. Side, top, back and doors without cutouts: minimum thickness per NEMA ICS 6.
2. Seams continuously welded and ground smooth.
3. Body stiffeners for extra rigidity if either height or width exceeds 28 IN.
4. Rolled lip around all sides of enclosure door opening.
5. Gasketed dust tight.
6. Three point latching mechanism operated by oil tight key locking handle.
7. Key doors alike.
8. Continuous heavy GA hinge pin on doors.
 - a. Hinges rated for 1.5 times door plus instrument weight.
9. After cutouts have been made, finish opening edges to smooth and true surface condition.
10. Front full opening door.
11. Brackets for wall mounting.

D. Panel Front Construction:

1. Minimum construction thicknesses: per NEMA ICS 6.
2. Welded construction.
3. Edges turned and ground smooth to touch and visual appearance.
4. At joints where panel face meets side walls, provide dustproof sponge rubber gasket entire height and face.
5. Use full length piano hinges rated for 1.5 times door weight for panel access door.
6. Equip doors with locking devices and handle and three point catches.
7. Finish all instrument cutouts smooth and true.

- E. Panel Wiring and Piping:
1. Factory pipe and wire panels to identified terminal blocks equipped with screw type lugs.
 2. Install all wiring without splicing in factory in raceways:
 - a. Size raceways per the requirements of NEC Article 312.
 - b. Raceways shall have removable covers.
 3. Wire bending space shall be in accordance with NEMA ICS 6.
 4. Keep AC power lines separate from low level DC lines, I/O power supply cables, and all I/O rack interconnect cables.
 5. Keep AC signal wires separate from DC signal wires.
 6. When I/O wiring must cross AC power wiring, it shall only do so at right angles.
 7. Arrange circuits on terminal blocks plus any spare conductors on adjacent terminals.
 8. Provide necessary power supplies for control equipment.
 9. Equip each panel with a main thermal magnetic circuit breaker. Limit load to maximum of 80 percent of circuit breaker rating.
 10. Provide all necessary stabilizing voltage transformers, balancing potentiometers, and rectifiers as necessary for specific instrument requirements.
 11. Assure each panel mounted device is bonded or otherwise grounded to panel or panel grounding system by means of locknuts or pressure mounting methods.
 - a. Equip panel with grounding terminals.
 12. Arrange wiring with sufficient clearance for all leads.
 13. Wiring to subpanels or rotary switches shall be individually bundled and installed with a "flexible loop" of sufficient length to permit the component to be removed from panel for maintenance without disconnecting wiring.
 14. Identify all wires with plastic sleeve type wire markers at each end. Markers shall:
 - a. Identify circuit numbers.
 - b. Identify function and polarity.
 15. Provide all wiring according to color code as follows:

COLOR OF INSULATION	120 V, 60 Hz SERVICE	LOW VOLTAGE DC SERVICE
Black	Phase Conductor	
Red	Signal Wire	
White	Neutral	
Brown		DC Common
Orange		24VDC/12VDC Power
Blue		Signal Wires
Green	Ground	Ground

- a. For intrinsically safe instruments, provide uniform and compatible additional color scheme.
 - 16. Termination requirements:
 - a. Terminal block markings, mechanical characteristics, and electrical characteristics shall be in accordance with NEMA ICS 4.
 - b. Terminals shall facilitate wire sizes as follows:
 - 1) 120 V AC applications: Wire size 12 AWG and smaller.
 - 2) Other: Wire size 14 AWG and smaller.
 - c. Provide terminal blocks with continuous marking strip.
 - d. Tag each I/O terminal to indicate tag number of the connected device.
 - e. Provide terminals for individual termination of each signal shield.
 - f. Provide 20 percent excess terminals for future expansion.
 - 17. Pneumatic tubes and appurtenances:
 - a. Provide 1/4 IN OD pneumatic control tubing.
 - b. Main headers within panels shall be minimum 1 IN.
 - c. Compression type pressure fittings.
 - d. Equip panel instrument leads with globe type isolation valve.
 - e. Connection to devices not in the panel shall be terminated on tubing terminal plate.
 - f. Install tubing neatly and mount securely.
 - g. Do not route tubing in front of or in wiring raceways.
 - h. Code terminal plates.
 - i. Supply and install dual function filter regulator to serve pneumatic devices.
- F. Panel Lighting and Power:
- 1. Receptacles:
 - a. Panels less than 4 FT long:
 - 1) One electrical outlet.
 - 2) One LED light fixture with switch(es) and separate circuit breakers.
 - b. Panels or panel faces greater than 4 FT long:
 - 1) One electrical outlet per 6 FT of length.
 - 2) Continuous LED lighting strip with switches and separate circuit breakers.
- G. Environmental Controls:
- 1. Furnish circulation fans near hot spots where required to prevent temperature from exceeding instrument rating.
 - 2. Over temperature switches shall be utilized to provide special cooling if required to maintain operating temperatures within the manufacturer's specified range.
 - 3. Air conditioning applications shall include means of preventing moisture condensation.
 - 4. For panels or control cabinets located outside, or in area classification requiring a NEMA 4 or 4X rating:

- a. Provide printed circuit boards with "Humiseal" conformal coating, covering entire components on both sides of board except not covering adjustable components.
- b. Furnish gold plated edge connectors on circuit board and socket contacts.
- c. Install thermostatically controlled condensation protection heaters or 10 CU IN desiccant packs in enclosures housing electronic equipment.
 - 1) Provide one pack for each 10 CU FT of panel capacity.
- d. All outdoor control panels equipped with PLC controllers shall be air conditioned. The air conditioning unit shall be 120VAC and sized by control panel manufacturer.

