SITE 12 TREATMENT EXPANSION – GMP 1
NEW WELLS, STORAGE TANK, RO SYSTEM AND TREATMENT BUILDING COMPONENTS
#WA-1710

PROJECT SPECIFICATIONS
90% SUBMITTAL

May 2018

HUNTER/NCS DESIGN-BUILD TEAM

202 E Earll Drive, Ste 110, Phoenix, AZ 85012
T: 602 629-0206 • F: 602 629-0223

CITY OF GOODYEAR
SITE 12 TREATMENT EXPANSION – GMP 1
NEW WELLS, STORAGE TANK, RO AND BUILDING COMPONENTS
#WA-1710

PROJECT SPECIFICATIONS
TABLE OF CONTENTS

DIVISION 1 - GENERAL REQUIREMENTS

01110	SUMMARY OF WORK
01330	SUBMITTALS
01331	REFERENCE FORMS
01340	TECHNICAL SUBMITTALS, SHOP DRAWINGS, PROJECT DATA & SAMPLES, OPERATION AND MAINTENANCE MANUALS, EQUIPMENT RECORD SHEETS
01414	EARTHMOVING AND DUST CONTROL
01452	TESTING LABORATORY SERVICES FURNISHED BY CONTRACTOR
01580	PROJECT IDENTIFICATION AND SIGNS
01651	TRANSPORTATION AND HANDLING OF MATERIALS AND EQUIPMENT
01661	STORAGE OF MATERIALS AND EQUIPMENT
01751	STARTING AND PLACING EQUIPMENT IN OPERATION
01781	OPERATIONS AND MAINTENANCE DATA
01783	SPARE PARTS AND MAINTENANCE MATERIALS
01810	COMMISSIONING

DIVISION 2 - SITEWORK

02100	SITE PREPARATION
02200	EARTHWORK
02223	TRENCHING, BACKFILLING AND COMPACTING
02235	AGGREGATE BASE COURSE
02242	STABILITY OF EXCAVATIONS
02260	FINISHED GRADING AND SOIL TREATMENT
02445	AUTOMATED GATE
02500	ASPHALT PAVING

DIVISION 3 - CONCRETE

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

03600 GROUT

DIVISION 4 - MASONRY

04100 MORTAR AND GROUT
04300 CONCRETE UNIT MASONRY

DIVISION 5 - METALS

05052 ANCHOR BOLTS, TOGGLE BOLTS AND CONCRETE INSERTS
05501 MISCELLANEOUS METALS

DIVISION 6 - WOOD AND PLASTICS (NOT USED)

DIVISION 7 - THERMAL AND MOISTURE PROTECTION

07900 JOINT SEALERS
07920 CAULKING AND SEALANTS

DIVISION 8 - DOORS AND WINDOWS (NOT USED)

DIVISION 9 - FINISHES

09800 SPECIAL COATINGS
09900 PAINTING

DIVISION 10 - SPECIALTIES

10400 PROCESS IDENTIFICATION DEVICES, STENCILING AND TAGGING SYSTEMS

DIVISION 11 - EQUIPMENT

11002 EQUIPMENT IDENTIFICATION TAG SYSTEM
11005 EQUIPMENT: GENERAL REQUIREMENTS
11211 VERTICAL TURBINE LINESHAFT WELL PUMPS
11212 VERTICAL HOLLOW SHAFT MOTORS
11215 STAINLESS STEEL VERTICAL TURBINE PUMPS

11228 SELF-CLEANING PRE-FILTERS
11237 SCALE INHIBITOR FEED SYSTEM
11337 PUMP CONTROL VALVE
11339 PRESSURE RELIEF SURGE ANTICIPATOR VALVE
11346 TREATMENT VESSELS
11347 ARSENIC ADSORPTION MEDIA
11400 REVERSE OSMOSIS SYSTEM
11405 HYDROPNUEMATIC TANK
11406 ARSENIC TREATMENT VESSEL INSTALLATION
11410 CARTRIDGE FILTERS FOR RO SYSTEMS
11950 HYDROPNUEMATIC SYSTEMS & AIR COMPRESSORS
11955 SAND SEPARATOR

DIVISION 12 - FURNISHINGS (NOT USED)

DIVISION 13 - SPECIAL CONSTRUCTION

13110 CATHODIC PROTECTION SYSTEM
13207 WELDED STEEL STORAGE TANKS

DIVISION 14 - CONVEYING SYSTEMS (NOT USED)

DIVISION 15 - MECHANICAL

15050 BASIC PROCESS PIPING MATERIALS AND METHODS
15062 DUCTILE IRON PIPING
15063 COPPER PIPING
15075 PLASTIC PIPING AND TUBING
15110 VALVES
15111 BALL VALVES
15112 BUTTERFLY VALVES, OPERATORS AND APPURTENANCES
15114 CHECK VALVES
15115 GATE VALVES
15117 SPECIALTY VALVES
15141 MECHANICAL - PROCESS PIPE SUPPORTS
15495 DISINFECTION OF PROCESS WATER PIPING
15496 DISINFECTION OF TREATMENT VESSEL

DIVISION 16 - ELECTRICAL

16000 GENERAL ELECTRICAL REQUIREMENTS
16010 ELECTRICAL BASIC REQUIREMENTS
16050 BASIC MATERIALS AND METHODS
16111 CONDUITS
16123 600 VOLT CLASS CABLE
16124 INSTRUMENTATION CLASS CABLE
16130 OUTLET, PULL AND JUNCTION BOXES
16141 WIRING DEVICES
16142 WEATHERPROOF WHILE IN USE OUTLET ENCLOSURES
16143 TERMINAL BLOCKS
16160 ENCLOSURES
16161 CONTROL PANELS
16170 GROUNDING
16190 SUPPORTING DEVICES
16195 ELECTRICAL IDENTIFICATION
16420 SERVICE ENTRANCE SECTION
16430 CUSTOMERS POWER METERING SYSTEM
16440 DISCONNECT SWITCHES
16461 TRANSFORMERS – DRY TYPE
16470 PANELBOARDS
16475 MINI POWER CENTERS
16476 LOW VOLTAGE CIRCUIT BREAKERS
16477 600V FUSES
16481 MOTOR CONTROL CENTER
16482 SOLID STATE MOTOR CONTROLLERS
16495 AUTOMATIC TRANSFER SWITCH
16500 LIGHTING
16505 TRANSIENT VOLTAGE SURGE PROTECTION SYSTEM (SPD)
16622 STANDBY DIESEL ELECTRIC GENERATOR
16902 ELECTRICAL CONTROLS, RELAYS AND ALARMS
16904 VARIABLE FREQUENCY DRIVES – LOW VOLTAGE
16906 PLC AND REMOTE IO CABINETS
16920 ELECTRICAL ACCEPTANCE TESTING

DIVISION 17 - INSTRUMENTATION AND CONTROLS

17000 INSTRUMENTATION
17052 RADAR LEVEL TRANSMITTER
17112 ELECTRODE TYPE LEVEL CONTROL
17120 PRESSURE TRANSMITTERS
17121 PRESSURE SWITCHES
17124 SUBMERSIBLE LEVEL TRANSMITTER
17137 MAGNETIC FLOWMETERS

APPENDICES

APPENDIX A GEOTECHNICAL REPORT

DIVISION 1

GENERAL REQUIREMENTS

SECTION 01110

SUMMARY OF WORK

PART 1 - GENERAL

1.01 LOCATION AND DESCRIPTION OF WORK

A. The Work is located on the following sites:
   1. Site 12 Treatment Facility located at 3200 S 173rd Ave., Goodyear, AZ 85338.
   2. Well 24
   3. Well 25

B. The Contract Documents include the following:
   1. Volume 1 of 2: Divisions 1 through 17 Specifications
   2. Volume 2 of 2: Drawings

1.02 OTHER CONSTRUCTION CONTRACTS

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

1.03 WORK BY OWNER

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

1.04 SEQUENCE AND PROGRESS OF WORK

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

1.05 SALVAGE OF EQUIPMENT AND MATERIALS

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

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

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

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01330

SUBMITTALS

PART 1 - GENERAL

1.01 DESCRIPTION

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

1.02 PROCEDURE

A. Submittal within thirty days after the Notice to Proceed: Location of information concerning each submittal is referenced and a copy of each required form is included in Section 01331 - Reference Forms.

B. Submittals During Construction: During progress of the construction, provide the following submittals in a timely manner to prevent any delay in the Work schedule:

1. Shop Drawings, Product Data and Samples: Submit Shop Drawings, product data and samples in accordance with Section 01332 - Shop Drawing Procedures, and as required in various Sections of the Contract Documents.
2. Request for Information: Submit a Request for Information, included in Section 01331 - Reference Forms, when any of the following are required: an interpretation of the Specifications; additional details; information not shown on the Drawings or in the Specifications; or clarification of discrepancies is needed. CONTRACTOR shall retain one copy and submit three copies to the ENGINEER for response.
3. Construction Photographs: Submit Construction Photographs with each month's Progress Payment Request as specified in Section 01323 - Construction Photographs.
4. Operation and Maintenance Manuals and Lesson Plans: Submit Equipment Operation and Maintenance Manuals for approval, by the ENGINEER, within 30 days after approval of Equipment Shop Drawing. Submit Equipment Training Lesson Plans for approval, by the ENGINEER, 60 days prior to commencement of training. Submit Operation and Maintenance Data and Lesson Plans in accordance with Section 01781 - Operation and Maintenance Data.

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

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED

END OF SECTION

SECTION 01331

REFERENCE FORMS

PART 1 - GENERAL

1.01 DESCRIPTION

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

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

	Form No.	Title
1.	01331-2	Request for Change Order Proposal
2.	01331-3	Change Order Proposal
3.	01331-4	Request for Information
4.	01331-5	Contractor's Daily Construction Report
5.	01331-6	Field Order
6.	01340-7	Shop Drawing Transmittal Form

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

REQUEST FOR CHANGE ORDER PROPOSAL

Date: _____

Contractor:_____

Project Name:

Request for Change Order Proposal No. _____

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

SCOPE OF WORK:

_____

OWNER

CHANGE ORDER PROPOSAL

Date:_____

Contractor: _____

Project Name:

Project No.

Change Order Proposal No.:_____

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

JUSTIFICATION:

The Contract Time will be (increased)(decreased) _____ calendar days.

The Contract Amount will be (increased)(decreased) $_____ dollars.

By:_____

Title:_____

Contractor:_____

REQUEST FOR INFORMATION

Project Name:

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

INFORMATION NEEDED:

Date:_____ Signature: _____

REPLY:

Date:_____ Signature:_____

CONTRACTOR'S DAILY CONSTRUCTION REPORT

Project Name:

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

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

Work Performed:

Material and Equipment Delivered:

Remarks:

_____
(Authorized Signature)

FIELD ORDER

Date: _____

Contractor:_____

Project Name:

Field Order No.: _____

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

Date:_____ Date:_____

SECTION 01340

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

PART 1 - GENERAL

1.01 SUMMARY

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

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

1.02 SUBMITTALS: GENERAL

A. Transmit all technical submittals electronically to:

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

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

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

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

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

E. Assure submittals meet the following schedule:
   1. Shop drawings:

a. Submittal and approval prior to that portion of work being installed and prior to 50 overall percent completion.
b. ENGINEER will attempt to return all submittals to CONTRACTOR within 14 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.

1.03 SUBMITTALS: SHOP DRAWINGS

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

B. Transmittal Contents:
1. Coordinate and identify shop drawing contents so that all items can be easily verified by the ENGINEER.
2. Identify equipment or material use, tag number, drawing detail reference, weight, and other project specific information.

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

1.04 SUBMITTALS: SAMPLES

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

B. Include application specific brochures, and installation instructions.

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

D. Resubmit samples of rejected items.

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

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

1.05 SUBMITTALS: OPERATION AND MAINTENANCE MANUALS

A. Transmittal Mechanics:
1. See Paragraph 1.02 and 1.03.

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

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

g. Outline, cross-section, and assembly (exploded view) drawings; engineering data; and electrical diagrams, including elementary diagrams, wiring diagrams, connection diagrams, word description of wiring diagrams and interconnection diagrams.
h. Test data and performance curves.
i. A list of recommended spare parts with a price list.
j. Copies of installation instructions, parts lists or other documents packed with equipment when delivered.
k. Tag numbers relating the equipment back to the Contract Documents.
l. Safety instructions.
m. ISO identification numbers for bearings.
n. List of specialty tools required and availability.
o. List weight of overall assemblies and individual weights of major individual components.
p. List of vendors and who to contact for warranty work.
q. List of fastener grades.
r. Copy of warranty, if applicable.

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

NCS

Shop Drawing Transmittal

Project Name:		Transmittal No.:
Project Location:		Date Received:
To: NCS Engineers 202 E. Earll Drive, Suite 110 Phoenix, AZ 85012 Attn:	From: Attn:	NCS Job No.: Reviewed By: Date Reviewed: Spec. Section:
Date Transmitted:	Previous Transmittal Date:	1st. Sub.☐ ReSub.☐

No. Copies	Description	Manufacturer	Drawing or Data No.	Action Taken*

Submitter's Remarks:

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

A - No Exceptions Taken
B - Furnish as Noted
C - Revise and Submitt
1. Not enough information for review.
2. No reproducibles submitted.
3. Copies illegible
4. Not enough copies submitted.
5. Wrong sequence number.
6. Wrong resubmittal suffix.
7. Wrong specification section.
8. Wrong form used.
9. See comments.

D - Rejected
E - Engineer's review not required.
1. Submittal not required.
2. Supplemental information. Submittal retained for informational purposes only.
3. Information reviewed and approved on prior submittal.
4. See comments.

Reviewer's Comments:

Returned by (NCS) : Date:

Distribution:	Supplier (if applicable)	____ Copies	NTUA:	____ Copies
	Sub Consultant 1:	____ Copies	NCS:	____ Copies
		____	Sub Consultant 2:	____ Copies

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 Maricopa County Air Pollution Control Regulations.

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 Rule 300 of Maricopa County's Air Pollution Control Regulations.

C. If requested by the OWNER, ENGINEER, or Maricopa County 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 Maricopa County. 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 to the OWNER by the USEPA, ADEQ, or Maricopa County 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 01452

TESTING LABORATORY SERVICES FURNISHED BY CONTRACTOR

PART 1 - GENERAL

1.01 DESCRIPTION

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

B. IF NEEDED, ENGINEER shall perform Quality Assurance/Quality Control sampling of the CONTRACTOR's samples, and verify results with an independent testing laboratory different from the laboratory used by the CONTRACTOR.

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

1.02 QUALIFICATIONS OF LABORATORY

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

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

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

1.03 LABORATORY DUTIES

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

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

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

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

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

1.04 CONTRACTOR'S COORDINATION WITH LABORATORY

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

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

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

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

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

1.05 PRODUCT TEST REPORTS

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01580

PROJECT IDENTIFICATION AND SIGNS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Furnish, install and maintain temporary project identification and informational signs.

B. 4-foot by 8-foot signs with information shown on Attachment 01580A shall be provided for the following locations:
   1. Site 12 Treatment Facility
   2. Well 24
   3. Well 25

C. No signs, except those specified, shall be displayed, unless approved by OWNER.

1.02 SUBMITTALS

A. Submit for approval the following:
   1. Type of grade of materials.
   2. Layout, size, trim, framing, supports and coatings.
   3. Size and style of lettering.
   4. Samples of colors.

1.03 CONSTRUCTION

A. Use 3/4-inch exterior grade plywood, unless shown otherwise.

B. Use, trim, mitered on all edges.

C. Design signs and supports to withstand 75 mile per hour wind.

D. Paint with exterior gloss-finish enamel. Sign painter shall be a professional in the type work required.

1.04 INSTALLATION AND MAINTENANCE

A. Location of signs shall be as shown or directed by ENGINEER.

B. Maintain signs so they are clean, legible and upright. Keep grass and weeds cut away from signs.

C. Repair and repaint damaged signs. Relocate signs as required by progress of the Work.

D. Remove signs when project is completed or when directed by ENGINEER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

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 01661

STORAGE OF MATERIALS AND EQUIPMENT

PART 1 - GENERAL

1.01 DESCRIPTION

A. Store and protect materials in accordance with manufacturer's recommendations and requirements of Specifications.

B. CONTRACTOR shall make all arrangements and provisions necessary for the storage of materials and equipment. All excavated materials, construction equipment, and materials and equipment to be incorporated into the Work shall be placed so as not to injure any part of the Work or existing facilities and so that free access can be maintained at all times to all parts of the Work and to all public utility installations in the vicinity of the Work. Materials and equipment shall be kept neatly and compactly stored in locations that will cause a minimum of inconvenience to other contractors, public travel, and adjoining owners. Arrange storage in a manner to provide easy access for inspection.

C. Areas available on the site for storage of materials and equipment shall be approved by the ENGINEER.

D. Materials and equipment, which are to become the property of the OWNER, shall be stored to facilitate their inspection and ensure preservation of the quality and fitness of the Work, including proper protection against damage by freezing, moisture and summer temperatures with ambient temperatures as high as 120°F. They shall be placed in inside climate controlled storage areas, unless otherwise acceptable to OWNER. When placing orders to suppliers for equipment and controls containing computer chips, electronics and solid-state devices, CONTRACTOR shall request and coordinate specific temperature limitations on equipment since cabinets and components stored in the summer can approach temperatures of 150°F.

E. CONTRACTOR shall be fully responsible for loss or damage, including theft, to stored materials and equipment.

F. Do not open manufacturer's containers until time of installation, unless recommended by the manufacturer or otherwise specified.

G. Do not store products in the structures being constructed, unless approved in writing by the ENGINEER.

H. Private property shall not be used for storage purposes without written permission of the OWNER or other person in possession or control of such premises.

1.02 PROTECTION

A. Equipment shall be boxed, crated or otherwise completely enclosed and protected during shipment, handling and storage. Each container or piece of equipment shall be clearly marked with CONTRACTOR'S name, project name and location. Equipment shall be stored on raised supports protected from exposure to the elements and shall be kept thoroughly dry at all times. Pumps, motors, drives, electrical equipment, instrumentation equipment (controls, devices, panels, etc.) and other equipment having anti-friction or sleeve bearings shall be stored in weathertight storage facilities, such as warehouses. Covering with visquine or similar material shall not be considered as a weathertight enclosure.

B. Painted surfaces shall be protected against impact, abrasion, discoloration and other damage. Painted equipment surfaces, which are damaged prior to acceptance, shall be repainted in entirety to the satisfaction of the ENGINEER.

C. Electrical equipment, controls, and instrumentation shall be protected against moisture, water damage, heat or dust. Space heaters provided in the equipment shall be connected and operating at all times until equipment is placed in operation.

1.03 UNCOVERED STORAGE

A. The following types of materials may be stored outdoors without cover:
   1. Masonry units.
   2. Reinforcing steel.
   3. Structural steel.
   4. Piping, except PVC.
   5. Precast concrete items.
   6. Castings.

B. Store the above materials on wood blocking so there is no contact with the ground.

1.04 COVERED STORAGE

A. The following types of materials may be stored outdoors if covered with material impervious to water:
   1. Rough lumber.
   2. Handrailing.
   3. PVC Piping.

B. Tie down covers with rope and slope to prevent accumulation of water on covers.

C. Store materials on wood blocking or skids.

D. Store loose granular materials, covered with materials impervious to water, in a well-drained area or solid surfaces to prevent mixing with foreign matter.

1.05 FULLY PROTECTED STORAGE

A. Store all products not named above in buildings or trailers which have a concrete or wooden floor, a roof, and fully closed walls on all sides.

B. Provide heated storage space for materials which could be damaged by freezing.

C. Provide air-conditioned storage space for materials that could be damaged by Arizona's severe high temperatures.

D. Protect mechanical and electrical equipment from being contaminated by dust, dirt and moisture.

E. Maintain humidity at levels recommended by manufacturers for electrical and electronic equipment.

1.06 MAINTENANCE OF STORAGE

A. Maintain periodic system of inspection of stored products on a scheduled basis to assure that:
   1. State of storage facilities is adequate to provide required conditions.
   2. Required environmental conditions are maintained on a continuing basis.
   3. Products exposed to elements are not adversely affected.

B. Mechanical and electrical equipment which require long term storage shall have complete manufacturer's instructions for servicing each item with notice of enclosed instructions shown on exterior of package.
   1. Comply with manufacturer's instructions on a scheduled basis.
   2. Space heaters which are part of electrical equipment shall be connected and operated continuously until equipment is placed in service.

1.07 PANEL AND INSTRUMENTATION STORAGE

A. All panels, microprocessor-based equipment and all other devices subject to damage or useful life decrease, because of temperatures below 40°F or above 100°F, relative humidity above 90 percent, or exposure to rain or exposure to blowing dust shall not be stored on site.

B. Storage shall be in an insured, climate-controlled warehouse within Maricopa County. The OWNER shall have the right to inspect the equipment during normal working hours. Placed inside each panel or device shall be a desiccant, volatile corrosion inhibitor blocks (VCI), a moisture indicator and maximum-minimum indicating thermometer. The panels and equipment shall be checked once per month. The desiccant, VCI and moisture indicator shall be replaced as often as required or every six months, whichever occurs first. A certified record of the daily maximum and minimum temperature and humidity in the warehouse shall be available for inspection by the OWNER. A certified record of the monthly inspection, noting maximum and minimum temperature for the month, condition of desiccant, VIC and moisture indicator, shall also be available for inspection by the OWNER.

C. All costs for the storage shall be at no additional cost to the OWNER. Any panel or device which has been damaged by any cause or for which the storage temperatures or humidity range has been exceeded shall be replaced at no additional cost to the OWNER and shall not be cause for a delay in Contract completion.

D. The panels and equipment shall not be shipped to the site until field conditions are ready for installation, including all slabs, walls, roofs, and environmental controls. The failure to have the site ready for installation shall not relieve CONTRACTOR from conforming to all of the Contract requirements.

1.08 RECORDS

A. Keep running account of products in storage to facilitate preparation of progress payments, if Agreement provides for payment for products delivered, but not installed in the Work.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01751

STARTING AND PLACING EQUIPMENT IN OPERATION

PART 1 - GENERAL

1.01 DESCRIPTION

A. CONTRACTOR shall initially start-up and place all equipment installed by him into successful operation according to manufacturer's written instructions and as instructed by manufacturer's field representative. CONTRACTOR shall provide all material, labor, tools, equipment, chemicals, lubricants, and expendables required to complete start-up.

B. No system or subsystem shall be started up for continuous operation unless all components of that system or subsystem, including instrumentation, have been tested and proven to be operable as intended by the Contract Documents.

C. To facilitate equipment start-up, checking, and operation, the ENGINEER and OWNER shall accommodate a Validation Period, where water is passed through the treatment system and discharged to the Backwash Equalization Basin, and subsequently the sanitary sewer.

D. General Activities Include:
   1. Cleaning.
   2. Removing temporary protective coatings.
   3. Flushing and replacing greases and lubricants, where required by manufacturer.
   4. Lubrication.
   5. Check shaft and coupling alignments and reset where needed.
   6. Check and set motor, pump and other equipment rotation, safety interlocks, and belt tensions.
   7. Check and correct if necessary leveling plates, grout, bearing plates, anchor bolts, fasteners, and alignment of piping which may put stress on pumping equipment connected to it.
   8. All adjustments required.

E. Provide chemicals and lubricants and all other required operating fluids.

F. Provide fuel, electricity, water, filters, and other expendables required for start-up of equipment, unless otherwise specified.

G. OWNER shall provide sufficient personnel to assist CONTRACTOR in the start-up, but the prime responsibility for proper mechanical operation shall belong to CONTRACTOR. Manufacturer's representatives shall be present during initial start-up and operation, unless otherwise acceptable to ENGINEER.

H. No system, unit process or any piece of equipment shall be started up for continuous operation without the approved Operation and Maintenance Manuals being turned over to the OWNER.

I. Training shall be provided prior to turning the operation of a system, unit process or piece of equipment over to the OWNER. Training shall be scheduled for each OWNER staff work shift accordingly. Training shall conform to the requirements of Section 01781 - Operation and Maintenance Data, and individual equipment sections in Divisions 2 through 17.

J. Completion of start-up shall be when the OWNER assumes responsibility for operation of the equipment. If the OWNER does not assume operational responsibility and in the opinion of the ENGINEER start-up tasks are completed, the ENGINEER will notify CONTRACTOR, in writing, of the completion of the start-up period.

1.02 SUBMITTALS

A. General:
1. Approved Operation and Maintenance manuals received by OWNER a minimum of two weeks prior to scheduled training of OWNER personnel.
2. Written request for OWNER to witness each system pre-demonstration start-up. Requests shall be received by the OWNER a minimum of 1 week before scheduled training of OWNER personnel on that system.
3. Equipment installation and pre-demonstration start-up certification.
4. Letter verifying completion of all pre-operational testing activities, including receipt of all specified items from manufacturers/suppliers as final item prior to initiation of validation period.

1.03 MINIMUM START-UP REQUIREMENTS

A. Bearings and Shafting:
1. Inspect for cleanliness, and clean and remove all foreign materials.
2. Verify alignment.
3. Replace defective bearings and those which run rough or noisy.
4. Grease as necessary and in accord with manufacturer's recommendations.

B. Drives:
1. Adjust tension in V-belt drives, and adjust varipitch sheaves and drives for proper equipment speed.
2. Adjust drives for alignment of sheaves and V-belts.
3. Clean and remove foreign materials before starting operation.

C. Motors:
   1. Check each motor for comparison to amperage nameplate value.
   2. Correct conditions which produce excessive current flow and exist due to equipment malfunction.

D. Pumps:
   1. Check glands and seals for cleanliness and adjustment before running pump.
   2. Inspect shaft sleeves for scoring.
   3. Inspect mechanical faces, chambers, and seal rings, and replace if defective.
   4. Verify that piping system is free of dirt and scale before circulating liquid through the pump.

E. Valves:
   1. Inspect both hand and automatic control valves, and clean bonnets and stems.
   2. Tighten packing glands to assure no leakage, but permit valve stems to operate without galling.
   3. Replace packing in valves to retain maximum adjustment after system is determined to be complete.
   4. Replace packing on any valve that continues to leak.
   5. Remove and repair bonnets that leak.
   6. Coat packing gland threads and valve stems with a surface preparation of "Moly-Cote" or "Fel-Pro" after cleaning.

F. Verify that control valve seats are free from foreign material and are properly positioned for intended service.

G. Tighten flanges and all other pipe joints after system has been placed in operation.
   1. Replace gaskets which show any sign of leakage after tightening.

H. Inspect all joints for leakage.
   1. Promptly remake each joint that appears to be faulty; do not wait for rust to form.
   2. Clean threads on both parts, and apply compound and remake joints.

I. After system has been placed in operation, clean strainers, drives, pockets, orifices, valve seats and headers in fluid system to assure freedom from foreign materials.

J. Open air vents, where used, and remove operating elements.
   1. Clean thoroughly, replace internal parts and put back into operation.

K. Remove rust, scale and foreign materials from equipment and renew defaced surfaces.

L. Check each electrical control circuit to assure that operation complies with Specifications and requirements and to provide desired performance.

M. Inspect each pressure gage and thermometer for calibration.
   1. Replace items which are defaced, broken, or which read incorrectly.

N. Repair damaged insulation.

O. Vent gasses trapped in any part of systems.
   1. Verify that liquids are drained from all parts of gas or air systems.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

A. Activities performed under this specification shall be conducted during the validation period.

B. Validation Period:
   1. CONTRACTOR Requirements:
      a. Operate the wells and treatment facility for 8 hours per day for five consecutive days.
      b. Provide all labor, supervision, utilities, equipment, vehicles, and required items to perform work during this period. The CONTRACTOR shall be responsible for wasted chemicals.
   2. OWNER Responsibilities:
      a. Collect water samples daily and perform lab tests at OWNER cost.
      b. Provide raw water. The quantity of water available to the CONTRACTOR will be contingent on water needed by OWNER's customers.
      c. ENGINEER will prepare procedure for CONTRACTOR to follow during the validation period.
      d. OWNER and ENGINEER shall operate the facility.

END OF SECTION

SECTION 01781

OPERATIONS AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide Operation and Maintenance Data in the form of instructional manuals for use by the OWNER'S personnel for:
   1. All equipment and systems.
   2. All valves and related accessories.
   3. All instruments and control devices.
   4. All electrical gear.

B. Training or start-up on any system, process, or piece of equipment shall not be allowed until Operation and Maintenance Manuals and Lesson Training Plans are approved by the ENGINEER and the approved Operation and Maintenance Manuals have been turned over to the OWNER.

C. Definitions:
   1. Operation and Maintenance Data:
      a. The term "Operation and Maintenance Data" includes all product related information and documents which are required for preparation of the plant operation and maintenance manual. It also includes all data which shall accompany said manual as directed by current regulations of any participating government agency.
      b. Required Operation and Maintenance Data includes, but is not limited to, the following:
         1) Complete, detailed written operating instructions for each product or piece of equipment including equipment function; operating characteristics; limiting conditions; operating instructions for startup, normal and emergency conditions; regulation and control; and shutdown.
         2) Complete, detailed written preventive maintenance instructions as defined below.
         3) Recommended spare parts lists, by generic title and identification number, and local sources of supply for parts.
         4) Written explanations of all safety considerations relating to operation and maintenance procedures.
         5) Name, address, phone number, fax number, e-mail address, and website of manufacturer, manufacturer's local service representative, and subcontractor or installer.
         6) Copy of warranty bond and service contract, as applicable.

7) As-built circuit diagrams, wiring diagrams, schematics and functional drawings, as applicable.
8) Final test data, where applicable, shall be submitted as an appendix when completed.
9) Disassembly, reassembly, installation, alignment, adjustment, and checking instructions.
10) Provide installation data in accordance with Section 01731, Installation Data.
11) Written reference to equipment tag number, as specified under Section 01752 - Equipment and System Startup and Performance Testing.
12) Provide the completed Equipment Information Forms found in Section 01331 - Reference Forms.

2. Preventive Maintenance Instructions:
   a. The term "preventive maintenance instructions" includes all information and instructions required to keep a product or piece of equipment properly lubricated, adjusted and maintained so that the item functions economically throughout its full design life.
   b. Preventive maintenance instructions include, but are not limited to, the following:
      1) A written explanation with illustrations for each preventive maintenance task.
      2) Recommended schedule for execution of preventive maintenance tasks.
      3) Lubrication charts.
      4) Table of alternative lubricants.
      5) Trouble shooting instructions.
      6) List of required maintenance tools and equipment.
      7) Special tools.

D. Submittals:
   1. General: Submit operations and maintenance data to the ENGINEER within thirty days after approval of Shop Drawings, unless noted otherwise.
   2. Each draft O&M manual must be submitted, reviewed and returned to CONTRACTOR before any payment is made for materials and equipment received and stored on-site.
   3. Final approval of all O&M Manuals will only be provided after the OWNER has reviewed and approved the individual final O&M Manuals.
   4. Number of Copies:
      a. One preliminary hard copy of each O&M Manual shall be submitted to the ENGINEER for approval within thirty days of the approval of the Shop Drawing, which indicated further submittals are not required. The O&M Manual shall conform to the requirements as specified herein.

b. Ninety days prior to placing the equipment into service submit six hard copies and two soft copies of the approved O&M Manual (except for field test data) to the ENGINEER.
c. Soft copy shall be provided on CD in PDF format and shall include all information provided in hard copy.

5. Format Requirements:
   a. Use 8-1/2-inch by 11-inch paper of high rag content and quality. Larger drawings or illustrations are acceptable if neatly folded to the specified size in a manner that will permit easy unfolding without removal from the binder. Provide reinforced punched binder tab or provide fly-leaf for each product.
   b. All text must be legible typewritten or machine printed originals or high quality copies of same. Manuals that contain copies that are not clear, not completely legible, off-center, skewed, or where text or drawings are cut by the binding holes shall be subject to disapproval. Pages that contain approval or date stamps, comments or other markings that cover any portion of text or drawing are unacceptable. Electronically transmitted facsimile (fax) copies are also unacceptable.
   c. Each page shall have a binding margin of approximately 1-1/2-inches and be punched for placement in a "D-ring" loose-leaf binder. Provide minimum 1-inch size, white in color, D-ring binders. Non-uniform binders will not be acceptable. Identify each binder with the following:
      1) Title "OPERATING AND MAINTENANCE INSTRUCTIONS".
      2) Title of Project.
      3) Identity of facility as applicable.
      4) Identity of general subject matter covered.
   d. CONTRACTOR shall coordinate with the ENGINEER and OWNER to develop a comprehensive, practical, and consistent indexing system for the Operations and Maintenance Manuals. The ENGINEER and the OWNER shall review the indexing system before any manuals are submitted in draft form.
   e. Use dividers and indexed tabs between major categories of information such as operating instructions, preventive maintenance instructions, or other. When necessary, place each major category in a separate binder.
   f. Provide a Table of Contents for each binder. The soft copy content shall be linked to the soft copy's Table of Contents.
   g. Identify products by their functional names in the table of contents and at least once in each chapter or Section. Thereafter, abbreviations and acronyms may be used if their meaning is explained in a table in the back of each binder. Use of model or catalog numbers or letters for identification is not acceptable.
   h. Indicate all components of the equipment on catalog pages by highlighting or some other clearly definable medium for ease of identification.
   i. Final test data determined after installations of the equipment shall be submitted as an appendix to the Operations and Maintenance Manuals.

6. Upon completion of the equipment installation, CONTRACTOR shall submit Form 01781-C located in Section 01331 - Reference Forms. The completed form shall also be included in the individual Operation and Maintenance Manuals.

1.02 OPERATION AND MAINTENANCE

A. Refer to Sections in Divisions 2 through 17 for equipment for which Operation and Maintenance data is to be provided.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01783

SPARE PARTS AND MAINTENANCE MATERIALS

PART 1 - GENERAL

1.01 DESCRIPTION

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

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

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

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

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

SPARE PARTS RECEIVER

SPECIFICATION SECTION 01783

CONTRACTOR PLEASE FILL OUT:

MANUFACTURER:_____

ITEM DESCRIPTION:_____

COST: _____

MANUFACTURER PART NUMBER:_____

SUPPLIER:_____

CROSS REFERENCE NUMBER:_____

VENDOR INFORMATION: _____

VENDOR ORDER PART NUMBER:_____

PART TO BE USED ON
WHAT EQUIPMENT:_____

_____

EQUIPMENT NUMBER:_____

SPECIFICATION SECTION:_____

****

CITY PERSONNEL FILL IN:

BIN NUMBER:_____

AIMS NUMBER:_____

LOCATION IN STORES:_____

RECEIVED BY:_____

END OF SECTION

SECTION 01810

COMMISSIONING

PART 1 - GENERAL

1.01 SUMMARY

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

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

1.02 REFERENCES

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

1.03 DEFINITIONS

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

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

C. Manual Operational Mode: This operational mode represents the lowest level of control philosophy utilized in the plant instrumentation and control system. For all practical purposes, it means that an operational control decision requiring equipment or process monitoring or control will require an individual to physically go to the local control for the associated task in order to operate the facility. In the manual operational mode, the focus will be on verifying that the equipment and processes function correctly, independent of the instrumentation system and control system.

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

1.04 SUBMITTALS

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

1.05 REQUIREMENTS

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

Startup and Commissioning Phases		
Work/Work Area	**Commissioning Requirements**	**Commissioning Duration (Calendar Days)**
Well Sites & Treatment Plant	All instruments in manual (local) and semi-automatic modes of operation	7
Wells & Treatment Plant	Automatic Operation	30

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

1.06 RESPONSIBILITIES

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

B. CONTRACTOR'S Responsibilities During the Commission Process:
   1. CONTRACTOR shall provide all staff, labor, materials, equipment and appurtenances required for carrying out CONTRACTOR'S commissioning duties described below.
   2. All Change Order work resulting from the evaluation of design-related issues by the ENGINEER and OWNER.

3. All preventive and unscheduled maintenance of all equipment and facilities. This shall include, but not be limited to the following:
    a. Providing all lubricants.
    b. Lubrication of all equipment in accordance with Manufacturer's recommendations.
    c. Perform all Manufacturer recommended preventive maintenance, including instrument calibrations.
    d. Exercise all equipment not in use during Commissioning phase.
    e. Repair all failed equipment.
    f. Periodic check of all equipment alignment, vibration, and noise levels to ascertain conformance with Specifications.
    g. Provide all parts required for equipment repair.
    h. Provide all tools and miscellaneous equipment required for equipment repair.
    i. Administration/logging/documentation of all preventive maintenance and repair work.
    j. Cleanup associated with equipment failure and repair.
4. Warranty related issues/items.
5. Other contractual requirements including, but not limited to, incomplete Work list.

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

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

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

A. Commissioning may be performed simultaneously at all sites or sequentially depending on the construction schedule.

B. Substantial completion of the project will not be granted until satisfactory completion of the commissioning period.

END OF SECTION

DIVISION 2

SITE WORK

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

C. Institute of Makers of Explosives (IOMOE).

D. Occupational Safety and Health Act (OSHA).

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

1.03 DEFINITIONS

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

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

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

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

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

1.04 SYSTEM DESCRIPTION

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

1.05 SUBMITTALS

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

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

1.06 QUALITY ASSURANCE

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

1.07 SEQUENCING AND SCHEDULING

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

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

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

PART 2 - PRODUCTS

2.01 MATERIALS

A. Water For Compacting Fills: Use water from source acceptable to OWNER.

B. Fill and Backfill Materials:
   1. General:
      a. Provide sand, aggregate base course, gravel, Class 2 permeable, drain rock, select material, and native material, where required for fill and backfill.
      b. Obtain material for fills from cut sections or from borrow source.
      c. Provide material having maximum particle size not exceeding 4 inches and that is free from frozen material, leaves, grass, roots, stumps, and other vegetable matter.
      d. Materials derived from processing demolished or removed asphalt concrete are not acceptable.

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

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

3. Drain Rock:
   a. Consist of hard, durable particles of stone or gravel, screened or crushed to specified size and gradation.
   b. Free from frozen material vegetable matter, lumps or balls of clay, or other deleterious matter.
   c. Crush or waste coarse material and waste fine material as required to meet gradation requirements.
   d. Durability Index: Percentage of wear not greater than 40 percent when tested in accordance with ASTM C 131.
   e. Conform to size and grade within the limits as follows when tested in accordance with AASHTO T-27 or ASTM C 136:

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

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

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

5. 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.

6. Sand:
    a. Clean, coarse, natural sand.
    b. Nonplastic when tested in accordance with ASTM D 4318.
    c. 100 percent shall pass a ½ inch screen.
    d. No more than 20 percent shall pass a Number 200 screen.

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

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

3.03 APPLICATION

A. General:
1. The CONTRACTOR shall assume responsibility and expense of disposing of excavated materials which are not required or unsuitable for fill and backfill in lawful manner.

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

B. Excavation:
1. Excavations for Structures:
   a. The building and slabs on grade shall be over excavated to a uniform depth of two feet below the foundation or two feet below the existing ground surface, which ever depth is greater. The over excavation shall extend five feet beyond the footprint of the building and slab on grade. The over excavated areas shall be filled with engineered fill. Include trenching for adjacent piping and all work incidental thereto.
   b. Where soil of Unsuitable Bearing Value is Encountered: The CONTRACTOR may direct in writing that excavation be carried to elevations above or below those indicated on the Drawings.
   c. Unless directed by the ENGINEER, excavations shall not be carried below elevations indicated on the Drawings.
   d. Where excavations are made below elevations required for the foundation, adjust elevations of excavations in accordance with requirements following:
      1) Under Slabs: Restore to proper elevation in accordance with procedure specified for backfill in this Section.
      2) Under Footings: Select one of the following:
         a) Increase heights of walls or footings.
         b) Refill space with Class C concrete, as specified in Section 03300, at no additional cost to the Contract.
         c) Excavation Width: Extend excavations at least 24 inches clear from walls and footings to allow for placing and removal of forms, installation of services, and inspection. Undercutting of slopes will not be permitted.

e. Bottom of Excavations For Structures: Consist of native material with top 8 inches compacted to 95 percent of maximum density and graded to conform to outside limits of structures as indicated on the Drawings, except where otherwise indicated on the Drawings or specified.
f. Difficulty of Excavation: No extra compensation will be made for removal of rock or any other material due to difficulty of excavation.
g. Location of Structures on Different Substrates: Where structure will be located partially on fill and partially on undisturbed or natural material, over-excavate entire area to depth of 12 inches below the structure and re-compact to 95 percent maximum density.

2. Excavation of Ditches and Gutters:
   a. Cutting: Cut ditches and gutters accurately to cross sections and grades indicated on the Drawings.
   b. Excavation: Take care not to excavate ditches and gutters below grades indicated on the Drawings.
   c. Over Excavation: Back fill excessive ditch and gutter excavation to grade with suitable thoroughly compacted material to form adequate gutter paving.
   d. Depositing Of Material Adjacent To Ditches: Do not deposit any material within three feet of edge of ditch unless otherwise indicated on the Drawings.
3. Necessary Over Excavation:
   a. General:
      1) Where it becomes necessary to excavate beyond normal lines of excavation in order to remove boulders or other interfering objects, backfill voids remaining after removal as specified below in "Backfilling Of Voids", or as acceptable to the ENGINEER.
      2) With ENGINEER's approval, perform necessary excavation beyond normal lines as specified in Subparagraph above and backfill such voids. Cost of such work shall be considered as included in price bid for the work.
      3) Backfilling of Voids:
         a) Fill voids with suitable material acceptable to the OWNER, placed in manner and to same uniform density as surrounding material.