2.05 MAINTENANCE MATERIALS

A. Extra Materials:

1. Replacement Bulbs. Provide minimum 25 percent or 25 bulbs, whichever is greater, for replacement indicating light bulbs for each type of indicator furnished in this Project.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install free standing panels on concrete pads as detailed on the Drawings.
- B. Anchor panel fronts rigidly into wall system with approved anchorage devices.

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 non-current-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 liquid-tight 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 sizes 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-gauge 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 studs
 6. Thin-wall 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 studs
 - 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 ensure 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 16476

LOW VOLTAGE CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall furnish and install, low voltage circuit breakers, as indicated on the Drawings and specified herein.

1.02 SUBMITTALS

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

1.03 QUALITY ASSURANCE

- A. The breaker manufacturer's facilities shall be ISO 9001 certified.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Circuit breakers shall be manufactured by Eaton, Square D/Schneider Electric, Allen-Bradley, General Electric, or equal.
- B. Circuit breaker frame, trip, short circuit, and interruption ratings shall be as indicated on the Drawings, except that they shall be coordinated with the ratings of the equipment actually furnished, and shall be modified where necessary to suit the equipment. Circuit breakers to be used in motor control centers shall be as indicated on the Drawings. Where no indication of type is given on the Drawings circuit breakers protecting motors shall be motor circuit protectors, and other circuit breakers shall be molded case type.
- C. Circuit breaker for mounting in motor control centers, or for separate mounting shall be of the air break type, quick make, and quick break, 600 volts, with number of poles as indicated on the Drawings.
- D. Each pole of the circuit breaker shall provide inverse time delay, and instantaneous circuit protection.
- E. The breakers shall be operated by a handle, and shall have a switching mechanism that is mechanically trip free from the handle, so that the contacts cannot be held

closed against short circuits, and abnormal currents. Tripping due to overload, or short circuit shall be clearly indicated by the handle automatically assuming a position between the manual ON and OFF positions. Latch surfaces shall be ground and polished. Poles shall be constructed so that they open, close, and trip simultaneously.

- F. Breakers must be completely enclosed in a molded case. Non-interchangeable trip breakers shall have their covers sealed; interchangeable trip breakers shall have the trip unit sealed to prevent tampering. Ampere ratings shall be clearly visible. Contacts shall be non-welding silver alloy. Arc extinction must be accomplished by means of arc chutes. The minimum interrupting ratings of the circuit breakers shall be at least equal to the available short circuit current at the line terminals.
- G. Circuit breakers shall conform to the applicable requirements of UL 489.
- H. Molded case circuit breakers shall be ambient temperature compensating that provides inverse time delay overload and instantaneous short circuit protection by means of a thermal magnetic element. Compensation shall be accomplished by a secondary bi-metal that will allow the breaker to carry rated current between 25 degrees C and 50 degrees C with tripping characteristics that are approximately the same throughout this temperature range.
- I. On breakers with interchangeable, thermal, adjustable magnetic trip, the accessibility and position of the adjustment knob shall not be changed from those on the standard breaker.
- J. Unless mounted in a switchboard, or panelboard, circuit breakers shall be housed in a NEMA rated enclosure as described elsewhere in these specifications.
- K. Provide circuit breakers with shunt trip mechanisms where shown on the Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Circuit breakers shall be installed as indicated on the Drawings and per manufacturer's instructions.

END OF SECTION

SECTION 16477

600 V FUSES

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. This section covers the requirements for protective fusing on this project. The Contractor shall furnish and install fuses and fuse holders per the Drawings and equipment manufacturer's recommendations.
- B. This specification includes the general requirements for various types of fuses, whether they are shown on the Drawings or not. If fusing is required by codes or manufacturers recommendations, but not shown on the Drawings, this specification shall apply to the type of fusing provided by the Contractor.
- C. Types of fuses specified in this section include the following:
 - 1. Class L time-delay.
 - 2. Class L fast-acting.
 - 3. Class RK1 time-delay.
 - 4. Class RK1 and Class J current-limiting.
 - 5. Class RK5 time-delay.
 - 6. Class K5 time-delay, noncurrent-limiting.
 - 7. Class T current-limiting.

1.02 QUALITY ASSURANCE

- A. The fuse manufacturer's facilities shall be ISO 9001 certified.

1.03 CODES AND STANDARDS

- A. UL Compliance and Labeling: Comply with applicable provisions of UL 248-1, "UL Standard for Safety Low-Voltage Fuses". Provide over-current protective devices which are UL-listed and labeled.
- B. NEC Compliance: Comply with NEC as applicable to construction and installation of fusible devices.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data on fuses, including specifications, electrical characteristics, installation instructions, furnished specialties, and accessories in accordance with Section 16000, and the Contract Documents. In addition, include voltages and current ratings, interrupting ratings,

current limitation ratings, time-current trip characteristic curves, and mounting requirements.

1.05 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers offering fusible devices which may be incorporated in the work include, but are not limited to, the following: Eaton (Bussmann), Ferraz-Shawmut, Reliance, or equal.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Except as otherwise indicated, provide fuses of types, sizes, ratings, and average time-current and peak let-through current characteristics indicated, which comply with manufacturer's standard design, materials, and constructed in accordance with published product information, and with industry standards and configurations.

2.02 CLASS L TIME-DELAY FUSES

- A. Provide UL Class L time-delay fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting transformers, motors, and circuit-breakers.

2.03 CLASS L FAST-ACTING FUSES

- A. Provide UL Class L fast-acting fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting service entrances and main feeder circuit-breakers.

2.04 CLASS RK1 TIME-DELAY FUSES

- A. Provide UL Class RK1 time-delay fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting motors and circuit-breakers.

2.05 CLASS RK1 CURRENT-LIMITING FUSES

- A. Provide UL Class RK1 current-limiting fuses rated 250-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting circuit-breakers.

2.06 CLASS J CURRENT-LIMITING FUSES

- A. Provide UL Class J current-limiting fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating.

2.07 CLASS RK5 TIME-DELAY FUSES

- A. Provide UL Class RK5 time-delay fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protecting motors.

2.08 CLASS K5 ONE-TIME FUSES

- A. Provide UL Class K5 one-time fuses rated 250-volts, 60 Hz, with 100,000 RMS symmetrical interrupting current rating for protecting non-inductive loads.

2.09 CLASS T FUSES

- A. Provide UL Class T fuses rated 600-volts, 60 Hz, with 200,000 RMS symmetrical interrupting current rating for protection of physically small devices.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Fuse types and sizes shall be as indicated on the Drawings. Fuses shall be installed in accordance with the National Electric Code (NEC) requirements and the manufacturer's written instructions.
- B. Install fuses in proper fuse holders.
- C. Where fuses are installed in the motor starters, fuses shall be sized to match the actual motor full load current.
- D. Where fuses are installed in disconnect switches at HVAC units, the fuse sizes shall be sized to meet the HVAC manufacturer's requirements.
- E. Fuses for control transformers shall be sized in accordance with the National Electrical Code.
- F. Fuses shall be installed with the labels clearly visible.

3.02 FIELD QUALITY CONTROL

- A. Prior to energizing fusible devices, test devices for circuit continuity and for short-circuits.

3.03 SPARE PARTS

- A. Furnish 3 spare fuses of each size and type.

END OF SECTION

SECTION 16482

SOLID STATE MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes
 - 1. Solid state motor controllers (SSMC) for use with NEMA Design "B" 460 VAC motors to reduce the current inrush as well as mechanical shocks that can result from starting or stopping a motor across the line.
 - 2. This section pertains to stand-alone solid state motor controllers in addition to those provided as part of a Motor Control Center.
 - 3. Provide SSMC fully assembled as part of a Motor Control Center or as a standalone controller, ready for field installation, testing, and startup.
- B. Related Sections include but are not necessarily limited to:
 - 1. Section 16000 Electrical: Basic Requirements.
 - 2. Section 16161 Control Panels.
 - 3. Section 16170 Grounding.
 - 4. Section 16902 Electrical Controls, Relays, and Alarms.

1.02 SUBMITTALS

- A. Submit the following in accordance with Specification 16000:
 - 1. Complete electrical data on the SSMC and all accessories.
 - 2. Dimensional and weight information on the enclosure (if applicable).
 - 3. Fully developed ladder style elementary diagrams complete with terminal and wire designations. Label or tag all control devices.
 - 4. Comprehensive bill of material for all components used to assemble the finished product.
 - 5. Anticipated heat load for sizing of starter panel HVAC system.
 - 6. Verification that unit is listed by an independent testing laboratory in accordance with Electric Industrial Control Equipment Specification UL508.
 - 7. List of recommended spare parts for 1 year operation.

1.03 QUALITY ASSURANCE

- A. Final assembly to be provided with a UL508 label installed at the point of manufacturer.
- B. The manufacturer shall be a certified ISO 9002 facility.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Package unit to protect against shipping damage.
- B. Store unit in a clean, dry, controlled environment until scheduled installation.
- C. Handle units in accordance with manufacturer's recommendations and in such a manner as to prevent damage.
- D. Replace any unit damaged as a result of improper shipping, storage, or handling.

1.05 PROJECT/SITE CONDITIONS

- A. Unit shall be designed specifically for the environment into which it will be installed.
- B. Provide weather protection, space heating to prevent condensation, and cooling or ventilation as recommended by SSMC manufacturer.
- C. Provide sufficient clearance and housekeeping pads to allow air circulation and to prevent damage from standing water.

1.06 WARRANTY

- A. Provide a 2 year warranty on materials and workmanship from date of startup.

PART 2 - PRODUCT

2.01 MANUFACTURERS

- A. Eaton
- B. Allen-Bradley
- C. ABB
- D. Schneider/Square D
- E. Engineer and Owner approved equal.

2.02 GENERAL DESCRIPTION

- A. Provided in a configuration suitable for panel mounting.
- B. Uses a thyristor bridge consisting of at least two SCRs per phase to control the

starting and stopping of industry standard motors. A soft start/current limit will be obtained by a timed voltage ramp of the thyristors. The thyristors will be controlled in such a manner that a smooth and stable acceleration ramp is ensured, independent of motor load.

- C. Controlled by a microprocessor that continuously monitors the current and thyristor phasing of the starter.
- D. All soft start power ratings shall use the same control module.

2.03 RATINGS

- A. Designed to operate in an ambient temperature of 0° to 50° C.
- B. Storage temperature range shall be -25° to 70° C.
- C. Maximum relative humidity shall be 93% at 40° C, non-condensing.
- D. Designed to operate in attitudes up to 3300 feet. For higher altitudes, derate by 1.2% for each additional 330 feet.
- E. Capable of operation within -15% to +10% of nominal voltage rating and automatically adapt for 50 or 60 Hz.
- F. Capable of supplying 300% of rated full load current for 60 seconds at maximum ambient temperature.
- G. The SCRs shall have a minimum P.I.V. rating of 1400V. Lower rated SCRs with “protection” by MOVs will not be acceptable.