C. Compaction:
1. Compacted Fills:
   a. Lines and Grades:
      1) Construct fills, embankments, and backfills, designated herein as fills, at locations and to lines and grades indicated on the Drawings.
      2) Borrow sources are not available within project site. Where required, CONTRACTOR shall provide necessary imported fill material from outside sources.

b. Compacted Fill Shape and Sections: Provide completed fill that corresponds to shape of typical sections indicated on the Drawings or that meets requirements for particular case.
c. Preparation of Areas Designated to Receive Fill Material: Scarify to minimum depth of 8 inches, unless otherwise indicated on the Drawings, and recompact to density of fill material as specified in following Article.
d. Fills and Backfills and Upper 6 Inches in Cuts: Compact to percentage of maximum density as follows:
    1) Backfill Adjacent to Structures: 95 percent.
    2) Under Present and Future Structures: 98 percent.
    3) Under Roadways (aggregate base course, and dirt), Parking, Curbs and Sidewalks: 95 percent.
    4) Aggregate Base Below Pavement 100 percent.
    5) Onsite or Imported Fill Below Exterior Slabs on Grade: 95 percent.
    6) Aggregate Base other than Below Pavement: 95 percent.
    7) Landscaped Areas: 90 percent unless otherwise noted.
    8) Compacted Embankments: 95 percent.
    9) Spoil Areas Indicated on the Drawings: No minimum required.
e. Placing Compacted Fills:
    1) Placement: Place loose material in successive layers that do not exceed 8 inches before compaction.
    2) Moisture Content: Bring each layer to optimum moisture content for maximum density before compaction by rolling.
    3) Defective Compacted Fills:
        a) Remove and replace any placed material that does not have correct moisture content.
        b) Remove and replace fills with suitable material when any one of the following 2 conditions exist as they shall serve as sufficient evidence, without further testing, that moisture content is not correct:
            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 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

TRENCHING, BACKFILLING AND COMPACTING

PART 1 - GENERAL

1.01 SUMMARY

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

1.02 REFERENCES

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

1.03 SUBMITTALS

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

PART 2 - PRODUCTS

2.01 MATERIALS

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

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

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

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

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

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

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

PART 3 - EXECUTION

3.01 PREPARATION

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

B. Protection: Stabilize excavation.

3.02 INSTALLATION

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

4) If bottom of excavation is found to consist of soft or unstable material which is incapable of properly supporting pipe, remove such material to a depth and for the length required, as determined by the OWNER, and then refill trench to grade with aggregate base course or sand, compacted to 95 percent of maximum density.
5) Where indicated on the Drawings, and where fill conditions dictate, cradle pipe in concrete.
6) Minimum Clear Width of Trench for Pipe 4 Inches in Diameter and Over (Measured At Top Of Pipe): Not less than outside diameter of pipe plus 18 inches.
7) Maximum Clear Width of Trench for Pipe (Measured at Top of Pipe):
a) For Pipe Sizes up to and Including 24 Inches: Not exceed outside diameter of pipe plus 24 inches.
b) For Pipe Sizes Over 24 Inches: Not exceed outside diameter of pipe plus 36 inches.

c. For Manholes, valves, or other accessories:
1) Provide excavations sufficient to leave at least 12 inches clear between their outer surfaces and embankment or shoring which may be used to hold banks and protect them.
2) Do not backfill with earth under manholes, vaults, tanks, or valves.
3) Fill any unauthorized excess excavation below elevation indicated on the Drawings for foundation of any structure with aggregate base material or concrete at no additional cost.
4) Backfilling of Manhole Excavation: Conform to backfilling requirements as specified for trenches in this Section.

d. Potable Water Pipe and Appurtenances:
1) Lay in trench separate from those used for sewers.
2) Unless otherwise specified or indicated on the Drawings, lay in trenches having cover of not less than 4 feet below surface of ground and located at distance of not less than 10 feet from any parallel sewer trench.

e. At Road Crossings or Existing Driveways:
1) Make provision for trench crossing at these points, either by means of backfills, tunnels, or temporary bridges.

B. Trench Fine Grading:
1. For Pipes 16 Inches in Nominal Diameter and Under:
a. Unless otherwise specified, accurately grade bottom of trench to provide uniform bearing and support for each section of pipe, on undisturbed soil at every point along pipe's entire length, except for portions of pipe where it is necessary to excavate for bells and for proper sealing of pipe joints.
2. For Pipe over 16 Inches in Diameter:

a. Overexcavate bottom of trench by at least 4 inches, or 1/12 outside diameter of pipe, whichever is greater.
b. Fill overcut with bedding material specified herein, and fine graded as specified above.
c. Place bedding material at uniform density, with minimum possible compaction.
d. Where trench excavation is below grade of bedding material, restore trench bottom to proper grade by backfilling and compacting backfill to 95 percent of maximum density, at no additional cost. Use bedding material as specified in this Section.

3. Bell or Coupling Holes:
   a. Dig holes after trench bottom has been graded.
   b. Provide holes of sufficient width to provide ample room for grouting, banding, or welding.
   c. Excavate holes only as necessary in making joints and to ensure that pipe rests upon prepared trench bottom and not supported by any portion of the joint.
4. Depressions for Joints, Other Than Bell-and-Spigot:
   a. Make in accordance with recommendations of joint manufacturer for particular joint used.

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

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

c. Trench Backfill for Trench Cuts in Areas Outside the Improved Section of Roadways and within open spaces: Backfill trench from 12 inches above top of pipe to finish grade with native material compacted to 90 percent of maximum density.
d. Trench Backfill through Earth Slopes or Embankments Supporting Structures, through Structural Fill, or Adjacent to and/or Under Structures: Backfill trench from 12 inches above top of pipe to finish grade with ABC material or approved select material compacted to 95 percent of maximum density.
e. The more stringent compaction requirements for trench backfill between the specifications and the geotechnical report shall be used.

E. Compacting Native Material:
1. Assure that native material, when used as previously specified, is capable of being compacted to degree specified.
2. If native material cannot be compacted to density as previously specified, remove and dispose of material whether it has been placed in trench as backfill or not, and utilize other backfill material from another source acceptable to the ENGINEER.

F. Excess Material:
1. Remove excess excavated material from the project site.

3.03 FIELD QUALITY CONTROL

A. Tests:
1. Confirmation Tests:
a. CONTRACTOR's Responsibilities:
1) Accomplish specified compaction of trench backfill.
2) Control operations by confirmation tests to verify and confirm that compaction work complies, and is complying at all times, with requirements specified in this Section concerning compaction, control, and testing.
3) Copies of Confirmation Test Reports: Submit promptly to the OWNER and ENGINEER.
b. Frequency of Confirmation Testing:
1) Perform testing not less than as follows:
a) For Trenches: At each location include tests for each type or class of backfill from bedding to finish grade.
b) In Open Fields: Two every 500 linear feet.
c) Along Dirt or Gravel Road or off Traveled Right-of-Way: Two every 500 linear feet.
d) Crossing Paved Roads: Two locations along each crossing.
e) Under Pavement Cuts or Within 2 Feet of Pavement Edges: One location every 200 linear feet.

f) Under structures and slabs: minimum of one, and one every 50 linear feet.

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

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

3.04 SCHEDULES

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

END OF SECTION

SECTION 02235

AGGREGATE BASE COURSE

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Aggregate base course.

B. Related Sections:
   1. Section 02200 - Earthwork.

1.02 REFERENCES

A. Maricopa Association of Governments - Arizona, 2015 Edition, with updates:
   1. MAG - Uniform Standard Specifications for Public Works Construction.

1.03 SUBMITTALS

A. Product Data:
   1. Source, gradation, and testing data for aggregate base course.

B. Field Quality Control:
   1. Test Reports: Reports for tests required by Sections of MAG Uniform Standard Specification for Public Works Construction.
   2. Certificates of Compliance: Certificates as required by Sections of MAG Uniform Standard Specifications for Public Works Construction.

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: Per Section 702 of the MAG Uniform Standard Specifications.

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 Section 301 of the MAG Uniform Standard Specifications for Roadways; per Section 601 of the MAG Uniform Standard Specifications for Pipelines.

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 Uniform Standard Specifications for Public Works Construction.
   2. Compacting: Compact in accordance with Section 310 of MAG Uniform Standard Specifications for Public Works Construction.
      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: Perform field tests as required by sections of MAG Uniform Standard Specifications for Public Works Construction.

END OF SECTION

SECTION 02242

STABILITY OF EXCAVATIONS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Stability of excavations (shoring or other means as required).

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 valued 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 trenchings, 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 AND SOIL TREATMENT

PART 1 - GENERAL

1.01 SUMMARY

A. General work included in this Section:
   1. All finished grading and soil treatment as indicated in the Contract Documents.

B. Related Sections include but are not necessarily limited to:
   1. Division 1.
   2. Section 02100 - Site Preparation.
   3. Section 02200 - Earthwork.

C. Location of Work: All areas within limits of grading and all areas outside limits of grading which are disturbed in the course of the work. Soil treatment shall be limited to areas under slabs, sidewalks, perimeter of structures, pavement, and areas to receive ABC.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Soil Treatment:
   1. Soil sterilization for vegetation control shall be Karmex 80W manufactured by DuPont; Diuron 4L manufactured by Drexel chemical Corporation; or equal. Application rate shall be per manufacturers recommendation.

2.02 TOLERANCES

A. Finish Grading Tolerance: 0.1 ft plus/minus from required elevations.

PART 3 - PREPARATION

A. Correct, adjust and/or repair graded areas:
   1. Cut off mounds and ridges.
   2. Fill gullies and depressions.
   3. Perform other necessary repairs.
   4. Bring all sub-grades to specified contours, even and properly compacted.

B. Loosen surface to depth of 2 in., minimum.

C. Remove all stone and debris over 2 in. in any dimension.

D. Prepare areas for soil treatment per manufacturer's recommendations.

3.02 ROUGH GRADE REVIEW

A. Reviewed by ENGINEER in Section 02100, Site Preparation.

3.03 TREATING SOIL

A. The CONTRACTOR shall provide all labor, material, equipment, and services necessary to complete all work involved in soil sterilization for unwanted plant life. The weed killer shall be applied according to the manufacturer's published instructions.

END OF SECTION

SECTION 02445

AUTOMATED GATE

PART 1 - GENERAL

1.01 SUMMARY

A. This Section specifies the site entrance slide gate, gate operator system, and appurtenances.

1.02 FACTORY TESTING

A. Gate operator system shall be tested in factory before shipping to project site.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. A 153 - Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
   2. F 2200 - Standard Specification for Automated Vehicular Gate Construction.

B. UL325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems.

1.04 SUBMITTAL

A. Manufacturer's product information designating specific materials and equipment provided.

B. The fabrication drawings for the gate and accessories, and posts.

C. The layout of photo electric eye system.

D. Electrical requirements for gate operator.

E. Gate operator.

F. Card reader interface.

G. Wiring diagrams.

H. Operation and maintenance manual.

1.05 QUALITY ASSURANCE

A. Manufacturer: A company specializing in the manufacture of hydraulic gate operators of the type specified, with a minimum of five years' experience.

B. Installer: A minimum of three years' experience installing similar equipment and provide proof of attending a HySecurity factory technical training within previous three years.

1.06 EQUIPMENT PROVIDED VIA ALLOWANCE

A. Under Allowance No. 1, City's security contractor will furnish and install the card reader.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Gate
   1. Structural steel tube frame with expanded metal plate. See Drawings. Gate and posts shall be fabricated with ASTM A-36 steel. Other metal components for the gate shall comply with Section 05501. Across top of gate, provide security barrier manufactured by Unisec, Inc., Model Ultra-Barrier.

B. Concrete:
   1. Concrete for foundation shall be Class A as specified in Section 03300.

C. Automated Gate:
   1. Gate shall be provided with hydraulic slide operator to allow for automatic opening and closing of the gate with a card reader interface.
   2. Provide slide gate per ASTM F 2200.
   3. The gate shall be capable of being opened and closed manually in the case of a power outage (by disengaging the gate actuator).
   4. Provide sufficient battery backup to include minimum 3 operations (open or close) of the gate.
   5. The gate installation shall comply with UL325.
   6. A built-in inherent entrapment sensor shall be provided with the gate operator to stop the gate anytime the moving gate encounters an object, whether opening or closing.
   7. The gate shall be equipped with a through beam photo electric eye to stop the gate when an object is present immediately in front of the gate. The photo electric eye shall be provided for two locations: gate opening and gate closing.

D. Operator for Automated Gate:
   1. Acceptable Manufacturer:
      a. HySecurity, Model SlideDriver 40
      b. Or approved equal.
   2. The gate operator shall utilize 208 VAC, single phase power.
   3. The gate operator shall include one 1 HP gate motor to open/close the gate. Provide local disconnect.
   4. Duty cycle shall be continuous.
   5. Drive wheels shall consist of two, 4-inch wheels.
   6. Drawbar pull shall be minimum 300 pounds.
   7. Uninterruptible power supply (UPS) to facilitate 3 minimum gate operations (open or close). The alternating current UPS shall be HyInverter as manufactured by HySecurity or approved equal. UPS shall utilize 208 VAC, single phase power.
   8. The apparatus shall include a Smart Touch Controller keypad and minimum 32 character display to indicate all input and output functions of the gate operator. Controller shall be microprocessor based.
   9. The operator and control board for the operator shall be enclosed in a heavy-duty, weather-proof cover.
   10. The gate operator shall interface with the two sets of photo electric eyes.
   11. The gate shall have a minimum travel time of one foot per second.
   12. The operator shall be able to operate the gate with a gate weight up to 2000 lbs.
   13. All metal parts shall be zinc plated for rust proof protection.
   14. Provide electric controls separated from gate drive mechanism, with NEMA ICS 6, Type 4 enclosure.
   15. Provide interface with card reader.
   16. Include in Bid two trips to site for programming services.
   17. Design gate operator system for minimum 125 degrees F.
   18. Provide drive rail section (Part # MX3885) and drive rail roll pin (Part # MX000814) for interface of the gate to the hydraulic operator.
   19. Provide written five year warranty for the gate operator.

PART 3 - EXECUTION

3.01 GATE OPERATOR SYSTEM

A. Gate drive system shall be installed in accordance with manufacturer's instructions.

B. The CONTRACTOR shall make arrangements with the appropriate parties for the training of OWNER personnel in the operation and maintenance of the gate and gate control system.

C. Furnish and install conduit and conductors as needed to provide complete and operating system.

END OF SECTION

SECTION 02500

ASPHALT PAVING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
1. Asphalt materials.
2. Aggregate materials.
3. Asphalt paving base course and surface course.

B. Related Requirement:
1. Section 02260 – Finished Grading: Preparation of site for paving and base.
2. Section 02235 - Aggregate Base Course: Compacted subbase for paving.

1.02 REFERENCE STANDARDS

A. American Association of State Highway and Transportation Officials:
1. AASHTO M17 - Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
2. AASHTO M29 - Standard Specification for Fine Aggregate for Bituminous Paving Mixtures.
3. AASHTO M140 - Standard Specification for Emulsified Asphalt.
4. AASHTO M208 - Standard Specification for Cationic Emulsified Asphalt.
5. AASHTO M288 - Standard Specification for Geotextile Specification for Highway Applications.
6. AASHTO M320 - Standard Specification for Performance-Graded Asphalt Binder.
7. AASHTO M324 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
8. AASHTO MP1a - Standard Specification for Performance-Graded Asphalt Binder.

B. Asphalt Institute:
1. AI MS-2 - Mix Design Methods for Asphalt Concrete and Other Hot- Mix Types.
2. AI MS-19 - Basic Asphalt Emulsion Manual.
3. AI SP-2 - Superpave Mix Design.

C. ASTM International:
1. ASTM C1371-2004a - Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers.

2. ASTM C1549-2004 - Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.
3. ASTM D242 - Standard Specification for Mineral Filler For Bituminous Paving Mixtures.
4. ASTM D692 - Standard Specification for Coarse Aggregate for Bituminous Paving Mixtures.
5. ASTM D946 - Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction.
6. ASTM D977 - Standard Specification for Emulsified Asphalt.
7. ASTM D1073 - Standard Specification for Fine Aggregate for Bituminous Paving Mixtures.
8. ASTM D1188 - Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples
9. ASTM D2027 - Standard Specification for Cutback Asphalt (Medium-Curing Type).
10. ASTM D2397 - Standard Specification for Cationic Emulsified Asphalt.
11. ASTM D2726 - Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
12. ASTM D2950 - Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods.
13. ASTM D3381 - Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction.
14. ASTM D3515 - Standard Specification for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
15. ASTM D3549 - Standard Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens.
16. ASTM D3910 - Standard Practices for Design, Testing, and Construction of Slurry Seal.
17. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
18. ASTM E408-1971(1996)e1 - Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.
19. ASTM E903-1996 - Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres.
20. ASTM E1918-1997 - Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field.
21. ASTM E1980-2001 - Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.

D. Maricopa Association of Governments:
1. Uniform Standard Specifications and Details for Public Works Construction, 2015 Edition, with updates.

E. Geotechnical Evaluation Report:
1. Geotechnical Evaluation Report prepared by Copper State Engineering, Inc., dated March 26, 2018.

1.03 SUBMITTALS

A. Section 01340 – Technical Submittals

B. Product Data:
   1. Submit product information for asphalt and aggregate materials.
   2. Submit mix design with laboratory test results supporting design.

C. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.04 QUALITY ASSURANCE

A. Mixing Plant: Conform to certification and inspection provisions contained in the 'Hot Mix Asphalt Productions Facilities' by the Arizona Rock Products Association in accordance with Maricopa Association of Governments Standard Specifications Section 321.

B. Obtain materials from same source throughout.

C. Perform Work in accordance with Maricopa Association of Governments Standard Specifications Part 300 and Sections 701, 702, 708, 710, 711, 712, and 713.

1.05 AMBIENT CONDITIONS

A. Place asphalt mixture when temperature is in accordance with Maricopa Association of Governments Standard Specifications Section 321.

PART 2 - PRODUCTS

2.01 ASPHALT PAVING

A. Performance / Design Criteria:
   1. Pavement shall be designed in accordance with Maricopa Association of Governments Standard Specifications Part 300 and Sections 701, 702, 708, 710, 711, 712, and 713 as well as the Geotechnical Evaluation Report. The asphalt pavement design shall utilize a MAG C ¾" High Volume Marshall mix.

B. Asphalt Materials:
   1. Asphalt materials shall be in accordance with Maricopa Association of Governments Standard Specifications Section 321 and 710.

C. Aggregate Materials:
   1. Aggregate materials shall be in accordance with Maricopa Association of Governments Standard Specifications Sections 321 and 710.

2.02 MIXES

A. Use dry material to avoid foaming. Mix uniformly.

B. Asphalt Paving Mixtures: In accordance with Maricopa Association of Governments Standard Specifications Section 321.

2.03 SOURCE QUALITY CONTROL

A. Submit proposed mix design of each class of mix for review prior to beginning of Work.

B. Test samples in accordance with Maricopa Association of Governments Standard Specifications Section 321.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify utilities indicated under paving are installed with excavations and trenches backfilled and compacted.

B. Verify compacted subgrade subbase is dry and ready to support paving and imposed loads.
   1. Proof roll subbase with pneumatic roller in minimum two perpendicular passes to identify soft spots.
   2. Remove soft subbase and replace with compacted fill as specified in Section 02200.

C. Verify gradients and elevations of base are correct.

D. Verify gutter drainage grilles and frames and manhole frames are installed in correct position and elevation.

3.02 PREPARATION

A. Prepare subbase in accordance with Maricopa Association of Governments Standard Specifications Section 301.

3.03 DEMOLITION

A. Saw cut existing paving to provide a clean joint surface.

B. Clean existing paving to remove foreign material, excess joint sealant and crack filler from paving surface.

3.04 INSTALLATION

A. Subbase:
   1. Aggregate Subbase: Install as specified in Section 02235.

B. Primer:
   1. Apply primer in accordance with Maricopa Association of Governments Standard Specifications Section 315.
   2. Use clean sand to blot excess primer.

C. Tack Coat:
   1. Apply tack coat in accordance with Maricopa Association of Governments Standard Specifications Section 329.
   2. Coat surfaces of manhole and catch basin frames with oil to prevent bond with asphalt paving. Do not tack coat these surfaces.

D. Asphalt Paving:
   1. Install Work in accordance with Maricopa Association of Governments Standard Specifications Sections 321 and 711. Pavement shall be placed in one lift.
   2. Compact paving by rolling to specified density. Do not displace or extrude paving from position. Hand compact in areas inaccessible to rolling equipment.
   3. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

3.05 TOLERANCES

A. Flatness: Maximum variation of 1/4 inch measured with 12 foot straight edge.

B. Scheduled Compacted Thickness: Within 1/4 inch.

C. Variation from Indicated Elevation: Within 1/2 inch.

3.06 FIELD QUALITY CONTROL

A. Test samples in accordance with Maricopa Association of Governments Standard Specifications Section 321.

B. Asphalt Paving Mix Temperature: Measure temperature at time of placement.

C. Asphalt Paving Thickness: ASTM D3549; test one core sample from every 1000 square yards compacted paving (minimum one test required).

D. Asphalt Paving Density: ASTM D1188 or ASTM D2726; test one core sample from every 1000 square yards compacted paving (minimum one test required).

END OF SECTION

DIVISION 3

CONCRETE

SECTION 03100

CONCRETE WORK

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Concrete formwork.

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

1.02 REFERENCES

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

1.03 SYSTEM DESCRIPTION

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

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

1.04 QUALITY ASSURANCE

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

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

1.05 PROJECT CONDITIONS

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

PART 2 - PRODUCTS

2.01 MATERIALS

A. Form Ties:
1. General:
a. Provide form ties for forming system selected that are manufactured by recognized manufacturer of concrete forming equipment.
b. Do not use wire ties or wood spreaders of any form.
c. Provide ties of type that accurately tie, lock, and spread forms.
d. Provide form ties of such design that when forms are removed they locate no metal or other material within 1-1/2 inches of the surface of the concrete.
e. Do not allow holes in forms for ties to allow leakage during placement of concrete.
2. Cone-Snap or Flat Bar Form Ties:
a. Cone-snap ties shall form a cone shaped depression in the concrete with a minimum diameter of 1 inch at the surface of the concrete and 1-1/2 inches deep.
b. Provide neoprene water seal washer which is located near the center of the concrete.
3. Taper Ties:
a. Neoprene Plugs for Taper Tie Holes: Size so that after they are driven, plugs are located in center third of wall thickness.
b. 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.

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

C. Built-Up Plywood Forms:
1. Studding:
a. Spaced at 16 inches or 24 inches on center.
b. Closer spacing may be required depending upon strength requirements of the forms, in order to prevent any bulging surfaces on faces of finished concrete work.
c. Install studs perpendicular to grain of exterior plys of plywood sheets.
2. Wales: Form wales of double lumber material minimum size as specified in this Section.
3. Number of Form Reuses: Depends upon durability of surface coating of overlay used, and ability to maintain forms in condition such that they are capable of producing flat, smooth, hard, dense finish on concrete when stripped.

D. Steel or Steel Framed Forms:
1. Steel Forms:
a. Adequately brace forms for minimum deflection of finish surface.
2. Steel Framed Plywood Forms:
a. Rigidly construct and brace with joints fitting closely and smoothly.
b. Number of Form Reuses: Depends upon durability of surface coating or overlay used.
3. Built-Up Plywood Forms: As specified in this Section may be used in conjunction with steel forms or steel framed plywood forms for special forming conditions such as corbels and forming around items which will project through forms.

E. Bracing and Alignment of Forms:
1. Line and Grade: Limit deviations to tolerances which will permit proper installation of structural embedded items or mechanical and electrical equipment and piping.
2. Formwork:
a. Securely brace, support, tie down, or otherwise hold in place to prevent any movement.
b. Make adequate provisions for uplift pressure, lateral pressure on forms, and defection of forms.
3. When Second Lift is placed on Hardened Concrete: Take special precautions in formwork at top of old lift and bottom of new lift to prevent:
a. Spreading and vertical or horizontal displacement of forms.
b. Grout “bleeding” on finish concrete surfaces.

4. Pipe Stubs, Anchor Bolts, and Other Embedded Items: Set in forms where required.
5. Cracks, Openings, or Offsets At Joints in Formwork: Close those that are 1/16 inch or larger by tightening forms of by filling with acceptable crack filler.

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

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

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

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

END OF SECTION

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Concrete reinforcement.

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

1.02 REFERENCES

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

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

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

1.03 SYSTEM DESCRIPTION

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

1.04 SUBMITTALS

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

1.05 DELIVERY, STORAGE, AND HANDLING

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

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

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

1.06 SEQUENCING AND SCHEDULING

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

PART 2 - PRODUCTS

2.01 MATERIALS

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

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

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

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

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

D. Tie Wires: Annealed Steel.

2.02 FABRICATION

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

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

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

3.03 INSTALLATION

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

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

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

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

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

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

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

END OF SECTION

SECTION 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.
4. Section 03356 - Tooled Concrete Finishes.
5. Section 07900 - Joint Sealers.

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-µm (No. 200) Sieve in Mineral Aggregates by Washing.
10. C 123 - Standard Test Method for Lightweight Particles in Aggregate.
11. C 131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

12. C 136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
13. C 142 - Standard Test Method for Clay Lumps and Friable Particles in Aggregates.
14. C 143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
15. C 150 - Standard Specification for Portland Cement.
16. C 157 - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
17. C 172 - Standard Practice for Sampling Freshly Mixed Concrete.
18. C 173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
19. C 203 - Standard Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation.
20. C 227 - Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method).
21. C 260 - Standard Specification for Air-Entraining Admixtures for Concrete.
22. C 1260 - Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Mortar Bar Method).
23. C 295 - Standard Guide for Petrographic Examination of Aggregates for Concrete.
24. C 309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
25. C 311 - Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete.
26. C 469 - Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression.
27. C 494 - Standard Specification for Chemical Admixtures for Concrete.
28. C 595 - Standard Specification for Blended Hydraulic Cements.
29. C 618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
30. D 75 - Standard Practices for Sampling Aggregates.

1.03 DEFINITIONS

A. Alkali: Is defined to mean sum of sodium oxide and potassium oxide calculated as sodium oxide.

B. Hairline Crack: Crack with a crack width of less than 4 thousandths of an inch.

1.04 SYSTEM DESCRIPTION

A. Performance Requirements:
   1. General:

a. Except as otherwise specified, provide concrete composed of portland cement, fine aggregate, coarse aggregate, and water so proportioned and mixed as to produce plastic, workable mixture in accordance with requirements as specified in this Section and suitable to specific conditions of placement.
b. Proportion materials in manner such as to secure lowest water-cement ratio which is consistent with good workability, plastic, cohesive mixture, and one which is within specified slump range.
c. Proportion fine and coarse aggregate in manner such as not to produce harshness in placing nor honeycombing in structures.

2. Watertightness of Concrete Work: It is intent of this Section to secure for every part of the Work, concrete and grout of homogeneous structure, which when hardened will have required strength, watertightness, and durability.
   a. It is recognized that some surface hairline cracks and crazing will develop in the concrete surfaces.
   b. Construction, contraction, and expansion joints have been positioned in structures as indicated on the Drawings, and curing methods specified, for purpose of reducing number and size of these expected cracks, due to normal expansion and contraction expected from specified concrete mixes.
   c. Class A and Class B Concrete: Watertight. Repair cracks which develop in walls or slabs and repair cracks which show any signs of leakage until all leakage is stopped.
   d. Pressure 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., Concressive 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 fo 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 as 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. Aggregate:
   1. General:
      a. Provide concrete aggregates that are sound, uniformly graded, and free of deleterious material in excess of allowable amounts specified.
      b. Grade aggregate in accordance with ASTM D 75 and C 136.
      c. Provide unit weight of fine and coarse aggregate which produces in place concrete with weight of not less than 140 pounds per cubic foot.

B. Fine Aggregate:
   1. Provide fine aggregate for concrete or mortar consisting of clean, natural sand or of sand prepared from crushed stone or crushed gravel.
   2. Do not provide aggregate having deleterious substances in excess of following percentages by weight of contaminating substances. In no case shall total exceed percent listed.

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

   3. Except as otherwise specified, grade fine aggregate from coarse to fine in accordance with requirements of ASTM C 33.

C. Coarse Aggregate:
   1. General: Provide coarse aggregate consisting of gravel or crushed stone made up of clean, hard, durable particles free from calcareous coatings, organic matter, or other foreign substances.
   2. Weight: Not exceeding 15 percent, for thin or elongated pieces having length greater than 5 times average thickness.

3. Deleterious Substances: Not in excess of following percentages by weight, and in no case having total of all deleterious substances exceeding 2 percent.

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

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

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

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

F. Admixtures:
   1. General:
      a. Do not use admixtures of any type, except as specified, unless written authorization has been obtained from the ENGINEER.
      b. Compatible with concrete and other admixtures.

c. Do not use admixtures containing chlorides calculated as chloride ion in excess of 5% by weight.
d. Use in accordance with manufacturer's recommendations accordance with manufacture's recommendations and add each admixture to concrete mix separately.
e. A single manufacturer shall provide all concrete admixtures.

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

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

H. Nonslip Abrasive:
1. Type: Aluminum oxide abrasive of size 8/16, having structure of hard aggregate, homogenous, 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.

I. Concrete Sealer:
   1. Manufacturers: One of the following or equal:
      a. Hillyard Chemical Company, St. Joseph, Missouri, SEAL 341.
      b. A. C. Horn, Inc., Horn Clear Seal EM-180.

J. Conduit Encasement Coloring Agent:
   1. Color: Red color concrete used for encasement of electrical ducts, conduits, and similar type items.
   2. Manufacturers: One of the following or equal.
      a. Frank D. Davis Company, Red Oxide Number 1117.
      b. I. Reiss Company, Inc., equivalent product.

K. Keyway Material: Steel, plastic, or lumber.

L. Sprayed Membrane Curing Compound: Clear type with fugitive dye conforming to ASTM C 309, Type 1D, unless noted otherwise. After curing, and if subsequent coatings or toppings are specified, the curing compound shall be removed per manufacturer's recommendations.

M. Surface Sealant System: Manufacturers: One of the following or equal:
   1. Radcon Laboratories, Inc., Las Vegas, Nevada, Formula Number 7.
   2. IPA Systems, Philadelphia, Pennsylvania, Duripal.

2.02 EQUIPMENT

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

B. Machine Mixing:
   1. Batch plant shall be capable of controlling delivery of all material to mixer within 1 percent by weight of individual material.
   2. If bulk cement is used, weigh it on separate visible scale which will accurately register scale load at any stage of weighing operation from zero to full capacity.

3. Prevent cement from coming into contact with aggregate or with water until materials are in mixer ready for complete mixing with all mixing water.
4. Procedure of mixing cement with sand or with sand and coarse aggregate for delivery to project site, for final mixing and addition of mixing water will not be permitted.
5. Retempering of concrete will not be permitted.
6. Discharge entire batch before recharging.
7. Volume of Mixed Material Per Batch: Not exceed manufacturer's rated capacity of mixer.
8. Mixers:
    a. Perform mixing in batch mixers of acceptable type.
    b. Equip each mixer with device for accurately measuring and indicating quantity of water entering concrete, and operating mechanism such that leakage will not occur when valves are closed.
    c. Equip each mixer with device for automatically measuring, indicating, and controlling time required for mixing.
        1) Interlock device to prevent discharge of concrete from mixer before expiration of mixing period.

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

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

2.03 MIXES

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

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

C. Concrete Mixes:
   1. Proportioning of Concrete Mix: Proportion mixes with required average compressive strength (f'cr) as defined in Subparagraph 2.04A.
   2. Mixes:
      a. Adjusting of Water: After acceptance, do not change mixes without acceptance by ENGINEER, except that at all times adjust batching of water to compensate for free moisture content of fine aggregate.

b. Total Water Content of Each Concrete Class: Not exceed those specified in Table A in this Section.
c. Checking Moisture Content of Fine Aggregate: Furnish satisfactory means at batching plant for checking moisture content of fine aggregate.

3. Change in Mixes:
a. Undertake new trial batch and test program as specified in this Section.
b. Each New Trial Batch and Test Program: Cost of such trail batches and test program shall be borne by CONTRACTOR.

D. Hand Mixed Concrete:
1. Perform hand mixing of concrete only when requested by the CONTRACTOR in writing and accepted by the OWNER.
2. Prepare hand mixed concrete on watertight, level platform in batches not to exceed 1/3 cubic yard each.
3. Aggregate:
a. First spread required amount of coarse aggregate on platform in an even and uniform layer, and then over such aggregate spread proper proportion of fine aggregate.
b. Combined Depth of Both Such Layers: Not be greater than one foot.
4. Cement:
a. First evenly spread required quantity of cement over fine aggregate.
b. Then turn entire batch with shovels at least twice before adding water.
5. Water:
a. Then uniformly sprinkle or spray proper amount of water over batched materials.
b. Then turn with shovels not less than three times before being removing from platform.

E. Classes of Concrete:
1. Provide concrete consisting of six classes, referred herein as Classes A, AAA, B, C, D and CE specified in this Section and use where specified or indicated on the Drawings.
2. Weight of Concrete Classes: Provide classes of concrete having minimum weight of 140 pounds per cubic foot.
3. Class B Concrete: Class B concrete may be substituted for Class A concrete, if high-early strength concrete is desired by the CONTRACTOR, only in those areas specifically accepted by ENGINEER and which do not require sulfate resistant concrete.
4. Class C Concrete: Class C concrete may be used for fill for unauthorized excavation, for thrust blocks and ground anchors for piping, for bedding of pipe, and where indicated on the Drawings.
5. Class D Concrete: Use Class D for precast concrete items.
6. Class CE Concrete: Use Class CE for electrical conduit encasements.
7. All other concrete, unless specified or otherwise indicated on the Drawings: Use Class A concrete.

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

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

8. Pumped Concrete: Provide pumped concrete that complies with all requirements of this Section.
9. Do not place concrete with slump outside limits indicated in Table A.
10. Classes:
    a. Classes A, C, D, and CE Concrete: Make with Type II low alkali cement.
    b. Class B Concrete: Make with Type III low alkali cement.
    c. Admixtures: Provide admixtures as specified in this Section.

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 manufacture'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 Section 07900.
   8. Repair of Concrete: Where it is necessary to repair concrete by bonding mortar or new concrete to concrete which has reached its initial set, first

coat surface of set concrete with epoxy bonding agent as specified in Section 03301.

C. Conveying and Placing Concrete:
   1. Convey concrete from mixer to place of final deposit by methods which prevent separation or loss of materials.
   2. Use equipment for chuting, pumping, and conveying concrete of such size and design as to ensure practically continuous flow of concrete at delivery end without separation of materials.
   3. Design and use chutes and devices for conveying and depositing concrete that direct concrete vertically downward when discharged from chute or conveying device.
   4. Keep equipment for conveying concrete thoroughly clean by washing and scraping upon completion of any day's placement.

D. Delivery of Concrete:
   1. Delivery time of concrete from batch to site of placement shall not exceed 90 minutes at 90° F. The ENGINEER has the right to reject the load if it fails to meet this criteria.

E. Placing Concrete:
   1. Do not place concrete without prior authorization of the ENGINEER.
   2. Do not place concrete until:
      a. Reinforcement is securely and properly fastened in its correct position and loose form ties at construction joints have been retightened.
      b. Dowels, bucks, sleeves, hangers, pipes, conduits, bolts, and any other fixtures required to be embedded in concrete have been placed and adequately anchored.
      c. Forms have been cleaned and oiled prior to placement around rebar 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 places, 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 nor more than 20 hours in advance of placing concrete.
   3. If it becomes dry prior to actual placing of concrete, sprinkle again, without forming pools of water.
   4. Do not place concrete if subgrade is muddy or soft.

H. Curing Concrete - General:
   1. Cure concrete by methods specified in this Section.
   2. Cure concrete minimum of 7 days.
   3. Cure concrete that is to be painted or coated with water or plastic membrane.
   4. Do not use curing compound on any concrete surface that is to receive paint or upon which any material is to be bonded.
   5. Water cure or plastic membrane cure concrete slabs which are specified to be sealed by concrete sealer.
   6. Cure other concrete by water curing or sprayed curing membrane at the CONTRACTOR's option.

I. Water Curing:
   1. Keep surfaces of concrete being water cured constantly and visibly moist day and night for period of not less than 7 days.
   2. Each day forms remain in place may count as 1 day of water curing.
   3. No further curing credit will be allowed for forms in place after contact has once been broken between concrete surface and forms.
   4. Do not loosen form ties during period when concrete is being cured by leaving forms in place.
   5. Flood top of walls with water at least 3 times per day, and keep concrete surfaces moist at all times during 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 regards 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:
   1. 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.
   2. Provide test equipment.
   3. Do not use concrete that does not meet Specification requirements as to air entrainment and shall remove such concrete from project site.

4. 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, which extend no deeper than reinforcement nearest surface.
   7. Concrete Replacement:
      a. Use: When holes extend entirely through concrete section or when holes are more than 1 square foot in area and extend halfway or more through the section.

b. Method of Repair for Surfaces of Set Concrete to be Repaired: First coat with epoxy bonding agent.

8. Acceptable Method of Concrete Repair:
   a. Make no repair until the ENGINEER has accepted method of preparing surfaces and proposed method of repair.

END OF SECTION

SECTION 03301

EPOXIES

PART 1 - GENERAL

1.01 SUMMARY

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

1.02 REFERENCES

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

1.03 SYSTEM DESCRIPTION

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

1.04 SUBMITTALS

A. Not Used.

PART 2 - PRODUCTS

2.01 MATERIALS

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

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

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

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

PART 3 - EXECUTION

3.01 INSTALLATION

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

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

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

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

END OF SECTION

SECTION 03356

TOOLED CONCRETE FINISHES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Tooled concrete finishes.

1.02 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.01 MIXES

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

PART 3 - EXECUTION

3.01 CONCRETE FINISHING

A. Cement for Finishes:
   1. Addition of white cement may be required to produce finish which matches color of concrete to be finished.

B. Vertical Concrete Surfaces: Use Following Finishes for Vertical Concrete Surfaces (use F4 finish if not otherwise indicated on drawings):
   1. F1 Finish: No special treatment other than repair defective work and fill depressions 1 inch or deeper and tie holes with mortar after removal of curing membrane.
   2. F2 Finish: No special treatment other than repair defective work, remove fins, fill depressions ½ inch or deeper and tie holes with mortar after removal of curing membrane.
   3. F3 Finish: Repair defective work, remove fins, offsets, and curing membrane, and grind projections smooth. Fill depressions 1/4 inch or larger in depth or width and tie holes with mortar after removal of curing membrane.

4. F4 Finish:
    a. Same as specified for F3 Finish, and in addition fill depressions and holes 1/16 inch or larger in width with mortar.
    b. "Brush-Off" sandblast surfaces prior to filling holes to expose all holes near surface of the concrete.
    c. Thoroughly wet surfaces and commence filling of pits, holes, and depressions while surfaces are still damp.
    d. Perform filling by rubbing mortar over entire area with clean burlap, sponge rubber floats, or trowels.
    e. Do not let any material remain on surfaces, except that within pits and depressions.
    f. Wipe surfaces clean and moist cure.
5. F5 Finish: Receive same finish specified for F3 Finish, and, in addition, receive special stoned finish, in accordance with following requirements:
    a. Remove forms and perform required repairs, patching, and pointing as specified in this Section.
    b. Wet surfaces thoroughly with brush and rub with hard wood float dipped in water containing 2 pounds of Portland cement per gallon.
    c. Rub surfaces until form marks and projections have been removed.
    d. Spread grindings from rubbing operations uniformly over surface with brush in such manner as to fill pits and small voids.
    e. Moist cure brushed surfaces and allow to harden for 3 days:
        1) After curing, obtain final finish by rubbing with carborundum stone of approximately Number 50 grit until entire surfaces have smooth texture and are uniform in color.
        2) Continue curing for remainder of specified time.
    f. If any concrete surface is allowed to become too hard to finish in above specified manner, sandblast and wash related surfaces exposed to view, whether finished or not:
        1) While still damp, rub over surface, plastic mortar, as specified for brushed surfaces and hand stoned with Number 60 grit carborundum stone, using additional mortar for brushed surfaces until surface is evenly filled without an excess of mortar.
        2) Continue stoning until surface is hard.
        3) After moist curing for 3 days, make surface smooth in texture and uniform in color by use of Number 50 or Number 50 grit carborundum stone.
        4) After stoning, continue curing until 7 day curing period is completed.

C. Horizontal Concrete: After proper and adequate vibration and tamping, use following finishes for horizontal concrete surfaces as indicated on the Drawings (Use finish S4 unless otherwise indicated on Drawings):
1. S1 Finish: Screened to grade and leave without special finish.
2. S2 Finish: Smooth steel trowel finish.

3. S3 Finish: Steel trowel finish free from trowel marks. Provide smooth finish free of all irregularities.
4. S4 Finish: Steel trowel finish, without local depressions or high points, followed by light hair broom finish. Do not use stiff bristle brooms or brushes. Perform brooming parallel to slab-drainage. Provide resulting finish that is rough enough to provide nonskid finish. Finish shall be subject to review and acceptance by the OWNER.
5. S5 Finish: Nonslip abrasive: After concrete has been screened level and hardened enough to support man standing on a board, sprinkle abrasive from shake screen into surface at uniform rate of 25 pounds for each 100 square feet of surface area, wood float into finish, then trowel abrasive into surface with steel trowel properly exposing abrasive in surface as required to provide nonslip surface.

D. Concrete Floor Surfaces to Which Surfacing Material is Applied: Finish smooth with tolerance within 1/8 inch in 10 feet in any direction from lines indicated on the Drawings.

END OF SECTION

SECTION 03600

GROUT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Concrete mortar, grout, drypack mortar, nonshrink grout, and epoxy grout.

B. Related Sections:
   1. Section 03301 - Epoxies.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. C 109 - Test Method for Compressive Strength of Hydraulic Cement Mortars.
   2. C 157 - Test Method for Length Change of Hardened Cement Mortar and Concrete.
   3. C 191 - Test Method for Time 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 Engineer Specifications 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 4

MASONRY

SECTION 04100

MORTAR AND GROUT

PART 1 - GENERAL

A. REQUIREMENTS INCLUDED
   1. Mortar and grout for masonry work.

B. RELATED WORK
   1. Section 04300 - Concrete Unit Masonry

C. REFERENCES
   1. ACI 530/530.1-13 - Building Code Requirements and Specification for Masonry Structures and Companion Commentaries
   2. ASTM C 5 - Standard Specification for Quicklime for Structural Purposes
   3. ASTM C 91 - Standard Specification for Masonry Cement
   4. ASTM C 144 - Standard Specification for Aggregate for Masonry Mortar
   5. ASTM C 150 - Standard Specification for Portland Cement
   6. ASTM C 199 - Standard Test Method for Pier Test For Refractory Mortar
   7. ASTM C 207 - Standard Specification for Hydrated Lime for Masonry Purposes
   8. ASTM C 270 - Standard Specification for Mortar for Unit Masonry
   9. ASTM C 387 - Standard Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar
   10. ASTM C 404 - Standard Specification for Aggregates for Masonry Grout
   11. ASTM C 476 - Standard Specification for Grout for Masonry
   12. ASTM C 595 - Standard Specification for Blended Hydraulic Cements
   13. ASTM C 780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
   14. ASTM C 1019 - Standard Test Method for Method for Sampling and Testing Grout
   15. ASTM C 1072 - Standard Test Method forMeasurement of Masonry Flexural Bond Strength
   16. ASTM C 1142 - Standard Specification for Extended Life Mortar for Unit Masonry
   17. ASTM C 1314 - Standard Test Method for Compressive Strength of Masonry Prisms
   18. ASTM E 518 - Standard Test Methods for Flexural Bond Strength of Masonry
   19. IMIAC (International Masonry Industry All-Weather Council) - Recommended Practices and Guide Specification for Cold Weather Masonry Construction

D. SUBMITTALS
   1. Submit under provisions of Section 01340 - Technical Submittals.

2. Certification of Material: Submit manufacturer's mill test certificates covering materials shipped. Bags shall show the contents meet specifications herein.
3. Design Mix: Indicate proportions of Portland cement, hydrated lime and sand to be used, required environmental conditions, and admixture limitations.
4. Color Admixture: Submit samples of color admixture, and mixed grout prepared to the proportions to be used, and cured in ambient environmental conditions for no less than seven days. Admixture color shall be selected by the OWNER, Final grout color shall be approved by the OWNER or ENGINEER prior to placement.

E. DELIVERY, STORAGE AND HANDLING
1. Maintain packaged materials clean, dry and protected against dampness, freezing and foreign matter.

F. ENVIRONMENTAL REQUIREMENTS
1. Maintain materials and surrounding air temperature to minimum 50 degrees F prior to, during and 48 hours after completion of masonry work.
2. Follow guidelines for cold weather work according to IMAIC recommendations.

G. MIX TESTS
1. Testing of Mortar Mix: In accordance with ASTM C 780.
2. Testing of Grout Mix: In accordance with ASTM C 1019.

H. QUALITY ASSURANCE
1. Perform work in accordance with ACI 530.

PART 2 - GENERAL

A. MATERIALS
1. Portland Cement: ASTM C 150, natural color, Type II (normal) or Type IIA (air entraining).
2. Hydrated Lime: ASTM C 207 Type S, no substitutes permitted.
3. Mortar Aggregate: In accordance with ASTM C 144, standard masonry type except containing not more than 10 percent material passing through No. 100 sieve. Measure damp and loose throughout batches.
4. Water: Clean, Nonstaining and nondetrimental.
5. Admixtures: Add integral color to match grout to existing wall.
6. Grout Aggregate: In accordance with ASTM C 404. Fine aggregate - size 2, No. 4 through No. 100 sieves. Coarse aggregate - Size 8-1/2 inch through No. 16 sieves.

B. MORTAR MIXES

1. In accordance with ASTM C 270. Vary volumes of materials in mix design only slightly to assist workability.
    a. Type S mix (1,800 psi at 28 days): For reinforced masonry with high flexural bond strength.
    b. Type M Mix (2,500 psi at 28 days): For structural masonry, front resistance, below grade masonry and masonry in contact with earth.
    c. Mixing: Mix for a minimum of three minutes.

C. GROUT MIXES

1. In accordance with ASTM C 476. Vary volumes of material in mix design only slightly to assist in workability.
    a. Reinforced masonry; 2,000 psi at 28 days.
    b. Do not use antifreeze additives.
2. Mixing: Mix for minimum of five minutes. Mix grout to have a slump of 10 inches ±1 inch at time of placement.

PART 3 - EXECUTION

A. INSTALLATION REQUIREMENTS

1. Concrete Masonry: In accordance with Section 04300.
2. Use mortar or grout within 2 hours after mixing at temperatures of 80 degrees F or 2-1/2 hours at temperatures under 50 degrees F.

B. SCHEDULE OF PLACEMENT

1. Use fine grout for filling concrete masonry unit cores and when pumping is required.
2. Use fine or coarse grout for bond beams or where grout must pass through openings less than 2 inches.
3. Color: Natural gray unless indicated otherwise.

END OF SECTION

SECTION 04300

CONCRETE UNIT MASONRY

PART 1 - GENERAL

A. REQUIREMENTS INCLUDED

1. Provide all labor, materials, equipment, and service necessary to furnish and install all concrete unit masonry work as shown on the drawings, as specified herein, and as required.

B. RELATED WORK

1. Section 04100 – Mortar and Grout

C. REFERENCES

1. ACI 530/530.1-13 - Building Code Requirements and Specification for Masonry Structures and Companion Commentaries
2. ASTM C 5 - Standard Specification for Quicklime for Structural Purposes
3. ASTM C 91 - Standard Specification for Masonry Cement
4. ASTM C 144 - Standard Specification for Aggregate for Masonry Mortar
5. ASTM C 150 - Standard Specification for Portland Cement
6. ASTM C 199 - Standard Test Method for Pier Test For Refractory Mortar
7. ASTM C 207 - Standard Specification for Hydrated Lime for Masonry Purposes
8. ASTM C 270 - Standard Specification for Mortar for Unit Masonry
9. ASTM C 387 - Standard Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar
10. ASTM C 404 - Standard Specification for Aggregates for Masonry Grout
11. ASTM C 476 - Standard Specification for Grout for Masonry
12. ASTM C 595 - Standard Specification for Blended Hydraulic Cements
13. ASTM C 780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry
14. ASTM C 1019 - Standard Test Method for Method for Sampling and Testing Grout
15. ASTM C 1072 - Standard Test Method for Measurement of Masonry Flexural Bond Strength
16. ASTM C 1142 - Standard Specification for Extended Life Mortar for Unit Masonry
17. ASTM C 1314 - Standard Test Method for Compressive Strength of Masonry Prisms
18. ASTM E 518 - Standard Test Methods for Flexural Bond Strength of Masonry
19. IMIAC (International Masonry Industry All-Weather Council) - Recommended Practices and Guide Specification for Cold Weather Masonry Construction

D. SUBMITTALS
   1. Section 01340 – Technical Submittals
   2. Submit samples of two colored units, one red tone and one yellow tone, matching the colors of the existing masonry wall, to the ENGINEER for approval prior to placement of order.

PART 2 - PRODUCTS

A. Concrete masonry units shall conform to ASTM C-90, grade N, hollow load bearing units. Block shall be of types and sizes as shown on the drawings, as required, and shall be plain concrete masonry units, with integral color, standard strength (f'm - 1350 PSI: 1,000 PSI on gross area) 8" x 8" x 16", and other sizes as shown and as required.

B. Unit moisture content, as delivered, shall not exceed 0.25% of total absorption. Units shall have a maximum linear shrinkage not to exceed .045 of 1% from a saturated to oven dry condition. All concrete masonry units shall be of sufficient age to have cured properly.

C. Horizontal joint reinforcing shall conform to ASTM A1064 and A153, 9 gauge, Hohmann and Barnard 220 Ladder-Mesh.

D. Premolded control joint filler for walls shall be one of the following:
   1. RS Series Rubber Control Joint; Hohmann and Barnard

PART 3 - EXECUTION

A. Mortar shall be mixed after all ingredients are added until a thoroughly uniform mix is obtained. The consistency of mortar shall be adjusted to the satisfaction of the mason.

B. All mortar shall be used within two hours of initial mixing, and no mortar or grout shall be used after it has begun to set or after it has become hard or non-plastic.

C. In hot, dry weather, the mortar board shall be wetted before loading.

D. Mortar joints shall be consistent, homogenous, and match throughout the job for each type of joint specified.

E. All masonry walls shall be reinforced with standard ladder-design Hohmann and Barnard wire reinforcing complying with ASTM A1064 and A153, as follows:
   1. Immediately above lintels and below sills (or other openings), extending a minimum of two feet beyond the jambs.
   2. Elsewhere at 16" vertical intervals beginning 16" above the bottom of the first course.

3. 8" below the top of the wall.
4. And as shown on drawings.

F. Wire reinforcement shall be lapped at corners and wall intersections. Preformed corners shall be used, or wire shall be cut and bent to form continuity around corner with side rods lapped a minimum of 6".

G. Wire reinforcement shall be completely embedded in mortar or grout. Joints with wire reinforcement shall be at least twice the thickness of the wire.

H. Side rods shall be lapped at least 6" at splices. Reinforcement shall be placed to assure a 5/8" mortar cover measured from outside face of mortar joint.

I. Transport and handle all masonry units in such manner as to prevent chipping and breakage. Locate storage piles and stacks in locations to protect material from damage. All masonry units shall be stored off the ground.

J. Fully protect all masonry units against freezing. Warm units to at least 50ºF. before laying. When necessary to remove frost or excessive moisture, heat units to a temperature not over 150ºF.
1. Do not lay masonry when the temperature of the surrounding atmosphere is anticipated to fall below 40ºF during the 24-hour period after laying, unless adequate protection is provided.
2. Protect all finished work against freezing for a period of not less than 48 hours by means of enclosures, artificial heat or other such protective methods as may be required.
3. Masonry work shall not be started when the horizontal or vertical alignment of the foundation is greater than a maximum of 1" total in error.
4. All masonry shall be laid true, plumb, and neatly in accordance with the drawings.
5. Units shall be cut accurately to fit all built in items, openings, etc., and all holes shall be neatly patched and pointed.
6. Extreme care shall be taken to prevent visible grout or mortar stains, and if they occur, shall be removed immediately.
7. Walls shall be true, level, plumb and to a plane surface. All necessary adjustments of coursing shall be done while laying out the story pole and before any work commences.
8. Masonry units shall be sound, dry, clean, and free from cracks when placed in the structure.
9. Proper masonry units shall be used to provide for all windows, doors, bond beams, lintels, etc., with a minimum of unit cutting.
10. All walls shall be laid in common running bond, except as shown otherwise. All coursing shall be laid out with a story pole and courses shall be maintained level.
11. Plates and structural members shall be anchored to the walls with anchor bolts or their equivalent. Anchors shall be fully and solidly grouted in place. Embedment shall not be less than two-thirds of the wall thickness.

12. All head joints shall be mortared, and shall be buttered well for a thickness equal to the face shell of the unit, and these joints shall be shoved tightly so that the mortar bonds well to both units. Joints shall be solidly filled from the face of the block to at least the depth of the face shell. Lintels, capping units, all bearing plates, etc., shall be set in a full bed of mortar.

K. The starting joint on foundation shall be laid with full coverage on the bed. Mortar joints shall be straight, clean, and uniform in thickness. Unless specified otherwise, the horizontal and vertical mortar joints shall be 3/8" thick with full mortar coverage on the face shells and on the webs surrounding cells to be filled with grout.

L. Tooling shall be done when the mortar is partially set but still sufficiently plastic to bond. All tooling shall be done with a tool which compacts the mortar, pressing the excess mortar out of the joint, rather than dragging it out. Mortar joints shall be tooled concave on the interior and exterior of the site.

M. All concrete masonry units shall be reinforced as shown on the drawings and as follows:
1. Install vertical steel at all corners, intersections, and ends of all walls, at each jamb of all openings, and as shown and detailed on the drawings.
2. All vertical steel shall be continuous (or lapped 40 bar diameters) from foundation to top of wall.
3. Vertical steel shall be positioned in center of grouted masonry void in all concrete block walls unless otherwise noted.
4. All masonry shall be reinforced with standard 9-gauge Hohmann and Barnard 220Ladder-Mesh wire reinforcing at 16" vertical intervals. All splices in Ladder-Mesh shall lap a minimum of 6".

N. All control joints shall be installed per manufacturer's recommendations.

O. Grout all cells, lintels, and bond beams containing reinforcement with concrete grout as follows:
1. Masonry Grout for Standard Strength (1,350 PSI) Concrete Masonry Units - 2,000PSI. (Grout is specified under Section 04100 of these Specifications.)
2. Provide cleanouts at bottom of each grouted cell if grout pour exceeds 4'-0". Covers for cleanouts shall be cut from face shells and shall be installed to maintain the appearance of exposed masonry units.
3. Maximum height of any grout lift shall not exceed 5'-0".

P. All metal frames for doors in masonry walls shall be filled solid with mortar as the masonry is erected. 3.17. Furnish, install, and maintain safe and adequate scaffolding, centering and other equipment necessary for proper execution of the work.
1. During construction, walls shall be adequately braced at all times to prevent wind damage. The CONTRACTOR assumes the responsibility for the structural stability of any unbraced wall during construction. Bracing shall

remain in place until masonry is cured and the floor and roof diaphragm is secure and in place.

2. All equipment for mixing, transportation, and placing mortar and block shall be clean and free from set mortar, dirt, or other foreign matter.

Q. Cooperate with all other trades, and do all cutting in masonry walls required for the installation of other work. Provide all chases, set all bearing plates, all lintels, bolts, frame anchors, etc., required by the drawings and these Specifications. Assist in setting of all frames and see that they remain plumb and in their proper position.

R. The first 100 square feet of each type of masonry shall be erected and finished as specified herein as a sample panel. If approved, all subsequent masonry work of each type shall match the approved sample.

END OF SECTION

DIVISION 5

METALS

SECTION 05052

ANCHOR BOLTS, TOGGLE BOLTS
AND CONCRETE INSERTS

PART 1 - GENERAL

1.01 DESCRIPTION

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

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

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

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

1.02 QUALITY ASSURANCE

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

8. ASTM F 593 - 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)
½	5,000	7,600
5/8	8,000	12,000
3/4	11,500	17,000
7/8	15,700	20,400
1	20,500	28,400

2.02 APPLICATION

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

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

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

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

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

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

2.03 MATERIALS

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

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

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

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

D. Toggle Bolts:
1. Provide spring-wing toggle bolts, with two-piece wings.
2. Provide carbon steel bolts with zinc coating in accordance with Federal Specification FF-S-325.

3. Product and Manufacturer: Provide toggle bolts by one of the following:
   a. The Rawlplug Company, Incorporated.
   b. Haydon Bolts, Incorporated.
   c. Or equal.

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

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

PART 3 - EXECUTION

3.01 INSPECTION

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

3.02 INSTALLATION

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

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

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

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

3.03 CLEANING

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

END OF SECTION

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. A 36 - Standard Specification for Carbon Structural Steel.
   2. A 48 - Standard Specification for Grey Iron Castings.
   3. A 53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   4. A 123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coating on Iron and Steel Products.
   5. A 240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   6. A 269 - Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
   7. A 276 - Standard Specification for Stainless Steel Bars and Shapes.
   8. A 307 - Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
   9. A 489 - Standard Specification for Carbon Steel Lifting Eyes.

10. A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
11. A 501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
12. A 554 - Standard Specification for Welded Stainless Steel Mechanical Tubing.
13. A 635 - 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. A 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-iron Alloy-coated (Galvanized) by the Hot-Dip Process.
15. B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
16. B 429 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
17. B 308 - Standard Specification for Aluminum Alloy 6061-T6 Standard Structural Profiles.
18. B 221 - Standard Specification for Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Profiles and Tubes.
19. F 3125 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength, Inch Dimensions.

D. AWS D 1.1 - Structural Welding Code.

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

F. International Building Code (IBC).

1.03 SUBMITTALS

A. Shop Drawings: Submit fabrication drawings for approval.

PART 2 - PRODUCTS

2.01 GENERAL

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

Item	ASTM Standard No.	Class, Grade Type or Alloy No.
Cast Iron		
Cast Iron	A 48	Class 40B
Steel		
Galvanized sheet iron or steel	A 653	Coating G90
Black steel, sheet or strip	A 569	–
Coil (plate)	A 635	–
Structural plate, bars, rolled shapes, 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 indicted 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 sidemount 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 think, 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 indicted 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 madrels 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, dot not begin this Work until such conditions have been corrected.

3.02 INSTALLATION, GENERAL

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

3.03 LADDERS

A. Secure to supporting surface with bent plate clips providing minimum 8 inches between supporting surface and center of rungs.

B. Where exit from ladder is forward over top rung, extend side rails 3 feet 6 inches minimum above landing, and return the rails with a radius bend to the landing.

C. Where exit from ladder is to side, extend ladder 5 feet 6 inches minimum above landing and rigidly secure at top.

D. Erect rail straight, level, plumb, and true to position indicated on the Drawings. Correct deviations from true line or grade which is visible to the eye.

E. Ladders to be fabricated of aluminum, unless noted otherwise.

3.04 RAILING

A. During construction, keep exterior surfaces of railing covered with 0.4 millimeters, minimum, heat shrink polyethylene film.

B. Do not remove protective film before railing have been accepted by OWNER nor before other Work in proximity of handrails and guardrails has been completed.

C. Discontinue railing at lighting fixtures.

D. Provide 1/8 inch diameter weep hole at base of each post.

E. Where protection is applied for prevention of dissimilar materials electrolysis, make application such that none of the protective material is visible in the completed assembly.

F. Space posts as indicated on the Drawings.

G. Anchor post into concrete by grouting posts into core drilled holes in concrete, into stainless steel sleeves cast in concrete; or bracket mount to face of concrete surfaces; as specified and indicated on the Drawings.

H. Space rails as indicated on the Drawings.

I. Make adequate provision for expansion and contraction of kickplates and rails. Make provisions for removable sections where indicated on the Drawings.

J. Make lower rails a single, unspliced length between posts, or continuous.

K. Make top rails continuous whenever possible, and attach single, unspliced length to 3 posts minimum.

L. Draw up fasteners tight with hand wrench or screw driver.

M. Space attachment brackets as indicated on shop drawings or in manufacturer's installation instructions.

N. Completed installation shall have railing rigid and free of play at joints and attachments.

O. Protect railing finish from scratches, gouges, dents, stains, and other damage.

P. Replace damaged or disfigured railing with new.

Q. Shortly before final acceptance of the Work, and after removal of protective polyethylene film, clean railing with mild detergent or with soap water.

R. After cleaning, thoroughly rinse railing and wipe with soft cloth.

S. Erect railing straight, level, plumb, and true to the positions as indicated on the Drawings. Correct deviations from true line of grade which are visible to the eye.

3.05 MISCELLANEOUS ALUMINUM

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

END OF SECTION

DIVISION 6

WOOD AND PLASTICS (NOT USED)

DIVISION 7

THERMAL AND MOISTURE PROTECTION

SECTION 07900

JOINT SEALERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Sealants and joint backing.

B. Precompressed foam sealers.

1.02 REFERENCES

A. ASTM C 834 - Standard Specification for Latex Sealants; 2010.

B. ASTM C 920 - Standard Specification for Elastomeric Joint Sealants; 2010.

C. ASTM C 1193 - Standard Guide for Use of Joint Sealants; 2009.

D. ASTM D 1667 - Standard Specification for Flexible Cellular Materials--Poly (Vinyl Chloride) Foam (Closed-Cell); 2005.

1.03 SUBMITTALS

A. See Section 01340 for submittal procedures.

B. Product Data: Provide data indicating sealant chemical characteristics, performance criteria, substrate preparation, limitations, and color availability.

C. Product Schedule: Provide schedule indicating manufacturer's products matched to the same Sealant Types (Type ES-1 and Type ES-2, etc.) listed in Part 2 of this Section.
   1. Failure to provide product schedule will result in immediate rejection of the submittal.

D. Manufacturer's Installation Instructions: Indicate special procedures, surface preparation, and perimeter conditions requiring special attention.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.

B. Applicator Qualifications: Company specializing in performing the work of this section with minimum five years' experience.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.06 COORDINATION

A. Coordinate the work with all sections referencing this section.

1.07 WARRANTY

A. Correct defective work within a one year period after Date of Substantial Completion.

B. Warranty: Include coverage for installed sealants and accessories which fail to achieve watertight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 - PRODUCTS

2.01 SEALANTS

A. Type ES-1: General Purpose Exterior Sealant: Polyurethane; ASTM C 920, Grade NS, Class 25, Uses NT, M, G, A and O; multi-component.
   1. Color: Standard colors matching finished surfaces.
   2. Product: Sonolastic NP 2 manufactured by Sonneborn Building Products Div., ChemRex, Inc: www.chemrex.com or equal.

B. Type ES-2: Self-leveling polyurethane; ASTM C 920, Grade P, Class 25, Uses T and M; multi-component.
   1. Color: Standard colors matching finished surfaces.
   2. Product: Sonolastic SL2 manufactured by Sonneborn Building Products Div., ChemRex, Inc: www.chemrex.com or equal.

C. Type ES-4: Butyl sealant, single component, non-hardening with no asbestos.
   1. Product and Manufacturer:
      a. CRL 777 Butyl Rubber.
      b. AP-77 manufactured by Adco Products, Inc: www.adcoglobal.com or equal.

D. Type AE-1 - General Purpose Interior Sealant: Acrylic emulsion latex; ASTM C 834, Type OP, Grade NF single component, paintable.
   1. Color: Standard colors matching finished surfaces.

2. Product: AC-20 manufactured by Pecora Corporation: www.pecora.com or equal.

E. Type SIL-1: White silicone; ASTM C 920, Type S, Grade NS, Class 25, Uses G and A; single component, mildew resistant.
1. Product: 786 Mildew Resistant Silicone Sealant manufactured by Dow Corning Corp: www.dowcorning.com or equal.

2.02 ACCESSORIES

A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.

C. Joint Backing: Round foam rod compatible with sealant; ASTM D 1667, closed cell PVC; oversized 30 to 50 percent larger than joint width.

D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that substrate surfaces and joint openings are ready to receive work.

B. Verify that joint backing and release tapes are compatible with sealant.

3.02 PREPARATION

A. Remove loose materials and foreign matter which might impair adhesion of sealant.

B. Clean and prime joints in accordance with manufacturer's instructions.

C. Perform preparation in accordance with manufacturer's instructions and ASTM C 1193.

D. Protect elements surrounding the work of this section from damage or disfigurement.

3.03 INSTALLATION

A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.

B. Completely seal joints indicated on Drawings and as required to render weathertightness, close openings, and allow movement of materials.

C. Perform installation in accordance with ASTM C 1193.

D. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer, except where specific dimensions are indicated.

E. Install bond breaker where joint backing is not used.

F. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.

G. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

H. Tool joints in accordance with manufacturer's instructions.

I. Do not lap or feather onto adjacent surfaces.

J. Joint Backing: Do not stretch; avoid joints except at corners, ends, and intersections; install with face 1/8 to 1/4 inch below adjoining surface.

3.04 CLEANING

A. Clean adjacent soiled surfaces.

B. Repair or replace defaced or disfigured finishes caused by work of this Section.

3.05 PROTECTION OF FINISHED WORK

A. Protect sealants until cured.

3.06 SCHEDULE

A. Exterior Joint Sealants:
   1. Exterior Joints for Which No Other Sealant Type is Indicated: Type ES-1; colors as selected.
   2. Expansion Joints in Paving Sloped 1:50 or Less: Type ES-2.
   3. Expansion Joints in Paving Sloped More than 1:50: Type ES-1.
   4. Joints Between Light Fixtures and Walls: Type ES-1.
   5. Joints Between Piping and Walls: Type ES-1.

6. Joints Between Ductwork and Walls: Type ES-1.
7. Joints Between Exterior Metal Frames and Adjacent Work: Type ES-1.
8. Under Exterior Door Thresholds: Type ES-4.

B. Interior Joint Sealants:
1. Interior Joints for Which No Other Sealant is Indicated: Type ES-1; colors as selected.
2. Joints Between Metal Frames and Adjacent Work: Type AE-1.
3. Exposed Control and Expansion Joints in Concrete Slabs and Floors: Type ES-2.
4. Joints Between Plumbing Fixtures and Walls: Type SIL-1.
5. Joints Between Plumbing Fixtures and Concrete Floors: Type ES-1.
6. Concealed Joints Between Ductwork and Walls: Type ES-1.
7. Joints Between Piping and Walls: Type ES-1.

C. Colors: Except for interior sealants to be painted and as may otherwise be indicated, provide colors that match adjacent surfaces.

END OF SECTION

SECTION 07920

CAULKING AND SEALANTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope:

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

B. Coordination:

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

1.02 QUALITY ASSURANCE

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

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

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

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

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

1.03 SUBMITTALS

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

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

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

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

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver materials in caulking and sealant manufacturer's original unopened, undamaged containers, indicating compliance with approved Shop Drawings and approved Sample color selections.
   2. Include the following information on the label:
      a. Name of material and supplier.

b. Formula or specification number, lot number, color and date of manufacture.
c. Mixing instructions, shelf life and curing time, when applicable.

3. Failure to comply with these requirements shall be sufficient cause for rejection of the material in question, by ENGINEER. Immediately remove rejected materials from the site and do not offer them again for approval by ENGINEER. Supply new material conforming to the specified requirements, at no additional expense to OWNER.

B. Storage and Handling of Materials:

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

1.05 JOB CONDITIONS

A. Pre-Installation Meeting:

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

B. Environmental Conditions:
   1. Do not proceed with installation of caulking and sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.
   2. Proceed with the Work only when forecasted weather conditions are favorable for proper cure and development of high early bond strength.
   3. Wherever joint width is affected by ambient temperature variations, install elastomeric sealants only when temperatures are in the lower third of manufacturer's recommended installation temperature range, so that sealant will not be subjected to excessive elongation and bond stress at subsequent low temperatures.
   4. When high temperatures prevail avoid mixing sealants in direct sunlight.

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

1.06 GUARANTEE

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

PART 2 - PRODUCTS

2.01 MATERIALS

A. Exterior and Interior Horizontal and Vertical Joints; submerged and intermittently submerged:
   1. Two-Component Polysulfide Sealant:
      a. Polysulfide-based, 2-part elastomeric sealant complying with the following:
         1) Thiokol's Building Trade Performance Specifications: Type II Class A (non-sag).
         2) Adhesion-in-Peel, FS TT-S-00227E and ASTM C 794 (minimum 5 lbs.): Glass, minimum 21 lbs./linear inch; Aluminum, minimum 18 lbs/ linear inch; Concrete, minimum 21 lbs/linear inch.
         3) Hardness (Standard Conditions), ASTM C 661: 15 to 50 (Shore A).
         4) Stain and Color Change, FS TT-S-00227E and ASTM C 510: No discoloration or stain.

5) Accelerated Aging, ASTM C 793: No change in sealant characteristics after 250 hours in weatherometer.
6) Rheological Vertical Displacement at 120°F, FS TT-S-00227E: No sag.

b. Product and Manufacturer: Provide one of the following:
1) Sonnolastic Two-Part by Sonneborn Building Products, Division of Chemrex, Inc.
2) Lasto-Meric by Tremco.
3) Or equal.

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

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

1) SL2 Sealant by Sonneborn Building Products, Division of Chemrex, Inc.
2) THC/900 by Tremco.
3) Or equal.

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

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

2.02 MIXING

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

B. Thoroughly mix components before use.

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

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

PART 3 - EXECUTION

3.01 INSPECTION

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

3.02 JOINT SURFACE PREPARATION

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

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

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

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

3.03 INSTALLATION

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

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

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

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

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

F. Employ only proven installation techniques, which will ensure that sealants will be deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of the joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and a vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.

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

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

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

3.04 FIELD QUALITY CONTROL

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

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

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

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

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

3.05 ADJUSTMENT AND CLEANING

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

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

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

END OF SECTION

DIVISION 8

DOORS AND WINDOWS (NOT USED)

DIVISION 9

FINISHES

SECTION 09800

SPECIAL COATINGS

PART 1 - GENERAL

1.01 SUMMARY

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

B. Related Sections:
   1. Section 13208 - Miscellaneous Work Associated with Welded Steel Storage Tank.

C. 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 storage reservoirs.

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

C. CONTRACTOR shall make every reasonable effort to provide a similar color coating for the two interior coating systems.

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.
20. Ventilation requirements.

D. Certified statement on lead free coatings for interior of water storage reservoirs.

E. 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.

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

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

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

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

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

D. 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.

E. 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.

F. 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 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, 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 tank, 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 (Devoe) Coatings.

C. Coating Systems:
1. System No. 1: Polyamide Epoxy and Aliphatic Polyurethane System - For ferrous metals and metals exterior surface coating (except galvanized steel and pre-primed steel). Items include but are not limited to entire tank exterior surface (shell and roof), exterior ladder with safety cage, shell manways, roof vents, handrails, roof hatch, conduit supports, steel and ductile iron piping, equipment and pipe supports.
a. Surface Preparation: Per Section 3.01.D.
b. Following are acceptable coating systems:
<u>Devoe Epoxy/Urethane System</u>
P1 = Bar-Rust 235 (Off White), 1 coat, 6-8 mils DFT.
F1E = Devthane 378H (color choice by OWNER) 1 coat, 3-5 mils DFT.
2. System No. 2 - 100% Solids Polyurethane (EPA/NSF) Coating System: For tank floor and interior shell surfaces. Items also include but are not limited to columns, column base assemblies, interior ladder, shell manways, discharge and drain piping, overflow weir boxes, and other tank interior appurtenances.
a. Surface Prep: Per Section 3.01.E
b. Coating system shall be NSF approved.
c. Following are acceptable coating systems:
<u>Polibrid Polyurethane (Devoe) System</u>
F1E = Polibrid 705(Buff), 1 coat, 30-40 mils DFT, 100% Solids, Zero VOC.
3. System No. 3 – Two Coat Polyamide Epoxy (EPA/NSF) Coating System: For tank interior surfaces above the tank High Water Level (HWL). Items include but are not limited to interior roof plates, column top plates,

beams/girders, rafters including rafter clips, interior surface of roof vents and roof hatch.

a. Surface Prep: Per Section 3.01.E
b. Coating system shall be NSF approved.
c. Following are acceptable coating systems:

Devoe Epoxy System

P1 = Bar-Rust 233H (buff), 1 coat, 6-8 mils DFT.
F1E = Bar-Rust 233H (Off white), 1 coat, 6-8 mils DFT.

4. System No. 4 - Two Coat Polyamide Epoxy - Aliphatic Polyurethane: For all assembled galvanized steel items; and all plastic including PVC, FRP, and CPVC surfaces. Exposed PVC and CPVC piping shall be painted.
   a. Items may include PVC, FRP and CPVC piping.

   Devoe Epoxy/Urethane System

   P1 = Bar-Rust 235 (gray), 1 coat, 3-5 mils DFT.
   I1 = Bar-Rust 235 (Off white), 1 coat, 4-6 mils DFT.
   F1E = Devthane 378H (color choice by OWNER), 1 coat, 2.5 - 3.5 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.

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.

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

D. Surface Preparation for Tank and Piping Exterior Surface Coating:
   1. The exterior surface shall be shop prepared.
   2. The tank 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.
   3. The exterior surface includes tank shell and roof surfaces, exterior ladder with safety cage, manways (shell and roof), handrails, roof vents, conduit support clips and tank piping.
   4. CONTRACTOR shall be responsible for all third party claims for over spray.

E. Tank Interior Surface:
   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 in accordance with SSPC SP-11.
   3. When abrasive blasted surfaces rust or discolor before coating, abrasive blast surfaces again to remove rust and discoloration.
   4. Do not coat surfaces before abrasive blasting.
   5. When metal surfaces are exposed because of coating damage, abrasive blast surfaces before touching-up.
   6. Include containment sheets over the tank openings to prevent airborne spreading of the blast material.

F. Shop Primed Metal:
   1. Exterior surface of shell and roof plates, handrails, ladder with safety cage, manways (shell and roof), roof vents, conduit support clips, tank piping and only top side of all rafters and beams.
   2. Submerged or non-submerged ferrous surfaces including structural steel and miscellaneous metal to be shop-primed, shall be prepared according to the coating manufacturers most current written guidelines for the submitted coating system and its intended service environment.
   3. Correct abrades, scratched or otherwise damaged areas of shop prime coat by power tool cleaning in accordance with SSPC SP-3
   4. When entire shop priming fails or has weathered excessively, or when recommended by paint manufacturer, abrasive blast shop prime coat to remove entire coat and prepare surface in accordance with SSPC SP-10.
   5. When incorrect prime coat is applied, remove incorrect prime coat by abrasive blasting in accordance with SSPC SP-10.

3.02 GENERAL PROTECTION

A. Protect adjacent surfaces not to be coated from weld spatter and droppings with drop cloths and other coverings:
   1. 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. Application of the coating to the tank interior surfaces shall be spray application only. No coating shall be applied to interior surface by roller application, unless otherwise specified. Apart from the specified interior coats, all weld seams, corners and edges, including roof plates, shall receive one additional hand rolled coat. The additional coat shall extend three to four inches on both sides of weld seams, and extend three to four inches from corners and edges.

M. Application of the coating to the exterior tank surfaces shall be rolled according to the manufacturer's recommendations.

N. 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.

O. 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.

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

Q. 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.

E. The interior wet area of the tank shall be tested and inspected by the ENGINEER to ensure a holiday free surface.

F. Interior wet area of the tank shall be tested and inspected by the ENGINEER to ensure that the coating has cured in accordance with the manufacturer's recommendations.

3.05 SCHEDULE OF ITEMS NOT REQUIRING COATING

A. Nameplates.

B. Caution signs

C. Serial number tags.

D. Control Panels.

E. Instruments.

F. Hardware (galvanized or stainless steel)

G. 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 tank as outlined in Specification section 13207.

3.07 FIRST ANNIVERSARY INSPECTION

A. Interior and exterior surfaces of the tank shall be inspected by OWNER, ENGINEER and CONTRACTOR approximately 12 months after the coating work has been completed. Inspection, remedial work, if required, and report shall be provided as required by AWWA D102, Section 5.2.

END OF SECTION

SECTION 09900

PAINTING

PART 1 - GENERAL

1.01 SUMMARY

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

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

1.02 DEFINITIONS

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

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

1.03 SUBMITTALS

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

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

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

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

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

1.04 QUALITY ASSURANCE

A. Products: First line or best grade.

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

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

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

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

1.05 PRODUCTS DELIVERY, STORAGE AND HANDLING

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

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

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

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

E. Take precautions to prevent fire and spontaneous combustion.

1.06 ENVIRONMENTAL CONDITIONS

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

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

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

1.07 PROTECTION

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

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

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

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

1.08 EXTRA MATERIALS

A. Extra Materials: Include minimum 1 gallon of each type and color of coating applied.
   1. When manufacturer packages material in gallon cans, deliver unopened labeled cans as comes from factory.

2. When manufacturer does not package material in gallon cans, deliver material in new gallon containers, properly sealed and identified with typed labels indicating brand, type and color.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

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

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

2.02 ARCHITECTURAL FINISHES

Exterior Materials	**Primer or First Coat**	**Second Coat**	**Third Coat**	**Fourth Coat**
Galv. Metal Alkyd Gloss	Galva-Etch GE-123	Versaprime 42-44	Syn-Lustro 10 Series	Syn-Lustro 10-Series
Ferrous Metal Alkyd Gloss	Corrobar 43-5	Syn-Lustro 10 Series	Syn-Lustro 10 Series	Syn-Lustro 10 Series
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% Acrylic Flat	Acrylic Stucco Primer/Sealer W-6232	Acri-Flat W704	Acri-Flat W704	If semi-gloss, use Permasheen W901 in lieu of W704

PART 3 - EXECUTION

3.01 INSPECTION

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

B. Start painting when unsatisfactory conditions have been corrected.

3.02 PREPARATION OF SURFACES

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

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

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

3.03 APPLICATIONS

A. Apply each coat at proper consistency.

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

C. Sand lightly between coats to achieve required finish.

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

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

3.04 CLEANING

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

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

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

END OF SECTION

DIVISION 10

SPECIALITIES

SECTION 10400

PROCESS IDENTIFICATION DEVICES, STENCILING AND TAGGING SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. All identification, stenciling, and tagging systems for process valves, process piping, process equipment, etc.

B. Related Sections include but are not necessarily limited to:
   1. Division 1
   2. Section 09800 - Special Coatings
   3. Section 05501 - Miscellaneous Metals

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI):
      a. A13.1 - Scheme for Identification of Piping Systems.

1.03 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgment that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Identification register listing all items to be identified, type of identification system to be used, lettering, location and color.
      d. Catalog information for all tagging systems.
      e. Manufacturer's illustration of safety and danger signs for selection by OWNER.
      f. Updated, complete, identification register with non-conflicting numerical assignments submitted prior to project acceptance.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURER'S

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Tagging Systems:

a. W.H. Brady Co.
b. Seton Name Plate Corp.
c. T & B/Westline.
d. Safety Sign Co.
e. Pre-approved Equal.

2.02 MATERIALS

A. Tags:
1. Aluminum.

B. Fasteners:
1. Stainless Steel Wire.

2.03 FABRICATION

A. General:
1. Lettering Color: Black.
2. Lettering Style: Helvetica.

B. Round Aluminum Tags (Type 1):
1. 2 inch diameter.
2. 1/4/inch high engraved letters.
3. Brushed aluminum finish.
4. Imprint tags with item designation indicated on Drawings.

C. Rectangular Plastic Signs (Type 2):
1. 7 x 10 x 1/16 inch.
2. 1 inch high black lettering.
3. Stainless steel grommets each corner.

D. Painted-On Stenciling System (Type 3):
1. Text as required for item being identified.
a. All text uppercase sized in accordance with ANSI A13.1.

E. Rectangular Plastic Signs (Type 4):
1. 10 x 14 x 1/16 inch.
2. Text as required by schedule in Part 3:
a. Text shall be largest practicable size based on number of characters required.
3. Rated indoor/outdoor.

F. Engraved Name Plates (Type 5).

2.04 MAINTENANCE MATERIALS

A. Tags:
   1. Aluminum.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Prior to installation, inspect and verify condition of substrate. Installation of product constitutes installer's acceptance of substrate condition for product compatibility.

3.02 PREPARATION

A. Correct defects which may interface with or prevent a satisfactory installation.

3.03 ERECTION, INSTALLATION, AND APPLICATION

A. Install tagging, stenciling, and identification items at required locations.

B. Provide arrows and markers on piping:
   1. At 20 foot maximum centers along continuous lines.
   2. At changes in direction (route) or obstructions.
   3. At valves, risers, "T" joints, machinery or equipment.
   4. Where pipes pass through floor, wall, and like obstruction.
      a. Provide markers on both sides of obstruction.

C. Position markers on both sides of pipe with arrow markers pointing in flow direction. If flow is in both directions use double headed arrow markers.

D. Apply stenciling in uniform manner parallel to piping.

E. Coat back of Type 1 aluminum tags with dissimilar metals protection when installed on concrete.

F. Process piping shall be color coded. Color to be selected by ENGINEER.

G. For 3-inch and smaller piping, provide adhesive labels to indicate flow direction and pipe service.

3.04 SCHEDULE

A. Identification Schedule.

ITEM	ID TYPE	FASTENER
Valves	1	Wire
Pumps, Pump Motors, and other Rotating Equipment, and electrical powered equipment	3 or 5	Epoxy if Type 5
Instrumentation Flow (Primary Elements etc.)	5	Epoxy
Piping	3	--
Control panels, Motor Control Centers, Lightening Panels not Factory Labeled	5	Epoxy
Safety Signs - Hazard Warning	4	Stainless Steel
Information and Caution Signs	4	See this Section
Steel Tanks, IX System, Brine Maker, Blowers	3	--

B. Piping Schedule (Colors based on Tnemec.):

1. Color Schedule:

Above Ground Pipe Labels	Color of Pipe & Letters
Untreated Water - WIL, WTL, PIL, POL	Olive Green
Finished or Potable Water - SWL, TWL	Dark Blue
Sewer - PDL, BDL	Dark Gray

Chemicals	Color
Sodium Hypochlorite	Black Letters on Yellow
Brine and Spent Brine	Black Letters on Yellow

2. Lettering Size Schedule:

OD of Pipe or Covering (inches)	Height of Letters (inches)
3/4 to 1-1/4	1/2
1-1/2 to 2	3/4
2-1/2 to 6	1-1/4
8 to 10	2-1/2
Over 10	3-1/2

3. Unless the line is in such a location that it can be seen only from one direction, such as pipes near a wall, two sets of the code designation shall be applied at each location, placed in the two visible quadrants, with respect to normal viewing positions. In general, pipe identification size, color, and arrangements shall be in accordance with ANSI A 13.1 (latest edition).

C. Safety Signs and Miscellaneous:

1. Provide and install a minimum of 10 custom worded signs. Type 4 with text and location to be provided by OWNER at later date. Locations will include, but not be limited to, electrical panels, hose bibbs. Signs will be mounted on a galvanized post.

END OF SECTION

DIVISION 11

EQUIPMENT

SECTION 11002

EQUIPMENT IDENTIFICATION TAG SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

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

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

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

1.02 QUALITY ASSURANCE

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

1.03 SUBMITTALS

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

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

PART 2 - PRODUCTS

2.01 EQUIPMENT IDENTIFICATION TAGS

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

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

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

PART 3 - EXECUTION

3.01 INSPECTION

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

3.02 INSTALLATION

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

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

END OF SECTION

SECTION 11005

EQUIPMENT: GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

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

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

1.02 QUALITY ASSURANCE

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

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

compatible and operates properly to achieve the performance requirements specified. Unless otherwise specified, the responsible manufacturer shall be the manufacturer of the driven equipment. This requirement for unit responsibility shall in no way relieve CONTRACTOR of his responsibility to the OWNER for performance of all systems.

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

1.03 DEFINITIONS

A. Product: Manufactured materials and equipment.

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

1.04 SUBMITTALS

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

i. Equipment factory primer and painting and coating data.
j. Manufacturer's recommended spare parts list.
k. Piping and duct connection size, type and location.

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

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

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

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

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

2.02 MANUFACTURED UNITS

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

2.03 ACCESSORIES

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

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

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

2.04 FABRICATION

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

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

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

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

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

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

G. Machine the mounting feet of rotating equipment.

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

2.05 WARRANTY

A. Provide 1 year manufacturer's warranty effective from the date when the equipment is placed into service.

PART 3 - EXECUTION

3.01 ERECTION/INSTALLATION/APPLICATION

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

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

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

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

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

F. Machine Base:
   1. Mount machine bases of rotating equipment on subbases in manner that they are level in both directions according to machined surfaces on base. Use machinist level for this procedure.
   2. Level machine bases on subbases and align couplings between driver and driven unit using steel blocks and shims.

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

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

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

I. Field coat in accordance with Section 09800.

3.02 WIRING CONNECTIONS AND TERMINATION

A. Clean wires before installing lugs and connectors.

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

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

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

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

F. Terminate spare conductors with electrical tape.

3.03 FIELD QUALITY CONTROL

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

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

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

END OF SECTION

SECTION 11211

VERTICAL TURBINE LINE SHAFT WELL PUMP

PART 1 - GENERAL

1.01 SUMMARY

A. This section provides the requirements for the vertical turbine line shaft well pump and its assembly.

B. Contractor shall be responsible for chlorinating the well in accordance with the latest AWWA Standards.

1.02 REFERENCES

A. American Water Works Association Standard E-101. Vertical Turbine Pumps - Line Shaft and Submersible Types.

B. Hydraulic Institute Standards:
Section E - Deep Well Turbine Pumps
Section F - Test Code

1.03 DEFINITIONS

A. Bowl Setting - Actual length of column pipe plus bowls.

B. Pump and Column Pipe - All "downhole" components. Includes, but not limited to, bowl/impeller assembly, discharge column pipe, line shaft bearings, shaft enclosure tube, pump discharge head or elbow, intake screen, and spiders.

C. Total Dynamic Head (TDH) - the head in feet against which the pump must operate.

D. All levels for design criteria are measured from the ground surface as shown on the Drawings.

1.04 SYSTEM DESCRIPTION

A. The well pump shall be a water-lubricated vertical turbine line shaft pump rated to deliver the flow rate at the TDH specified in this section. Pump motor is to be powered by a variable frequency drive unit (VFD).

1.05 SUBMITTAL

Information specified below shall be required for approval of the column pipe and discharge.

A. General: The Contractor shall furnish a complete description of all equipment covered under this specification, including catalogs, cut sheets, and pertinent engineering data. Where the product differs from the specified requirements and/or catalog description, each point of difference shall be clearly stated. This requirement is set forth to facilitate the review of submittal data and is not to be construed by the Contractor as waiving the requirements of these Specifications. Setting and foundation plans and dimension sheets for the equipment offered shall be submitted.

B. Data Sheet: A data sheet supplying the following information for the pumping equipment shall be submitted by the Manufacturer:

1. Name of Manufacturer of pump.
2. Type of pump.
3. Number of stages.
4. Diameter size(s) of impeller; trimmed or full impeller, impeller material, finish grade, coatings, impeller balance test data or upper limit.
5. Bowl material and pressure rating.
6. Bowl shaft material and diameter.
7. Head and capacity at design point.
8. Shut-off pressure.
9. Thrust computations:
    a. Complete computations on thrust conditions.
    b. Computed pump thrust at operating condition and shut-off.
10. Factory recommendations of impeller setting for best efficiency and satisfactory lateral setting of 80% of the design point capacity and associated TDH.
11. Available bowl lateral compared to the design capacity and 80% of design capacity recommended lateral settings, noting whether the available bowl laterals at these settings is sufficient for pump up thrust at a zero TDH start-up condition.
12. Calculate the maximum horsepower (HP) anywhere on the curve.
13. Calculate Net Positive Suction Head (NPSH) anywhere on the curve as adjusted for the impeller diameter and RPM.
14. Guaranteed HP required to pump the following flows against the required head at design point:
    a. Well 24 - 2500 gpm
    b. Well 25 - 1500 gpm
15. Net weight of pump.
16. List differences between specified requirements and equipment offered.
17. List equipment not covered by catalogs, descriptive literature, etc., operation and maintenance manual, etc. which shall be supplied.
18. Pump curve with pump impeller data.