2.04 ADJUSTMENTS AND CONFIGURATIONS

- A. All dialog functions, display units, remote functions, terminal blocks, configuration switches, and adjustment potentiometers shall be accessible on the front of the control module. Exposure to control circuit boards or electrical power devices during routine adjustments shall be prohibited.
- B. Dialog indication shall provide, as a minimum, the following conditions:
 - 1. Soft start ready for start.
 - 2. Soft start starting/stopping motor.
 - 3. Soft start running at full voltage.
 - 4. Thermal pre-alarm condition.
 - 5. Thermal fault.
 - 6. Soft start internal fault.
 - 7. Power supply fault.

- C. Dip switches shall be used for configuring the soft start and will select:
 1. Manual or automatic reset.
 2. Freewheel or controlled stopping.
 3. Stop by deceleration ramp or DC injection braking.
 4. Full voltage boost on start (on or off).

- D. Potentiometers or keypads shall be used for adjusting the operating parameters and will provide:
 1. Motor full load amps adjustable from 50 to 100% of the controller's current rating.
 2. Current limitation on starting adjustable from 2 to 5 times rated motor current.
 3. Voltage ramp adjustable from 1 to 30 seconds.
 4. Deceleration ramp or DC injection time adjustable from 2 to 60 seconds.

- E. Output relays shall provide the following status indications:
 1. Fault trip or soft start: one form A and one form B minimum.
 2. Thermal pre-alarm: one form A and one form B or one form C minimum.
 3. End of start (voltage ramp complete and current below 130% motor FLA): one form A.
 4. Brake (for control of braking contactor if this function is specified): one form A.
 5. Relay functions listed above must be isolated with respect to common.

2.05 PROTECTION

- A. A microprocessor controlled thermal protection system shall be included which continuously calculates the temperature-rise of the motor and soft start and provides:
 1. An overload pre-alarm which indicates by relay contact that the motor has exceeded its rated temperature rise by 100%. This function shall be annunciated only without resulting in fault trip of the motor.
 2. A thermal fault condition which stops the motor if the temperature-rise exceeds 120% of the motor thermal capability.
 3. An analog electronic circuit with a time constant adjustable to the motor's thermal cooling time constant ensuring the memorization of the thermal state even after power supply disconnection or shorting out of the power semiconductors.

- B. The soft start shall have phase loss, phase unbalance and undervoltage protection.

2.06 CONTROL OPTIONS

- A. Provide lockable disconnecting means to isolate the SSMC from incoming power. Disconnects may be either fused or circuit breaker style as shown on the contract

drawings.

- B. Provide lights, push buttons, selector switches, indicators, run time meters, and other accessories as shown on the contract documents. These accessories are to be full size, NEMA 4 rated, heavy duty type. Lights are to be 120 VAC, transformer style, LED, with push-to-test feature.
- C. Control relays are to be plug in style, 120 VAC, provided with DIN rail mounting sockets and shall have an indicating light to show when relay is energized. Contact sets to be rated at minimum 5 amps, 250 VAC.
- D. Provide a control power transformer, 480-120V, sized to accommodate all the control circuit requirements in addition to 25% spare capacity.
- E. The soft start shall accept control logic either by operator devices (push buttons, selector switches, etc.) wired directly into the unit or from external relay logic.
- F. Provide warning label in accordance with the NEC if power is available from more than one source.
- G. Provide nameplates identifying all panel mounted equipment and operator controls.

2.07 SHORTING CONTACTOR

- A. A microprocessor shall control the operation of the shorting contactor via an output relay.
- B. The shorting contactor shall close, shorting the thyristors after the motor current is below 130% of motor FLA and voltage is below nominal voltage (indicating the acceleration ramp is complete), and open on a stop command to allow a deceleration ramp or DC injection stop.
- C. Overload protection shall continue to protect the motor when shorting is used.

2.08 BRAKING CONTACTOR

- A. If required by contract drawings, a microprocessor shall control the operation of the braking contactor via an output relay.
- B. If an overload condition occurs during the injection brake period, braking shall continue as set. When braking is complete, restart shall be prohibited until the motor has cooled.

2.09 ISOLATION AND BYPASS CONTACTORS

- A. If required by contract drawings, provide NEMA rated three-pole isolation

contactor to completely isolate the SSMC from the incoming power in the event of a shorted SCR or another defined fault condition.

- B. If required by contract drawings, provide NEMA rated three-pole reversing style contactor to both isolate the output of the SSMC as well as allow across-the-line starting of the motor.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Mount the SSMC in accordance with manufacturer's recommendations.
- B. Provide sufficient clearance for air circulation and operation of any vent fans or cooling equipment.
- C. Install conduit, pull and terminate all power and control conductors.

3.02 TESTING

- A. Test in accordance with Specification 16920 - ELECTRICAL ACCEPTANCE TESTING.

END OF SECTION

SECTION 16902

ELECTRICAL CONTROLS, RELAYS, AND ALARMS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. This Section includes the following:
 - 1. Pushbutton and Selector Switches
 - 2. Relays
 - 3. Alarms
 - 4. Intrinsic Safety Barriers
 - 5. Wireways
 - 6. Watthour Transducers
 - 7. Elapsed Time Meters and Time Clocks

1.02 RELATED SECTIONS

- A. Section 16000 - General Electrical Requirements
- B. Section 16160 – Enclosures

1.03 REFERENCES

- A. NEMA ICS 1-2000 - Industrial Control and Systems: General Requirements.
- B. NEMA ICS 2-2000 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.
- C. NEMA ICS 6-1993 - Industrial Controls and Systems: Enclosures.
- D. UL 506 – UL Standard for Specialty Transformers.