C. A data sheet supplying the following information for the pumping equipment shall be submitted:

1. Size and pressure rating of discharge head flange.

2. Column pipe:
    a. Length of sections
    b. Materials
    c. Weight per foot
    d. Thickness and pressure rating
    e. Type of joint
    f. Inside diameter
3. Line shaft:
    a. Material
    b. Diameter
    c. Length of sections
    d. Computations justifying size selection (attached to data sheet)
4. Line shaft bearings:
    a. Length
    b. Spacing
    c. Type
    d. Material
5. Computations of column, tube and shaft stretch at shut-off, 50% capacity, 80% capacity, design capacity, and 120% capacity.

1.06 QUALITY ASSURANCE

A. The column and discharge head shall be a product of a manufacturer regularly engaged in the production of this type of equipment. The Manufacturer must display at least eight years of satisfactory performance for equipment of this type, size and setting.

B. Materials used in the manufacture of equipment shall be of the best quality used for the purpose in commercial practice. Workmanship shall be of the highest grade throughout and in accordance with the best standard practice for this type of equipment.

C. Parts damaged in shipment shall be replaced at no additional cost to the Owner.

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Goulds Pump

B. National Pump Company

C. American Turbine

D. HydroFlo Pumps

2.02 PUMP

A. The water-lubricated deep well turbine pump shall be constructed in accordance with Hydraulic Institute Standards and AWWA Specification E-101, except as modified hereinafter. The pump discharge head shall be designed for flanged discharge above the pump base. The pump bowls shall be of such size that they can be installed in a “18” nominal I.D. well casing.

2.03 PUMP DISCHARGE

A. The pump shall have a discharge head construction, arranged for bolting to the foundation as shown on the drawings, and shall be provided with at least two (2) lifting lugs minimum of suitable size to facilitate lifting and setting. The head shaft coupling shall be accessible without disassembly at the discharge head. Due to weight, the discharge head shall be fabricated steel and shall be designed to meet local sanitary requirements. The seal shall be mechanical-type only.

B. The overall head room over the pump shall be confirmed the actual discharge head height being provided for the pump. The discharge head base flange bolt holes sizes and their pattern shall be coordinated with those of the sole plate. The discharge head at its highest point shall have threaded tap for relieving air and breaking vacuum with appurtenances as shown on the drawings. The pump discharge head shall be designed with a flanged connection.

C. Provide and install a 1" thick carbon steel sole plate. Sole plate shall be anchored to pump pedestal foundation with four symmetrically arranged anchor bolts conforming with the manufacturer’s requirements. Non-shrink grout shall be used to buildup and level sole plate. See drawings for placement and dimensions.

2.04 DISCHARGE COLUMN

Each section of discharge column shall consist of a column pipe, alignment spiders, a shaft enclosing pipe or tube, inner column, line shaft bearing and couplings.

A. Column Pipe: The column pipe shall meet the requirements of Table 2 of AWWA E-101 and shall have threaded connections for each 20 feet of pipe length. Pipe shall be such that the friction loss will not exceed 5 feet per 100 feet based on the rated capacity of the pump. The column pipe shall comply with ASTM A-53 Grade B steel pipe and have a minimum diameter of 8-inches. Minimum wall thickness to be specified by the pump manufacturer.

B. Shaft Tube: The shaft tube shall be extra strong Schedule 80 steel pipe per ASTM A120 Grade B. Pipe lengths shall be coordinated with the Line Shaft being provided.

C. Line-shaft: The line shaft shall be of ANSI C1045 steel. Surface finish shall not exceed RMS 40. It shall be furnished in lengths not greater than 20 feet with the ends faced squarely to assure perfect alignment after installation. The shafting shall be coupled with 316 stainless steel couplings, designed with a safety factor of one and half times the shaft safety factor and shall be left hand thread to tighten during pump operation.

D. Line-shaft Bearings: The shaft bearings shall be impregnated carbon, neoprene or brass and appropriate for water-lubricated operations. The bearings and retainers shall be located at intervals recommended by the pump manufacturer.

E. Spiders: Spiders shall be of a type standard with the manufacturer of the pumps, and shall be spaced in accordance with the pump manufacturer's recommendations to reduce vibration to within specified limits.

2.05 BOWL ASSEMBLY

A. General: The bowl impeller units shall be of deep set high pressure construction and shall correspond to the following specification requirements:

1. Bowl wall thickness accommodate stress limitations of A48 Class 30 cast iron tensile strength or ductile iron.
2. Neoprene "O" rings shall be provided in flange faces between stages.
3. The impeller shaft shall be supported by standard bronze bearings. Discharge and suction cases shall both be filled with steel sand collars. All bowl bolting shall be stainless steel.

B. Bowls: Bowls shall be porcelain enamel lined coarse-grained cast iron or semi-steel with the interior surfaces finished smooth. The bowls shall be register fit to assure perfect alignment at all times.

C. Guide passages for water shall be designed to minimize friction. Guide bearings shall be provided in each stage to ensure proper alignment of the impellers, together with a water-lubricated bronze bushing or bearing at the bowl assembly intake to serve as the bottom bearing of the impeller shaft. The bowls shall be capable of withstanding a hydrostatic pressure equal to twice the pressure at rated capacity or 1-1/2 time shut off head, whichever is greater.

D. Impellers: Impellers shall be 316 SS containing not less than 79% copper and shall be cast in one piece, accurately machined, and precision tested for dynamic balance. All impellers shall be fixed rigidly and concentrically to the impeller shaft in such a manner that they will not work loose but will be easily removable. Open or semi-open impellers will not be acceptable.

E. Impeller Shaft: The impeller shaft shall be of 416 stainless steel, accurately machined, and of adequate size and strength to do the work required. Shaft shall conform to paragraph 4.2.3 of AWWA Standard E-101.

F. The bowl shall have a maximum diameter of __ inches.

2.06 SUCTION STRAINER

A. The suction strainer shall be of the conical type and shall be made of material standard with the manufacturer of the pump and shall be attached to the bottom bowl as recommended by the manufacturer. Total inlet area shall be at least 3 times the suction pipe area.

2.07 AIR AND VACUUM RELEASE VALVE

A. An air and vacuum release valve with the necessary pipe connections shall be provided to permit the automatic escape of all air from the discharge column during the period between the pump starting and the water reaching the ground surface. The size and type of the air and vacuum release valve and piping shall be as shown on the drawings and recommended by the pump Manufacturer and approved by the Engineer. Provide a synthetic seat appropriate for the well pump discharge pressure. The valve shall have a combined air release mechanism or in a separate air release valve shall be provided for the release of air during the pumping period after the water reaches the ground surface. The valve will have an anti-slam regulated closure mechanism to prevent a shock or water hammer condition.

2.08 MINIMUM REQUIREMENTS

A. Discharge Column: The discharge column pipe size, shaft enclosing tube size and line shaft size shall be based on the selected characteristic curve. Pump capacity and setting are listed below. The pump setting is the actual length of column pipe to be furnished.

B. Motor: A **350 HP for Well 24 and a 100 HP for Well 25,** both electric motors compatible with variable frequency drive (VFD) service in accordance with Specification Section 11212

C. Pump Requirements:

Well 24:

Design Point:	*2500* gpm at 380 ft TDH at Full Load Speed
Max Ambient Temperature:	__ º C
Estimated Static Water Level:	__ feet
Anticipated Drawdown:	__ feet
Pump Setting:	300 feet
Minimum Bowl Efficiency:	83% at Full Load Speed

Minimum column/tube/shaft: __" x __" x ___"

Maximum NPSHR: __ ft.
Maximum Hydraulic Thrust: ____ LBS
Minimum Total Available Bowl Lateral: __ in.

Site Elevation: 7 ft.

Well 25:

Design Point: *1000* gpm at 240 ft TDH at Full Load Speed
Max Ambient Temperature: __^{o} C
Estimated Static Water Level: __ feet
Anticipated Drawdown: __ feet
Pump Setting: 150 feet
Minimum Bowl Efficiency: 83% at Full Load Speed
Minimum column/tube/shaft: __" x __" x ___"

Maximum NPSHR: __ ft.
Maximum Hydraulic Thrust: ____ LBS
Minimum Total Available Bowl Lateral: __ in.

Site Elevation: 30 ft.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Contractor shall install equipment, complete and ready for operation with all necessary appurtenances. The Contractor is responsible for coordinating pump installation with the Owner. The pumping equipment shall be installed under the direct supervision of competent representatives from the various equipment manufacturers. Final impeller setting (adjustment) shall not be made until all discharge and wash piping is installed and ready for service and until so requested by Owner. The pump representative, shall, during the installation and testing period, instruct the operating personnel in the care, operation and adjustment of the equipment his company is furnishing. The services of the manufacturer's representative shall be without cost to the Owner.

B. Contractor must maintain the appropriate licenses to meet local regulations.

3.02 TESTS

A. Factory Witnessed Performance Test and Certification: The pump shall be tested and certified by the factory. The test shall include, but not be limited to, a complete set of flow, head, efficiency, horsepower, and NPSH required points over the full range for the pump. The pump shall be tested and adjusted to 1770/1760 rpm (depending on the pump) based on the horsepower load of the motor to be furnished by the Contractor. Tests showing characteristics out of the tolerance as specified by the Hydraulic Institute Standard shall be cause for rejection of the unit. Contractor must provide written copies of the test results shall be submitted to the City of Goodyear for approval. Approval of the test certification does not relieve the Contractor of his responsibility for meeting the requirements of Field tests.

B. Field Acceptance Test: Pump shall be field tested at the place of installation to determine actual flow-head and power characteristics. Pump shall be within the tolerances of no less than 5% of design point capacity at design point head, and plus 2% of the power load as determined by the Factory Witness Test. Design points shall be modified for actual conditions at time of test to account for water pumping level, discharge pressure, speed of rotation or other parameters that may affect design points. Determination of a modified design point shall be by the Engineer.

1. The Contractor shall provide accurate calibrated measuring devices, including pressure gage, tachometer and volt-amp meter. Measurement of water level shall be accomplished by using an electronic well sounding cable furnished by the Contractor and by the water drawdown level monitoring system provided in this project.

2. The Contractor at his option may provide his own measuring equipment to verify results. Measurement of flow rate shall be with the well flow meter provided in this project. The pump with the specified motor shall be accepted by the Owner after 200 consecutive hours of trouble-free operation. Warranty Term shall be standard factory 1-year warranty and shall start from the date of start-up and commissioning of the equipment.

3. The Owner shall conduct the field test in the presence of the Contractor.

C. Vibration Limitation: Each pumping unit shall be tested by the Contractor at rated rpm for vibration amplitude prior to acceptance with data at each frequency recorded. Measurement shall be made at the top motor bearing. Amplitudes in excess of 0.15 inch/sec. will be corrected by the Contractor at no cost to the Owner prior to acceptance.

3.03 WELL DISINFECTION

A. The Contractor shall notify the Owner seven (7) calendar days in advance of performing well disinfection.

B. The well disinfection shall be performed with the permanent pumping equipment in place

C. The well and pumping equipment shall be disinfected in accordance with AWWA Standard Specification C654.

D. All disinfection materials shall be in compliance with NSF Standard 61.

3.04 MEASUREMENT AND PAYMENT

A. Work covered under this section of the specifications and all costs associated therewith shall be included in the contract price for the item to which the work applies. No separate payment shall be made.

END OF SECTION

SECTION 11212

VERTICAL HOLLOW SHAFT MOTORS

PART 1 - GENERAL

1.01 SUMMARY

A. Description: This section specifies the requirements for custom built premium efficient motors. The motors shall be inverter duty rated, poly phase, in strict compliance with the requirements specified herein. The motor size shall be coordinated with peripheral clearances. The minimum horsepower of the Well 24 motor shall be 350 HP and Well 25 motor be 200 HP. Motor speed shall be as specified in Section 11211, Vertical Turbine Line Shaft Well Pump. The motor must be compatible with variable frequency drive (VFD).

B. To assure unit responsibility, the deep well vertical turbine pump and the vertical hollow shaft inverter duty motor shall be furnished and coordinated by the pump supplier. The pump supplier shall coordinate with Contractor for the incorporation of the Owner supplied variable frequency drive. The Contractor and pump supplier shall assume responsibility for the satisfactory installation and operation of the complete pumping system.

C. The motor shall be installed on the pump.

1.02 REFERENCES

A. ANSI/NEMA MG-1. Motors and Generators

B. UL 1004, Standard for Safety for Electric Motors.

C. ANSI/NEMA MG-11. Installation and Operation of Electric Motors.

D. IEEE SID 112. Standard Test Procedure for Polyphase Induction Motors and Generators.

E. IEEE SID 85. Standard Test Procedure for Airborne Sound Measurements on Rotating Electric Machinery.

F. ANSI 51.2. Physical Measurement of Sound.

G. Other Standards. Motors shall be built to all other applicable NEMA, ANSI and IEEE standards not included above.

1.03 SUBMITTALS

A. Design Information. For the motor specified under this Section, provide the following design information and information on the Electric Motor Questionnaire included at the end of this Specification:

1. Manufacturer
2. Rated full load horsepower
3. Rated volts
4. Numbering of phases
5. Frequency of Hertz
6. Full load amperes (FLA)
7. No load amperes
8. Locked rotor amperes (LRA) at rated voltage or NEMA code letter
9. Maximum RPM at full load in percent
10. NEMA insulation system classification, and description of manufacturer's method of application
11. Temperature rise by resistance at full load.
12. Ambient Temperature for which motor is designed
13. Service factor
14. Frame size complete with outline drawing, outline dimensions, net weight and weight of rotation element for all motors. Include surge protection dimensions and weight.
15. NEMA Enclosure (ODP, WP-1, TEFC, etc.)
16. Bearing size, thrust capacity, & B-10 Bearing life.
17. Bearing lubrication (upper, lower) (grease, oil)
18. Safe stall time
19. Number of safe stars in succession when starting form a 40 degree Celsius ambient, intermediate waiting periods and other conditions for driving equipment with a NEMA standard wk2 value
20. Efficiency at full load, ¾ L, & ½Land Service Factor
21. Power factors at full load, ¾ L & ½ L, and Service Factor load
22. Space heater voltage and wattage
23. 100 ohm Platinum Winding RTD wiring diagram

B. Shop Drawings and Product Data. Provide the following information:

1. Data to be included on nameplate
2. Dimensioned outline drawings
3. Net weight of assembled motor
4. Dimensions and internal arrangements of terminal boxes
5. Actual information on manufactured unit when in variance with information

1.04 OPERATION AND MAINTENANCE MANUAL

A. The following information shall be included:

1. Project record drawings clearly indicating operation features and including as-built shop drawings, outline drawings, and schematic and wiring diagrams.
2. Instructions for erection, alignment (including tolerances) and preparation for use.
3. Complete description of safety equipment, safety procedure, and safety precautions.
4. Normal starting, running and shut-down procedures, as well as emergency shut-down procedures
5. Recommended number of starts in any 24-hour period
6. Normal maintenance inspection and lubrication procedures
7. Recommended spare parts list.

1.05 JOB REQUIREMENTS AND CONDITIONS

A. Unit Responsibility: The electric motor shall be furnished and guaranteed by the Pump Supplier.

B. Structural, mechanical, and electrical changes that are necessitated because the Contractor selects equipment with dimensional, power, or mechanical differences from that shown on the Drawings shall be made by the Contractor at no additional cost to the Owner. All Engineering costs associated with revisions shall also be borne by the Contractor.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Ratings

1. Each motor shall develop ample torque for its required service throughout its acceleration range at a voltage 10 percent below nameplate rating. Where shown on the Electrical Drawings to be operated on a reduced voltage starter, the motor shall develop ample torque under the conditions imposed by the reduced voltage starting method.
2. The motor shall not be required to deliver more than its rated nameplate horsepower, at unity (1.15) service factor, under any condition of mechanical or hydraulic loading.
3. Motors shall be designed to operate at rated load in an ambient 50 degrees C or 120 degrees F at a maximum altitude of 1000 feet above sea level.
4. Motor shall be non-overloading across the pumps operating curve.

5. Specific motor data such as HP, RPM, enclosure type, etc., is specified under the detailed specification for the mechanical equipment with which the motor is supplied.

B. Enclosures
1. Motors shall conform to the following standard enclosure design as specified in the detailed mechanical equipment sections:
a. Weather Protected Type 1 (WP1)

C. Nameplates
1. The motor manufacturer's nameplates shall be engraved or embossed on stainless steel and fastened to the motor frame with stainless steel screws or drive pins. Nameplates shall indicate clearly all of the items of information listed in NEMA Standard MG1-10.38 or MG1-20.60, as applicable.
2. Nameplates shall have NEMA nominal efficiency, full load power factor and max kVAR required to bring power factor to 95 percent at full load.

D. Anti-Condensation Heaters
1. Anti-condensation heaters, where specified under the detailed mechanical specifications shall conform to the following:
a. Heaters shall be of the flexible silicone wrap around type installed within the motor enclosure, heaters shall be installed at the end turns adjacent to the core iron. Heaters shall be rated for 120 Volt, single phase with wattage as required. The heater wattage and voltage shall be embossed on the nameplate. Power leads for heaters shall be brought out at the motor accessory lead junction box.

E. Temperature Detectors
1. Motors shall be provided with Q-6 100 ohm Platinum Winding (2/phase) with Q-2 100 ohm Bearing RTD's (1/bearing) suitable for use with GE Multilin 269+ monitor provided by others.

2.02 THREE PHASE AC INDUCTION MOTORS

A. Design Criteria

1. Type: Vertical Hollow Shaft squirrel cage induction motor.
2. Operating voltage: 480 volts, 3 phase, 60 Hz.
3. Class F Insulation designed for Inverter Duty to meet NEMA MG1 part 31.
4. Environment: Deep Well Vertical Turbine Pump.
5. Maximum ambient temperature: 110 degrees F.
6. Operational humidity: up to 90 percent non-condensing.
7. NEMA nominal or minimum efficiency levels that match NEMA band efficiencies for the HP, speed, and voltage specified.
8. Power Factor in line with HP, speed, voltage specified. Provide recommended KVAR capacitor to correct Full Load Power Factor to 95%.
9. Service Factor: 1.15 times rated load.

10. Temperature Rise: Class F Insulation with Class B Rise, 70 deg C Rise by Resistance at Full Load over a 50 deg C Ambient.
11. Noise Level: Limited to 91 dBA at no load measured at 3 feet from the motor
12. Vibration limits: Not to exceed 0.2 in/sec at any frequency.
13. Efficiency: Motor efficiency shall be evaluated and determined by the pump supplier to achieve and guarantee the overall wire to water efficiency of the pumping unit. All motors shall have the efficiency evaluated with pump.
14. Slip: Not more than 3.0 percent of 100% speed but nevertheless the full load RPM shall match or exceed the pump design RPM.
15. Starting-Full Voltage: Each motor shall be capable of producing the required starting torque as required by the pump manufacturer. All motor driven pump units shall be readily capable of starting with the pump primed and against check valve having a static or operating head on the discharge side.
16. Locked Rotor Current: The locked rotor current of the motor shall be limited in accordance with the National Electrical Code, maximum of Code letter F, which permits 5.0 - 5.59 KVA per horsepower and concurs with the NEMA Code F ratings. The code letter shall be clearly shown on the nameplate.
17. Safe Stall Time: Safe stall time shall not be less than 15 seconds when hot, unless approved by the Engineer.

B. Construction

1. Enclosure Weather Proof 1 (WP-1) conforming to NEMA MG-1.
2. Stator Frame: Fabricated from steel plate or cast iron sized to withstand normal and maximum overload/shot circuit stresses.
3. Stator Core: Laminated low-loss electrical sheet steel with individual laminations coated with insulating varnish.
4. Coils: Form wound copper windings with a sealed solid-type resin insulation system utilizing a vacuum impregnation process (VPI).
5. Bearings:
   a. Oil lubricated, anti-friction type thrust and upper guide bearings and grease or oil lubricated lower guide bearing.
   b. Minimum L-10 life rating of 2.3 years or 20,000 hours at design.
   c. Insulation on non-drive end bearing to prevent flow of shaft currents.
   d. Coordinated lubrication system requirements with operating speed range of pumps in Section 11211.
   e. Motors to carry weight and thrust of entire rotating assembly at design and shut-off thrust condition.
   f. Thrust bearings to provide 30% momentary up thrust protection.
6. Motor Mount:
   a. Coordinated with high-ring mounting base to be furnished under Section 11211.
   b. Contractor provide mounting bolts.
7. Insulation

a. Insulation systems shall be Class F, operated at the specified temperature rise and shall be manufacturer's premium grade, resistant to attack by moisture, acids, alkalis, and mechanical or thermal shock.

8. Leads
   a. Motor Leads: Use ASTM B173, Class G, stranded copper conductors with insulation the same as or better than specified in the preceding Motor Insulation paragraph. Provide permanent identification numbers on leads according to NEMA MG 1-2.02. Provide each lead with additional identification within six inches of the stator frame. Use crimp-on, solderless copper terminals on leads and place heat-shrink insulation sleeves or covers between leads and terminals.
9. Nameplates
   a. Main Nameplate: Provide each motor with an embossed stainless steel nameplate meeting the requirements of NEMA MG 1-20.60 for squirrel-cage induction motors and the National Electrical Code, Section 430-7. Include the following additional information on the main or additional nameplate:
      1) Insulation system classification
      2) Connection diagram
      3) Direction of rotation for driven equipment
      4) Electrical phase rotation for NEMA standard direction of rotation
   b. Heater Nameplate: Voltage and wattage
   c. Bearings Nameplate: Bearing manufacturer's name and identification and recommended lubricant.
   d. Attachment: Attach nameplates to the motor with stainless steel fastening pins or screws.
   e. Dynamic Balance Nameplate: Furnished and mounted on motor.
10. Canopy Caps: Shall be of plastic or aluminum construction and be easily removable for maintenance.

C. Accessories
1. Resistance Temperature Detectors (RTD's)
   a. Quantity:
      1) Two (2) for Bearings Platinum, 100 OHM
      2) Six (6): 100 ohm Platinum Winding RTD's (2/phase).
   b. Resistance: 100 OHMs at 25 degrees C.
   c. Electrical Contractor shall supply #16 twisted shielded pair wire in conduit from Pump Bearing RTDs to the control conduit box on the motor. The Contractor shall extend all RTD connections to the Medium Voltage starters via twisted shielded pairs as shown on the drawings.
2. Space Heaters

a. Type: Electric resistance, 120 volts, silicon rubber clad or equivalent non-oxidizing exterior, with maximum surface temperature of 130 degrees C (266 degrees F). Alternatively, provide two stainless steel sheathed conventional space heaters, each with rated watts at the specified voltage equal to twice the required value, and connect in series.

3. Lifting Lugs on motor frame.
4. Minimum of two copper grounding pads on motor frame at opposite sides of the frame.
5. Terminal Boxes
   a. Description: Provide custom built, gasketed, "oversized" conduit boxes and terminal housing cabinets for all wiring connections to motor. The box entrance shall be from the bottom side. Verify exact location of cable entry before design from the Contract Drawings
   b. Main Terminal Housing: The main terminal box shall be custom designed to accommodate lightning arrestors and surge capacitors. Motor leads shall be marked for permanent identifications. Provide grounding lug in box for incoming equipment grounding conductor. The main terminal box shall be installed integral with the motor.
   c. Control Cable Conduit Box (es): Terminated RID, motor and pump bearing temperature RTDs, space heater and leads in a separate control cable conduit box. Provide 600 volt rated molded insulation terminal blocks with ring-tongued terminals under screws. Use only corrosion resistant materials and brass screws. Effectively isolated terminal blocks for different functions by suitable air separation or individual boxes. Permanently identify all leads and terminals.

D. Acceptable Manufacturers
   1. US Electric Motors
   2. General Electric Motors

2.03 SURFACE PREPARATION AND SHOP COATINGS

A. External Surfaces
   1. Factory Standard External Paint System. All external surfaces on assembled motors shall be cleaned free of grease, oil, dirt, or other contaminants before painting.

B. Internal Surfaces
   1. The stator bore and end turns shall be coated with clear epoxy varnish in addition to the insulating varnish treatment.
   2. The entire rotor assembly, except bearing journals, shall be coated with clear epoxy varnish.
   3. Machined joints and threaded parts shall be coated with rust inhibiting compound.

C. All machined bolts and screws and other hardware shall be of the hex head type and shall be zinc plated.

PART 3 - EXECUTION

3.01 INSTALLATION

A. These motors and pumps will be installed under the same Contract.

3.02 TESTS

A. Factory Performance Test and Certification: The pump shall be tested and certified by the factory. Certified copies of each factory test report should be provided by the Contractor.

1. One motor of each rating shall be provided with Complete Initial Test & Report per IEEE 112A Method B Dynomometer test. Test includes full load run, percent slip, no load current, full load current, locked rotor current, locked rotor torque, breakdown torque (calculated), efficiency and power factor at 100%, 75%, and 50% of full load, short circuit, meggar, winding resistance, high potential, and bearing inspection.
2. All motors shall be provided with Short Commercial Test & Report per NEMA MGl-12.51. Test includes no load current, locked rotor current, winding resistance, high potential, and bearing inspection.
3. One motor of each rating shall be provided with a Sound Test & Report in accordance with IEEE 85 standard.
4. Locked rotor current and torque at rated voltage and frequency
5. Readout of all Rill's under stabilized heat-run
6. High Potential tests
7. Motor performance test including: current, power factor, speed and efficiency at ¼, ½, ¾, full load, and service factor at rated voltage and frequency
8. Heat run at rated full load for motor
9. Certified noise level test according to IEEE Standard 85, with motor running uncoupled, under no load, on an open factory floor. The method of physical measurement of sound in ANSI 51.2.

B. Field Acceptance Test:

1. General: Provide all necessary instruments, labor, and personnel required to perform motor inspection and testing.
2. Inspection: Inspect all motors for damage, moisture, alignment, freedom of rotation, proper lubrication, oil leaks, phase identification and cleanliness; report any abnormalities to Engineer before energizing.
3. Energizing: After installation has been thoroughly checked and found to be in proper condition, with thermal overloads and other protective devices in

motor controllers properly rated and all controls in place, notify the Engineer for his final review before energizing the equipment system voltage for operational testing.

4. Vibration Tests: Measurements shall be made with an accelerometer probe. The vibration of the pump and motor together shall not exceed 0.1 in/sec. The Engineer's decision shall be final on any questions concerning this testing.

3.03 ACCEPTANCE

A. The motor shall be accepted by the Owner after 200 consecutive hours of trouble-free operation. Warranty Term shall be standard factory 1-year warranty and shall start from the commissioning and final acceptance of the equipment.

3.04 ELECTRIC MOTOR QUESTIONNAIRE

A. The attached motor questionnaire shall be filled in and submitted at the time of the shop drawing submittal. Motors shall not be acceptable without a completed motor questionnaire.

END OF SECTION

ELECTRICAL MOTOR QUESTIONAIRE

MOTOR DATA

Manufacturer: _____ Motor HP: _____

Frame: _____ Enclosure: _____

Type:_____ RPM: _____

Voltage:_____Phases: _____ Hertz: _____

Insulation Class: _____ Duty:_____

Full Load AMPS: _____ No Load AMPS: _____

Locked Rotor AMPS: _____ Locked Rotor Time: _____

Locked Rotor Torque: _____ % Breakdown Torque: _____

Locked Rotor KVA/HP: _____ Rotor WK2 (lb-ft2) : _____

NEMA Design: _____ Service Factor: _____

Inrush Current :(% of Full Load):_____

Max. Safe Stalled Time (Seconds): _____

Number of Safe Starts per Day: _____

Number of Consecutive Starts: _____

*Full Load Temp Rise, deg Cover 50 deg C Ambient (at 1.0 SF): _____

*Service Factor Temp Rise, deg Cover 50 deg C (at 1.15 SF): _____

*Limiting Temperature Rise: _ Resistance (at 25 deg C):_____

Bearings: Type/Size:_____ Life_____ Lubrication: _____
Data Currently Available

Starting Method:_____

Shaft Size:_____
Data Currently Available

ELECTRIC MOTOR QUESTIONAIRE (continued)

Efficiency:	Power Factor:
1.15 S.F. Load: _____	1.15 S.F. Load: _____
4/4 Load: _____	4/4/ Load: _____
¾ Load: _____	¾Load: _____
½ Load: _____	½Load: _____
¼ Load: _____	¼Load: _____

*Temperature rise measured by embedded detectors and not by resistance.

SECTION 11215

STAINLESS STEEL VERTICAL TURBINE CAN PUMPS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Work of this section includes requirements for the stainless steel Vertical Turbine Pumps (VTP) in stainless steel cans for Reverse Osmosis (RO) Feed. The pump manufacturer shall coordinate and provide all pumps, cans and motors. VFDs will be provided by the Contractor.

B. Water shall be tested prior to execution for the presence of *Gallionella* Bacteria.

1.02 MANUFACTURERS

A. Pumps shall be provided with the features and options specified and as manufactured by:
   1. Afton Pumps
   2. Hydroflo Pumps
   3. Goulds Pumps
   4. National Pumps
   5. American Turbine

1.03 DEFINITIONS

A. Terms shall be as defined in ASME Performance Test Code PTC 8.2 for Centrifugal Pumps and the following:
   1. Submergence: Vertical distance in feet between the minimum pumping water level and the bottom of the suction bell.
   2. RO Feed Pumps: Designed and manufactured specifically for brackish water with high chloride, TDS and salt concentrations.

1.04 DESIGN AND PERFORMANCE

A. Design and Performance Criteria shall be as specified for each type of pump
   Quantity: 4
   Tag Numbers: RO-A, RO-B and RO-C

	Minimum Capacity (gpm)	Total Head (Feet)	Efficiency Minimum (%)
At Shut off:	0	TBD	
At Design Point (full speed):	1050	470	81
During RO Flush	960	TBD	

Liquid Pumped:	Brackish Water
Maximum pump speed:	1800 RPM
Minimum submergence available:	3.0feet
Motor horsepower:	200
Pump lubrication:	Pumped Fluid
Discharge flange rating:	Class D
Bearing lubrication:	Internal Loop Water
Suction strainer:	Yes
Anti-vortex suction baffle:	Yes

1.05 SUBMITTALS

A. General: Submit in accordance with Section 01300.

B. Shop Drawings and Product Data:
   1. Submit detailed certified dimensional shop drawings and manufacturer's product data for materials and equipment, including wiring and control diagrams.
   2. Show complete information concerning materials of construction, fabrication, protective coatings, installation, anchoring, fasteners and other details.
   3. Include the manufacturer's specific displacement tolerances for vibration at the operational speeds specified.
   4. Submit pump curves on which the specified operating points are marked. Show efficiency and brake horsepower for the selected pump curve. Include moment of inertia of the impeller, motor, shafting and liquid. Show required submergence and NPSH.
   5. Submit manufacturer's certification of compliance with AWWA E103.
   6. As part of the test procedure for the pumps, record measurements for impeller adjustment and total lateral shaft deflection (shaft runout) above the packing box.
   7. Submit manufacturer's sample form for reporting performance test results at least two weeks before the tests. The test form should contain the data presented in the sample form in Section 6 of the ASME Performance Test Code, PTC 8.2.
   8. Submit manufacturer's certified performance curves for review at least two weeks prior to shipping the units from the factory. Show pump total head, flow, torque, brake horsepower, pump efficiency, required submergence, and required NPSH.

C. Equipment Certification:
   1. At the time of submitting shop drawings, submit, on the form provided, the equipment manufacturer's warranty and certification attesting that the manufacturer has examined the Contract Drawings and specifications and that the equipment provided will meet the performance criteria and conforms to specification requirements.

2. Before shipment, submit certified pump performance curves showing head/capacity relationships and required horsepower after pump assemblies have been fabricated and performance tested at the factory.
3. Submit two copies of certified results of all start-up and performance tests.

D. Maintenance Data and Operating Instructions:
1. Submit required number of copies of Operation and Maintenance Manuals per Section 01300 for the equipment furnished including a detailed description of the function of each principal component, procedures for operation, instructions for overhaul and maintenance.
2. Include lubrication schedule, safety precautions, test procedures, electrical schematics, and parts lists.

1.06 SPARE PARTS

A. Provide the following spare parts for each model of pump:
1. Two sets Pump bearings
2. Two sets Bowl Bearings
3. Two sets Suction bell bearings
4. Two sets Line shaft bearing (if applicable)
5. Two sets Mechanical seal
6. Two sets Gaskets, O-rings and seals
7. Two sets Shaft coupling

B. Pack spare parts in wooden boxes; label with manufacturer's name and local representative's name, address, and telephone number; and attach list of materials contained therein.

1.07 FIELD SERVICES

A. Provide the services of a manufacturer's representative experienced in the installation, testing and operation of the equipment supplied under this specification for not less than two days on-site for installation inspection, start-up and performance testing, and instructing Owner's personnel in the operation and maintenance of the equipment.

B. The above services to be performed during two separate visits to the project site and excludes travel time.

PART 2 - PRODUCTS

2.01 PUMP MATERIAL OF CONSTRUCTION

A. Materials of construction shall conform to the requirements listed below.

	Component	Material
2.	Pump Shafts	316 L Stainless steel, ASTM A 276

3.	Bowl wear rings	Babbitted carbon
4.	Impellers	Stainless steel, CF8M
5.	Coupling	4 part, nickel-plated carbon steel
6.	Impeller wear rings	Type 316 SST L
7.	Pump bowls	Stainless Steel type, CF8M
8.	Bowl bearings	Babbitted carbon
9.	All parts made of fabricated SST discharge head	Type 316L SST including the
10.	Bolts and nuts for T-head B8M	Bolts shall be Type 316 stainless steel conforming to ASTM A 193, Grade Nuts shall be Type stainless steel conforming to 304 or Silicon Bronze.
11.	Coupling bolts and nuts	Bolts shall be B-7 and nuts shall be H
12.	Gland bolts and nuts	Stainless steel Type 316
13.	Mechanical seal metal parts	Tungsten or silicon carbide running against carbon, John Crane type, AES SCUSI full seal or accepted equal
14.	Suction bell	316 L stainless steel
15.	Cans	316 L stainless steel

2.02 MOTORS

A. The motor thrust bearings shall be rated for a 40,000 hour L-10 bearing life at the rated conditions and be able to handle a thirty (30) percent momentary upthrust. The shaft shall be solid with a maximum run-out of 0.001 inches and not have any taper or dog leg. The service factor shall be 1.0 on VFD power and 1.15 on sine wave power. The temperature rise shall be 80º C at 40º C ambient.

B. Motors shall be Premium Efficiency, NEMA Design B, vertical operating, totally enclosed fan cooled, squirrel cage, premium efficiency, definite purpose inverter duty motor complying with NEMA MG1-Part 31, capable of a 6:1 speed reduction without damage due to loss of motor cooling. The motors shall have Class F insulation and shall be designed for a 40 degree C temperature rise above a 40 degree C ambient at nameplate horsepower. Motor shall have a service factor of 1.0 for VFD operation. Motor shall be non-overloading at any point on the pump curve without exceeding the 1.0 service factor. Each motor shall be wound for 460 volt, 3 phase, 60 Hertz variable frequency inverter service. Motor insulation to be minimum 2100 volt rated. Provide motor with oversized terminal box. Both the radial and the thrust bearings shall be designed to withstand all loads applied at the full nameplate horsepower for a B-10 life of 100,000 hours at this load. The motor shall be factory tested as specified in NEMA Standard No. MG1, Paragraph MG1-12.51.

C. Pumps shall be driven by a motor that is controlled by a variable frequency drive (VFD) as specified in electrical specifications.

D. The motors shall be furnished with normally closed thermal switches in each stator winding to detect a high motor temperature. Wire for single point connection.

E. Pump manufacturer shall submit the maximum horsepower and torque requirement at the pump input shaft. The motor manufacturer shall verify that the motor output equals or exceeds these requirements.

F. Motors shall be provided with lifting eyes for convenient attachment to hoist capable of sustaining the weight of the motor unit less the discharge head and pump assembly.

G. Motors shall be provided with shaft grounding rings installed at the factory. Grounding rings shall meet NEMA MG1 Part 31.

H. Motors shall be provided with internal winding space heaters installed at the factory.

I. Motors shall be of the high thrust type and sized to cover BHP at full speed at any point on the curve without overloading nameplate.

2.03 DISCHARGE HEADS

A. Provide a fabricated stainless steel head. The head shall be of one-piece fabrication with all fabricated parts of 316L stainless steel. The head shall have rabbet-fit connections for the motor. Discharge head shall have connections for the pump column and shall support the loadings, which it imposes as well as hydrostatic and hydrodynamic heads. All stainless steel shall be electro polished.

B. Design columns and discharge heads for 150% of the pump discharge pressure (suction pressure plus pump differential pressure) at shutoff. Hydrostatically test columns and discharge heads at 1.5 times the rated pressure.

C. Access to the stuffing box shall be through windows placed 90 degrees from the discharge. Fit handholes and/or windows with Type 316 stainless steel expanded metal guards to protect the exposed shaft. The coupling guards shall be 316 SS expanded metal with solid 316 SS frames which are removable.

D. The motor mounting flange on the discharge head shall be of the same diameter as the motor base flange with structural ribs to provide strong support for the motor.

E. Provide for lifting the heads by means of lifting eyes that are capable of sustaining the weight of the complete unit less the motor.

F. Provide threaded outlets on the discharge head for pressure gauge assemblies, vents, and flush connections.

G. The discharge head shall be pickled and passivated

2.04 STUFFING BOXES

A. The stuffing box shall be removable without disturbing the driver and shall have a replaceable throat bushing.

2.05 LUBRICATION

A. Pumps shall be self-lubricating. The seal flush system for the RO feed pumps shall include an internal product lubrication system that allows the pumped liquid to enter the stuffing box between the clearance of the shaft and the stuffing box bearing into the stuffing box using the pump discharge pressure. The liquid leaving the stuffing box shall be directed through a tapped hole in the seal gland to the suction nozzle through type 316L SST tubing. The lubrication system is to be completely furnished by the pump manufacturer. This lubrication process is to be continuous when the pump is running and it will function to keep the seals clean, cool and lubricated.

B. Provide a 1-inch 316 stainless steel half coupling welded to the side of the T-head for vent. Provide stainless steel plug.

2.06 SHAFTS

A. The pump shaft shall be fabricated from A276-316 pump shaft quality (PSQ) 316 SST meeting ASTM A276 and ASTM 479 PSQ and polished over its full length.

B. Total lateral deflection of the shaft above the packing box shall not exceed 0.002-inch total indicator reading.

2.07 BOWL ASSEMBLY

A. Each bowl assembly shall consist of a suction bell, bowls, impeller and impeller wear rings, bowl wear rings, pump shaft and bearings. Bearings shall be located above and below the impeller. Impeller shall be dynamically balanced.

B. Pump bowls shall be of the material listed under the subsection on "Pump Materials of Construction." Bowls shall be sufficiently rigid to prevent adverse changes in bearing alignment and to maintain the running clearance of seal rings. Bowls shall be flanged with male and female rabbets for joining to the suction bell and the discharge column. Waterways and the diffusion vanes shall be smooth and free from nodules, bumps, and dips. Provide the bowls with a renewable wear ring adjacent to the impeller, made of babbitted carbon.

2.08 SUCTION BELL

A. The suction bell shall be of the anti-vortexing type and shall have, as an integral part, vanes supporting a central hub in which the bottom bearing is carried below the impeller. The outer suction bell entrance shall be at least the size of the maximum pump bowl dimension and as much larger as is practical. The contour between the outer edge and the impeller suction eye shall be smooth, continuous, and bell shaped.

2.09 IMPELLERS

A. Pump impellers shall be of the enclosed type made of the material listed in the subsection on "Pump Materials of Construction" and shall be cast in one piece. Machine to fit the contour of the bowl, hand file in the waterways, and equip with wearing rings of 316 SST. Impeller shall be key-mounted with circular thrust rings. Provide for adjustment of the axil position of the impeller in the shaft coupling connection to the motor shaft so that the proper clearance between bowls and impellers may be maintained.

PART 3 - EXECUTION

3.01 WELDING PROCEDURE AND WELDER QUALIFICATIONS

A. Welding shall comply with the ASME Boiler and Pressure Vessel Code, Section IX.

3.02 PAINTING AND COATING

A. Do not coat stainless steel components. All stainless steel components shall be electro polished.

B. Pickle and passivate the discharge head prior to final assembly at the factory.

C. Coat the motor per Owner's instructions. Apply prime coat at factory. Apply finish coat in field. Submit color chart for owner selection.

3.03 INSTALLATION

A. Install the pump where indicated on the Contract Drawings and in accordance with the manufacturer's instructions.

B. Provide and connect accessories, power, and control conduit and wiring as required to ensure a complete and operable system as intended.

C. Obtain and provide the Owner with an Installation Certificate signed by the manufacturer's representative attesting that the equipment has been properly installed and is ready for start-up and performance testing.

D. Install equipment horizontal and vertical within 1 degree and according to the manufacturer's written instructions and the contract documents. Confirm that the pump cans and pumps are set to meet the vertical alignment requirements established by the manufacturer.

E. Provide the manufacturer's recommended lubricants and operating fluids and verify that each piece of equipment contains the amount recommended by the manufacturer.

F. Verify that the installed pump is fully self-supporting before bolting pipe flanges, so that no strain is imparted on the flanges, pipes, or pipe supports from the pump assembly. Adjust the position of the pump assembly so that the pump flanges are plumb and aligned with the adjacent pipe flanges. Do not use temporary shims or jacking nuts for leveling, aligning, or supporting equipment. Provide final grouting of the pump assembly base according to the General Contractor's specifications.

G. Connect motor electrical leads, heater wiring, and thermostat wiring.

H. Provide continuous protection of the installed equipment from the elements, dust, debris, paint spatter, or other conditions, which will adversely affect the unit's operation until such time as the equipment is scheduled for start-up testing.

3.04 FIELD TESTING

A. Bump motor to ensure that motor has been connected for proper rotation prior to connecting the pump coupling.

B. If the measured flows vary by more than 5% below the flows obtained on the laboratory or factory test, adjust the impellers or provide new impellers or otherwise repair or replace the pumps or calibrate meters or pressure gauges.

C. Conduct vibration level tests with pump operating at its rated capacity. Adjust or replace pump if it exceeds the maximum vibration levels. Provide a certification from a certified laboratory to the Engineer for reviews.

D. Operate the pump. Manually adjust the speed for the pump (one at a time) via the respective speed control unit such that the pump output is 40%, 50%, 60%, 80%, and 100% of the maximum capacity specified.

E. Assure that in the automatic mode the pump responds to the appropriate control signal. Assure that the pump operates at a steady rate (+/- 5% of set point) at any given flow for 40%, 50%, 60%, 80% and 100% of the maximum capacity specified.

3.05 PRE-OPERATIONAL CHECK

A. Before operating system or components, make the following checks:
   1. Check pump/motor alignment according to standards of the Hydraulic Institute
   2. Check for proper motor rotation
   3. Check pump and drive units for proper lubrication
   4. Vent air from system to assure water in the pump

3.06 START-UP AND PERFORMANCE TESTING

A. Operate each pump on clear water at the design point for a continuous period of eight hours, under the supervision of the manufacturer's representative and in the presence of the Engineer. Demonstrate correct alignment, smooth operation, freedom from noise, vibration and overheating.

B. Verify pump performance by taking the following data and comparing with the certified pump curves submitted:
   1. Flow (gpm)
   2. Total head
   3. Brake horsepower

C. Use installed metering devices to verify pump performance.

D. Check pumps and motors for high bearing temperatures and excessive vibration. Check for motor overload by taking ampere readings.

3.07 VIBRATION AND PERFORMANCE TESTING

A. General

   1. Perform a vibration analysis on all motors and pumps after they are installed and ready to run. All final vibration reading used for acceptance will be taken with the machinery under operating/loaded conditions. The analysis shall be performed by qualified technicians and whose credentials are approved in advance by the Engineer.
   2. The contractor shall include cost of such testing and services in the base bid.
   3. All results shall meet the Hydraulic Institute Standards.
   4. Overall Lateral Vibrations (i.e. vibrations acting side-to-side, up and down or axially) are required in the field.

B. Methods for Taking Vibration Readings
   1. Vibration readings shall be taken with test equipment that is capable of complete discrete frequency analysis and will produce an "x-y" frequency vs. amplitude plot or spectrum in printed form. The equipment shall also be capable of providing a complete broadband unfiltered reading or "Total" reading in addition to the aforementioned individual frequency components.

2. The sensor/pickup shall be of the seismic type (i.e. accelerometer or velocity pickup).
3. Vibration velocity readings in inches/sec. Peak vs. frequency shall be used. Both filtered and unfiltered readings shall be provided for each measurement point as shown on the testing diagram at the end of this section.
4. When coupled or belt-driven equipment is running and operating under load, record vibration readings. If the equipment fails to meet vibration tolerances record vibration readings on the driver unit disconnected from the driven equipment. Use this record to compare with the vibration of the complete unit to determine source of problem.

C. Documentation
1. Six copies of a vibration report shall be provided to the Engineer for distribution.
   a. Outlining procedures used
   b. Vibration standard used for equipment
   c. Analysis results - pass/fail
   d. Source of any unacceptable vibration found (rotor unbalance, shaft misalignment, hydraulic vibration, etc.)
2. Vibration analysis signature (x-y plots) shall also be provided for each piece of equipment tested.
3. Certification that equipment rotating assembly has been statically and dynamically balanced either by the manufacturer or his representative supplier.

D. Should results of the full-scale tests indicate that the pumps will fail to meet any of the specified requirements, The Manufacturer will notify the System Supplier of such failure. The Manufacturer shall thereupon, at no expense to the Owner, make such modifications and perform additional tests as may be necessary to comply with these specifications.

E. Adjust, repair, modify or replace any components that fail to perform as specified and rerun the tests. Make final adjustments to the equipment under the direction of the manufacturer's representative and to the satisfaction of the Engineer.

END OF SECTION

SECTION 11228

SELF-CLEANING PRE-FILTERS

PART 1 - GENERAL

1.01 SUMMARY

A. General work included in this Section:
   1. Four self-cleaning pre-filters for well(s) water entering the RO system.
   2. Tag No. PF 1, PF 2, PF 3 and PF 4.

B. Related Sections include but are not necessarily limited to:
   1. Division 1 - General Requirements
   2. Division 16 - Electrical
   3. Section 09800 - Special Coatings
   4. Division 17 - Instrumentation and Controls

C. Reference Standards
   1. National Sanitation Foundation (NSF) 61 - Drinking Water System Components - Health Effects as per Arizona Administrative Code (AAC) Title 18, Chapter 4, and Section R18-4-119.

1.02 SUBMITTALS

A. Manufacturers certified drawings and material specification showing conformance to specifications.

B. Operation and maintenance manuals.

1.03 JOB CONDITIONS

A. Self-cleaning pre-filter.
   1. Water Temperature: 20 Deg. C to 42 Deg. C with a pH range of 7.5-8.5.
   2. Ambient Temperature: 30 Deg. F to 125 Deg. F.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Self-cleaning pre-filter.
   1. Amiad Filtration System (SAF-4500)
   2. VAF Filtration System
   3. Or approved equal.

2.02 PERFORMANCE AND DESIGN

A. Self-cleaning pre-filter.
   1. Design Flow Rate: 650 to 1,100 gpm.
   2. Inlet/Outlet: 8"
   3. Operation Description -The water flows into the filter body and through the stainless steel coarse filter element (10,000-micron) inside out, keeping large debris from entering the fine screen. Once water flows through the coarse screen, the water enters the stainless steel fine filter element (25-micron) inside out, allowing the dirt to accumulate on the inside surface of the element. An adjustable Differential Pressure Switch (DPS) senses the pressure differential across the filter as filter cake builds up on the element. The DPS shall signal the control panel to initiate the cleaning cycle of the filter when the filter cake causes a pressure differential of 5-10 PSI. A Y-strainer will be placed on either side of the DPS. During the flushing cycle, there will be no interruption of flow and with a clean screen the filter will lose less than 2 psi at the maximum flow rate. The filter operation and flushing shall be controlled by a local control panel provided by the pre-filter supplier/manufacturer. The capability to initiate the cleaning cycle on a timer will be provided.
   4. Four pre-filters will be operated in parallel. Each will treat approximately one-fourth of the total flow of 3,000 gpm. In the event of a malfunction, three pre-filters shall be capable of treating the entire flow. The pre-filters shall self-clean in series.
   5. Cleaning Mechanism - The pre-filter cleaning mechanism shall consist of spiral moving cleaning heads, constructed of a 316 stainless steel assembly. By opening a 2" flush valve the scanner shall create high efficiency suction force on each of the four cleaning nozzles. The nozzle head distance from the screen surface shall be adjustable to maximize cleaning efficiency during the flushing cycle. The flushing flow rate shall not exceed 110 gpm at 30 psi. The cleaning cycle of each filter shall be completed in 20 seconds or less. During that time, the four nozzles shall cover the total area of the screen. The minimum pressure required for flushing shall be 35 psi.
   6. The differential pressure switch or the timer shall actuate a cleaning cycle.

B. Self-Cleaning Pre-filter Motor
   1. The self-cleaning pre-filter motor shall have the following characteristics
      a. 3 phase, 480 V, 1/3 HP

2.03 MATERIALS

A. Self-cleaning filter
   1. Filtration Element -The filter element shall be of a patented construction of a combination of wedge and weave wire-screens, consisting of four layers, fabricated together in order to achieve both greater open area and mechanical strength. The collective screen shall be made of 316L stainless steel. The screen's external support shall be constructed of wedge-wire for

mechanical strength. The fine weaved-wire screen shall be sandwiched (protected) between two 3000-micron weaved-wire additional layers. The total surface area of the screen shall be 930 square inches and shall be able to withstand an internal/external pressure differential of 150 psi without any damage. The micron ratings of the screen elements shall be available from 500 to 10 with complete interchangeability in the same body.

2. Housing Construction - The filter housing shall be of high-grade carbon steel (#37-2), zinc phosphate dipped, shall be factory coated with multi-layer epoxy as per Section 09800, System 1. The maximum operating pressure of the body is 150 psi and a maximum operating temperature of 140° F. The filter body shall have the capability to accept fine filter elements with varying micron degrees (500 to 10-micron), of a weave-wire design, and that are totally interchangeable in the same body.
3. Exhaust Valve - epoxy coated cast iron, natural rubber.
4. Seals - synthetic rubber, Teflon.

2.04 ACCESSORIES

A. Control System

1. There shall be four individual control panels to control each of the four self-cleaning pre-filters. Each control panel shall be an electro-mechanical relay and timer based panel. The control panel shall include provisions for the following modes of operation:
   a. Hand - manual initiation of self-clean mode by operator at the pre-filters.
   b. Off
   c. Auto - filter cleaning shall be automatic, based on timer or pressure differential set point.
   d. Each filter shall have a local disconnect.
2. The control panels shall have NEMA 4 enclosure and made of steel. Panel construction shall meet the requirements of Divisions.
3. The control panel shall interface with the RO PLC. The following control functions and interfaces shall be included:
   a. Send fault alarm and In Cleaning Mode status signals to the RO PLC
   b. Receive remote Clean command from RO PLC
   c. Control operations of all four self-cleaning pre-filters

PART 3 - EXECUTION

A. Install self-cleaning pre-filters as shown on the Drawings and in accordance with the manufacturer’s recommendations.

B. System shall be installed to prevent vibration under normal operating conditions.

C. Provide 1-day startup support services and operators training with manufacturer's representative.

END OF SECTION

SECTION 11237

SCALE INHIBITOR FEED SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. Description:
1. This section includes general requirements for materials and installation of the scale inhibitor feed system for the Reverse Osmosis (RO) feed. Refer to the contract drawings for sizes and detailed requirements.
2. The chemical feed system shall be pre-packaged and skid mounted including dosing pumps, calibration tubes, pulsation dampener, pressure gauge, pressure relief valve, flow switches, isolation valves, power outlets and related accessories and suction and discharge piping shall be pre-assembled by the pump manufacturer or their system builder on a UV protected corrosion resistant shelf and backboard as a complete unit and as a skid with floor platform support. Submit a dimensional drawing for each chemical skid.
3. The control panel for the chemical feed system shall be as shown on the electrical drawings. Coordinate controls with control panel supplier and pump manufacturer.
4. Direct and Indirect Additives, suppliers of water shall only use products (any materials that come in contact with water intended for use in public water supply) that meet the applicable American National Standards Institute/ NSF International (ANSI/NSF) standards for direct or indirect drinking water additives.

1.02 SUBMITTALS:

A. General: Submit in accordance with Section 01300.

B. Shop drawings shall show dimensions, shelves, anchor bolt layout, coatings, equipment layout, wiring and piping diagrams.
1. Manufacturer's literature and certified drawings of pumps, valves and other components shall show dimensions, piping, electrical connections, capacities, method of anchorage, materials of construction, and coatings.
2. Shop drawings and manufacturer's literature shall be of sufficient detail to determine compliance with the plans and specifications.

C. Prior to start-up of equipment, the manufacturer shall provide five copies of operation and maintenance manuals for all equipment in the chemical feed systems.
1. Manuals shall include installation instructions, information on all components, including parts list, mechanical drawings, wiring drawings, start-up, and shutdown, trouble shooting and operating instructions.

D. Provide material compatibility certificates and valve, pump, and accessories certificates for all chemicals being used by the pump/tank manufacturers.

E. Show all inlets, outlets, overflow vent and all other nozzles with dimensions required for all tanks. Orientation and size of connections shall be verified by the Contractor after all equipment has been selected.

F. All chemical containers shall be fully labeled, including chemical name, purity, concentration, supplier name and address, handling precautions, NSF, FDA or AWWA certification for drinking water.

1.03 SPARE PARTS

A. Provide the following spare parts in well-marked boxes with model and manufacturer identification:
   1. As recommended by the manufacturer for two years of operation.
   2. Provide one complete spare pump.

1.04 FIELD SERVICES

A. Provide feed pump manufacturer/supplier's services at the jobsite for the minimum man-days listed below, travel time excluded:
   1. 3 hours to check the installation, supervise start-up, supervise testing and make adjustments of each system and 2 hours to instruct the operators in the operation and maintenance of the chemical feed system equipment. Two (2) separate trips.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General: These are general requirements for the chemical system components. For sizes, dimensions and manufacturers refer to chemical feed systems on contract drawings. For voltage and power requirements, refer to electrical drawings.
   1. Chemical Feed Pump Skid:
      a. Five (5) pumps shall be provided on the skid. Four (4) operating, one for each RO skid, with the fifth pump as a spare. Pumps shall be capable of pumping 0.2 gph at 50 psi pressure at the injection point.
      b. Pumps shall be positive displacement diaphragm type in which the diaphragm is actuated by an electromagnetic solenoid, controlled by an electric circuit, capable of accurately metering (+/- 2%) the designated fluids at the rates given and be turned on/off by the PLC logic based on the RO skid running. Pumps shall have a local manual stroke length adjustment of 10 to 100% and a stroking rate adjustment from 1 to 120 strokes per minute. Pump manufacturer shall select seal and other components of materials compatible with chemical service.

c. The pump drive mechanism shall be totally enclosed with no exposed moving parts.
d. All pumps shall be provided with power cord and plug in connection to the PLC controlled outlet on the chemical skid panel, rated for single phase 115 volts.
e. The pumps shall be manufactured by ProMinent, Grundfos or accepted equal.
f. Complete skids shall be as manufactured by Tuff Skid, UGSI Chemical Feed, or accepted equal.

2. Feed Tank:
   a. Day tanks shall be 60 gallons cone bottom type with self-supporting legs.
   b. Provide certification from the manufacturer for the material compatibility with the chemical being stored. The entire tank construction shall be FDA or NSF approved for potable water application. Verify height and size to meet requirements as shown on the drawings before bidding.
   c. Tanks shall be made of high density polyethylene. Provide a 4" wide adhesive strip with calibrations in gallons.
   d. Provide removable HDPE lid with hinged hatch.
   e. Provide tank side wall mounted low level switch. Switch material of construction shall be polypropylene. Switch shall be Gems Sensors and Controls LS-7 Series Type 3 Internal Mounting, or accepted equal.
   f. Cone bottom tanks shall be minimum 15° cone type. Stands shall be manufactured of high density polyethylene.
   g. Provide 2"diameter tank drain/suction nozzle. Provide a 2" Schedule 80 PVC U-vent.
   h. Tank manufacturer shall provide flexible connector made of materials compatible with the chemical stored for all required pipe connections to the tanks. Flexible connectors shall be selected to absorb all expansion and contraction of the tank during filling and draining. Flexible connectors shall be Flexijoint as manufactured by Ethylene, LLC, or accepted equal.
   i. Tanks shall be manufactured by Snyder Industries, Polyprocessing Company, Assmann, or accepted equal.

3. Pressure Relief Valve:
   a. Pressure relief valves shall be 3 port, PVC/CPVC/Viton construction by ProMinent, Griffco, or accepted equal. Pipe pressure relief valve back to feed tank.

4. Back Pressure Valve:
   a. Back pressure valve shall be CPVC construction with anti-siphon function by ProMinent, Griffco, or accepted equal.

5. Calibration Column:

a. The calibration column shall be graduated and made from Borosilicate glass for all chemicals. The calibration columns shall be threaded at both ends and vented with tubing to feed tanks with isolation valves. Provide hard piping and isolation valves from calibration columns to all chemical feed pumps so that any of the pumps can be calibrated, while others are in operation. Calibration Columns shall be as manufactured by Griffco, Accudraw, or accepted equal.

6. Pulsation Dampener:
   a. The pulsation dampeners shall consist of an air chamber containing compressed air, a fluid chamber, and a bladder or bellows which separates the air and fluid. Provide with an integral pressure gauge. Pulsation dampener shall be manufactured by Blacoh, Sentry or accepted equal.
7. Chemical Injector:
   a. Injectors shall be retractable type as manufactured by Saf-T-Flo, or approved equal, and shall include the following:
      1) 1/2" diameter flexible hose assembly and CPVC ball valve.
      2) 1/2" diameter male inlet connector with CPVC quick release coupling.
      3) CPVC spring loaded ball check valve.
      4) Stainless steel limit chain.
      5) Stainless steel corporation stop and compression gland.
      6) 3/4" diameter main connection
      7) 3/8" diameter stainless steel solution tube of the length required to inject chemical in the center of the pipe
8. Wye Strainers:
   a. The wye strainers shall be clear CPVC construction with a screen rated for 150 microns. The strainers shall be manufactured for corrosive chemicals by Hayward Industrial Products, or accepted equal.
9. Flow Switch/Monitor:
   a. Flow switch/monitors for scale inhibitor feed system shall be of low flow accuracy range type with measuring range of 1 to 200 milliliters/minute, with dual outputs, 4-20 mA Analog Output and Pulse. Flow monitors shall be Efector 300, model SQ0500 by IFM flow sensors, or accepted equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Furnish and install each tank in accordance with the manufacturer's instructions and the Contract Drawings.

B. All chemical tanks shall be installed and certified by a certified tank installer in the State of Maryland.

C. Hydrostatically test each storage tank by filling with water to the overflow pipe level. Check tank carefully for leaks. Allow tank to sit for 24 hours and then one again check for leakage. Empty tank when check has been completed.

3.02 INSPECTION AND TESTING

A. Preliminary Inspection/ Testing:
   1. Initial Tests:
      a. Test all chemical tanks, pumps, and piping using potable water. Run through all operational cycles and show that proper signals are received by the PLC and that the system works in full automation. Demonstrate all valves and piping are operable and leak-free.
      b. Some chemicals may react with process water and may cause excessive heat, which can damage piping and valves. Utilizing low pressure clean air supply, purge all water out of the system up to the application point. Then reconnect piping and fill with chemicals.

END OF SECTION

SECTION 11337

PUMP CONTROL VALVES

PART 1 - GENERAL

1.01 SUMMARY

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

B. See Drawings.

1.02 QUALITY ASSURANCE

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

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

1.03 SYSTEM DESCRIPTION

A. The Deep Well Pump Control Valve shall maintain a specified flow rate based on an input signal (set point) to the valve controller.

1.04 SUBMITTALS

A. Provide certificate indicating unit system responsibility.

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

1.05 WARRANTY

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

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Cla-Val Co.
   1. Valve 1 shall be a 12" Cla-Val Co. Model No. 60-08 Booster Pump Control Valve.
   2. Valve 2 shall be a 12" Cla-Val Co. Model No. 61-02 Deep Well Turbine Pump Control Valve.
   3. All the valves shall include a check feature and a limit switch.

B. AMES

2.02 MAIN VALVE

A. Number of units: 4 (2 for each Well site)

B. General:
   1. The valve shall be hydraulically operated, diaphragm, globe pattern.
   2. The valve shall consist of three major components: the body with seat installed, the cover with bearing installed, and the diaphragm assembly.
   3. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure.
   4. See equipment schedule for flow ranges and pressure requirements for each valve.

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

D. Materials
   1. Valve Size: See Drawings
   2. Main Valve Body and Cover: Ductile Iron
   3. Main Valve Trim: Stainless Steel
   4. Pressure Rating: 150 psi
   5. Temperature Range: 180 Degrees F Maximum
   6. Rubber Material: Buna-N
   7. Exterior Coating: According to Section 09800, System 1.

2.03 CONTROL VALVE PILOT SYSTEM

A. Number of units: 2

B. General:
   1. The hydraulic control valve pilot system shall be stainless steel and include a solenoid that controls the pressure to the diaphragm chamber. The control system shall be designed such that electrical or control failure of the solenoid in the main valve closing.
   2. Solenoids shall be 120 volt AC with NEMA type 4X enclosure.
   3. Pilot system will be pressure rated to 100 psi for temperatures between 30 and 110 degrees F.
   4. A manual system to by-pass the solenoids shall also be provided.
   5. Provide pilot water supply line from system side of check valve.

PART 3 - EXECUTION

3.01 START-UP AND TEST

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

3.02 MANUFACTURER'S SERVICES

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

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

END OF SECTION

SECTION 11339

PRESSURE RELIEF SURGE ANTICIPATOR VALVE

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes: Pressure Relief Surge Anticipator Valve (PRLFV):
   1. Provide one PRLFV (Tag No. PRLFV 1) for the Well 24 raw water piping (combined well piping), as shown on the Drawings.
   2. The Supplier shall furnish all labor, materials, tools, equipment, and services for all valve equipment as specified herein or as required for a complete functioning system.
   3. All valve equipment shall be furnished by a single manufacturer who shall be responsible for proper operation and interfacing of the equipment, testing and startup.
   4. Although such work may not be specifically indicated, the manufacturer of the valve equipment shall furnish all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

B. Related Sections include but are not necessarily limited to:
   1. Section 01330 – Submittals
   2. Section 09800 – Special Coatings

1.02 QUALITY ASSURANCE

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

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

1.03 SYSTEM DESCRIPTION

A. The PRLFV shall control high pressures and power failure surges by bypassing system pressure that exceeds the high pressure control setting and also by opening a preset amount when sensed pressure decreases below a preset minimum in anticipation of a surge.

1.04 SUBMITTALS

A. The equipment manufacturer shall:
   1. Submit shop drawings showing the layout of all equipment furnished, dimensional data, fabrication assembly, and the piping configuration.
   2. Submit operation and maintenance manuals incorporating all major equipment furnished under these Specifications. Also, submit copies of all approved shop drawings.
   3. Provide data on range, accuracy and repeatability as applicable for all major equipment furnished under these Specifications.
   4. Submit data on capacity, weight, and material of each item of equipment.

1.05 WARRANTY

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

PART 2 - PRODUCTS

2.01 MANUFACTURER

A. Cla-Val Co.:
   1. The valve shall be a Cla-Val Co. Model No. 652-03 Pressure Relief Surge Anticipator Valve.

B. AMES Equivalent

2.02 MAIN VALVE

A. General:
   1. The valve shall be hydraulically operated, pilot controlled, diaphragm, globe pattern.
   2. The valve shall consist of three major components: the body with seat installed, the cover with bearing installed, and the diaphragm assembly.

3. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure.

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

C. Materials:
1. Valve Size: See Equipment Schedule
2. Main Valve Body and Cover: Ductile Iron
3. Main Valve Trim: Bronze
4. Pressure Rating: 150 psi
5. Temperature Range: 150 Degrees F Maximum
6. Rubber Material: Buna-N
7. Exterior Coating: According to Section 09800 – Special Coatings

2.03 PILOT SYSTEM

A. General:
1. High Pressure Surge Relief Pilot: the pressure relief/sustaining pilot shall be a direct-acting, adjustable, spring-loaded, diaphragm valve designed to permit flow when controlling pressure exceeds the adjustable spring setting. Pressure relief pilot control sensing shall be upstream of the pilot system strainer so accurate control may be maintained if the strainer is blocked partially.

2. Low Pressure Pilot: the pressure reducing pilot control shall be a direct-acting, adjustable, spring-loaded, normally open, diaphragm valve designed to open when the sensed pressure falls below the control setting and close when pressures are normal. The pilot control shall have a downstream sensing port which can be utilized to install a pressure gauge.
3. Pilot controls shall be hard piped or bracket mounted to the main valve.
4. The pilot system shall include a strainer, closing speed control and all required control accessories, equipment, control tubing and fittings.

PART 3 - EXECUTION

3.01 START-UP AND TEST

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

3.02 MANUFACTURER'S SERVICES

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

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

END OF SECTION

SECTION 11346

TREATMENT VESSELS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Two pressure vessels (12’ dia) for use as adsorption contactor for arsenic removal. The working internal components include an upper distribution system and a lower collection system, hydraulically balanced for even distribution of water in both filter and backwash cycles. Vessel supplier shall provide underdrains, ladder, access platform, headers, and appurtenances as shown on the attached diagrams and specified herein. Vessel supplier shall have unit system for all related components and their connection details. Refer to drawings for configuration of ladder, platform, pipe connections, etc. Unit system responsibility shall be provided for the entire vessel and associated components.

B. Supplier Qualifications: The vessel supplier shall have 3-years’ experience with the manufacturing of 8-ft diameter or larger pressure vessels for water treatment plant applications using stainless steel components as specified herein.

C. Related Sections: Include but are not necessarily limited to:
   1. Section 09800 - Special Coatings
   2. Section 11005 - Equipment: General Requirements

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. A 36 - Specification for Structural Steel.

B. American National Standards Institute/National Sanitation Foundation (ANSI/NSF):
   1. Standard 60 and 61
   2. Surface Preparation Specifications.

C. American Society of Mechanical Engineers (ASME):
   1. ASME Code - Boiler and Pressure Vessel Code, Section VIII, Rules for Construction of Pressure Vessels, Division 1.

D. Code of Federal Regulations (CFR):
   1. 49 CFR 178 - Code of Federal Regulations, Part 178, Subpart J - Specifications for Containers for Motor Vehicle Transportation.

E. Steel Structures Painting Council (SSPC):
   1. Steel Structures Painting Manual, Volumes 1 and 2
   2. Pictorial Standards for Surface Preparation - SSPC-VIS 1.
   3. Measurement of Dry Paint Thickness With Magnetic Gages - SSPC SP A2.

1.03 OPERATING CONDITIONS

A. Influent flow: 900 gpm

B. Backwash: 1,700 gpm

C. Pressure: The pressure vessel shall be rated for 100 psi, which includes a 25 psi factor of safety per ASME Code.

1.04 SUBMITTALS

A. Product Data: List of materials and coatings used.

B. Form U-1, Manufacturer's Data Report for Unfired Pressure Vessels.

C. Shop Drawings and Calculations:
   1. Provide detail drawings to indicate compliance with the specified requirements.
   2. Provide dimensional drawings verifying vessel dimensions, wall thickness, mounting details, internals, laterals, header, underdrain piping, interior concrete anchors and vessel anchorage requirements.
   3. Provide vessel installation procedures.
   4. Provide structural calculations for vessel and for all support legs.
   5. Certification and ASME Code data reports in accordance with the ASME Code as applicable 49 CFR 178.337 or other similar codes. The certification shall include certification of hydrostatic testing.
   6. Fabrication drawings.
   7. Provide the pressure test specifications and test results.
   8. Copy of structural, and wind loading calculations for the support system signed by a registered mechanical engineer.

D. Operation and Maintenance Manual:
   1. Provide prior to shipment of the vessels per Section 01781.
   2. The manual shall include: magnified views, interior piping configuration, and condition assessment of internals.

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. Components of the pressure vessel shall be the latest standard products of manufacturers regularly engaged in the production of equipment of this type.

C. Provide 21 days' notice to the Engineer prior to final assembly and surface preparation of each vessel to allow the Engineer to thoroughly inspect the interior and exterior at the fabrication shop.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Pressure Vessels:
   1. IES Southwest, Inc.
   2. Smyth Steel
   3. Preapproved equal (prior to bid)

B. Air Release Valve:
   1. APCO Valves
   2. Approved equal

C. Pressure Relief Valve:
   1. Spencer Model 810
   2. Approved Equal

D. Underdrains and Headers:
   1. Federal Screens
   2. Johnson Screens

2.02 MATERIALS

A. Vessel: Construct the vessels using SA 516-70 Carbon Steel (ASME steel plate).

B. Underdrain Piping: The underdrain piping shall be fabricated from Type 304 Stainless Steel.

C. Distribution Manifold: The distribution manifold shall be fabricated from Type 304 Stainless Steel.

2.03 SYSTEM DESCRIPTION

A. Vessel Design and Performance Requirements:
   1. Tank Size: Tank size shall be as indicated on the attached diagrams.
   2. Pressure Rating: The rated pressure shall be per Section 1.03-C. All pressure vessels shall be fabricated in accordance with the ASME Code for all unfired pressure vessels.
   3. Vessel Heads: The vessels shall have ASME Code Dished and Flanged heads. The heads shall meet the design requirements for formed heads subject to internal pressure as described in the ASME Code, and have the following specifications:
      a. 144" OD nom 100% 6% 2" SF
      b. SA 516-70 Carbon Steel (ASME steel plate)
   4. Provide calculations for head and sideshell thicknesses.

B. Cathodic Protection: Provisions shall be made to accommodate installation of sacrificial anodes, as shown in the Drawings. Provide four 1-inch nominal diameter openings with fittings to install anodes, as shown on attached diagrams.

C. Concrete Anchors: Concrete anchors shall be welded to the interior of the bottom vessel head to attach rebar per manufacturer's instructions.

D. Protective Coating: Prepare the surface to be lined in accordance with the ANSI Surface Preparation Specifications. Interior coating shall be in accordance with Section 09800, System 2, and shall be applied at the vessel manufacturing location after all required attachments to the vessel interior have been made. For exterior coating, only primer is required.

E. Base Plate: Each leg shall come equipped with a base plate for mounting purposes. (maximum dimension 2' - 0" x 2' - 0") See diagrams for opening dimensions for anchor bolts.

F. Underdrain Piping Design Requirements:
   1. Provide 304 SS underdrain piping (Schedule 40), wrapped in 304 SS wedgewire (60 x 100 mesh equivalent) in configuration shown on attached diagrams.
   2. Pipe Wrap: As per the configuration shown on attached diagrams, the underdrain piping shall be wrapped in wedgewire to prevent gravel migration.
   3. Sizes and layout of underdrain piping shall be as per manufacturer. Exact connection details for underdrains to vessel per manufacturer. All connecting hardware that is inside the vessel (nuts, bolts, couplings and adapters, structural members shall be 304 SS).
   4. Provide threaded NPT connections to connect laterals to primary underdrain collector pipe.

G. Distribution Manifold Piping Requirements (header):

1. Header piping shall be 304 SS Schedule 40 pipe. Sizes and layout of header piping shall be per manufacturer's requirements. Exact connection details of manifold to vessel per vessel manufacturer. All connecting hardware that is inside the vessel (nuts, bolts, couplings and adapters, structural members shall be 304 SS).

H. Relief Valves:

1. Air/Vacuum Release: The vessel shall be equipped with an automatic air/vacuum valve, capable of displacing approximately 210 cubic feet per minute (3.4 scfs).
2. Pressure Relief: The vessel shall be equipped with a pressure relief valve to evacuate water (partial flow) in the case of an emergency (1 ½ " x 2 ½ "). Valve shall have bronze bonnet and base, stainless steel disc, and packed cap. Valves shall be set to relieve pressure at the design pressure of the vessel.

2.04 COMPONENTS

A. Lifting Lugs: Provide exterior lifting lugs to facilitate vessel installation.

B. Anchor Bolts: Anchor bolts shall have a minimum diameter of at least ¾ -inch, unless otherwise indicated on the attached diagrams, and shall be anchored to concrete foundations using methods designed to transfer the full ultimate strength of the bolt to the concrete foundation. Attach anchor bolts to the tank by the use of anchor bolt chairs or rings, as required. Chairs or rings shall be designed to transfer 125 percent of the ultimate strength of the bolt, or 150 percent of the calculated load, whichever is less, to the vessel shell.

C. Nameplates and Code Stamps: Design, fabricate, and test vessels in accordance with the ASME Code. Each tank shall bear a stainless steel ASME nameplate. Each nameplate shall bear the applicable code symbol. The Manufacturer shall be authorized by ASME to apply the applicable code symbols.

D. Ladder and Platform: A ladder with a handrail and an entry platform shall be provided as indicated on the drawings. Provide safety gate at ladder to platform entry. The steel ladder and steel entry platform shall be in accordance with all applicable Structural and Safety Codes (OSHA). Aluminum grating shall be used to fabricate the platform per Section 05500. Relevant metal fabrications shall be coated as per Section 09800, System 1.

E. Fittings shall be as specified as indicated on the attached drawings. Fittings larger than 1-inch shall be flanged. Fittings 1-inch and smaller shall be National Pipe Thread. Reinforce openings in accordance with the ASME Code. Access openings shall be sealed and hinged, as indicated on the attached diagrams, and have a nominal diameter of at least 24-inches. The cover plate and flange of access openings shall have a net thickness, after machining, of at least ½-inch or as required to meet the vessel design pressure.

F. Attachments: Weld shell attachments for pipe supports, tank gages, instruments, cathodic protection support requirements, interior concrete anchors and other items as indicated on the attached diagrams before application of the tank protective lining.

G. Support Media will be supplied by CONTRACTOR.

2.05 APPURTENANCES

A. Appurtenances shall include mounting flanges, drain valves, air/vacuum release valves, pressure relief valves, connections for cathodic protection system, and lifting lugs, as indicated on the attached diagrams.

2.06 FABRICATION

A. Provide schedule of all fabrication, testing, and coating activities to ENGINEER with 21 days' notice to allow for factory inspection by ENGINEER. Update schedule as changes occur and provide updates to ENGINEER.

B. Welding: Weld reinforcement shall be in accordance with ASME Code. Excessive reinforcement shall be ground down to within the ASME Code requirements, and as required to install the lining systems. Full penetration welds shall be used for heads and sideshells when adjoining multiple steel plates. All internal corners and edges shall be ground to 1/8-inch radius, or a greater radius if required by the lining system.

C. Painting: Paint the vessel interior and prime the exterior as specified in Section 09800. Final Coat of exterior will be performed under a separate contract.

D. Internal piping (i.e. upper and lower headers) shall be shipped loose.

2.07 SOURCE QUALITY CONTROL

A. Hydrostatic test the vessel in accordance with the ASME Code for Unfired Pressure Vessels. The vessel shall be airtight and watertight.

B. The vessel manufacturer shall prepare a Form U-1 "Manufacturer's Data Report for Unfired Pressure Vessels" to certify that the vessel was built in accordance with ASME Code Rules for the Construction of Unfired Pressure Vessels and inspected by a certified inspector. Submit copies of this report to the National Board of Boiler and Pressure Vessel Inspectors; to the Department of Industrial Relations, Division of Industrial Safety, Pressure Vessel Section, and to the CONTRACTOR with copies for submittal.

PART 3 - EXECUTION

3.01 WARRANTY

A. Vessels shall be warrantied by the manufacturer for a period of two years from the date of delivery to the job site. This shall cover all labor and materials required to correct deficiencies in workmanship at the location of the installation.

3.02 MANUFACTURER SERVICES

A. Manufacturer shall provide training manuals on operation and maintenance of the vessel, and provide training per Section 01781.

END OF SECTION

SECTION 11347

ARSENIC ADSORPTION MEDIA

PART 1 - GENERAL

1.01 SUMMARY

A. As part of the arsenic adsorption treatment system procurement, adsorption media capable of removing arsenic from groundwater, shall be supplied by a qualified supplier.

B. Installation of adsorption media will also be performed under this purchase order.

C. Delivery locations per contractor -- Site 12 Treatment Facility, 3200 S 173rd Ave., Goodyear, AZ-85338.

D. Quantities needed:
   1. 672 cubic feet (based on shipped density). (336 c.f. per vessel)

E. Media prices shall be complete, to the job site inclusive of freight, taxes, tariffs, and on-site storage materials.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. C 117 - Method for material finer than 0.75-µm (No. 200) sieve in mineral aggregates by washing.

B. NSF International Standards 61 - All media shall be certified by NSF International for conformance to Standard 60 and/or 61.

C. Submittals:
   1. NSF Certification that media is approved for potable water use prior to issuance of final purchase order.
   2. One representative media sample prior to shipment.
   3. Media supplier shall provide written confirmation that he will comply with all the requirements of this specification section.
   4. Unit weight and moisture content data.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. All media suppliers (including those named) submitting a bid must be pre-qualified by the OWNER 14 days in advance of the bid submittal date. The OWNER reserves the sole right to accept or reject the media suppliers not named. The approved adsorption media include GFH, Bayoxide E-33, or preapproved equal.

2.02 PERFORMANCE PARAMETERS

A. Site 12 Wells
   1. Raw water quality for the Wells 24 and 25 is attached to this specification.
   2. Media guarantee
      a. Current Scenario: Only Wells 24 and 25 are in operation
   3. Media guarantee is estimated to be 80,000 Bed Volumes (BVs), for water quality with an flow-weighted arsenic level of 22 ppb at an average operating pH of 7.0 at a 50% well utilization rate.
   4. Should the performance of the media not meet the guarantee conditions listed above, the media supplier shall, fully at his own expense (including shipping), provide replacement media meeting these specifications to compensate the owner for the loss in treatment capacity. See Section 3.01 for terms of compensation.

PART 3 - EXECUTION

3.01 ACCEPTANCE AND TESTING

A. Media will be shipped by media supplier to each individual jobsite in Supersacs or other acceptable methods to ensure integrity of media physical and chemical parameters.

B. Provide one representative media sample (1 lb.) for City's evaluation from lot designated for shipment to this project for initial media installation, and prior to each media replacement event at each site. The City will review and approve media samples prior to final shipment.

C. Price adjustment for out-of-specification materials, based on physical parameters of Adsorption Media.
   1. The media supplier shall provide the Owner with replacement media if:

a. Operating Scenario: The media in the vessel fails to treat 80,000 BVs (within 10%) when the vessel reaches 8 ppb arsenic breakthrough (after initial installation and normal operating conditions specified above). The amount of replacement media to be provided shall be calculated as follows: (80,000 BVs - BVs Treated)/80,000 BVs x quantity of initial media shipment. Media supplier shall bear all costs, including shipping, for the replacement media.

ATTACHMENTS - WATER QUALITY DATA

Table 1: Water Quality Summary for Wells 24, 25 and 12

Constituent	Threshold Level (mg/L)	Wells 24 and 25	Well 12
Arsenic	>0.010	0.04	0.046
Silica (as SiO_2)	>35	21.58	28.77
Fluoride	>2.0	8.47	4.8
Sulfate	>200	183.13	134
Chloride	>250	411.95	632
TDS	>750	1106.99	1184
Iron	>0.3	<0.2	0.06
Manganese	>0.05	<0.004	<0.0050
Nitrate	>10	1.24	1.94

SECTION 11400

REVERSE OSMOSIS SYSTEM

PART 1 - GENERAL

1.01 SCOPE AND DESCRIPTION

A. The scope of work for the Reverse Osmosis Equipment Manufacturer (ROEM) shall include four RO skids and all RO instrumentation, RO Main Control Panel, software and programming, as well as associated testing and operator training.

B. RO feed pumps and VFDs will be provided by the installation contractor.

C. The RO system is designed primarily to reduce Total Dissolved Solids (TDS), Arsenic and Fluoride. Well water will be pre-treated with scale inhibitor and cartridge filters.

D. The entire skids including pressure vessels, supports, and instruments pre-wired to the instrument panel, and laterals mounted and connected to vessels shall be pre-assembled, factory tested and shipped as one unit by the ROEM, with the exception of the membrane elements.

E. Pressure transmitters shall be mounted on a rod next to the control panel with tubing run to each tap of the piping. All pressure transmitters and flow meters shall be pre-wired to the skid control panel. Refer to the P&ID drawings.

F. Each RO skid shall be provided with a standalone control panel, which will be in constant communication with the RO Main PLC Panel.

G. RO system shall have a TWO year warranty by the manufacturers. RO membrane elements shall have a THREE year warranty for manufacturing and performance. Submit warranty certificates.

H. The skids and other related equipment will be installed by the contractor in this contract, referred to as Installation Contractor (IC).

1.02 PREQUALIFIED ROEM

A. Only the following four ROEM firms listed are considered pre-qualified ROEM and allowed to participate. No other company will be considered for this project.

FIRM	CONTACT	TELEPHONE/ EMAIL
Biwater, Inc. 190 E. Arrow Highway, Unit F San Dimas, California 91773	Richard White	(P): 909-599-4129 Richard.White@biwater.com
Harn R/O Systems, Inc. 310 Center Court Venice, FL 34285	Julie Nemeth-Harn	(P): 941-488-9671 JuliaNemeth@harnrosystems.com
Wigen Water Technologies 302 Lake Hazeltine Drive Chaska, MN 55318	Eric Geibel	(P): 952- 448-4884 eric.geibel@wigen.com
H2O Innovation 1048 La Mirada Court Vista, California 92081	David Faber	(P): 760-598-2206 David.Faber@h2oinnovation.com

1.03 SKID CAPACITY AND SIZE

A. The array size shown in the table below is for maximum "Design Flow" and shall be used for bidding. Depending on the ROEM selected, membrane, and membrane computer projections, the array may be changed (if technically justified) subject to Engineer's approval. Submit projections based on the above and design water quality table under section 1.5.A.

DESIGN FLOW PARAMETERS

1.	Number of RO Skids	4
2.	RO skid tags	RO1, RO2, RO3, RO4
3.	RO feed flow per skid	868 gpm
4.	Permeate capacity per skid	695 gpm
5.	Stages	2
6.	Array (2:1), Pressure Vessels (PV)	24:12
7.	Design RO System Recovery	80%
8.	Membrane diameter (standard)	8-inch
9.	Membrane length (standard)	40-inch
10.	Membrane area (standard)	400 Square Feet
11.	Pressure vessel length to hold	6 elements

12.	Number of vessel positions vertically	6	
13.	Number of vessel positions horizontally	6	
14.	Maximum System Permeate Flux		<14.0 GFD
15.	Maximum height from floor to center of top vessel		<9'-0"

1.04 SUBMITTALS

A. The ROEM shall submit to the engineer complete sets of shop drawings, details, data sheets, and other descriptive drawings and material as may be required to fully describe the equipment proposed and to verify compliance with the contract documents, in accordance with specification 01300.

B. All submittals shall be complete, neat, and orderly. The submittals shall include the following, as a minimum:

1. Custom, CAD (version 2012 or later) generated shop drawings pertinent to this specific application showing interconnections of the components in the system, including scaled double line piping drawings (schematics will not be acceptable), skid detail, pressure vessel supports, control logic schematic/wiring diagrams, control panel drawings to include front panel view, internal wiring detail, and panel internal arrangements, control panel equipment charts, equipment arrangements, installation and erection details, anchor bolts, equipment pads, etc. Include a CD of the skid design with the submittal so the engineer can check for compatibility, coordination and potential conflicts with other plant components.
2. Interconnection piping shall be arranged based on the plant piping shown on the contract drawings. Revisions to the layout will be considered, however must be approved by the engineer.
3. Detailed descriptions of each piece of equipment.
4. Description of the operation and control of the equipment, along with a documented copy of the control logic program.
5. Five (5) hard copies and one CD with color scan of operation and maintenance manual detailing the requirements for the overall system, per Section 01300.
6. Submit Manufacturer's Certificate of Compliance with applicable codes and warranty certificates.
7. Submit individual membrane element test data.
8. Submit certificate from the membrane element manufacturer on acceptability of the specified design feed water stating no adverse impact on the membrane and acceptance of the ROEM membrane projections
9. Submit computer membrane projections using the design feed water, showing that the blended stream meets the water quality goals in Section 1.6. In addition, any projection warnings shall be addressed in technical memoranda, subject to engineering approval.
10. Submit ANSI/NSF Certification for all material and products, which may come in contact with process or potable water.
11. Certification of ownership of the control and graphics software to the owner's name.

12. Valve, pipe, and orifice sizing calculations.
13. Dimensions showing the minimum upstream and downstream pipe diameters for valves and flow meters are met with manufacturer's written recommendations, plus additional 15% as a minimum.
14. Vessel preparation and membrane loading procedure.
15. Cleaning procedure and description specific to this project.
16. Proposed element loading lubricants.

1.05 RO DESIGN FEED WATER QUALITY

A. RO Feed Water Quality (Design Feed Water) to be utilized for the computer projections. Provide two projections, one for each extreme temperature listed.