1.04 SUBMITTALS

- A. Data - a complete list of equipment and material including manufacturer's descriptive data and technical literature, performance charts, catalog cuts and installation instructions, spare parts data for each different item of equipment specified. The data shall include a complete Bill of Materials.
- B. Drawings - containing complete wiring and schematic diagrams, control diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout, anchorage, support and appurtenances of equipment and equipment relationship to

other parts of the work including clearances for maintenance and operations.

- C. Submit shop drawings in accordance with the Contract Documents, and NEMA ICS 1 specifications indicating control panel layouts, wiring connections and diagrams, dimensions, support points.

1.05 PROJECT RECORD DOCUMENTS

- A. Submit record documents in accordance with the Contract Documents.
- B. Accurately record actual locations of control equipment. Revise diagrams included in Drawings to reflect actual control device connections.

1.06 OPERATION AND MAINTENANCE DATA

- A. Submit operation data in accordance with the Contract Documents.
- B. Include instructions for adjusting and resetting time delay relays, timers, and counters.
- C. Submit maintenance data in accordance with the Contract Documents.
- D. Include recommended preventative maintenance procedures and materials.

PART 2 - PRODUCTS

2.01 PUSHBUTTONS AND SELECTOR SWITCHES

- A. Pushbuttons, pilot lights, and selector switches shall be of the full size, heavy-duty industrial, oil tight, 120 volt, with interchangeable pilot lights, plug-in construction, double break silver contacts, chrome plated lock rings, with modular contacts, and NEMA rating equal to that of the enclosure on which devices are installed. All components shall be flush mounted on front of panel, unless otherwise noted.
- B. Provide individual legend plates for indication of switch, push button, and light function (e.g., Open, Closed, Hand-Off-Auto). A list shall be submitted for review and approval.
- C. Pilot lights shall be high intensity LED type. Pilot lights shall have clear lenses and LED lamps colored as shown on the Drawings. Common, remote push-to-test circuitry shall be provided for each control panel to simultaneously test all indicating lights on the panel using a single pushbutton when there are 10 or more lights on the panel. Control panels with less than 10 lights shall utilize individual push-to-test lights and control circuitry.

- D. Pushbuttons shall be maintained or momentary as required and as shown on the Drawings. Provide extended head pushbutton for all stop functions, mushroom head for emergency stop functions, and flush head pushbuttons for all other functions. Where indicated on the Drawings pushbuttons shall be illuminated type. Provide locking mechanism for all lock out functions. Selector switches shall have black knob operator, be maintained contact type unless noted otherwise, number and arrangement as required to perform intended functions specified but not less than one double pole, double throw, double break contact per switch. Contact rating shall be compatible with AC or DC throughput current of devices simultaneously operated by the switch contact but not less than 10 amperes resistive at 120 volts AC or DC continuous.
- E. Potentiometers shall be provided with operators and resistive elements of the type and quantity indicated on the Drawings and as required with legend plates indicating percent of span.
- F. The above devices shall be manufactured by Eaton, Square D/Schneider Electric, Allen Bradley, General Electric, or equal.

2.02 RELAYS

- A. TIMING RELAYS shall be heavy duty, have 250V/5A rated contacts, solid state design, poles as required per application, -10°C to +60°C, have timing repeatability of $\pm 2.0\%$ of setting, and be UL listed. The range shall be determined from the control descriptions and or schematic drawings. Provide mounting accessories, as required. The timing relays shall be manufactured by Eaton, Allen Bradley, Square D/Schneider Electric, or equal.
- B. CONTROL RELAYS shall be of the plug-in socket base type with dust-proof plastic enclosures, with silver-cadmium oxide contacts rated 250-volt, 10 amperes, with contact arrangement and operating coils of the proper voltage as required by the control circuit sequence. Relays shall have indicating lamps to show energized state. Each relay shall have a minimum of two double pole, double throw contacts, or as required. Control relays shall be Eaton, Allen Bradley, Square D, or equal.
- C. ALTERNATING RELAYS shall be UL listed, 120 VAC, with contacts rated for 10 amperes at 250 VAC, life expectancy of 100,000 operations, load indicating LEDs, and switch for load locking and load selecting options. Alternating relays shall be manufactured by TimeMark Corporation models 261, 271, and B471, ATC Diversified Electronics model ARA, or equal.

2.03 ALARMS

- A. AUDIBLE ALARMS shall be UL listed, 120 VAC, with solid state circuitry, vibrating horn, non-metallic corrosion resistant housing, with required mounting hardware, suitable for outdoor use capable of producing 100 dB at 10 feet. The

audible alarm shall be manufactured by Federal Signal model 350, Edwards model 870-EX, or equal.

- B. ROTATING BEACONS for interior and/or exterior locations shall be UL listed, 120 VAC, rotating lights at 60 times per minute minimum with required mounting hardware. Lens color shall be verified at the time of construction. The rotating beacons shall be manufactured by Federal Signal model 371LED or equal.
- C. ROTATING BEACONS for corrosive and/or hazardous locations shall be UL listed, 120 VAC, with solid state circuitry, rotating lights at 60 times per minute minimum, suitable for outdoor use with halogen bulb capable of producing 265 lumens with required mounting hardware. Lens color shall be verified at the time of construction. The rotating beacons shall be manufactured by Edwards model 52 or equal.
- D. STROBE BEACONS shall be UL listed, NEMA 4X, 12-24VDC or 120 VAC as indicated on drawings, flashing at 80 times per minute minimum, producing peak candlepower of 520,000, effective candlepower of 165, with required mounting hardware. Lens color shall be verified at the time of construction. The rotating beacons shall be manufactured by Federal Signal model 151XST, or equal.