PARAMETER	DESIGN VALUE
Total Calcium	14 mg/L
Total Magnesium	1 mg/L
Total Sodium	412 mg/L
Total Potassium	3.5 mg/L
Ammonia	1.2 mg/L
Arsenic III	<0.005 mg/L
Arsenic V	0.04 mg/L
Total Strontium	0.70 mg/L
Total Barium	0.06 mg/L
Total Iron	<0.1 mg/L
Total Manganese	<0.01 mg/L
Bicarbonate	58 mg/L
Sulfate	165 mg/L
Chloride	494 mg/L
Nitrate	1.9 mg/L
Fluoride	7.1 mg/L
Silica (SiO2), Dissolved	24 mg/L
TDS	1185 mg/L
pH	7.2 (feed)
Feed Water Temperatures	Min: 95, Max: 103 degrees C
Total Hardness	30 mg/L
SDI	<3.0

1.06 PERMEATE WATER QUALITY GOAL

A. The following is set as water quality goal for the combined two-stage permeate at design flow. Provide projections for 3-year membrane age at 95 and 103 degrees Centigrade to show compliance of the following at maximum expected temperature. Provide a reasonable estimate of Arsenic III and Arsenic V in permeate at the above projection conditions.
1. Chloride < 25 mg/L
2. Sodium < 22 mg/L
3. Hardness < 6.0
4. Nitrate <0.6 mg/L

5. TDS < 60 mg/L

1.07 ORIFICE PLATE

A. For the purposes of balancing fluxes and recoveries within stages, provide removable orifice plates (PVC or stainless steel) on common permeate line of first stage (if required). The orifice size shall be for the permeate back pressure requirements of the element projections. Submit calculations for orifice sizing. Provide blank plates for the initial hydrostatic testing.

1.08 PRETREATMENT

A. Well water is pre-treated with cartridge filters containing nominal XX-micron cartridges. Scale inhibitor will be injected to cartridge filter inlet piping prior to RO skid.

1.09 SPARE PARTS

A. Organize and provide labels on boxes and submit to OWNER and obtain receipt confirmation after completion of RO system testing.
   1. 1 extra Concentrate Control Valve complete with actuator and battery backup
   2. 3 extra membrane elements in sealed/preserved bags and unopened boxes
   3. 2 Threaded Tee bolts for removal of pressure vessel end caps
   4. 6 sections of permeate tube of sufficient length cut for permeate port connection
   5. 4 permeate port valves
   6. 4 sample panel valves
   7. 50 feet of sample tubing for each type (permeate, concentrate and feed)
   8. 4 spare pressure vessel end caps, gaskets and washers
   9. 8 extra brine seals for membrane elements
   10. Adequate lubricant recommended by the element manufacturer for loading membranes
   11. 12 extra o-rings.
   12. 1 spare pressure transmitter, 1 spare valve actuator, and 25 extra spacers.

1.10 TECHNICAL SERVICES

A. ROEM
   1. ROEM shall submit a complete Operations and Maintenance (O&M) manual for the entire system in their scope in accordance with specification 01300.
   2. ROEM shall provide a minimum of 7 days of training (excluding travel time, in three trips) by experienced staff who are very familiar with this project, for facility operators on all unit processes, cleaning, and plant operation. A detailed training manual shall be provided in advance. This is

in addition to software, PLC and instrumentation training specified in control section and coordination and site visits to assist installing contractor.

3. As a part of ROEM bid, include one year of technical service (by phone or email) to answer operator questions, review trend charts and normalized data and provide recommendations for adjustments, cleaning and improvements. This performance phase technical service will start after the conditional acceptance of the RO system for a period of one year. All correspondences and phone conversations will be emailed to the engineer for record-keeping. Include cost of this service in the base bid.

PART 2 - PRODUCTS

2.01 MEMBRANE SKIDS

A. The membrane skids shall consist of membrane elements, pressure vessels, support structures, piping and valves, instrument panel and sample panel.

B. The drawings show a combination of "conventional" feed/concentrate pipe design, with certain Port to Port design to minimize air trap and for efficient hydraulics. This arrangement must be followed by the ROEM.

2.02 MEMBRANES

A. The membrane elements shall be Polyamide Thin Film Composite (TFC) Reverse Osmosis membranes with 400 square feet of nominal active membrane surface area in a standard 8-inch x 40-inch spiral wound configuration.

B. The membranes shall be individually tested and permanently marked with a factory serial number. Test conditions shall be as on the membrane data sheet submitted with bid. A test report shall be submitted to the Engineer prior to membrane loading. The test report shall provide for each element, the following:

1. Membrane Serial Number
2. Date of Test
3. Test conditions: Temperature, pressure, feed water composition, recovery, meeting performance requirements specified
4. Test results: Rejection, Characteristic membrane productivity in gpd, meeting performance requirements specified.

C. Only new membranes shall be provided. "Patched" new membranes, or membranes that have been reconditioned, or refurbished, will not be accepted.

D. Membrane elements shall be specifically manufactured for brackish water as manufactured by Toray, Dow/Filmtec or Hydranautics. No other company equals will be acceptable.

2.03 PRESSURE VESSELS

A. Pressure vessels shall have a diameter and length designed specifically to contain the quantity of standard membrane elements as specified. The feed and concentrate ports shall be located and recessed in the side-wall of the pressure vessel.

B. Vessels shall be designed, constructed, third party inspected and code-stamped in accordance with the latest edition of the ASME Boiler and Pressure Vessel Code - Section X, Fiber-Reinforced Plastic Pressure Vessels (Code). The requirements include, but are not limited to, the following:

1. The Manufacturer shall be qualified to produce Code Certifiable Pressure Vessels and possess a current Certificate of Authorization issued by the ASME.
2. Vessel qualification shall include destructive pressure tests of prototype vessels. To qualify, a prototype must not burst at less than six times (6X) its rated pressure after being pressure cycled 100,000 times at 150ºF.
3. Each vessel shall pass a Hydrostatic Leakage Test, at a pressure of 1.3 times the rated pressure.

C. Vessels shall have a maximum working pressure of not less than 300 psi at a temperature up to 1200F with a minimum operating temperature of not less than 200F (-70C.)

D. The shell of the vessel shall be fabricated of filament-wound fiberglass reinforced plastic (FWFRP) using continuous glass roving, impregnated with an elevated temperature cure epoxy resin system to provide superior dimensional stability and long term service life. The use of single monomer resin such as polyester is strictly prohibited.

E. Vessels shall be complete with end closures, hardware and membrane element end adapters. The end closure surfaces in contact with the process fluid shall be PVC or other inert plastic.

F. Each shell inside diameter shall be free of pits or voids that may promote bacterial growth or corrosive attack of the resin-rich barrier and shall conform to level 1 criteria as ASME Section X, section 6-100.1. The bore diameter shall be a mirror-like, smooth surface and measure a 7.955 plus or minus 0.005 inches.

G. Each shell shall have a smooth exterior surface that has been coated with a two-part polyurethane enamel for superior gloss retention, abrasion resistance and to block light that may promote biological growth. Each end-bell shall be free of any grinding or sanding marks. The length of the shell between the bells shall be straight and smooth, and without any lumpiness that may indicate filament-winding inconsistency that could affect performance.

H. The shell shall be fail-safe to prevent catastrophic failure while in service. The wall of the shell shall fail in weep mode at a nominal value of not less than 4 times the design pressure to ensure safe operation over a long service life. This failure shall not occur around the side ports. The head retention system shall fail at a nominal value of not less than 6 times design pressure to prevent the possibility of catastrophic failure while in service.

I. Each head seal gland shall be designed to eliminate dead space and to expose the seal surface to high-pressure fluid for flushing of the seal to minimize bacterial growth.

J. Each side-ported feed/concentrate port shall incorporate a flush elastomeric seal that seals to vessel shell so that edge laminate surfaces are not exposed. Side port designs that do not eliminate seal dead space and may lead to biological growth are strictly prohibited.

K. The primary means for head retention shall be a single retaining mechanism that provides ASME-required redundancy and is constructed of stainless steel for ease of use and long-term reliability. This mechanism shall be able to be removed by hand, without the use of any tools.

L. Each head shall contain an integral secondary interlock that requires a simple, yet specific sequence of events to remove the end closure and shall not require the use of separate components that may become separated from the vessel.

M. In order to assure field serviceability, all seals, whether in the shell or head, shall be visible so as to be directly accessible for replacement without the removal of any other components.

N. All permeate connection seals shall be designed to prevent rolling that may lead to seal damage.

O. Vessels shall not leak when properly installed. If leaking occurs, the vessel supplier is responsible for the repair or replacement of the vessel. Such leaking must be remedied within 14 working days from the notification of the leak.

P. Vessel manufacturer shall recommend vessel port location and sizes based on the flow requirements in these specifications.

Q. Pressure vessels shall be manufactured in USA. Vessels manufactured outside the United States will not be accepted.

R. Pressure vessels shall be manufactured by Bekaert/Arisawa, Pentair/Codeline or accepted equal.

2.04 SKID FRAMING AND SUPPORTS

A. The supports shall be designed and provided with three (3) point vessel support on the skid framing. Provide saddles and bolt down straps at all three locations.

B. Skid framing support shall be made of a complete "box" frame fabricated from either:
   1. Glued and bolted Poly-Coated FRP components
   2. Bolted and welded 316 stainless steel, or
   3. Welded and baked powder coated aluminum (8 mil minimum thickness) components, with adequate cross bracing and connector members for pipe/valve supports. All FRP shapes shall be Extern 525 with water adsorption complying with ASTM D-570.
   4. Coated steel framing is not acceptable.

C. Support structures must be free of pockets and niches.

D. All mounting hardware, for pressure vessels, manifolds, instrument panels and sample boards shall be 316 SS. Bolts, washers, and other fasteners shall be 316 SS. Nuts shall be silicon bronze on grooved end couplings, 316 SS with anti-seize for other hardware.

E. Support structures shall be anchored to concrete foundations, provided by IC. 304 Stainless steel expansion bolts, 5/8"- diameter shall be used for this purpose. Equipment supplier shall coordinate with the IC.

F. All piping, valving, cleaning connections and instrumentation take off points within the membrane train shall be placed such that easy and convenient access is provided for inspection and maintenance purposes. Provide the skid with adequate lifting lugs, and written procedures for lifting.

2.05 RO SKID, FEED, CONCENTRATE AND PERMEATE PIPING

A. All skid manifold piping shall be provided by the RO system supplier, and shall be an integral part of the membrane assemblies. Feed and Concentrate manifolds shall be fabricated from 316 L stainless steel piping, schedule 10S rated for 300 psi. For cut grooved pipes provide schedule 40S. Permeate manifold shall be fabricated from S80 PVC. Assemblies shall be thoroughly cleaned inside and out, and all scale and welding slag removed. Completed stainless steel headers and laterals shall be electro polished or acid dipped on the outside to bright finish. Insides shall be Glass Bead Blasted with pickling and passivation. Completed components shall be pressure-tested to 1.3 times working pressure as part of the final assembly.

B. All stainless-steel manifold tees required for vessel connections shall be fabricated by the "pull-tee method". Welded stubs will not be permitted.

C. The feed and concentrate manifolds shall be connected to the pressure vessels ports with grooved end-type connectors, with bolts, nuts, and washers as described previously.

D. Grooved end couplings shall be 316 stainless steel meeting ASTM-A351 rated for 300 psi. Couplings shall be as manufactured by Victaulic, Piedment, Gruvlok or accepted equal.

E. Connection between permeate manifolds and pressure vessels shall be with 1¼" reinforced black plastic tubing, made from Food Grade material approved by NSF and/or FDA. The bend radius of the tubing shall be sufficient to avoid leaking or cracking of the tubing. Provision shall be made for a sample port in each connection, ¼ inch female threaded. Stainless steel tubing may be acceptable subject to engineer's approval.

F. For pipes and valves shown with sizes on drawings, provide the size indicated. For all other locations, maximum acceptable flow velocities within the membrane skid piping system shall be as follows:
   1. 316 L SS Sch 10, 8 feet per second
   2. Schedule 80 PVC, 6 feet per second

G. Permeate laterals shall be stainless steel. Threading PVC pipe, glued, or welded outlets are not acceptable.

H. Provide manual stainless steel ball valves for air release on all high points of feed pipe at locations shown.

I. Provide automatic PVC air release/vacuum valves on permeate and concentrate pipe high points. Refer to drawings.
   1. ARI Valves
   2. Or approved equal.

J. All instrument and sensors on PVC piping shall be installed using saddles or blank tees.

K. Provide adequate velocity and upstream/downstream distances for flow meters and instruments and literature indicating compliance of the manufacturer's procedures and a 15% increase in minimum distance requirements.

L. Both concentrate and permeate piping shall be provided with the "goosenecks" as shown on the drawings to prevent skid from draining and have a full pipe condition at all time.

M. Valves shall be as specified in section 11100.

2.06 INSTRUMENT CONNECTIONS

A. All instrument tubing to and from the main tap to instruments and analyzers shall be 316 stainless steel for feed and concentrate and pressure rated non-metallic tubing for permeate with a minimum of ¼" size.

2.07 SAMPLE BOARD

A. The ROEM shall provide one sample board on each RO skid. The boards shall be fabricated from PVC, stainless steel or coated FRP with 316L stainless steel hardware. Refer to details on drawings.

B. The board shall be fitted with sample valves. There shall be one (1) sample valve for each vessel permeate, plus valves for feed, to each stage, concentrate, and combined permeate. The sample board shall be equipped with a deep trough, of the same material as the panel, which will be drained to the floor drain. There should be adequate distance between rows of valves for the hand-held conductivity analyzer. Sample valves shall be arranged in rows staggered so that the upper valves discharge between the lower valves. Each valve will be fitted with a 1 /4-inch OD 316L stainless steel tubing discharge spout, to prevent splashing. Valves shall be 1/4 turn plug valves. Each valve will be labeled with an engraved label white on blue for permeate, white on red for feed and/or concentrate, indicating source of sample. Refer to details on drawings.

C. Sample tubing shall be ¼-inch OD. Tubing shall have a minimum working pressure of 100 psi for permeate and 300 psi for feed and concentrate at 120º F. Sample tubing shall be blue for permeate, red for feed water and black for concentrate. Tubing material shall be stainless steel or nylon. Tubing shall be manufactured by Imperial Eastman Division, Imperial Clevite, Inc., or accepted equal.

D. Tubing shall be neatly arranged and bundled where possible. Bundles shall be retained with nylon "Tywraps", and "Polytube" racks, as required. Tubing shall be run through conduits along length of pressure vessel.

E. Sample tubes shall be connected to the permeate tubes on opposite end of feed, adjacent to permeate hose utilizing tee connections.

F. At the other end of pressure vessels, a special port ball valve should be installed for the purpose of probing each pressure vessel while system is in operation.

G. Provide a separate port/valve for feed water SDI Testing.

2.08 MOTORIZED SLIDING GATE CONCENTRATE CONTROL VALVE (CCV)

A. Valves shall be a variable orifice gate design with 316 Ti stainless steel construction and a working pressure rating to 300 psi.

B. The valve shall be of wafer design, bolt cutouts to align between flanges with adjacent class type piping as shown on drawings. The valve seats shall be satellite fixed plate and a Triballoy (STN2) moving disc. Shutoff shall exceed 0.001% of rated valve CV.

C. Valve electric motor actuator shall be supplied as a package by the valve manufacturer. Motor voltage shall be 110VAC with Electronic Positioner to be top mount and integral to the actuator with 4-20 mA signals.

D. Provide each valve with a battery pack backup to keep valve in open position in case of power failure.

E. The positioner shall be self-calibrating and water tight. Motor shall be IP 65 rated, temperature rated from -5oF to 140oF. Motor shall have manual over drive, fail safe protection and battery pack and two limit switches.

F. Submit manufacturer's size and CV calculations based on the RO membrane projections for engineer approval.

G. Provide Five (5) complete valve and actuator assembly with battery backup, 4 for RO skids and 1 as shelf spare.

H. Valve shall be Series 8036, as manufactured by Schubert & Salzer, with the control options shown on P&ID.

2.09 MOTORIZED FLUSH BY-PASS VALVE

A. Valves shall be 316 L stainless steel Butterfly valves, rated for 300 psi, with electric motor actuators.

B. Valve and electric actuators shall be as manufactured by Bray or accepted equal.

2.10 SILT DENSITY INDEX (SDI) KIT

A. Provide two (2) complete SDI kits with 400 quantities of 47 mm, 0.45 micron pads, pressure regulator, membrane holder, isolation valve. The second SDI kit is a spare. SDI test kits shall be model 4701 and membrane pads shall be model 4700 as manufactured by GE Osmonics Labstore, or accepted equal.

B. Provide two 500 mL plastic graduated cylinders and a stopwatch.

C. Install taps on all cartridge filters inlet/outlet piping with a stainless-steel isolation ball valve, at convenient locations approved by the engineer.

2.11 RO SYSTEM CONTROL PANELS

A. Each RO skid shall be provided with a NEMA 4X skid remote I/O panel and Ethernet card. All instruments and devices on the skids shall be factory wired to the skid panel as shown on P&IDs. Each skid panel shall be provided with digital displays of instruments and analyzers as specified and shown for RO skids.

B. RO skid panels shall be connected to the RO system control panel by Ethernet cables. The RO system control panel shall be provided with a PLC control system with OIT and HMI Interface. The RO system control panel shall be installed at the location shown on contract drawings.

C. RO system main control panel PLC shall be Allen Bradley ControlLogix with adequate I/O capacity as required for the system required for this project, plus an additional 20% spare I/O for future use. The PLC shall be programmed for "heartbeat" with periodic verification of PLC status.

D. Provide a 15" color OIT touch panel on front of the RO System Control Panel. The OIT panel shall have all operator selectable set points organized with graphics for ease of display and adjusting. The OIT shall have a minimum of 20 screens and adequate storage for messages and alarms. The graphic display shall include all digital and analog points being monitored by the PLC system. It shall also indicate auto/manual status, run status and alarms for all process equipment. Additionally, the graphic shall allow the plant operator to set and adjust all analog set-points and timer settings for control of process equipment. The OIT shall have capacity to install passwords, security codes and shall be as manufactured by Allen Bradley.

E. Mounted on the front of the control panel shall be a Common Operator Interface Terminal (OIT) touch panel. Provide a diagonal color screen OIT by Allen-Bradley Panelview 600 or Panelview 7. Provide touch Panels that are programmable and can communicate to the Allen-Bradley PLC Ethernet driver or equal. Local process monitoring and control of the system shall be performed at the OIT, utilizing object-based graphical screens resembling the control functions and diagrams.

F. An emergency stop (E-Stop) button shall be provided on each RO skid panel to shut down the RO pump and open the concentrate control valve in case of emergency. A master E-stop shall also be provided in the RO system control panel which will shut down all RO pumps and open all concentrate control valves.

G. The HMI graphics and software shall be provided with two separate passwords, one for the operator (basic plant operations) and one for instrumentation & control technicians (programming changes and advanced set points).

H. The control panel shall be UL rated and be a NEMA 4 X standing control cabinet. The panel shall include PLC, memory modules, and relays all shop wired to a marked terminal strip and tested before shipment.

I. All relays shall be of the plug in the type for easy servicing.

J. Provide hinged lockable door handles for closing the Panel (multiple bolts with fasteners will not be acceptable).

K. All wire inserts shall be lock in place type. Keyed tongue wire connections are not acceptable.

L. Input/Output minimum requirements: Refer to P&IDs for actual I/O counts.
   1. Analog Inputs:
      a. 0 to 5V or 0 to 20 mA, 1 to 5V, or 4 to 20mA 24V dc
      b. Differential inputs.
      c. 14-bits sign bipolar, 15 bits unpolar.
      d. Accuracy: 0.1 percent at 25 degrees C
      e. Input filtering
   2. Analog Outputs:
      a. 0 to 10V, 0 to 20 mA, or 4 to 20mA 24V dc
      b. Isolated Outputs
      c. 14-bits sign bipolar, 15 bits unpolar.
      d. Accuracy: 0.1 percent at 25 degrees C
      e. Input filtering
   3. Discrete Inputs:
      a. 24V ac/dc.
      b. Isolation: Optical, 1,500V common mode isolation.
      c. Dry contact inputs.
   4. Discrete Outputs:
      a. 24V dc solid state switch open collector outputs.
      b. Provide 10A interposing relays with contact rated 10A at 120V ac on each output

M. Main processor module, with communication ports: Provide serial option and port adapters to provide as follows:
   1. Ports: Minimum of two:
      a. RJ-45 Ethernet Port
      b. RS232/RS485 Selectable

N. Communication Protocols: Ethernet/IP

O. Battery backup and Time of Day Clock Adapter

P. ROEM shall include programming services as needed for OIT graphics configuration, and all necessary application programming for all skids and conduct related start-up, alarm testing, commissioning, and field testing of RO PLC systems.

Q. All alarms, trending data and graphics shall be sent to the main plant PLC for historical trending and alarm notifications.

R. For the RO system control description, refer to project P&ID and project control description.

2.12 INSTRUMENTS AND ANALYZERS

A. Electromagnetic flow meters shall be as follows:
   1. Provide 304 stainless steel construction with flanged ends
   2. PTFE lining
   3. 316L stainless steel electrodes
   4. NEMA 4X housing
   5. Provide grounding rings for all meters installed in non-metallic pipe
   6. Electromagnetic flow meters shall be as manufactured by Endress Hauser or approved equal.

B. Pressure Indicator Transmitters shall be as follows:
   1. Stainless steel housing
   2. Integral LCD display, calibrated in pounds per square inch (psi)
   3. Electronics capable of field scaling, digital calibration, configuration, diagnostics, and communication
   4. Stainless steel mounting bracket
   5. The pressure transmitter shall be Model 3051S as manufactured by Endress Hauser or approved equal.

C. Pressure gauges shall be as follows:
   1. Gauges shall have a 4.5-inch dial and shall be provided with ½" SS snubber, and type 101 diaphragm seal. Provide gauges with the following features:
      a. 316 SS diaphragm
      b. 316 SS lower ½" FNPT connection with ¼" flushing connection.
      c. Steel rings and clamps.
      d. Silicone fill fluid
   2. Connect to process pipe with 3/4" diameter tap, 1/2" diameter stainless steel ball valve, and 1/2" diameter stainless steel tubing.
   3. The pressure gauge shall be as manufactured by Ashcroft, or approved equal.

D. Conductivity analyzers shall be as follows:
   1. NEMA 4X enclosure with LCD display mounted on the skid panel
   2. Stainless steel mounting accessories
   3. The conductivity transmitter shall be manufactured by Endress Hauser, HACH or approved equal.
   4. Feed water conductivity meter shall be provided with dual output, temperature and conductivity.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install all components of the system in strict conformance to various manufacturers recommended installation procedures.

B. The owner representatives should be present during orifice testing and membrane element loading, to visually inspect elements and record all serial numbers and witness installation.

C. Refer to other Sections of Specifications for cleaning, disinfection, dechlorination, pipe pressure testing, vessels and skid piping testing with non-chlorinated water before loading elements.

D. Membrane elements shall be kept at the manufacturers' facility in a controlled environment. Early delivery of elements (more than 4 weeks prior to facility being ready for element loading) will not be accepted.

E. When membranes are on site, they must be kept in un-opened boxes in an air controlled facility with no debris or dust.

F. All associated piping and pressure vessels shall be disinfected and dechlorinated prior to membrane loading. Test to ensure there is no chlorine residual prior to element loading. IC shall include all costs for disinfecting and pressure testing the entire RO skid and appurtenances using a suitable NSF-60 approved chemical that will not damage membranes. A test plan for disinfecting and pressure the testing the RO system shall be submitted for approval by OWNER and the ENGINEER. Any form of chlorine shall not be used in the disinfection procedure. IC shall include costs for disposal of the waste disinfectant after testing. Testing shall be repeated until negative microbiological results are obtained after 24 hours of contact with the RO system. The pressure test shall be conducted for a minimum of two hours with no more than 2 psi loss allowed without any observable leaks. Pressure testing shall be repeated until satisfactory results are obtained. IC shall be responsible for all costs of testing except laboratory sampling costs, which will be paid by Contractor.

G. Follow the membrane manufacturer's procedures for cleaning, de-chlorination, lubrication and installing the membrane elements.

H. Installation Contractor (IC) shall coordinate with ROEM and provide the required consumables and supplies for pressure vessels preparation and element loading such as, but not limited to towels, rags, empty new trash cans for solution preparation, plastic rope and swab ball for element loading, clean plastic trap for laydown area, sodium hypochlorite for disinfection and sodium bisulfite for dechlorination. IC is also responsible for providing clean and safe work area and adequate number of personnel to assist the ROEM with skids preparation and membrane element installation. IC shall provide scaffolding on both ends of RO skid for easy/safe access to load elements.

I. Provide PVC shims of different thicknesses if necessary after elements are in place. Measure the gap to end cap in presence of the engineer to determine shimming needs.

3.02 TESTING

A. RO SKID FACTORY TESTING

1. Each skid, complete with prewired instrumentation and controls, with all skid piping and valves installed (without membranes) shall be factory tested using a low pressure pump. Initial I/O checks and programming shall be conducted at the factory. Coordinate with the Engineer to be present for factory testing of at least one skid. A factory test report shall be provided for all skids. High pressure leakage test will be done on site with orifices.

B. RO SKID SITE TESTING

1. When all skid components are installed and complete, install blank plates and pressurize entire skid, cartridge filter and piping from RO pump using a small hydrostatic controlled pump with gauges and safety feature to a pressure of 250 psi. Fix any leaks. A blind flange or "frying pan" plate will be needed to reduce one way pressure on RO pump and check valve.
2. Install orifice plates or valves to simulate pressure losses and test the skids with clean water, in presence of the OWNER and the engineer. Provide temporary pipes and chemical adjustments and neutralization before discharging to the sewer system
3. Coordinate with the RO feed pump manufacturer to conduct pump tests and vibration checks at the same time as orifice testing.
4. Upon successful completion of orifice test and the necessary adjustments, install cartridge filters and membrane elements and flush the systems and piping while monitoring water quality for residual preservatives. Do not send permeate to finished water tanks unless provisions have been made by the Contractor for temporary discharge of permeate pumps to waste.
5. The engineer must be present for inspection of all pressure vessels and during membrane element loading.

6. When all systems have been tested and proper calibration and adjustments are complete, start monitoring the permeate water quality. After a minimum of 8 hours of operation, notify the owner for collecting samples for drinking water standards. Allow 3 days in the schedule for obtaining laboratory results.

END OF SECTION

SECTION 11405

HYDROPNEUMATIC TANK

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: A Steel pressure vessel for use as hydropneumatic tank, at Well 25 for the City of Goodyear. Vessel manufacturer shall provide piping connections and appurtenances as shown on the Construction Drawings and specified herein. Note that the terms vessel and tank are used interchangeably.

B. Supplier Qualifications: The vessel supplier shall have 3-years' experience with the manufacturing of steel pressure vessels for water applications.

C. Related Sections: Include but are not necessarily limited to:
   1. Section 11950 - Hydropneumatic System and Air Compressors.

D. See Drawings.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. A 36 - Specification for Structural Steel.

B. American National Standards Institute/National Sanitation Foundation (ANSI/NSF):
   1. Standard 61

C. American Society of Mechanical Engineers (ASME):
   1. ASME Code - Boiler and Pressure Vessel Code, Section VIII, Rules for Construction of Pressure Vessels, Division 1.

D. Steel Structures Painting Council (SSPC):
   1. Steel Structures Painting Manual, Volumes 1 and 2
   2. Pictorial Standards for Surface Preparation - SSPC-VIS 1.
   3. Measurement of Dry Paint Thickness With Magnetic Gages - SSPC SP A2.
   4. SP 6 - Commercial Blast Cleaning.
   5. SP 10 - Near White Metal Blast Cleaning.
   6. SP 11 - Power Tool Cleaning to Bare Metal.

1.03 OPERATING CONDITIONS

A. Pressure: The vessel shall have the following rated pressure, which includes 25 psi factor of safety per ASME Code:
   1. Rated Pressure: 125psi

B. Wind: Vessel will be located outside. Design for wind loading.

C. Snow: Design for snow loading.

D. Seismic: Design for seismic loading.

E. Ambient Air Temperature: Design for 0°F to 100°F.

1.04 SUBMITTALS

A. Product Data: List of materials and coatings used.

B. Form U-1, Manufacturer's Data Report for Unfired Pressure Vessels.

C. Shop Drawings and Calculations:
   1. Provide calculations and detail drawings to indicate compliance with the specified requirements. Calculations shall be sealed by a Professional ENGINEER registered in Arizona.
   2. Provide dimensional drawings verifying vessel dimensions, wall thickness, internals and vessel anchorage requirements.
   3. Provide vessel installation procedures.
   4. Provide certification and ASME Code data reports in accordance with the ASME Code as applicable 49 CFR 178.337 or other similar codes. The certification shall include certification of hydrostatic testing.
   5. Provide fabrication drawings.
   6. Provide the pressure test specifications and test results.
   7. Provide calculations for anchor bolts.
   8. Provide calculations for head and side shell thicknesses.

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. Components of the pressure vessel shall be the latest standard products of manufacturers regularly engaged in the production of equipment of this type.

C. Provide7 days' notice to the Engineer prior to final assembly and surface preparation of the vessel to allow the Engineer to thoroughly inspect the interior and exterior at the fabrication shop.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Pressure Vessels:
   1. Supplied by approved ASME Code vessel manufacturer.

2.02 MATERIALS

A. Vessel: Construct the vessel using SA 516-70 Carbon Steel (ASME steel plate).

2.03 SYSTEM DESCRIPTION

A. Vessel Design and Performance Requirements:
   1. Vessel Size: Vessel size shall be as indicated on the Drawings.
   2. Vessel Heads: The vessel shall have ASME Code heads. The heads shall meet the design requirements for formed heads subject to internal pressure as described in the ASME Code, and have the following specifications:
      a. SA 516-70 Carbon Steel (ASME steel plate)
   3. Provide calculations for head and side shell thicknesses.

B. Protective Coating: The vessel surface preparation and coating shall be performed as described below:
   1. Surface Preparation
      a. The vessel interior surface shall be abrasive blasted 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 in accordance with SSPC SP-11.
      b. The vessel exterior surface including steel legs 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.
   2. Coating
      a. Following are acceptable coating manufacturers:
         1) Tnemec Coatings.
         2) Carboline Coatings.
         3) Or pre-approved Equal.
      b. Interior Coating: The entire vessel interior surface shall be coated with a two coat Epoxy-Epoxy coating system.
         1) The coating shall be NSF approved.
         2) The interior coating shall applied after all required attachments to the vessel interior have been made.
         3) The following manufacturer's paint systems are acceptable:

Tnemec Coating:
Prime Coat: N140-1255 (beige) Pota Pox Plus, one (1) coat, spray applied to 6-8 mils DFT. Additional one (1) brushed coat of N140-15BL applied after the full prime coat on weld seams, corners, or other irregular surfaces.Finish Coat: N140-15BL (white) Pota Pox Plus, one (1) coat, spray applied to 6-8 mils DFT.

Carboline Coating:
Prime Coat: Carboguard 891 Gray (0794), one (1) coat, spray applied to 6-8 mils DFT. Additional one (1) brushed coat of Carboguard 891applied after the full prime coat on weld seams, corners, or other irregular surfaces.
Finish Coat: Carboguard 891 White (S800), one (1) coat, spray applied to 6-8 mils DFT.

c. Exterior Coating: The entire vessel exterior surface including steel legs shall be coated with a three coat Epoxy-Epoxy -Polyurethane coating system.
   1) The following manufacturer's paint systems are acceptable:

Tnemec Coating:
Prime Coat: N140-1255 (beige) Pota Pox Plus, one (1) coat, spray applied to 2-3 mils DFT.
Intermediate Coat: N140-1255 (beige) Pota Pox Plus, one (1) coat, spray applied to 2-3 mils DFT.
Finish Coat: Series 1075 (color choice by Owner) Endura-Shield II, one (1) coat, spray applied to 3-5 mils DFT.

Carboline Coating:
Prime Coat: Carboguard 891 White (0794), one (1) coat, spray applied to 2-3 mils DFT.
Intermediate Coat: Carboguard 891 White (0794), one (1) coat, spray applied to 2-3 mils DFT.
Finish Coat: Carbothane 133, (color choice by Owner), one (1) coat, spray applied to 3-5 mils DFT.

3. Shop Blasting and Coating: Following surface preparation and coating work shall be performed at the Contractor's Shop:
   a. Vessel interior and exterior surface preparation.
   b. Vessel interior surface prime and finish coats.
   c. Vessel exterior surface prime coat and intermediate coats.

C. Base Plate: Each leg shall come equipped with a base plate for mounting purposes. Manufacturer shall also provide SS anchor bolts.

2.04 COMPONENTS

A. Lifting Lugs: Provide exterior lifting lugs to facilitate vessel installation.

B. Nameplates and Code Stamps: Design, fabricate, and test vessel in accordance with the ASME Code. Vessel shall bear a stainless steel ASME nameplate. Nameplate shall bear the applicable code symbol. The manufacturer shall be authorized by ASME to apply the applicable code symbols.

C. Fittings shall be as indicated on the Drawings. Fittings larger than 1-inch shall be flanged. Fittings 1-inch and smaller shall be National Pipe Thread. Reinforce openings in accordance with the ASME Code.

D. Attachments: Weld shell attachments for vessel gages, instruments, and other items as indicated on the Drawings before application of the vessel coating.

2.05 APPURTENANCES

A. Appurtenances shall include mounting flanges, inspection hatch, lifting lugs, and other items, as indicated on the Drawings.

2.06 FABRICATION

A. Welding: Weld reinforcement shall be in accordance with ASME Code. Excessive reinforcement shall be ground down to within the ASME Code requirements, and as required to install the lining systems. Full penetration welds shall be used for heads and side shells when adjoining multiple steel plates. All internal corners and edges shall be ground to 1/8-inch radius, or a greater radius if required by the lining system.

B. Coating: Refer to Paragraph 2.03.B.

2.07 SOURCE QUALITY CONTROL

A. Hydrostatic test the vessel in accordance with the ASME Code for Unfired Pressure Vessels. The vessel shall be airtight and watertight.

B. The vessel manufacturer shall prepare a Form U-1 “Manufacturer’s Data Report for Unfired Pressure Vessels” to certify that the vessel was built in accordance with ASME Code Rules for the Construction of Unfired Pressure Vessels and inspected by a certified inspector. Submit copies of this report to the National Board of Boiler and Pressure Vessel Inspectors; and to the Contractor with copies for Submittals.

PART 3 - EXECUTION

3.01 WARRANTY

A. Vessel shall be warrantied by the manufacturer for a period of one year from the date of delivery to the job site. This shall cover all labor and materials required to correct deficiencies of the vessel interior and exterior coating, equipment, piping, etc., in workmanship at the location of the installation.

END OF SECTION

SECTION 11406

ARSENIC TREATMENT VESSEL INSTALLATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes: Installation of arsenic treatment vessels, installation of vessel internals per manufacturer's instructions, cathodic protection system, attachment of ladder (supplied with vessel), concrete fill, rebar installation within vessel, support media adsorption, media installation, and associated accessories. CONTRACTOR shall provide all services associated with these activities that are necessary for a proper working installation. The arsenic treatment vessels and adsorption media shall be supplied to CONTRACTOR by OWNER as pre purchased equipment.

1.02 REFERENCES

A. Manufacturer's Installation instructions: The manufacturer shall provide instructions for the erection of the contactors, and the contactors shall be erected in strict accordance with these instructions.

B. Related Sections included but are not necessarily limited to:
   1. Section 03300 - Concrete
   2. Section 09800 - Special Coatings
   3. Section 13510 - Cathodic Protection System
   4. Section 13221 - Support Media
   5. Section 15110 - Valves

1.03 DESIGN REQUIREMENTS

A. Equipment Mounting and Anchoring:
   1. Concrete footings shall be constructed as per the drawings. Use 316 S.S. anchor bolts to anchor tanks to footings unless otherwise shown in the drawings.
   2. Vessels shall not be mounted until supportive concrete base has reached full design strength.

1.04 SUBMITTALS

A. Manufacturer's certified drawings.

B. Construction Photos: Additional digital photographs will be taken during vessel installation (including internal of vessel) in order to have full photographic record of the entire installation process.

1.05 QUALITY CONTROL

A. Concrete slump test shall be conducted prior to any concrete being placed in the vessel. The OWNER shall witness slump test and give approval prior to concrete fill of the vessel. Other concrete tests will be conducted as specified in section 03300.

PART 2 - PRODUCTS

2.01 ADSORPTION CONTACTORS

A. Arsenic treatment vessels fabricated as per drawings, all required mounting hardware as per manufacturer's recommendations, and all accessories supplied with vessel.

2.02 ACCESSORIES

A. Accessories: Accessories include, ladder, manway hatch, manway platform, platform railing, and cathodic protection.

B. Support Media: See support media specification - 13221.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Orientation of vessel will be verified and approved by OWNER prior to vessel being anchored.

B. Vessel shall be inspected by OWNER prior to concrete fill, during fill, after fill.

C. Vessel testing, surface preparation, and coating shall be coordinated with the Engineer so that the Engineer may inspect and supervise the installation process.

3.02 INSTALLATION

A. Installation of vessel: CONTRACTOR will ensure that vessel is oriented in the correct manner, prior to anchoring. After tank is fully anchored, CONTRACTOR will fill bottom with concrete, as per tank manufacturer's specifications, in such a manner as not to disrupt and/or damage any of the internal tank components. Rebar reinforcement will be added to the concrete fill according to Drawings.

B. Bonding agent and sealant as specified by vessel manufacturer shall be applied prior to concrete being placed in vessel.

C. Concrete will be placed in 6" lifts, vibrating each lift as specified in section 03100.

D. CONTRACTOR shall make provisions to submerge underdrain piping within concrete section as per drawings and manufacturers shop drawings.

E. Concrete will be coated with Polywall 4000 according to manufacturer's instructions.

F. Concrete fill shall have a sealant between top of concrete fill and vessel surface to protecting concrete from water intrusion. The following steps shall be taken to apply this sealant:
   1. Lay 3/4-inch diameter rope around the perimeter of the vessel and concrete while the concrete is wet.
   2. Remove rope after concrete has set. Clean dust and debris left by rope from the channel. Clean vessel wall.
   3. Install suitable sealer to seal concrete and vessel wall around perimeter. Food grade Silkaflex 1A is approved.

G. Installation of Cathodic protection shall be performed as per Section 13510.

H. Paint Exterior of vessel as per Section 09800.

I. Attach ladder to vessel according to drawings.

J. Installation of adsorption media:
   1. Place 3-feet of standing water in vessels (above support gravel) prior to loading adsorption media. Media shall be placed evenly within the adsorption contactor in layers. CONTRACTOR shall use a potable water pressure spray, with 0.8 mg/L minimum chlorine residual to evenly distribute and consolidate media. OWNER shall provide potable water from hydrant for this purpose. Supersacs shall be directly emptied into contactor without use of a pump.
   2. Media will be rinsed (in backwash mode) to remove fines after initial placement under the direction of the ENGINEER.

END OF SECTION

SECTION 11410

CARTRIDGE FILTERS FOR RO SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section includes materials, installation and testing of housings, filter cartridges, and appurtenances for the Reverse Osmosis (RO) and Clean In Place (CIP) systems.

B. Water shall be tested prior to execution for the presence of Gallionella Bacteria

1.02 SUBMITTALS

A. Submit shop drawings in accordance with Section 01300. Submit dimensional drawings.

B. Submit manufacturer's instruction manual covering cartridge changing and housing maintenance.

C. Show materials of construction by ASTM reference and grade.

D. Submit certification of compliance with ASME code.

E. Submit operation and maintenance manual in accordance with Section 01300.

F. Submit ANSI/NSF Certification for all materials that will come in contact with water.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturer shall be Parker Filtration, "MP" Series as indicated, Fil-Trek, Clear Blue Filtration, or accepted equal.
   1. RO Pretreatment: Model MP-103H-3-8FK1, Fulflo MP, Horizontal, 150 psi
   2. RO CIP Cleaning: Model MP-52-3-6FK1, Fulflo MP, Vertical, 125 psi

B. Housing
   1. Fabricate the filter cartridge housing, support legs and eyebolts for cover closure and all accessories of Type 316L stainless steel. All components shall be factory pickled and passivated. All stainless steel components shall be electro polished.

2. Housing shall be divided into two chambers. The inlet chamber shall house the filter cartridges and have a removable cover. Cover closure shall use swing bolts with nuts. The outlet chamber shall be sized to transport water from the cartridge filters to the outlet.
3. The O-ring cover gaskets shall be EPDM
4. Inlet and outlet flanges shall be sized for piping diameters as specified in the "Service Condition".
5. Housing shall be of sufficient dimension to contain the cartridges as specified in the "Service Conditions."
6. Housing shall have the following connection: one 1/2-inch threaded vent connection on the cover, one 1/2-inch threaded pressure gauge/sample connection for each chamber, one 2-inch treaded connection for draining the upper chamber, and one 2-inch threaded connection for draining the lower chamber. Connections shall be 3,000-pound NPT coupling. Provide plugs for all threaded connections.
7. Design housing for the working pressure specified. Housing materials, design, fabrication, and inspection shall conform to Section VIII of the ASME Boiler and Pressure Vessel Code. Design temperature shall be 250 degrees F. Provide the ASME code stamp.
8. Each cartridge filter housing shall come factory equipped with a manual davit-lifting device for removing the access cover of the filter housing.
9. Design housing to meet the hydraulic conditions listed in the section on "Service Conditions."
10. Provide two 316 Stainless Steel ball valves at the bottom of each cartridge filter for draining the two chambers.

C. Cartridges
1. Cartridges shall be of the full depth honeycomb type with polypropylene core specially made for RO pretreatment. Cartridge filters shall remove 90% of all particles greater than the "Filtering Particles" size as listed in the section on "Service Conditions."
2. Cartridge materials shall be FDA or NSF approved for use in potable water.
3. Provide 316 stainless-steel cartridge spring seal assemblies for each cartridge.
4. Provide cartridge with extended polypropylene cores.

D. Service Conditions
1. RO Pretreatment Cartridge Filter:
   a. Quantity: 8
   b. Type: Horizontal
   c. Design Flow/Filter: 1,050 gpm
   d. Maximum Flow per 10" cartridge equivalents: 3.5 gpm
   e. Cartridge Length: 30 Inches
   f. Number of Filters 103
   g. Nominal Filtering Particles: 1 and 20 micron
      (To be confirmed after pump testing)
   h. Inlet and outlet Flanges: 150 psi, 8 inch

i.	Pressure Loss, Clean:	<3 psi
2.	Cleaning System (RO CIP) Cartridge Filter:	
a.	Quantity	1
b.	Type:	Vertical
c.	Design Flow/Filter:	540 gpm
d.	Maximum Flow per 10” cartridge equivalents:	3.5 gpm
e.	Cartridge Length:	30 inches
f.	Number of Filters	52
g.	Filtering Particles:	1 micron
h.	Inlet and outlet flanges:	125 psi, 6 inch
i.	Pressure Loss, Clean:	<3 psi

PART 3 - EXECUTION

3.01 PRESSURE TESTING

A. Pressure test the housing at factory in accordance with ASME requirements.

3.02 INSTALLATION

A. Set each cartridge filter in place on preset anchor bolts, plumb, level with leveling nuts, and securely anchor. Grout under feet as shown on the drawings. Extend drains and vent as shown in the drawings. Provide fittings as necessary.