2.04 INTRINSIC SAFETY BARRIERS

- A. INTRINSIC SAFETY BARRIERS shall permit connection of devices located in a hazardous area to other devices located in a safe area. Intrinsic safety barriers shall be EMC compliant, 24 VDC, up to 35 mA output current, hazardous area terminals identified by blue labels, terminals accommodating conductors up to 12 AWG, ambient temperature rating of -20 to +50°C. The intrinsic safety barriers shall be manufactured by Eaton MTL, Ronan Engineering Co., R. Stahl Inc., or equal.

2.05 WIREWAYS

- A. WIREWAYS shall be PVC, snap-in slot design, with non-slip cover. Safe area wireways shall be light gray and marked "Safe Area Wiring." Hazardous area wireways shall be intrinsic blue and marked "Hazardous Area Wiring." The wireways shall be manufactured by Panduit Corporation, or equal.

2.06 WATTHOUR TRANSDUCERS

- A. WATTHOUR TRANSDUCERS for active or reactive power shall be DIN rail and surface mount, single phase or three phase with balanced or unbalanced load, electrically isolated input, and output signals, 4 to 20 mA output signal, 1 to 6 A input current, 100 to 690 VAC input voltage. The wathour transducers shall be manufactured by Camille Bauer Sineax model P530/Q531, or equal.

2.07 ELAPSED TIME METERS AND TIME CLOCKS

- A. ELAPSED TIME METERS shall be self-powered, non-reset, solid state counter which provides silent, accurate and noise immune operation. Elapsed time meters shall require no external power, five year minimum battery life, 120 VAC power, accessories for panel mounting, nameplate below LCD display reading "HOURS", liquid crystal display with 6 digits approximately 2 inches high with 99,999 hour minimum display life and indication of sufficient battery power. The elapsed time meters shall be manufactured by Eaton, or equal.
- B. TIME CLOCKS shall be microprocessor based, have 24 hour time control, up to 24 operations per day, programmable from panel face keys, skip-a-day feature allowing schedule to be skipped for one to seven days, SPDT switch contact rated at 15 amps at 120 VAC, with battery carryover to maintain time and program during power outage for 275 hours. The time clocks shall be manufactured by Tork, or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Fasteners shall be type 304 stainless steel.
- B. Install devices in strict accordance with NEC requirements and per manufacturer's recommendation.
- C. Coordinate with other trades as necessary during installation of these devices.

3.02 ACCEPTANCE

- A. All installations are subject to evaluation in accordance with NEC requirements and manufacturer's recommendations. Contractor shall remove the unacceptable work and correct work at no charge to Owner.

END OF SECTION

SECTION 16920

ELECTRICAL ACCEPTANCE TESTING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes
 - 1. Requirements for electrical acceptance testing of electrical equipment and materials.
 - 2. It is the intent of the tests described herein to assure that all electrical equipment is operational and within industry and manufacturer's tolerances and is installed in accordance with design specifications.
 - 3. Acceptance testing performed by equipment vendors at the point of manufacturer must conform to all requirements of this specification. Testing performed at the point of manufacture which conforms to generally accepted industry practices is also acceptable so long as adequate test result documentation is provided.

- B. Scope
 - 1. All of the Acceptance Tests are required to be performed whether they are described in this Section or other applicable Sections. At a minimum, the following electrical systems are to be tested:
 - a. Service entrance section.
 - b. Standby generator
 - c. Main distribution panel
 - d. Motor control centers
 - e. Switchgear, low and medium voltage
 - f. Panelboards, power, and lighting/receptacle
 - g. Transformers, dry type, and oil filled.
 - h. Feeders
 - i. Cables rated 600 volts and higher
 - j. Transfer switches, manual and automatic
 - k. Surge Protective Devices
 - l. Grounding and bonding system
 - m. Lighting fixtures and associated controls
 - n. 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
INSTRUMENTS AND CONTROLS

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 in the drawings:
 - a. Provide all instruments.
 - b. Provide all control panels.
 - 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 conduits, 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 in 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 in this section.

- F. Unit Prices
 - 1. Not applicable in this section.
- G. Measurement Procedures
 - 1. Not applicable in this section.
- H. Special Payment Procedures
 - 1. Not applicable in 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 principles 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 the 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)
 - 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, owner's 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. Contractors performing the work shall have a minimum of 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 in this section.

D. Field Samples

1. Not applicable in this section.

E. Mock-Ups

1. Not applicable in this section.

F. Pre-Installation Meetings

1. Not applicable in 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 since the 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, require excessive operator intervention, or result 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, and so on. 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, and so on.
 - 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 are all 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 has 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. Contractors are 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 logbook. 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 in 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 in this section.

2.03 MATERIALS

- A. All materials are to be new and the manufacturer's 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 multiloop supply shall be indicated on the respective instrument panel or enclosure.

2.05 EQUIPMENT

- A. All equipment is to be new and the manufacturer's 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 in this section.

2.07 ACCESSORIES

- A. Not applicable in this section.

2.08 MIXES

- A. Not applicable in 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 in this section.

PART 3 - EXECUTION

3.01 ACCEPTABLE INSTALLERS

- A. Contractors having a minimum of 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 in this section.
- B. Surface Preparation
 - 1. Not applicable in 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 support for heavy equipment or assemblies. Prime and paint support 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 wirings 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 in this section

3.07 CONSTRUCTION

- A. Special Techniques
 - 1. In accordance with manufacturer's recommended installation procedure.
- B. Interface with Other Work
 - 1. Coordinate with all other trades.
- C. Sequences of Operation
 - 1. Not applicable in this section.

- D. Site Tolerances
 - 1. Not applicable in this section.

3.08 REPAIR/RESTORATION

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

3.09 RE-INSTALLATION

- A. Not applicable in 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 in this section.

END OF SECTION

SECTION 17120

PRESSURE TRANSMITTERS

PART 1 - GENERAL

1.01 SCOPE

- A. This section includes furnishing Pressure Transmitters as shown 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. Manufacturers shall assume responsibility for, and guarantee performance of furnished equipment. 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.

1.04 MANUFACTURERS

- A. Pressure transmitter manufacturers shall be as manufactured by Endress + Hauser, Rosemount, Yokogawa, or equal.

PART 2 - PRODUCTS

2.01 PRESSURE TRANSMITTER

- A. Provide pressure transmitters with ½-inch NPT process connection, block and bleed valve, and local LCD indicator scaled in engineering units.

- B. Transmitters shall be of a two-wire type, 24 VDC powered, producing a 4 to 20 mA output proportional to the calibrated pressure range of the instrument. Transmitters shall be capable of driving a minimum of a 500-ohm loop load.
- C. Instrument accuracy shall be within +/- 0.75 percent of calibrated span.
- D. Transmitters shall have external zero and span adjustment for field calibration.
- E. Instrument housing shall be NEMA 4 rated or NEMA 6P rated if any potential for instrument submersion exists. Instrument wetted parts shall be 316 stainless steel or hastiloy C based on process fluid being measured.
- F. Diaphragm seals:
 - 1. Provide fill/bleed screw to permit filling of instrument and diaphragm seal.
 - 2. Process Connection: ½-inch NPT.
 - 3. Filling fluid: Silicone
 - 4. Provide a clean-out ring which holds the diaphragm captive in the upper housing to allow the upper housing assembly to be removed for recalibration or cleaning of the process side housing without the loss of filling liquid or change in calibration.
 - a. ¼-inch NPT flushing connection.
 - 5. Top housing shall be type 316 stainless steel.
 - 6. Complete diaphragm seal assembly, including gage, transmitter, shall be factory assembled, filled, and calibrated to the ranges specified prior to shipment.
 - 7. System suppliers shall be responsible for assuring that fill volumes and sensitivities of the supplied seals and diaphragms are suitable to provide the required gage or transmitter accuracy over the specified measurement range.
 - 8. Diaphragm seals shall be manufactured by Ashcroft or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Equipment and materials specified in this section shall be installed, connected, and tested in accordance with the manufacturers' recommendations, as shown in the Drawings. Contractors shall coordinate with other trades to ensure proper connection to piping and other mechanical equipment.

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.

END OF SECTION

SECTION 17121

PRESSURE SWITCHES

PART 1 - GENERAL

1.01 SCOPE

- A. This section covers Pressure Switches and Differential Pressure Switches as shown in the Drawings.
- B. Related work specified elsewhere includes, but is not limited to Section 16000, electrical. Also refer to requirements of General Conditions 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. Manufacturers shall assume responsibility for, and guarantee performance of the equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functioning of the equipment.
- B. Reference standards shall be the latest edition, including addenda, supplements, and revision. Applicable reference publications include the following:
 - 1. NEC
 - 2. NEMA

1.03 SUBMITTALS

- A. Submit product information cut sheets containing manufacturer's specifications, Operations and Maintenance data, instrument enclosure type, installation location, and process pressure range to be supplied. Indicate product part number in full.
- B. Provide submittals in accordance with Section 16000, and elsewhere in the Contract Documents.

PART 2 - PRODUCTS

2.01 PRESSURE SWITCHES

- A. Pressure switches shall be capable of dual control with independent set points and adjustable deadbands. Differential pressure switches shall be capable of single control with adjustable set points and adjustable deadband. Switches shall be snap action, single-pole, double-throw switching elements with an electrical rating of at least 10 amperes at 120 VAC. Pressure

switches shall be enclosed in a NEMA 4 or weatherproof housing.

- B. Operating pressures and set points shall be determined in the field, unless otherwise indicated on the Drawings.
- C. Set points shall be fully adjustable and shall be in the middle of the working range. Set point adjustments shall be made with adjustment screws or thumbwheels. Accuracy shall be plus or minus one percent of adjustable range.
- D. For pressures up to 150 PSIG pressure sensing element shall be of the diaphragm or bourdon tube type, and shall have a proof pressure of at least twice the maximum working pressure. For pressures above 150 PSIG, sensing element shall be bourdon tube type. Diaphragms or bourdon tubes shall be stainless steel.
- E. Pressure switches shall be installed with individual ball valves for isolation. Valve material shall be compatible with the process piping and process fluid. In addition, process piping up to the sensor shall be insulated to protect against freezing.
- F. Setpoint accuracy: +/- one percent of span.
- G. All wetted parts shall be rated for fluid being measured.
- H. Pressure switches shall be manufactured by Mercoid Controls Series DAW, Barksdale Control Products Series D2H, or equal.
- I. Differential pressure switches shall be manufactured by Mercoid Controls Series DPAW, Barksdale Control Products Series DPD1T, or equal.
- J. Diaphragm seals:
 - 1. Provide fill/bleed screw to permit filling of instrument and diaphragm seal.
 - 2. Process Connection: ½-inch NPT.
 - 3. Filling fluid: Silicone
 - 4. Provide a clean-out ring which holds the diaphragm captive in the upper housing to allow the upper housing assembly to be removed for recalibration or cleaning of the process side housing without the loss of filling liquid or change in calibration.
 - a. ¼-inch NPT flushing connection.
 - 5. Top housing shall be type 316 stainless steel.
 - 6. Complete diaphragm seal assembly, including gage, transmitter, shall be factory assembled, filled, and calibrated to the ranges specified prior to shipment.
 - 7. System suppliers shall be responsible for assuring that fill volumes and sensitivities of the supplied seals and diaphragms are suitable to provide the required gage or transmitter accuracy over the specified measurement range.
 - 8. Diaphragm seals shall be manufactured by Ashcroft or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Equipment and materials specified in this section shall be installed and connected as specified and shown on the drawings. Contractor shall coordinate with Mechanical and Piping to ensure proper connection to piping and/or other mechanical equipment.