B. Do not install cartridge elements until each housing has been thoroughly cleaned and connecting pipelines have been thoroughly flushed.

C. Field test cartridge filter housing and piping with well water during RO skid orifice testing.

3.03 LABELING AND MARKING

A. Provide a tag for each unit bearing the tag number.

3.04 SPARE PARTS

A. Provide two spare sets of complete cartridges for all 9 cartridge filter housings. These spare cartridges are in addition to those used during startup and commissioning.

B. Provide one O-ring cover gasket for each type of housing.

C. Provide five spare end cap spring assembly per housing.

D. Pack spares in boxes; label with manufacturer's name and representative's name, address, and telephone number; and attach list of materials contained within.

END OF SECTION

SECTION 11950

HYDRO PNEUMATIC SYSTEM AND AIR COMPRESSORS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Package System Air compressors, filters, air system appurtenances, and integrated control panel and related instruments for use in controlling water level in surge tanks at locations 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 Tanks
   5. Division 16 – Electrical

C. Vendor shall review all reference sections and Drawings when developing pricing.

1.02 SYSTEM DESCRIPTION

A. Furnish all materials, equipment, and incidentals required to install, start-up, test, and place into operation, air compressors for use in controlling the water level in surge tanks 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, psia
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. Furnish 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 system shall be suitable for continuous service. Air compressor shall be suitable for outdoor installation.

B. Typical site conditions are as follows:
1. Elevation 10 feet above sea level - Well 24
2. Elevation 30 feet above sea level - Well 25
3. Ambient temperature for Well 21:
   a. Maximum – 110 degrees Fahrenheit.
   b. Minimum – 0 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, include 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 compressor.

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 AIR COMPRESSOR

A. The air compressor system shall include rotary screw air compressors. Capacity of air compressors - 20 cfm at standard pressure rated for 100 psig (Wells 24 and 25).
   1. The air compressors shall be Ingersoll-Rand
   2. Or Champion

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 shall be 5 hp for compressor and comply with electrical specifications. Power supply shall be 208 volts, 3-phase, 60 Hz.

C. Baseplate for air compressor:
   1. Prove folded mild steel base-plate protected from corrosion with a high grade of powder coated paint finish. The baseplate shall support all of the components within the air compressor package.
   2. The baseplate shall be provided with fork truck slots to enable easy handling.
   3. The compressor unit and drive motor shall be mounted on a secondary sub-base that is supported on vibration isolating mounts, to reduce operating sound emissions to a very low level.

D. Enclosure for air compressor:
   1. Provide enclosure for effective sound emission control. However the enclosure shall provide easy access for maintenance and eventual refurbishment.
   2. The front door shall be designed such that it lifts off if required to provide easy access to all routine maintenance points.

3. The enclosure shall be NEMA 4 rated.

E. Hydropneumatic Control System (One for each surge tank) shall consist of the following:
   1. Hydropneumatic Local Control Panel with the following features:
      a. NEMA 4 Steel enclosure
      b. Induction relays
      c. Control relays
      d. Time delay relays
      e. High and low level alarm lights
      f. Dry contacts for alarms
   2. 66" long probe bottle including two isolation valves and drain valve. Refer to 13329 for specifications.
   3. Solenoid valves
   4. Ball valves
   5. Check valve
   6. Air Compressor shall be equipped with a "HAND-OFF-AUTO" selector switch and "START" and "STOP" pushbuttons.
      a. "HAND" mode will allow manual control of the compressor 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 surge tank levels.
      c. "AUTO" mode will cause the compressor to be controlled by the relay from the levels on the surge tank.
   7. Hydropneumatic Local Control Panel shall have the followings IOs
      a. Digital inputs to the control panel are as follows.
         1) Air compressor "RUN" status
         2) Air compressor "FAIL" status
         3) Surge tank low level alarm
         4) Surge tank high level alarm
         5) Air compressor start/stop command.
         6) Normal operations level.
         7) Low operations level.
      b. Digital output from the control panel to the Site PLC shall indicate the following outputs. Output is a status indicator only.
         1) Air compressor "RUN" status
         2) Air compressor "FAIL" status
         3) Surge tank low level alarm
         4) Surge tank high level alarm
      c. Digital outputs from local control panel to field instruments.
         1) Compressor run command.

F. Air compressor shall be capable of adjusting water level in surge tank in 20 minutes.

G. 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.

H. Provide fused disconnect switch at panel for the air compressor.

I. Refer to Section 11005 for additional control panel requirements.

J. Provide level probes and pressure transducers (for surge tank). See Drawings.

K. Each air compressor shall be provided with manufacturer's silencer to reduce noise level.

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

SECTION 11955

SAND SEPARATOR

PART 1 - GENERAL

1.01 SUMMARY

A. General work included in this Section:
   1. Two sand separators that would be installed at Well 24 and Well 25.

B. Related Sections include but are not necessarily limited to:
   1. Division 1 - General Requirements
   2. Division 16 - Electrical
   3. Section 09800 - Special Coatings
   4. Division 17 - Instrumentation and Controls

C. Reference Standards
   1. National Sanitation Foundation (NSF) 61 - Drinking Water System Components - Health Effects as per Arizona Administrative Code (AAC) Title 18, Chapter 4, and Section R18-4-119.

1.02 SUBMITTALS

A. Manufacturers certified drawings and material specification showing conformance to specifications.

B. Operation and maintenance manuals.

1.03 SEPARATOR TYPE & PERFORMANCE

A. Separator Type & Performance:

The removal of specific unwanted solids from a pumped/pressurized fluid flow system shall be accomplished with a centrifugal-action vortex separator. Solids removal efficiency is principally predicated on the difference in specific gravity between the liquid and the solids. Fluid viscosity must be 100 SSU or less.

In a single pass through the separator, given solids with a specific gravity of 2.6 and water at 1.0, performance is predictably 98% of 74 microns and larger. Additionally, particles finer in size, heavier by specific gravity and some lighter by specific gravity will also be removed, resulting in an appreciable aggregate removal of particles (up to 75%) as fine as 5 microns.

In a recirculating system, 98% performance is predictable to as fine as 40 microns (given solids with a specific gravity of 2.6), with correspondingly higher aggregate

performance percentages (up to 90%) of solids as fine as 5 microns.

B. Performance Requirement

Separator performance must be supported by published independent test results from a recognized and identified test agency. Standard test protocol of upstream injection, downstream capture and separator purge recovery is allowed with 50-200 mesh particles to enable effective, repeatable results. Single-pass test performance must not be less than 95% removal. Model tested must be of the same flow-design series as specified unit.

C. Separator Design & Function

A tangential inlet and mutually tangential internal accelerating slots shall be employed to promote the proper velocity necessary for the removal of the separable solids. The internal accelerating slots shall be spiral-cut (Swirlex) for optimum flow transfer, laminar action and particle influence into the separation barrel. The separator's internal vortex shall allow this process to occur without wear to the accelerating slots.

Separated particle matter shall spiral downward along the perimeter of the inner separation barrel, in a manner that does not promote wear of the separation barrel, and into the solids collection chamber, located below the vortex deflector stool.

To insure maximum particle removal characteristics, the separator shall incorporate a vortex-induced pressure relief line (Vortube), drawing specific pressure and fluid from the separator's solids collection chamber via the outlet flow's vortex/venturi effect, thereby efficiently encouraging solids into the collection chamber without requiring a continuous underflow or excessive system fluid loss. System fluid shall exit the separator by following the center vortex in the separation barrel and spiral upward to the separator outlet.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Sand Separator:
   1. LAKOS Filtration Systems (Model 1850-L (Well 24) and Model 1160-L (Well 25)

B. Motorized Pinch Valve:
   1. AKE Series by Lakos

C. Quarter-Turn Flanged End:
   1. Dia-cam pinch valve by LARAD Equipment Corporation

D. Electric Actuator:
   1. Series 75 Electric Actuator by Flowserve

2.02 PERFORMANCE AND DESIGN

A. Inlet & outlet shall be grooved couplings, size: 10” (Well 24) & 8” (Well 25)
B. Purge outlet shall be threaded with screw-on flange, size: 2” (Well 24) & 1-1/2” (Well 25)
C. The separator shall operate within a flow range of: 420-775 (Well 24) & 265-490 (Well 25)
D. Pressure loss shall be between 3-12 psi (.2 - .8 bar), remaining constant, varying only when the flow rate changes.
E. Included shall be pressure gauges with petcock valves for both the inlet and outlet of the separator and an isolation valve at the purge outlet for servicing of the automatic valve as necessary without interrupting system flow.

2.03 CONSTRUCTION

A. The separator shall feature the following access capabilities for either inspection or the removal of unusual solids/debris:
   1. An upper-chamber full-size grooved coupling, allowing complete access to the inlet chamber, acceleration slots and internal separation barrel
   2. A hand-hole port at the collection chamber, with Neoprene gasket (low flow rate models to feature full-size coupling at collection chamber)
   3. An inspection port, located at the lowest point of the upper chamber

B. The separator shall be of unishell construction with A-36, A-53B or equivalent quality carbon steel, minimum thickness of .25 inches 6mm). Maximum operating pressure shall be 150 psi (10.3 bar), unless specified otherwise.

C. Paint coating shall be acrylic urethane, spray-on, royal blue.

D. As a specified option only: The separator shall be constructed in accordance with the standards of the American Society of Mechanical Engineers (ASME), Section VIII, Division 1 for pressure vessels. Certification shall be confirmed with the registered "U-stamp" on the body of the separator. Weld-on flanges also available.

2.04 ACCESSORIES

A. Purging
   1. Evacuation of separated solids shall be accomplished automatically, employing a dedicated solid-state controller in a NEMA 4 housing. Available for worldwide single-phase voltages of 24VAC to 250VAC. Programming options to include a purge frequency range of every 60 seconds to every 23 hours, 59 minutes. Purge duration options range from 2 seconds to 59 minutes, 59 seconds. Non-volatile memory. Meets CSA

requirements. This controller shall automatically operate one of the following techniques:

a. Motorized Ball Valve - A full-port, electrically-actuated valve shall be programmed at appropriate intervals and duration in order to efficiently and regularly purge solids from the separator's collection chamber. Valve body shall be bronze (optional stainless steel also available). Valve ball shall be stainless steel with sealant seat.
b. Pneumatic Pinch Valve - Compressed air shall be provided to actuate this full- port valve at appropriate intervals and duration in order to efficiently and regularly purge solids from the separator's collection chamber. System shall include a pressure regulator for proper modulation of air pressure. Valve liner is natural gum rubber.
c. Pneumatic Ball Valve - A fail-safe valve shall be programmed at appropriate intervals and duration in order to efficiently and regularly purge solids from the separator's collection chamber. A spring-control shall provide that this full-port valve closes in the event that compressed air or electricity is interrupted. Valve body shall be bronze (optional stainless steel also available). Valve ball shall be stainless steel with sealant seat.
d. Purge Liquid Concentrator - A dual pneumatic pinch valve package shall be employed in order to effectively minimize the fluid loss when purging. The controller shall provide proper sequential valve actuation at appropriate intervals and duration in order to efficiently and regularly evacuate solids from the separator's collection chamber. Liners for the pinch valves shall be natural gum rubber (optional, at extra cost: neoprene, butyl, buna N and hypalon also may be specified). System shall also include a pressure regulator to modulate air pressure to the valves, a full-size sightglass for inspection of solids accumulation during operation and a manual isolation valve for servicing requirements.

B. Solids Handling:

1. An appropriate solids collection device shall be provided with the separator, suitable for capturing solids and returning all excess purged liquid to system use. Size and type of collection device shall be determined according to the application requirements, selected from the following options (or custom, as specified):

a. Solids Collection Drum - In conjunction with the appropriate automatic purge valve, this package shall be employed to capture and concentrate separated solids (up to 90% solids by volume) from the separator directly into a standard 55-gallon drum, returning excess purged liquid to system use via an integral decant line on the drum shroud. Solids collection capacity: 12,700 cubic inches (200 liters). Package includes two shrouds, two shroud clamps, two drum carts for transporting the drums and a manual liquid evacuation pump. Recommended option: A Purge Diffuser shall be installed on the discharge of the automatic purge valve in order to reduce the velocity of the purge flow and enhance the settling of solids within the drum.

b. Solids Collection Hopper - In conjunction with the appropriate automatic purge valve, a one cubic yard (764 liter) hopper shall be employed to capture and concentrate separated solids (up to 90% by volume) from the separator, returning excess purged liquid to system use via an integral decant line installed directly on the hopper. The hopper shall feature a manually-actuated tilting mechanism for dumping accumulated solids as necessary. Recommended option: A Purge Diffuser shall be installed on the discharge of the automatic purge valve in order to reduce the velocity of the purge flow and enhance the settling of solids within the hopper.

C. Systemization:

The separator and its accessories shall be packaged as a complete system, with all componentry from a single source. In addition to the equipment already specified, the system shall also include an appropriate support frame for positioning the separator accurately and effectively for solids purging/handling. If the specified purging technique is a pneumatic pinch valve: A spare pinch valve liner shall also be included.

PART 3 - EXECUTION

A. Install sand separators as shown on the Drawings and in accordance with the manufacturer's recommendations.

B. System shall be installed to prevent vibration under normal operating conditions.

C. Provide 1-day startup support services and operators training with manufacturer's representative.

END OF SECTION

DIVISION 12

FURNISHINGS

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.

B. See Drawings.

1.02 QUALITY ASSURANCE

A. Manufacturer's/Installer's Qualifications: 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: 50°C 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 ½" through 2". Conduit or fittings having areas with thin or no coating shall be unacceptable. Do not use "LB" fittings for conduit sizes of 1¼" or larger. Use type "LBD" fittings wherever the use of fittings for conduit sizes of 1¼" 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 and shall be a minimum of 6 inches above the tank roof with a raised welded flange and gasket.

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 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 13207

WELDED STEEL STORAGE TANK

PART 1 - GENERAL

1.01 SUMMARY

A. Scope:
1. CONTRACTOR shall provide all labor, materials, equipment and incidentals specified or required to design, fabricate, deliver, and erect steel storage tanks of welded construction, including accessories and concrete ring wall.
2. Section includes: One 2.0 MG welded water storage tank for use as potable water storage.

1.02 QUALITY ASSURANCE

A. Tank Supplier Qualifications:
1. Manufacturer 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. Tank Supplier shall have on his staff a full-time Registered Professional Engineer having not less than five years' experience in the design and field construction of welded steel storage tanks, who will be in responsible engineering charge of the work associated with the welded steel storage tank specified herein. All detailed tank drawings and design calculations shall be signed and sealed by a Registered Professional Engineer.

B. Design and Fabrication Criteria:
1. Except as otherwise specified, all design, materials, joints, workmanship and all other aspects of the tank design and fabrication shall conform to AWWA D100.
2. Calculate earthquake loads for Seismic Use Group II, Importance Factor 1.25 in accordance with AWWA D100.
3. Use roof live load of 15 PSF for the design of the tank structural support system.

C. Testing Agency:
1. General: Testing of materials and field welds for compliance with technical requirements of the Specifications shall be provided by CONTRACTOR.
2. Testing Services:
a. Perform field radiograph tests to assure that the proper quality of field welding has been obtained.
b. Report all test results to the ENGINEER.

3. Authority and Duties of Testing Agency: Technicians representing the testing laboratory shall inspect the materials in the field and perform tests, and shall report their findings to the ENGINEER and OWNER. When the materials furnished or work performed fails to fulfill Specification requirements, the technician will direct the attention of the ENGINEER and OWNER to such failure.
    a. The technician shall not act as foreman or perform other duties for CONTRACTOR. Work will be checked as it progresses, but failure to detect any defective work or materials shall not in any way prevent later rejection when such defect is discovered, nor shall it obligate the OWNER for final acceptance. Technicians are not authorized to revoke, alter, relax, enlarge, or release any requirements of the Specifications, nor to approve or accept any portion of the work.
4. Responsibilities and Duties of CONTRACTOR: The use of testing services shall in no way relieve CONTRACTOR of his responsibility to furnish materials and construction in full compliance with the Contract Documents.
    a. Furnish labor as is necessary to obtain and handle samples at the Project or at other sources of material.
    b. Advise the testing agency sufficiently in advance of operations to allow for completion of quality tests and for the assignment of personnel.

D. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. AWWA D100, Standard for Welded Steel Tanks for Water Storage.
2. AWWA D102, Standard for Painting Steel Water-Storage Tanks.
3. SP0178-2007, Design, Fabrication and Surface Finish Practices for Tanks and Vessels to Be Lined for Immersion Service.

E. Refer to Section 13110 for Tank Cathodic Protection System.

1.03 SUBMITTALS

A. Shop Drawings:
1. Submit for approval the following:
    a. Copies of detailed tank drawings. Drawings shall include all dimensions, sizes, plate thicknesses, anchorage, piping details, roof, wall and floor detail, materials specifications and details of all required accessories. Drawings shall show interior and exterior surface areas of the tank and shall include details of all required accessories. Use welding symbols recommended by American Welding Society. All detailed tank drawings and design calculations shall be signed and sealed by a Registered Professional Engineer. Fabrication shall not be started until drawings are approved.
    b. Descriptions and drawings of premanufactured pipe supports, ladders, safety cage, safety railing, external water level gage, and mounting bracket to tank floor, shell manways, roof vents, roof hatch and overflow pipe.

c. Provide the name and experience record of the tank supplier.

B. Manufacturer's Design Computations:
1. CONTRACTOR shall submit for record:
a. Three copies of manufacturer's design computations signed and sealed by a Registered Professional Engineer, who may be an employee of the manufacturer. The state of registration, registration number and name on the seal shall be clearly legible.

C. Test Reports:
1. Furnish, in duplicate, certified copies of test results from radiographs.

D. Construction Schedule.

E. Welding Procedures.

F. Containment or Environmental Compliance Plan.

G. Welder certifications and mill test reports.

H. Record Drawings:
1. Immediately upon completion of the work, submit Record Drawings showing actual in-place installation of the work specified in this Section. Record Drawings shall show locations of all radiographs.

1.04 OWNER'S RESPONSIBILITIES

A. All samples for bacteriological tests shall be taken and analyzed by the OWNER.

B. Potable water shall be furnished by the City for the following services:
1. Initial tank disinfections and filling.
2. Water for any additional disinfection; if required, during the initial disinfection procedure to obtain satisfactory bacteriological samples.
3. If the tank must be emptied, re-sprayed, flushed and refilled to obtain satisfactory bacteriological samples, or because of extensive leakage, the OWNER will furnish additional water for the work at the expense of CONTRACTOR. CONTRACTOR shall also pay for the additional chlorine required.

PART 2 - PRODUCTS

2.01 TANKS

A. Size: Dimensions - See Drawings.

B. Roof Type:
   1. Clear Span.
   2. No horizontal structural member shall project below the water line in the interior of tank.
   3. Slope as shown on Drawings.

C. Minimum Steel Thickness:
   1. The minimum thickness of any part of tank structure, except floor plates, shall be the larger of the following:
      a. 1/16-inch greater than the minimum values specified in Section 3.10 of AWWA D 100.
      b. 1/16-inch greater than the values determined from design criteria specified in Paragraph 1.2.B above.
   2. Floor plates shall be minimum 1/4-inch thick.
   3. Roof plates shall be minimum 3/16-inch thick.

D. Tank shall be fabricated of steel produced in the United States.

E. Manufacturers:
   1. Smyth Steel
   2. MMI
   3. Or Approved Equal

2.02 ACCESSORIES

A. Shell Manways:
   1. Install in bottom ring of tank at locations shown on Drawings.
   2. See Drawings for sizes.

B. Piping Connections:
   1. Provide nozzles for tank fill, discharge, overflow and drain pipes.
   2. See Drawings for sizes.
   3. Provide ¾" sample port with hose bib near bottom of the tank.
   4. Provide 2" flanged port for level transducer 4 feet above tank base.

C. Overflow:
   1. Provide a steel overflow pipe, of the size shown on the Drawings, with welded or flanged connections. Attach pipe to tank shell with suitable brackets spaced at proper intervals. Pipe shall extend from the weir box to approximately the base of the tank. Pipe shall conform to ASTM A53, Type E or S, Grade B.

D. Ladders:
   1. Provide one exterior and one interior steel ladder. Include structural design of ladders with submittal.
   2. Ladder shall be located adjacent to roof hatch for ease of access and inspection of tank.

3. Attach ladders to the tank shell with suitable brackets spaced at proper intervals.
4. Safety railing shall be installed on the tank roof prior to painting. Toe plates shall be welded to the roof in accordance with the detail on the Drawings.
5. Materials shall conform to AWWA D 100.
6. Refer to Drawings for details.

E. Vents:
1. Furnish one center vent and four circumvents as shown on the drawings.
2. Vent shall be designed and constructed to exclude birds and insects and to provide anchorage for painter's rigging.
3. Overflow pipe shall not be considered a tank vent.

F. Roof Hatches:
1. One hatch shall be located on the roof of the tank as shown on the Drawings.
2. The hatch shall be equipped with suitable hinges and a hasp to permit locking. The opening shall have a curb at least 4-inches high. The cover shall be arranged to provide an insect tight closure and shall overlap the curb at least 2-inches.

G. Roof Openings:
1. As indicated on the Drawings, one coupling shall be provided in the roof. The top of the coupling shall be set level. The coupling shall accept the liquid level gauge system. The coupling location shall be coordinated by the CONTRACTOR and Tank Supplier.
2. A flanged opening shall be installed on the roof to receive the ultrasonic level sensor.

H. External Water Level Gage:
1. An external water level gage shall be provided. The gage shall be a guided float type indicator complete with all necessary piping, guides, float, gage board, brackets, wire and all appurtenances required for a complete and workable installation. The unit shall have the interior float travel the entire height of tank.

I. Handrails:
1. Provide 42-inch high, 10 ft. long steel roof handrails, see Drawings.
2. Handrails shall meet the current OSHA standard requirements.
3. Provide toe plate.

J. Safety Climb ‘D’ Rings:
1. Shall meet current OSHA Personal fall arrest systems requirements.
2. Tensile Strength: Minimum of 5,000 pounds. D-ring shall be proof-tested to a minim tensile load of 3,600 pounds.
3. Material
   a. Anchorage Plate: Hot rolled steel, ASTM A36 or ASTM A529.
   b. D-Ring: Cadmium plated alloy steel.

4. Apply shop prime and field finish coats to anchorage plates per Specification Section 09800. D-rings shall not be coated.
5. Model and Manufacturer
    a. Model No. 2101634, DBI Sala.
    b. Or pre-approved equal.

K. Gasket Materials
1. For manways that use a flat style gasket, the gasket is 1/4 inch thick and use either a Neoprene or a EPDM material with a durometer hardness of 50 on the Shore A scale.
2. For manways that require a 3/4 inch, round, solid core gasket, material shall be Buna-N Rubber with a durometer hardness of 50 on the Shore A scale. A possible source of this material is Power Process Equipment, Inc., Mpls., MN (952) 937-1000.
3. For flat cover roof hatches, roof vents and similar applications use a flat style gasket that is 1/8-inch thick and use either a neoprene or a EPDM material with a durometer hardness of 50 on the Shore A scale.

2.03 SURFACE REPAIRS

A. All erection scab marks shall be removed and repaired by welding and grinding to restore the plate to a smooth, flush condition. All weld spatter shall be removed by grinding in conformance with the requirements of NACE SP0178-2007. All weld defects shall be removed and repaired by welding and grinding in conformance with the requirements of NACE SP0178-2007 for NACE Weld Preparation Designation "C". Included in this work but not limited to are the radius grinding of all sharp edges on the overflow weir box, inlet/outlet pipe, painters rigging brackets, stiffener rings, manway curbs and covers.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Except as otherwise shown on the Drawings or specified, tank shall be erected in accordance with the requirements of AWWA D 100. Seal underside of roof plate joints with a continuous weld.

B. Pipe Connections:
1. Connections between tank and all piping shall be made by Tank Supplier. Method of connection shall be approved by ENGINEER and, when completed, shall provide a completely watertight joint.
2. Where approved method of connecting pipes to tank bottom requires welding, Tank Supplier shall use caution during welding operation to prevent damage to pipe lining. Any damage that may result shall be repaired by Tank Supplier in a manner approved by ENGINEER.

C. All penetrations through tank roof shall be on the top and bottom of the roof plate.

D. Tank building contractor shall be responsible for all work associated with attachment and welding of supports, appurtenances, conduits piping and openings to tanks.

3.02 FIELD QUALITY CONTROL

A. Qualifications of Welders and Welding Procedures:
   1. Welding shall be performed only by welders qualified in accordance with AWWA D 100.
   2. Welding shall be performed in accordance with AWWA D 100.

B. Inspection:
   1. If tank is designed, fabricated and erected in accordance with standard design procedures of AWWA D 100, comply with provisions of Section 11 of that Standard.
   2. Inspection shall include both spot radiographs. The first welding inspection shall be made in the presence of ENGINEER, and at such other times as he may require. AWWA D 100 standard shall be used to designate locations where spot radiographs are to be made.
   3. CONTRACTOR shall provide and operate the necessary equipment for spot radiographs required by the above specification. CONTRACTOR shall have tested as many spot radiographs as ENGINEER may require, in accordance with Section 11 of AWWA Standard D100. Cost of taking spot radiographs, preparing them, and testing them shall be paid for by CONTRACTOR.

C. Testing and Repair:
   1. Bottom Plates:
      a. After tank has been completely erected, bottom welds shall be tested for leakage by covering weld seams with soap suds and applying a partial vacuum of at least two psi by means of a vacuum box with a gage and an observation window. All bottom welds shall be tested and tests shall be witnessed by ENGINEER, unless otherwise permitted.
   2. Shell Plates:
      a. After tank has been completely erected and painted, it shall be filled with water furnished at tank site by OWNER at sufficient pressure to fill tank to its maximum level and inspected for leaks. Any leaks should be repaired at no cost to OWNER.
   3. Piping:
      a. Pipe shall be pressure tested as required by the ENGINEER.
   4. Repair and Retesting:
      a. Any leaks or defective welds shown by testing shall be repaired in accordance with requirements of AWWA D 100 and to complete satisfaction of ENGINEER.

b. After repairs have been made, water level shall be raised and repaired area shall be retested.
c. If leakage from tank is of a magnitude that entire tank must be retested, CONTRACTOR shall pay for additional water required. OWNER'S water rate schedule shall be used in computing water cost.
d. During the filling of the tank, the tank shall be inspected for leaks. Leaks occurring during or after filling of the tank, shall be repaired by drilling, chipping or gas gouging out all defective welds and rewelding. No repair work shall be done on any joint unless the water is at least two-feet below the area being repaired. If the number and/or severity of the leaks are, in the opinion of the ENGINEER, too extensive to correct while the tank is filled with water, the ENGINEER may direct that the tank be emptied and the entire disinfection and re-filling procedure be repeated until all leaks are sealed and the tank is properly disinfected. All defects and leaks shall be repaired by the TANK SUPPLIER in accordance with the requirements of AWWA D 100 and to the complete satisfaction of the ENGINEER. The interior and exterior paint coatings shall be completely repaired, including repeat of surface preparation of the steel before re-coating.

3.03 COATING

A. Coating and surface preparation of tank shall be per Section 09800.

3.04 DISINFECTION

A. CONTRACTOR shall be responsible for disinfection. Disinfection shall conform to all applicable requirements of AWWA C 652, and as specified below.

B. After tank has been painted and interior surfaces have thoroughly and properly cured, the inside of the tank shall be thoroughly cleaned in accordance with Section 3.4. Interior of tank shall be disinfected by spraying all surfaces, including underside of roof and roof support members, with a 200 ppm chlorine solution. Solution shall remain in contact with surfaces for a minimum of 30 minutes. Technique shall be such that a sterile tank will result. After spray disinfection, tank shall be flushed to drain for at least ten minutes, then shall be filled and allowed to overflow for another ten minutes. In lieu of over flow, the CONTRACTOR can propose another method to disinfect the overflow line. 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 tank 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 tank is tested safe and acceptable for use as part of a potable water supply system.

D. Water for initial disinfection and for filling and for any additional disinfection during the initial disinfection procedure if required to obtain satisfactory bacteriological samples, will be furnished by the OWNER, to the site boundary. Responsibility belongs to CONTRACTOR for pumps, hoses and other temporary equipment required to fill the tank, all chlorine required, and for obtaining proper disinfection as determined by bacteriological tests made by the testing laboratory.

E. If the tank must be emptied, re-sprayed, flushed and refilled to obtain satisfactory bacteriological samples, or because of extensive leakage, the OWNER will furnish additional water for the work at the expense of CONTRACTOR. Additional chlorine required costs shall belong to CONTRACTOR.

F. Supply all necessary pumps, hoses and other required equipment each time the tank is to be emptied.

3.05 CLEANING

A. Exposed concrete surfaces shall be protected from blemishes and stains during tank construction. If discoloration of exposed concrete results from painting, rusting or any other aspects of tank construction, it shall be removed to the satisfaction of ENGINEER.

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

C. On completion of the work on the interior of the tank, the CONTRACTOR shall remove all dirt, litter and leave all surfaces in reasonably clean condition, scrubbing the same with water and approved soap or other cleaning agent. Cleaning and rinsing shall be performed by a CONTRACTOR provided power or jet truck using a minimum 2-inch diameter sanitary hose. When this has been completed, inspected and approved by the OWNER or ENGINEER, the final sterilization of said interior will be done by the CONTRACTOR at no cost to the OWNER.

D. The CONTRACTOR shall, at all times, keep the premises free from accumulations of waste material or rubbish caused by his employees or work. He shall clean-up abrasive material or rubbish on a daily regular schedule as directed by the ENGINEER. All unneeded construction equipment shall be removed from the site and all damages, repaired expeditiously so that the adjacent property is inconvenienced as little as possible.

E. During exterior sandblasting and coating operations, the CONTRACTOR shall provide adequate protection and containment to prevent damage to adjacent structures and property by his operations. The CONTRACTOR shall also perform intermittent or periodic clean up of adjacent grounds to prevent the accumulation of sandblast sand and debris caused by his operations. This shall include but not be limited to, sidewalks, streets, driveways, yards, and rooftops.

F. The CONTRACTOR shall be responsible for compliance with local, state and federal regulations concerning emissions or disposal of solid, particulate, liquid or gaseous matter as a result of the cleaning, painting or other operations. Compliance with this provision shall be accomplished without direct supervision from the ENGINEER or OWNER. The OWNER shall not grant additional compensation for changes in the law, regulations or interpretations of said laws or regulations. The burning of trash, paper or wood on the job site is not permitted. Unless otherwise provided by these specifications, the CONTRACTOR is responsible for all containing, shielding, waste retrieval or other precautions required by any regulatory agency at no additional cost to the OWNER. Any fines imposed on the OWNER or ENGINEER by any regulatory agency because of the CONTRACTOR's non-compliance with Environmental Regulations shall be paid or reimbursed by the CONTRACTOR.

G. The OWNER intends to perform timely laboratory testing of waste materials to verify test results taken by the CONTRACTOR. In the event of discrepancies in test results and the resultant classification of waste materials, it is agreed by the parties to this Contract that the ENGINEER shall perform independent testing and shall determine all questions in relation to the classification of waste materials. The CONTRACTOR will be held liable for all supplementary testing, Engineering and associated Contract Administration cost.

H. On or before the completion of work, the CONTRACTOR shall, unless otherwise directed in writing, remove all temporary works, tools and machinery or other construction equipment placed by him. He shall remove all rubbish from any grounds that he has occupied and shall leave all of the premises and adjacent property affected by the operation in a neat and restored condition satisfactory to the ENGINEER.

3.06 AREAS TO PROTECT

A. Do not coat over vent or overflow screens, and ladder safety equipment devices. Temporarily remove the ladder safety climb equipment for abrasive blasting and coating operations. Reinstall ladder safety climb devices after approval by Engineer of the coatings.

END OF SECTION

DIVISION 14

CONVEYING SYSTEMS (NOT USED)

DIVISION 15

MECHANICAL

SECTION 15050

BASIC PROCESS PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Basic piping materials and methods.

1.02 REFERENCES

A. American Society of Testing and Materials (ASTM):
   1. A 106 - Specification for Seamless Carbon Steel Pipe for High Temperature Service.
   2. D 2240 - Test Method for Rubber Property - Durometer Hardness.
   3. A-536 - Specification for Ductile Iron Casting.

B. National Sanitation Foundation (NSF) 61.

C. AWWA C-111 - Standard for Rubber Gasketed Joints for Ductile Iron Pressure Pipe and Fittings.

D. Refer to Section 09800 for coating requirements for exterior of exterior piping.

1.03 DEFINITIONS

A. Exposed Piping: Piping within buildings, vaults, tunnels, or other structures without regard to elevation of piping, or exposed piping outside buildings and structures.

B. Buried Piping: Piping actually buried in soil or cast in concrete.

C. Wet Wall: Wall with water on at least one side.

1.04 INTENT OF DRAWINGS AND SPECIFICATIONS

A. Except in details, piping is indicated diagrammatically. Sizes and locations are indicated on the Drawings. Not every offset and fitting, or structural difficulty that may be encountered has been indicated on the Drawings.

B. Perform minor modifications to piping alignment where necessary to avoid structural, mechanical, or other type of obstructions that cannot be removed or changed:
   1. Modifications are intended to be of minor scope, not involving a change to the design concept or a change to the Contract Price or Contract Time.

1.05 SYSTEM DESCRIPTION

A. Performance Requirements:

1. Restraining Piping:
   a. Restrain piping as follows:
      1) When piping is underground, use mechanical restraints throughout. All buried piping shall be restrained.
      2) When piping is aboveground or under water, use mechanical or structural restraints.
   b. Provide restraints with ample size to withstand thrust forces resulting from test pressures.
2. Connections to Existing Piping:
   a. Expose existing piping to which connections are to be made with sufficient time to permit, where necessary, field adjustments in line, grade, or fittings:
      1) Protect domestic water supplies from contamination:
         a) Make connections between domestic water supply and other water systems in accordance with requirements of public health authorities.
         b) Provide devices approved by owner of domestic water supply system to prevent flow from other sources into the domestic supply system.
   b. Make connections to existing piping and valves after sections of new piping to be connected have been tested and found satisfactory.
   c. Provide sleeves, flanges, nipples, couplings, adapters, and other fittings needed to install or attach new fittings to existing piping and to make connections to existing piping.
3. Connections to In-Service Piping:
   a. Shutdown in-service piping in accordance with Section 01040:
      1) Establish procedures and timing in a conference attended by CONTRACTOR, ENGINEER, and OWNER of the in-service piping.
4. Connections of Dissimilar Metals:
   a. Connect ferrous and nonferrous metal piping, tubing, and fittings with dielectric couplings especially designed for the prevention of chemical reactions between dissimilar metals.
   b. Nonferrous metals include aluminum, copper, and copper alloys.
   c. For flanged piping with dissimilar metals, use an insulated coupling or insulating gasket.
5. All pipe tapping saddles are to be of bronze construction, unless noted otherwise on the Drawings.

PART 2 - PRODUCTS

2.01 ESCUTCHEONS

A. Manufacturers: One of the following or pre-approved equal:
   1. Dearborn Brass Company, Model Number 5358.
   2. Keeney Manufacturing Company, Model Number 102 or Number 105.
   3. Beaton and Corbin, Model Number 1 or Number 13.

B. Material: Chrome plated steel plate.

2.02 LINK SEAL

A. Manufacturers: One of the following or pre-approved equal:
   1. Calpico, Inc.
   2. Thunderline Corporation.

B. Characteristics:
   1. Modular mechanical type, consisting of interlocking neoprene or synthetic rubber links shapes to continuously fill the annular space between the pipe and wall opening.
   2. Assemble links solely with stainless steel bolts and nuts to form a continuous rubber belt around the pipe.
   3. Provide a stainless steel pressure plate under each bolt head and nut. Isolate pressure plate from contact with wall sleeve.
   4. The link seals used in the chemical storage containment areas shall be corrosion resistant to the chemicals contained in the chemical storage tanks.

2.03 COUPLINGS

A. Ductile Iron Couplings:
   1. Provide ductile iron couplings for use in connection of smooth end joints of ductile iron, steel or other types of pipe.
   2. General Requirements.
      a. Sleeve or center rings shall be of nominal O.D. size, range and length specified. Sleeve shall be of Ductile Iron ASTM A536. Ends shall have a smooth inside taper to provide uniform gasket seal. Sleeve shall be given a shop coat of oil-modified urethane, corrosion-resistant paint.
      b. Follower flanges or end rings shall be of the thickness determined by the coupling size, and shall be of ductile iron, ASTM-536. Flanges shall be identified by a color coded shop coat finish as described in Item 2a.
      c. Gaskets shall be compression-type, formed with Virgin Styrene Butadiene Rubber (SBR), compounded with ingredients to produce permanence and resistance to set after installation. O.D. range shall be imprinted on the gasket in permanent ink (minimum).

d. Bolts and nuts shall be of high-strength, low-alloy steel, with nominal coarse thread, and hex nuts with black finish. Dimensions and minimum stress values shall be in accordance with AWWA/ANSIC111/A21.11.
e. Where specification states a cast transition or reducing coupling in place of a straight coupling, the sleeve and follower flange shall be of the same manufacturer and compatible for the specific use intended.
f. Quality control procedures shall be employed to ensure that the sleeve, follower flanges, and gaskets are properly fabricated and free of any visible defects. Coupling shall have pressure rating of 150 psi.

3. Manufacture: EBAA Iron Inc., Romac Industries Inc., or Pre-approved equal.

B. Expansion Joint (Flexible Bellows Coupling):
1. Manufacturer:General Rubber or Pre-approved equal.
2. Performance and Design:
a. Provide single and double arch expansion joints, as shown on the drawings, complete with restraining rods to prevent over-expansion. Provide flanged spool with single or multiple arches, designed to provide motion capability as specified. Rubber expansion joints shall be rated for 250℉ and 150 psi.
3. Materials:
a. Tube - Provide single, seamless, leakproof tube made of synthetic rubber that extends through the bore to the outside edges of both flanges.
b. Body - Fabric reinforcement shall be used as the flexible and supporting member between the tube and the cover. Fabrics of high strength synthetic fibers shall be used. All Fabrics plies shall be impregnated with rubber or synthetic compounds to permit flexibility between the fabric plies to reduce service strain.
c. Cover - The exterior surface of the joint shall be formed from synthetic rubber to protect the body from outside damage. Utilize special polymers to resist sunlight.
d. Integral Flanges - Constructed of resilient rubber, and smooth finish, the full-faced flanges form a tight seal against the pipe flange without the need of gaskets. Provide standard AWWA flanges as specified in Section 15062.
e. Provide restraining rods attached to flanges for thrust protection.
4. Execution:
a. Install expansion joint as shown on the Drawings and in accordance with the manufacturer's recommendations.

C. Flanged Coupling Adapter:
1. Description: One end of adapter shall be flanged and the other end shall have a sleeve type flexible coupling.
2. Pressure and Service: Same as connected piping.
3. Material: Cast iron or steel.
4. Bolts and Nuts: Type 316 stainless steel.

5. Harnessing:
   a. Harness adapters to restrain pressure piping. Test pressures for pressure pipelines shall conform to the requirements of Section 15050, Piping Systems.
   b. For adapters 12-inch diameter and less, provide 1/2-inch minimum stainless steel anchor studs installed in a pressure tight anchor boss. Provide number of studs required to restrain test pressure and service conditions. Harness shall be as designed and recommended by manufacturer; however, the following minimum anchor studs shall be provided, unless otherwise approved by ENGINEER:
      1) 6-inch diameter and less: Two.
      2) 8-inch diameter and less: Four.
      3) 10-inch diameter and less: Six.
      4) 12-inch diameter and less: Eight.
   c. For adapters larger than 12-inch diameter, provide split-ring harness clamps with a minimum of four Type 316 stainless steel bolts. Harness assembly shall be as designed and recommended by manufacturer. Dimensions, sizes spacings and materials shall be suitable for service and conditions encountered and shall be approved by ENGINEER.
   d. Harness couplings to restrain pressure piping.
   e. Test pressures for pressure pipe lines shall conform to the requirements of Section 15050, Piping Systems.
   f. Harnessing shall conform to the details shown on the Drawings.
6. Product and Manufacturer: Provide one of the following:
   a. Smith-Blaire, Model 912.
   b. Romac Industries Inc., FC400/FCA501/RFCA.
   c. Ford FFCA.

2.04 CONTROLLED LOW STRENGTH MATERIAL

A. Controlled low strength material shall consist of portland cement coarse and fine aggregate, and water.

B. Cement content shall be 0.5 sack of cement per yard.

C. The material shall have slump of 7 inches ± dye inch.

D. Compressive strength at 28 days shall be 70 psi ± 30 psi.

2.05 BURIED PIPING

A. All buried piping shall have tracer wire placed 1 foot above the crown of the pipe. The magnetic tracer wire shall be 12 gauge insulated solid copper wire.

B. All buried piping shall also be provided with an identification tape (non-detectible) placed 3 feet above the crown of the pipe. The tape shall be an inert polyethylene-plastic impervious to alkalis, acids, chemical reagents, and solvents likely to be encountered in the soil. The tape shall be a minimum of 4.0 mils thick and not less than 3" wide. The color of the tape and the text will be selected by OWNER. Lettering shall be minimum 1 ½" high. The OWNER will select text for each pipe run using manufacturer's normally available stock.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verification of Existing Conditions:
   1. Locate and expose existing structures, piping, conduits, and other facilities and obstructions which may affect construction of underground piping before starting excavation for new underground piping and appurtenances.
   2. Verify sizes, elevations, locations, and other relevant features of existing facilities and obstructions. Determine conflicts for the construction of the new underground piping and appurtenances.
   3. Make piping location and grade adjustments to resolve conflicts between new piping and existing facilities and obstructions.

3.02 WALL AND SLAB PENETRATIONS

A. Provide sleeves for piping penetrations through masonry and concrete walls, floors, ceilings, roofs, pilasters, columns, piers, and beams unless specified or otherwise indicated on the Drawings.

B. For piping 1 inch in nominal diameter and larger, provide sleeves with minimum inside diameters of 1 inch plus outside diameter of piping. For piping smaller than 1 inch in nominal diameter, provide sleeve of minimum twice the outside diameter of piping:
   1. Arrange sleeves and adjacent joints so piping can be pulled out of sleeves and replaced without disturbing the structure.
   2. Cut ends of sleeves flush with surfaces of concrete, masonry, or plaster.
   3. Conceal ends of sleeves with escutcheons where piping runs through floors, walls, or ceilings of finished spaces within buildings.
   4. Seal spaces between pipes and sleeves.

C. Cast couplings or wall pieces in walls for penetrations of buried rigid piping including cast iron, ductile iron, reinforced concrete, and vitrified clay through structures:
   1. Provide couplings or wall pieces with mechanical push-ons, or similar flexible joints at outside of walls.
   2. Provide additional similar joints in piping at transition points between trenches and structure excavations.

3. For steel piping, single joints may be used in lieu of two joints. Locate single joints outside within 2 feet from outside faces of walls.

D. Link Seal: Use 2 link seals where seal is used to seal at wet wall sleeves. Mount one seal on the inside face of the wall and the other on the outside face of the wall. Coordinate the inside diameter of the wall sleeve with the size of the seal to provide watertight sealing.