3.02 ACCEPTANCE

- A. As a condition precedent 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.

END OF SECTION

SECTION 17123

ULTRASONIC LEVEL TRANSMITTER

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. This section covers the Ultrasonic Level Transmitters and Controllers 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. Manufacturers shall assume responsibility for, and guarantee performance of furnished equipment. 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 ULTRASONIC LEVEL CONTROLLER

- A. The ultrasonic level controller system shall be comprised of a transmitter in a NEMA 4X housing, an ultrasonic transducer, and cabling. 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 LCD indicator, scalable in engineering units. The transmitter shall provide a minimum of two isolated 4-20 mA DC analog output signals which are proportional to level and are capable of driving a minimum of a 750-ohm loop load. The unit shall also have a minimum of two form 'C' relays and a minimum of four form 'A' relays assignable for level control, totalizing, sampling, and alarming. The LCD shall provide messages for loss of echo, and cabling trouble.

- C. Minimum operating temperature range shall be -20 degrees C to +50 degrees C.
- D. The transducer shall be capable of operating from -40 degrees C to +95 degrees C. The transducer shall be compatible with the level range as indicated in the Drawings and shall operate with up to 1200 feet of separation from respective transmitter. Transducer shall be a Siemens EchoMax series or equal.
- E. The transducer shall be capable of measuring a minimum span of 33 feet, or as required to satisfy minimum span requirements of specific application, whichever is greater. The span and range shall be set in the field.
- F. Shall be capable of differential control.
- G. Accuracy shall be +/-0.25 percent of full scale.
- H. Shall have built in Modbus RTU (via RS-485) communications provision and shall be capable of being equipped with a communications module to facilitate communications of instrument data via the Ethernet/IP or Modbus TCP/IP protocols.
- I. The system shall operate on 120 VAC or 12-30VDC, as indicated on drawings, and shall be Siemens HydroRanger 200 HMI, or equal.

2.02 ULTRASONIC LEVEL TRANSMITTER

- A. Where ultrasonic measurement is indicated on the Drawings, but relay control is not required, and the measurement span is less than 16 feet, the Siemens Sitrans LU240 or equal shall be used. For intrinsically safe applications, the Siemens Sitrans LU240 or equal shall be utilized.
- B. Transmitter shall be 2-wire, 4 to 20mA loop powered.
- C. The instrument shall have a measurement range of 0.8 to 16.4 feet.
- D. Accuracy in air shall be 0.25% of measurement range.
- E. Transmitter shall have integral temperature compensation.
- F. Operating temperature shall be -30 to +60 degrees C.
- G. Output shall be 4-20 mA and capable of driving a minimum of a 600-ohm loop load.
- H. Enclosure shall be NEMA 6 rated.
- I. All mounting hardware shall be stainless steel.

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

END OF SECTION

SECTION 17137
MAGNETIC FLOWMETERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. This section covers the Magnetic Flowmeters 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. Manufacturers shall assume responsibility for, and guarantee performance of furnished equipment. 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 MAGNETIC FLOWMETERS:

- A. Materials:
 - 1. All mounting hardware shall be 316 stainless steel, flow sensor liner shall be Polyurethane, and electrode material shall be 316 stainless steel.
- B. Transmitter configuration whether remote mount style or integral mount, shall be as indicated on drawings.
- C. Design and fabrication
 - 1. Utilize characterized field principle of electromagnetic induction to produce signal directly proportional to flow rate.
 - 2. Provide flanged end connections per ANSI B16.5 - 2017 rated for piping system operating and test conditions.

3. Operating pressure: 100 psi (min.).
 4. Transmitter/display ambient temperature range: -4 to 122 deg. F (min.).
 5. Allowable process temperature range: -4 to 122 deg. F (min.).
 6. Grounding requirements:
 - a. Nonmetallic or lined pipe:
 - 1) Inlet and outlet grounding rings of same material as electrode.
 - b. Conductive piping:
 - 1) Conductive path between the meter and the piping flanges.
 7. Provide cable between magnetic flowmeter and transmitter (N/A for applications requiring integral mount transmitter).
 8. Pulsed DC magnetic field excitation.
 9. Adjustable low flow cutoff.
 10. Transmitter: NEMA 4X rated.
 11. Capable of being equipped with a communications module to facilitate communications via Ethernet/IP protocol.
 12. 4-line backlit display with touch control and guided menus.
 13. Empty pipe detection to prevent false measurement when tube is empty.
 14. Accuracy:
 - a. +/- 0.5 percent of reading.
 15. Flow rate signal: isolated, 4-20 mA output capable of driving a 0-700-ohm load.
 16. Scaled totalized flow pulse output.
 17. Power supply: 100-240V AC 60 Hz, or 24V DC or AC 60 Hz, as required by application.
 18. Fluid conductivity range: 5 to 10,000 $\mu\text{S}/\text{cm}/\text{cm}$.
- D. Acceptable Manufacturers:
1. Endress + Hauser Promag W 400
 2. 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. The Contractor shall coordinate the installation with the other trades, to insure proper installation of the flow element, 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 the Owner with a list of the manufacturers' recommended spare parts.

END OF SECTION