E. Where not indicated on the Drawings, penetrations for conditions other than those specified under the preceding subparagraphs shall be one of the three types specified in such subparagraphs found by OWNER to be the most suitable for the particular conditions.

3.03 EXPOSED PIPING

A. Install exposed piping in straight runs parallel to the axes of structures, unless indicated otherwise:
   1. Install piping runs plumb and level, unless otherwise indicated on the Drawings.

B. Install exposed piping after installing equipment and after piping and fitting locations have been determined.

C. Support piping in accordance with Section 15141 and as shown on Drawings:
   1. Do not transfer pipe loads and strain to equipment.

D. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, and other types of joints or means which are compatible with and suitable for the piping system, and necessary to allow ready assembly and disassembly of the piping.

E. Assemble piping without distortion or stresses caused by misalignment:
   1. Match and properly orient flanges, unions, flexible couplings, and other connections.
   2. Do not subject piping to bending or other undue stresses when fitting piping. Do not correct defective orientation or alignment by distorting flanged joints or subjecting flange bolts to bending or other undue stresses.
   3. Flange bolts, union halves, flexible connectors, and other connection elements shall slip freely into place.
   4. After piping assembly to fit when proper fit is not obtained.
   5. Install eccentric reducers or increasers with the top horizontal for pump suction piping.

3.04 BURIED PIPING

A. Bury piping with minimum 4 foot cover without air traps, unless otherwise indicated on the Drawings.

B. Where 2 similar services run parallel to each other, piping for such services may be laid in the same trench. Lay piping with sufficient room for assembly and disassembly of joints, for thrust blocks, for other structures, and to meet separation requirements of public health authorities having jurisdiction.

C. Laying Piping:
   1. Lay piping in finished trenches free from water or debris. Begin at the lowest point with bell ends up slope.
   2. Place piping with top or bottom markings with markings in proper position.
   3. Lay piping on an unyielding foundation with uniform bearing under the full length of barrels.
   4. Where joints require external grouting, banding, or pointing, provide space under and immediately in front of the bell end of each section under and immediately in front of the bell end of each section laid with sufficient shape and size for grouting, banding, or pointing of joints.
   5. At the end of each day's construction, plug open ends of piping temporarily to prevent entrance of debris or animals.

3.05 CLEANING

A. Piping Cleaning:
   1. Upon completion of installation, clean piping interior of foreign matter and debris. Perform special cleaning when required by the Contract Documents.
   2. Maintain pipe in clean condition during installation.
   3. Before joining piping, thoroughly clean and wipe joint contact surfaces and then properly dress and make joint.
   4. Immediately prior to pressure testing, clean and remove grease, metal cuttings, dirt, or other foreign materials which may have entered the system.
   5. At completion of work and prior to final acceptance, thoroughly clean work installed under these Specifications. Clean equipment, fixtures, pipe, valves, and fittings of grease, metal cuttings, and sludge which may have accumulated by operation of system, from testing, or from other causes. Repair any stoppage or discoloration or other damage to parts of building, its finish, or furnishings, due to failure to properly clean piping system, without cost to Owner.
   6. Clean chlorine piping by pulling a cloth saturated with trichloroethylene or other suitable chlorinated solvent through each length of pipe. Disassemble valves and clean with suitable solvent. All surfaces which may come in contact with chlorine shall be thoroughly dry, and free of oil or grease before placing in service.

B. Cleaning Potable Water Piping:
   1. Flush and disinfect potable water piping in accordance with Section 15495.

3.06 FIELD QUALITY AND CONTROL

A. General:
   1. Upon completion of piping, but prior to application of insulation on exposed piping or covering concealed/buried piping, test all piping systems.
   2. Test all piping systems at 150 psi for 2 hours, unless otherwise indicated. Pressure shall stabilize within 2% of 150 psi.
   3. Isolate equipment which may be damaged by the specified pressure test conditions.
   4. Perform pressure test using calibrated pressure gauges and calibrated volumetric measuring equipment to determine leakage rates. Select each gauge so that the specified test pressure falls within the upper half of the gauge's range. Notify the OWNER 24 hrs prior to each test.
   5. Unless otherwise specified, completely assemble and test new piping systems prior to connection to existing pipe systems.
   6. Acknowledge satisfactory performance of tests and inspections in writing to OWNER prior to final acceptance.
   7. Provide all necessary equipment and perform all work required in connection with the tests and inspections.
   8. Bear the cost of all testing and inspecting, locating and remedying of leaks and any necessary retesting and re-examination.
   9. CONTRACTOR to dispose of testing water.

B. Pressure Testing Methods and Criteria:
   1. Types of pressure testing and inspection to be employed include hydrostatic pressure testing, and hydrostatic infiltration/exfiltration testing.
   2. Liquid systems:
      a. The following liquid piping systems shall have zero leakages at the specified test pressure throughout the specified duration:
         1) Exposed piping.
         2) Buried insulated piping and buried or exposed pressure piping.
   3. Hydrostatic pressure testing:
      a. All joints, including welds, are to be left exposed for examination during the test.
      b. Provide temporary restraints for expansion joints for additional pressure load under test. Equipment in piping system with rated pressure lower than pipe test pressure shall be isolated by valves or blind flanges.
      c. Do not paint or insulate exposed piping until successful performance of pressure test.

d. Test soil, waste and drain piping at completion of installation of each stack or section of piping by filling system with water to highest point and checking joints and fittings for leaks. Leaks must be eliminated before proceeding with work or concealing piping. Minimum test heights shall be 10 ft.

3.07 PIPING SCHEDULE

A. See Drawings.

END OF SECTION

SECTION 15062

DUCTILE IRON PIPING

PART 1 - GENERAL

1.01 SUMMARY

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

1.02 REFERENCES

A. American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME):
   1. B 16.1 - Cast Iron Pipe Flanges and Flanged Fittings.

B. American Society for Testing and Materials (ASTM):
   1. A 47 - Ferritic Malleable Iron Casting.
   2. A 183 - Carbon Steel Tank Bolts and Nuts.
   3. A 536 - Ductile Iron Castings.
   4. A 674 - Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids.
   5. D 792 - Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement.
   6. D 4976 - Polyethylene Plastics Molding and Extrusion Materials.

C. American Water Works Association (AWWA):
   1. C 104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
   2. C 105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
   3. C 110 - Ductile-Iron and Gray-Iron fittings, 3 Inches through 48 Inches, for Water and Other Liquids.
   4. C 111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   5. C 115 - Flanged Ductile-Iron Pipe with Threaded Flanges.
   6. C 150 - Thickness Design of Ductile-Iron Pipe.
   7. C 151 - Ductile-Iron Pipe, Centrifugally Cast for Water or other Liquids.
   8. C 600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
   9. C 900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings.

D. National Sanitation Foundation (NSF) 61.

1.03 SUBMITTALS

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

B. Product Data: Photographs, drawings, and descriptions of fittings, gaskets, couplings, grooving of pipe and fittings, and pipe lining.

C. Test Reports: Manufacturer's test reports for polyethylene lining certifying successful performance of the wet sponge spark tests.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Block piping material for shipment, prevent damage to castings and linings.

B. Carefully handle piping material during loading, unloading, and installation. Do not drop piping material from trucks. Lower piping material by mechanical means. Do not drop or pound pipe to fit grade.

C. Repair damaged pipe lining to match quality, thickness, and bonding or original lining. When lining cannot be repaired or repairs are defective, replace defective piping with undamaged piping.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Ductile Iron Piping:
   1. Type, Typical: AWWA C 150 and AWWA C 151 with minimum Class 350 wall thickness.
   2. Manufacturers: Griffin Pipe Prods, US Pipe, American Cast Iron Pipe Co.

B. Joints:
   1. Flanged Joints:
      a. Flanges: One of the following with diameter, thickness, drilling, and other characteristics in accordance with ANSI B 16.1:
         1) Cast integrally with the pipe.
         2) Screw-on: Comply with the following:
            a) Ductile iron.
            b) Long hub, threaded, and specially designed for ductile iron pipe.
            c) After attaching to pipe, machine flange face to make pipe end and flange even and perpendicular to the axis of the pipe.
      b. Bolt Holes: Two-holed and aligned at both ends of pipe.
      c. Cap Screw or Stud Bolt Holes: Tapped.
      d. Bolt and Nuts: ANSI/ASME B 16.1 or when connecting flanges underground, in concrete pipe valve boxes, or underwater, Type 304 or Type 316 stainless steel; cut and finished to project a maximum of 1/4 inch beyond nut when joints are assembled.
      e. Class 150 flange.
   2. Mechanical Joints: AWWA C 111/ANSI A 21.11.

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

2.02 ACCESSORIES

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

2.03 PIPE LININGS

A. Cement-Mortar Lining and Coating: AWWA C 104/ANSI A 21.4, applied on clean bare metal surfaces; extended to faces of flanges, ends of spigots, and shoulders of hubs; painted with bituminous material.
    1. Coating on Cement-Mortar Coating: Bituminous material, or none when specified to receive another coating (epoxy, etc.).

PART 3 - EXECUTION

3.01 INSTALLATION

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

B. Special Techniques:

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

3.02 JOINTS

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

3.03 FIELD QUALITY CONTROL

A. Clean and test ductile iron piping as specified in Section 15050.

END OF SECTION

SECTION 15063

COPPER PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section specifies copper piping, tubing, couplings and fittings.

1.02 REFERENCES

A. This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
ANSI B16.22-80	Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
ANSI B16.26-83	Cast Copper Alloy Fittings for Flared Copper Tubes
ASTM B32-83	Solder Metal
ASTM B88-83	Seamless Copper Water Tube

PART 2 - PRODUCTS

2.01 COPPER TUBING

A. Copper tubing shall be seamless copper, conforming to ASTM B88. Unless otherwise specified, copper tubing shall be Type L, drawn.

B. Provide Type K - Soft for buried piping and Type K - Hard for exposed piping.

2.02 COUPLINGS AND FITTINGS FOR COPPER TUBING

A. Unless otherwise specified, couplings and fittings for copper tubing 1/2-inch and smaller nominal diameter shall be compression type, brass or bronze, capable of holding the full bursting strength of the tubing; shall meet the requirements of ANSI B16.26; and shall be Swagelok, Gyrolok, or pre-approved equal.

B. Couplings and fittings for copper tubing larger than 1/2-inch nominal diameter shall be wrought copper or bronze, solder joint pressure fittings and shall conform to ANSI B16.22.

2.03 SOLDER

A. Solder to be used in copper piping shall be ASTM B32, Alloy Grade 50B.

PART 3 - EXECUTION

3.01 FABRICATION

A. SOLDER JOINTS: All pipe and fittings to be jointed with solder shall be free from all burrs and wire brushed or steel wool cleaned. After cleaning, a paste flux shall be evenly and sparingly applied to the surfaces to be joined. Solder shall then be applied and flame passed toward the center of the fitting until the solder disappears. All excess solder shall be removed while it is still plastic. Absolutely no acid flux or acid wipe shall be used in making solder joints.

B. TAKEDOWN COUPLINGS: Takedown couplings shall be screw union type.

C. DIELECTRIC PROTECTION: Copper tubing or fittings shall not be permitted to come in contact with steel piping, reinforcing steel, or other steel at any location. Electrical checks shall be made to assure no contact is made between copper tubing and steel elements. Wherever electrical contact is demonstrated by such tests, the CONTRACTOR shall provide dielectric protection.

3.02 INSTALLATION, CLEANING, DISINFECTION, AND TESTING

A. The installation, cleaning, disinfection, and testing of copper piping shall be in accordance with governing codes and authorities.

END OF SECTION

SECTION 15075

PLASTIC PIPING AND TUBING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Plastic pipe, tubing, and fittings.

1.02 REFERENCES

A. American National Standards Institute (ANSI):
   1. B 16.12 - Cast Iron Screwed Drainage Fittings.

B. American Society for Testing and Materials (ASTM):
   1. D 648 - Test Method for Deflection Temperature of Plastics Under Flexural Load.
   2. D 1248 - Specification for Polyethylene Plastics Molding and Extrusion Materials.
   3. D 1784 - Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated by Poly (Vinyl Chloride) (CPVC) Compounds.
   4. D 1785 - Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
   5. D 1869 - Specification for Rubber Rings for Asbestos-Cement Pipe.
   6. D 2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications.
   7. D 2412 - Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
   8. D 2466 - Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings Schedule 40.
   9. D 2467 - Specification for Socket-Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings Schedule 80.
   10. D 2513 - Specification for Thermoplastic Gas Pressure Pipe Tubing and Fittings.
   11. D 2564 - Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
   12. D 2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
   13. D 2665 - Specification for Poly (Vinyl Chloride) (PVC) Plastic, Waste and Vent Pipe Fittings.
   14. D 2680 - Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Pipe.
   15. D 2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittingss

16. D 3034 - Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
17. D 3212 - Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
18. D 3261 - Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
19. D 3350 - Specification for Polyethylene Plastic Pipe and Fittings Material.
20. D 4101 - Specification for Propylene Plastic Injection and Extrusion Materials.
21. F 439 - Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
22. F 441 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
23. F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
24. F 483 - Method for Total Immersion Corrosion Test for Aircraft Chemicals Maintenance.
25. F 493 - Specification for Solvent Cements for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
26. F 645 - Guide for Selection, Design and Installation of Thermoplastic Water Pressure Piping System.
27. F 679 - Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
28. F 714 - Specification for Polyethlene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

C. American Water Works Association (AWWA):
   1. C 900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings.
   2. C-115 - Standard for Flanged Ductile Iron Pipe with Grey Iron Threaded Flanges.

D. Code of Federal Regulations:
   1. Title 49.

E. Plastic Pipe Institute (PPI):
   1. PE 3408.

F. United States Department of Transportation:
   1. Materials Transportation Bureau.

G. National Sanitation Foundation (NSF) 61.

1.03 ABBREVIATIONS

A. ABS: Acrylonitrile-Butadiene-Styrene.

B. CPVC: Chlorinated Polyvinyl Chloride.

C. DWV: Drain, waste, and vent.

D. ID: Inside diameter of piping or tubing.

E. NPS: Nominal pipe size followed by the size designation.

F. NS: Nominal size of piping or tubing.

G. PE: Polyethylene.

H. PP: Polypropylene.

I. PVC: Polyvinyl Chloride.

J. SDR: Standard dimension ratio.

1.04 SUBMITTALS

A. Product Data: Describe materials and installation equipment including fusion machine.

B. Manufacturer's published Installation Instructions.

C. Certificates:
   1. Submit manufacturer's certificate attesting that plastic pipe, tubing, and fitting meet specified requirements.
   2. Copies of solvent cement manufacturer's report and certification in accordance with ASTM D 2564 for PVC piping, and ASTM F 493 for CPVC piping.

D. Qualifications of installation crew for PE piping, including qualifications of the fusion machine technician.

1.05 QUALITY ASSURANCE

A. Fusion Machine Technician Qualifications: 1 year experience in the installation of similar PE piping systems from the same manufacturer.

B. Provide pipe and tubing bearing NSF seal, except for drainage piping.

C. Mark plastic pipe with nominal size, type, class, schedule or pressure rating, and manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect piping materials from sunlight, scoring, and distortion.

B. Do not allow surface temperatures on pipe and fittings to exceed 120 degrees Fahrenheit.

C. Store and handle pipe and fittings as recommended by manufacturer in published instructions.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Extruding and Molding Material: Virgin material containing no scrap, regrind, or rework material except where permitted in the referenced standards.

B. Fittings: Same material as the pipe and of equal or greater pressure rating, except the DWV fittings need not be pressure rated.

C. Unions 2-1/2 inches and smaller: Socket end screwed unions. Make unions 3 inches and larger with flange ends with 1/8 inch full face soft rubber gasket.

2.02 PVC PIPING, SCHEDULE TYPE

A. Materials:
   1. PVC schedule type piping: Designation PVC 1120 conforming to ASTM D 1785 and appendices thereto.
      a. Pipe and fittings: Extruded from Type I, Grade 1, Class 12454-B material in accordance with ASTM D 1784.
      b. PVC Schedule Type Piping: Schedule 80 unless otherwise indicated on the Drawings.
   2. Fitting:
      a. Supplied by pipe manufacturer.
      b. Pressure Fittings: In accordance with ASTM D 2466 or ASTM D 2467.
      c. DWV Fittings: In accordance with ASTM D 2665.
   3. Solvent Cement: In accordance with ASTM D 2564.

2.03 PVC PIPING, CLASS TYPE

A. Materials:
   1. PVC pipe, Class type: Pipe shall have outside diameters of ductile iron pipe sizes:
      a. ASTM D2241 PVC Pipe, Pressure rating 250 psi: SDR 17 and Uni-Bell Standard UNI-B-2-72.
      b. PVC Pipe, Class Type: AWWA C 900, Pressure Class 150 and SDR 18.

c. Bell Section: At least as strong as the pipe barrel.

2. Fittings: Cast or ductile iron fittings as specified under Section 15062, sized for the dimensions of the pipe being used.
   a. Fittings for joining pipe 4 inches in diameter and larger: Flanged fitting to meet AWWA C115, and nitrite gaskets.
3. Gaskets: Meeting the requirements of ASTM D 1869 or ASTM F 477.

2.04 PVC EXPANSION JOINTS

A. Materials:
   1. PVC schedule type expansion joints: Designation PVC 1120 conforming to ASTM D 1785 and appendices thereto.
   2. Seals: EPDM or Viton.

B. Manufacturers:
   1. Spears.
   2. Or Pre-approved equal.

C. PVC expansion joints shall be provided every 50 ft for pipe run.

2.05 PE AND HDPE PIPING FOR DRAIN, WATER, AND VENT

A. General:
   1. Pipe and fittings: High density polyethylene.
   2. Dimensions of pipe and fittings: Based on controlled outside diameter in accordance with ASTM F 714.
      a. SDR: Equal to or less than 11.

B. Materials:
   1. Manufacturers: One of the following or equal:
      a. DuPont, Sclairpipe.
      b. Polaris, Duratuff; or Pre-approved equal:
         1) Pipe, fittings, and adapters: Furnished by the same manufacturer, and compatible with components in the same system and with components of other systems to which connected.
   2. Polyethylene: In accordance with ASTM D 1248, Type III, Class C, Category 5, Grade P34; listed by the Plastic Pipe Institute under the designation PE 3408; and have a minimum cell classification, in accordance with ASTM D 3350, of 345434C.
      a. Pipe and fittings: Manufactured from material with the same cell classification.

2.06 CPVC PIPE

A. CPVC pipe shall be Schedule 80, Class 23447-B, conforming to ASTM D 1784 and ASTM F 441.

B. All joints shall be solvent welded. At all valves, appurtenances and connections to equipment, CONTRACTOR shall provide unions for ease of disassembly. (THIS APPLIES TO ALL CPVC PIPING INSTALLED UNDER THIS PROJECT).

C. Provide flanged fittings at all valves and equipment with nitrile gaskets, unless shown otherwise on the Drawings. Provide type 316 stainless steel bolts and nuts.

D. Provide CVPC expansion joints for every 50 feet of pipe run. Confirm locations with ENGINEER in field.

2.07 SOURCE QUALITY CONTROL

A. PVC Piping, Schedule Type:
   1. Mark pipe and fittings in accordance with ASTM D 1785.

B. PVC Piping, Class Type:
   1. Test pipe to withstand, without failure, 150 psi, hydrostatic pressure .
   2. Test integral bell with the pipe.

C. CPVC Piping:
   1. Mark pipe and fittings in accordance with ASTM F 441.

2.08 DETECTABLE TAPE

A. Materials:
   1. 3.5 mil thick solid foil core encased in a protective plastic jacket.
   2. Resistant to alkalies, acids and other destructive elements commonly found in soil.
   3. Lamination shall have sufficient strength that the layers cannot be separated by hand.
   4. Total composite thickness shall be 4.3 mils minimum.
   5. Foil core to be visible to ensure continuity.
   6. Minimum tensile strength of 63 lbs in the machine direction and 68 lbs in the transverse direction per three (3) inch strip.
   7. Continuous warning message repeated every 16 to 36 inches shall be imprinted on the tape surface. Tape shall be colored.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General:
1. Where not otherwise specified, install piping in accordance with ASTM F 645, or manufacturer's published instructions for installation of piping, as applicable to the particular type of piping.
2. Provide molded transition fittings for transitions from plastic to metal or IPS pipe. Do not thread plastic pipe.
3. Locate unions where indicated on the Drawings, and elsewhere where required for adequate access and assembly of the piping system.
4. Provide serrated nipples for transition from plastic pipe to rubber hose.
5. All buried plastic pipe shall have detectable tape applied along the entire length of pipe.
6. PVC expansion joints installed on PVC pipelines as conditions require.

B. Installation of PVC Piping, Schedule Type:
1. Exposed 4-inch and larger connections will be van stone style flanged as shown on the drawings. Spigot van stone style will be used to flange fittings. Socket van stone style will be used for piping flanges exposed less than 4" and smaller connections will be solvent welded.
2. Neoprene gaskets will be used for all water piping.
3. Solvent weld joints in accordance with ASTM D 2855.
4. Install piping in accordance with manufacturer's published instructions.

C. Installation of PVC Piping, Class Type:
1. Install piping in accordance with the Appendix of AWWA C900 complemented with manufacturer's published instructions.
2. For contraction and expansion at each joint, provide rubber ring and integral thickened bell as part of each joint.
3. Direct burial installation tie-ins will be done at the proper buried temperatures.

D. Installation of Polyethylene (PE) Tubing and Fittings:
1. Install small bore PE tubing in accordance with manufacturer's printed instructions, in neat straight lines, supported at close enough intervals to avoid sagging, and in continuous runs wherever possible.
2. Bundle tubing in groups of parallel tubes within protective sheath.
3. Tubes within protective sheath may be color coded, but protect tubing other than black outside the sheath by wrapping with black plastic electrician's tape.
4. Grade tubing connected to meters in one direction.

E. Installation of PE Piping for Drain, Waste, and Vent:
1. Install piping as recommended in manufacturer's published instructions.

3.02 FIELD QUALITY CONTROL

A. Clean and test piping as specified in Section 15050.

END OF SECTION

SECTION 15110

VALVES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Basic requirement for valves:
   1. Requirements indicated on the Drawings and specified elsewhere in these Specifications take precedence over the requirements specified under this Section.
   2. Furnish and install valves required for proper piping and equipment operation and maintenance, in addition to the valves indicated on the Drawings, and specified.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   2. A126 - Gray Icon Casting for Valves, Flanges, and Pipe Fittings.
   3. A48 - Specifications for Gray Iron Castings.
   4. A536 - Ductile Iron Castings.

B. American Water Works Association (AWWA):
   1. C111 - Rubber-Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe and Fittings.
   2. C504-00 - Rubber Seated Butterfly Valves.
   3. C508 - Swing Check Valves for Waterworks Service, 2 through 24 IN NPS.
   4. C-110 - Standard for Ductile Iron and Grey Iron Fittings.
   5. C-207 - Steel Pipe Flanges for Waterworks Service.

C. Steel Structures Painting Council (SSPC):
   1. SP-2 - Hand Tool Cleaning.
   2. SP-10 - Near-White Blast Cleaning.

D. American National Standards Institute (ANSI):
   1. B1.20.1, Pipe Threads, General Purpose.

E. NSF 61 - Drinking Water System Components.

1.03 DESIGN REQUIREMENTS

A. Pressure Rating: 150 psi.

B. Valve to Piping Connections:
   1. Valves 3 inch nominal size and larger: Flanged ends unless otherwise specified on the Drawings.
   2. Valves less than 3 inch nominal size: Screwed ends.

1.04 SUBMITTALS

A. Product Data: Submit detailed technical information relating to the valve including description of component parts, materials of construction, performance, dimensions, and weights.

B. Manufacturer's Published Instructions:
   1. Submit instructions for installation, operation, and maintenance of valves.
   2. Furnish bound sets of installation, operation, and maintenance instructions for each type of valve 3 inch nominal size and larger.

1.05 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.01 MATERIALS

A. Underground Bolts: Low-alloy steel in accordance with AWWA C111.

B. Bronze and Brass Alloys: Use bronze and brass alloys with not more than 6 percent zinc and not more than 2 percent aluminum in the manufacturing of valve parts.

C. Interior Protective Coating:
   1. Epoxy coat interior non-working surfaces, except stainless steel surfaces.
   2. Coating Types:
      a. Powder Epoxies:
         1) Manufacturers: One of the following or equal:
            a) 3-M Company, ScotchKote 134; certified to NSF 61 for drinking water use.
            b) Michigan Chrome and Chemical Company, Micron 650 or 651.
            c) Or Pre-approved equal.

b. High Solids Polyamine Cured Epoxy:
1) Manufacturers:
a) AkzoNobel International Protective (Devoe) Coatings - Bar Rust 223H.

3. Clean surfaces to meet SSPC-SP-10, near-white metal blast cleaning, with grit of size recommended by epoxy manufacturer.
4. Apply in accordance with manufacturer's published instructions:
a. High Solids Polyamine Cured Epoxy:
1) Not less than 2 coats to the specified thickness.
5. Coating Thickness: 12 mils except that:
a. Coating thickness in grooves for gaskets: 5 mils.
b. Do not coat seat grooves in valves with bonded seat.
6. Quality Control:
a. Coating Thickness: Measured with a nondestructive magnetic type thickness gauge.
b. Verify coating integrity with a holiday detector set at 1,800 volts.
c. Consider tests successful when coating thickness meets specified requirements and when no pin holes are found:
1) Correct defective coating disclosed by unsuccessful tests, and repeat test.
2) Repair pinholes in accordance with manufacturer's published recommendations.

D. Underground Valves:
1. Provide underground valves with flanged, mechanical, or other type of joint required for the type of pipe to which the valve is to be connected.
2. Coating and Wrapping:
a. Paint buried valves with 3 coats of asphalt varnish in accordance with AWWA C 504:
1) Protect coating from damage during handling and installation; repair coating where damaged.
b. After installation, wrap valves in polyethylene as specified for ductile iron piping in Section 15062:
1) Ascertain that polyethylene wrapping does not affect operation of valve.

E. Valve Boxes:
1. Furnish and install access to operators of buried valves through cast-iron valve boxes, as shown on Drawings:
a. Do not support boxes on valve, valve operator, or pipe.
b. Boxes: Fabricated of cast-iron; provided with cover, asphalt varnished or enameled. Adjust to grade, install centered on the upper portions of the valve and valve operator.
c. Use seamless pipe inside valve box. If seam is required, use a sealed bell joint.
d. Minimum clear inside diameter of 6 inches.

e. Install per MAG Detail 391-1 Type A.

F. Valve Operators:
1. Open counterclockwise.
2. Provide valves located below operating level or deck with extensions for key operation or floor stands and hand wheels.
3. Provide manually operated valves and gates located not more than 6 feet above the operating level with levers, tee handles, wrenches, or hand wheels, as shown on Drawings.
   a. Make the valve operator more conveniently accessible by rolling valves, located more than 5 feet but less than 6 feet above the operating level, toward the operating side.
   b. Secure tee handles and wrenches to the valve head or stem, except where a handle or wrench so secured constitutes a hazard to personnel; in which case, stow handle or wrench immediately adjacent to the valve on or in a suitable hanger, bracket, or receptacle.
4. Fit valves located more than 6 feet above operating level with chain operated handles or valve wheels:
   a. Chains: Sufficient length to reach approximately 4 feet above the operating level.
   b. Where chains constitute a nuisance or hazard to operating personnel, provide hold-backs or other means for keeping the chains out of the way.

G. Air Release Valve:
1. Manufacturer: ARI.
2. Orifice: 5/16".
3. Size: See Drawings.
4. Body: stainless steel.
5. Float: HDPE.
6. Seat: Buna-N (soft seat).
7. Float Guide: stainless steel.
8. O Ring Seat: EPDM rubber.
9. Other internal parts: stainless steel.
10. Pressure rating: 150 psi.
11. Provide isolation valve upstream of air release valve.

2.02 FABRICATION

A. Valves:
1. End connections:
   a. Provide end connections for valves as required in Piping Schedule.
   b. Assure end connections meet the following standards:
      1) Threaded: ANSI B1.20.1
      2) Flanged: AWWA C207.
      3) Bell and spigot or mechanical (gland) type: AWWA C111.

PART 3 - EXECUTION

3.01 PREPARATION

A. Once flanged valves and flanged check valves are selected, determine face-to-face dimensions of valves.

B. Fabricate piping to lengths taking into account the dimensions of flanged valves and flanged check valves.

3.02 INSTALLATION

A. Prior to installation, valves that will be electrically actuated will have actuators mounted and tested by the valve manufacturer. Actuators will be shipped by the actuator manufacturer to the valve manufacturer for mounting and testing.

B. Provide incidental work and materials necessary for installation of valves including flange gaskets, flange bolts and nuts, valve boxes and covers, concrete bases, blocking, and protective coating.

C. Where needed, furnish and install additional valves for proper operation and maintenance of equipment and plant facilities under the following circumstances:
   1. Where such additional valves are required for operation and maintenance of the particular equipment furnished by CONTRACTOR.
   2. Where such additional valves are required as a result of a substitution or change initiated by CONTRACTOR.
   3. Install valves with their stems in vertical position above the pipe, except as follows:
      a. Butterfly valves, gate valves aboveground, globe valves, and angle valves may be installed with their stems in the horizontal position.

D. Install valves so that handles clear obstructions when the valves are operated from full open to fully close.

E. Place top of valve boxes flush with finish grade or as otherwise indicated on the Drawings.

3.03 ADJUSTING

A. Make sure all adjustments to valves, operators and appurtenant equipment prior to Project Acceptance. Operate valve, open/close, at system pressures.

END OF SECTION

SECTION 15111

BALL VALVES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: DIP ball valves, plastic body ball valves and instrument isolation ball valves.

1.02 REFERENCES

A. American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME):
   1. B16.5 – Pipe Flanges and Flanged Fittings.

B. American Petroleum Institute (API).

C. American Society for Testing and Materials (ASTM):
   1. A 351 – Specification for Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts.

D. American Water Works Association (AWWA):
   1. C 507 – Standard for Ball Valves 6 Inch Through 48 Inch.

E. National Sanitation Foundation (NSF) 61.

1.03 SYSTEM DESCRIPTION

A. General: Unless otherwise indicated on the Drawings use:
   1. Plastic body ball valves on plastic pipelines.
   2. Where valves are connected to electric actuators, the valve and actuator assembly shall be supplied by the same Supplier/Manufacturer.

PART 2 - PRODUCTS

2.01 BALL VALVE TYPES

A. Full Port Ductile Iron (DI) Ball Valves:
   1. Manufacturers: One of the following or equal.
      a. Conbraco.
      b. Dezurik.
      c. Or pre-approved equal.

B. Plastic Ball Valves:
   1. Manufacturers: One of the following or equal.
      a. Asahi America.
      b. Spears.
      c. Or pre-approved equal.

C. General:
   1. Type: Non-lubricated and capable of sealing in either flow direction.
   2. End Connections: for PVC valves - flanged or socket end connections, True union; for DI valves - flanged end connections.
   3. Operator Handle: Lever.
   4. Valves bodies requiring actuators shall have integrally mounted molded stem support and platform to assure proper alignment of the actuator to the valve.
   5. 150 psi pressure rated.

D. Materials:
   1. Body: Ductile iron body for DI valves; PVC/CPVC body for plastic valves.
   2. Ball: PVC/CPVC for plastic valves.
   3. Seats: FKM (Viton) or EPDM or PTEF.
   4. O-rings: FKM (Viton) or EPDM.
   5. All ball valves installed on chemical system lines shall be made of CPVC/PVC as shown on Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Install each type of valve in accordance with manufacturers' printed instructions.

B. Schedule: All valves 3-inches and smaller are not shown on the Valve Schedule in the Drawings.

END OF SECTION

SECTION 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.

1.02 REFERENCES

A. American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME):
   1. ANSI/ASME B16.1 – Cast Iron Pipe Flanges and Flanged Fittings, Class 125.
   2. ANSI/ASME B16.5 – Pipe Flanges and Flanged Fittings.

B. American Society for Testing and Materials (ASTM):
   1. A 126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. D 429 - Test Methods for Rubber Property - Adhesion to Rigid Substrates.

C. American Water Works Association (AWWA):
   1. C 110 – Standard for Ductile-Iron and Gray-Iron Fittings 3 inches through 48 inches for Water and Other Liquids.
   2. C 504 – Standard for Rubber-Seated Butterfly Valves.

D. National Sanitation Foundation (NSF) 61.

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 on 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 and 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 shutoff 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. Kennedy, Series 4500.
   2. Keystone
   3. Clow
   4. Grinnel
   5. VSI.

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 valve 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 a totally 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 watertightness.

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, provide speed crank.

G. Electric Actuators: The electrical actuators shall be AUMA SQ Series. All electric actuators shall be equipped with local disconnects and position indicators that are transmitted to the Arsenic Treatment Facility Programmable Logic Controller (ATF PLC). Electric actuators shall be controlled from the ATF PLC. External bi-directional travel stop, open/close indicator, reversible motor, integral heater, thermal overload protection, and 2 SPDT limit switches on auxiliary stem for open/close indication. Power requirement for electric actuators shall be 480 VAC, three phase.

1. Provide actuator operable with handwheel or chainwheel even after the electric motor has been disengaged and removed.
2. Coordinate sizing of each electric actuator with the valve manufacturer who shall furnish the valve and the electric actuator as a unit.
3. The electric actuators shall be suitable for the valve orientation as shown on the Drawings.
4. Provide NEMA 4X enclosure for all valve controls.

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:
   d. Houghton, Rust Veto 344.
   e. 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, and plastic body ball check valves

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. A 48 – Specification for Gray Iron Castings.
   2. A 126 – Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   3. A 276 – Specification for Stainless Steel Bars and Shapes.
   4. B 582 – Specification for Nickel-Chromium-Iron-Molybdenum-Copper Alloy Plate, Sheet and Strip.
   5. B 584 – Specification for Copper Alloy Sand Castings for General Applications.

B. American Water Works Association (AWWA):
   1. C 508 – Standard for Swing-Check Valves for Waterworks Service 2 Inch Through 24 Inch NPS.

C. American Petroleum Institute (API).

D. National Sanitation Foundation (NSF) 61

1.03 SYSTEM DESCRIPTION

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

PART 2 - PRODUCTS

2.01 SILENT CHECK VALVES (METAL BODY)

A. Globe Style Silent Check Valves 3 Inches through 24 Inches:

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

2.02 BALL CHECK VALVE (PLASTIC BODY)

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

PART 3 - EXECUTION

3.01 INSTALLATION

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

3.02 ADJUSTING

A. Adjust cushioned check valves in the field by means of external adjustment devices to minimize pressure surges.

B. Adjust weight on check valves to affect proper closing action on equipment shutdown.

END OF SECTION

SECTION 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 includes, but is not necessarily limited to:
   1. Division 1 - General Requirements
   2. Section 09800 - Special Coatings.

D. See Drawings.

1.02 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer 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 from 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, chain, crank, 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 terminate12-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 on the Drawings.
11. Protect wetted parts form galvanic corrosion due to contact of 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) Kennedy

4) M&H
5) VSI
6) 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 15117

SPECIALTY VALVES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Backflow Preventer.
   2. Solenoid Valve.

B. Related Sections:
   1. Section 15110 – Valves.

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. A 126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. D 2000 – Standard Classification System for Rubber Products in Automotive Applications.

1.03 SUBMITTALS

A. Furnish submittals as specified in Sections 15110 and submitted in accordance with Section 01340.

B. Submittals Prior to Installation:
   1. Product Data: Submit detailed technical information relating to each type of valve including description of component parts, materials of construction, performance, dimensions, and weights.

C. Operation and Maintenance Data:
   1. In accordance with Section 01340.

D. Copy of test report by a certified backflow prevention tester documenting the backflow preventers have been field tested.

1.04 QUALITY ASSURANCE

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

B. Backflow preventer must be field-tested by a City of Goodyear certified tester and test report shall be provided to ENGINEER.

1.05 DELIVERY STORAGE AND HANDLING

A. Protect valves from damage during handling and installation.

PART 2 - PRODUCTS

2.01 BACKFLOW PREVENTERS

A. Backflow prevention assembly shall be reduced pressure type.

B. Size and Pressure Rating: See Drawings.

C. The backflow preventer device shall meet requirements of AWWA C511 and ASSE1013.

D. Body: Bronze body with bronze internal parts and stainless steel springs.

E. Provide two independently operating, spring loaded check valves, diaphragm type differential pressure relief valve located between check valves, third check valve that opens under back pressure in case of diaphragm failure and non-threaded outlet.

F. The backflow preventer shall be assembled with two gate valves and four test cocks.

G. Furnish for horizontal installation with vent elbow and air gap device. Provide suitable pipe supports for the backflow preventer assembly.

H. Backflow preventors shall be approved through laboratory and field evaluation tests performed by the Foundation for Cross-Connection Control and Hydraulic Research (University of Souther California, Kaprielian Hall 200, Los Angeles, CA 90089-2531; http://ww.usc.edu/fccchr/) Or an entity with equivalent testing requirements acceptable to the City of Goodyear.

I. Manufacturer: Watts or approved equal.

2.02 SOLENOID VALVES

A. Pilot operated, two port valve for drinking water applications. See valve schedule for size.

B. Construction:
   1. Body: Brass.
   2. Seal/Disc: PTFE
   3. Disc Holder: PA
   4. Core Tube/Springs: 305 Stainless Steel
   5. Core and Plugnut: 430F Stainless Steel
   6. Shading Coil: Copper

C. Ambient Temperature Rating: 32°F to 125°F

D. Valves shall be suitable for pressures up to 150 psi.

E. Electrical Requirement: 120 VAC, 60 Hz.

F. Solenoid Enclosure: Watertight, NEMA 4.

G. Configuration: See Valve Schedule.

H. Product and Manufacturer: Provide one of the following:
   1. ASCO Redhat.
   2. Approved Equal.

PART 3 - EXECUTION

A. Valve Schedule:
   1. See Drawing.

END OF SECTION

SECTION 15141

MECHANICAL - PROCESS PIPE SUPPORTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Supports for pipe, fittings, valves, and appurtenances.

1.02 REFERENCES

A. American National Standard Institute or Manufacturer's Standardization Society (ANSI/MSS):
   1. SP 58 - Pipe and Supports, Design and Manufacture.
   2. SP 69 - Pipe Supports and Hangers, Selection and Applications.

1.03 SUBMITTALS

A. Shop Drawings: Include schedule, indicating where supports will be installed, and drawings of pipe support system components.

PART 2 - PRODUCTS

2.01 PIPE SUPPORTS

A. Pipe Supports:
   1. 3-inch and larger: As indicated on the Drawings.
   2. 2-inch and smaller: Supplied by CONTRACTOR under constraints of these specifications. Locations for these supports are not specifically shown in drawings but are the responsibility of the CONTRACTOR.

2.02 MATERIALS

A. Materials: As indicated on the Drawings.

B. Materials not specifically indicated on the drawings: Hot-dip galvanized steel with stainless fasteners.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Properly support, suspend or anchor exposed pipe, fittings, valves, and appurtenances to prevent sagging, over-stressing, or movement of piping and to prevent thrusts or loads on or against connected pumps, valves, meters and other equipment.

B. Carefully determine locations of inserts. Anchor to form work prior to placing concrete.

C. Do not use stud type powder actuated fasteners for securing metallic conduit or steel pipe larger than 1 inch to concrete, masonry, or wood.

D. Suspend pipe hangers from hanger rods. Secured with double nuts.

E. Install continuously threaded hanger rods only where indicated on the Drawings.

F. Use adjustable ring hangers; or adjustable clevis hangers, for 6-inch and smaller diameter pipe.

G. Use adjustable clevis hangers for pipe larger than 6 inches in diameter.

H. Secure pipes with galvanized double nutted U-bolts or suspend pipes from hanger rods and hangers.

I. Support Spacing (unless otherwise specified on drawings):
   1. Support 2-inch and smaller piping on horizontal and vertical runs at maximum 5 feet on center, unless otherwise specified.
   2. Support larger than 2-inch piping on horizontal and vertical runs at maximum 8 feet on center, unless otherwise specified.
   3. Support exposed polyvinyl chloride and other plastic pipes at maximum 5 feet on center, regardless of size.
   4. Support tubing, copper pipe and tubing, fiber-reinforced plastic pipe or duct, and rubber hose and tubing at intervals close enough to prevent sagging greater than 1/4 inch between supports.

J. Install Supports at the following Locations (unless otherwise shown on Drawings):
   1. Horizontal bends.
   2. Both sides of flexible pipe connections.
   3. Base of risers.
   4. Floor penetrations.
   5. Connections to pumps, blowers and other equipment.
   6. Valves and appurtenances.

K. Securely anchor plastic pipe, valves, and headers to prevent movement during operation of valves.

L. Anchor plastic pipe between expansion loops and direction changes to prevent axial movement through anchors.

M. Size hanger rods, supports, clamps, anchors, brackets, and guides in accordance with ANSI/MSS SP 58 and SP 69.

N. Do not use chains, plumbers' straps, wire, or similar devices for permanently suspending, supporting, or restraining pipes.

O. Support plumbing drainage and vents in accordance with Uniform Plumbing Code.

P. Supports, clamps, brackets, and portions of support system bearing against copper pipe: Copper plates, copper throughout, or isolated with neoprene or PVC tape.

Q. Where pipe is insulated, install over-sized supports and hangers.

R. Install insulation shield in accordance with ANSI/MSS SP 69, Type 40. Shield shall be galvanized steel unless specified elsewhere.

S. Install riser clamps at floor penetrations and where indicated on the Drawings.

T. Paint or Coat support system components as specified in Section 09800.

END OF SECTION

SECTION 15495

DISINFECTION OF PROCESS WATER PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Disinfection of water lines and piping, bacteriological testing, and flushing at lines at completion of construction. This includes piping at water treatment facility site.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. AWWA C 651 - Disinfecting Water Mains.

B. Standard Methods for Examination of Water and Wastewater.

1.03 SUBMITTALS

A. Submit disinfection test plan which details procedure to be utilized to disinfect water lines including:
   1. Method and locations of disinfectant application.
   2. Locations of sampling points.
   3. Method of flushing and location of flushing ports.
   4. Method of dechlorination.
   5. Disposal location for dechlorinated water.

B. Submit disinfection reports and include the following:
   1. Date issued.
   2. Project name and location.
   3. Treatment subcontractor's name, address, and phone number.
   4. Type and form of disinfectant used.
   5. Time and date of disinfectant injection start.
   6. Time and date of disinfectant injection completion.
   7. Test locations.
   8. Initial and 24-hour disinfectant residuals in part per million for each outlet tested.
   9. Time and date of flushing start.
   10. Time and date of flushing completion.
   11. Disinfectant residual after flushing in parts per million for each outlet tested.

C. OWNER will perform sampling and laboratory analyses for microbiological testing.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Protect against damage and contamination.

B. Maintain caution labels on hazardous materials.

C. Maintain storage room dry with temperatures as uniform as possible between 60 and 80 degrees Fahrenheit.

1.05 PROTECTION

A. Provide necessary signs, barricades, and notices to prevent persons from accidentally delivering water for potable use.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Disinfectant: Free chlorine in liquid form.

PART 3 - EXECUTION

3.01 CLEANING WATER LINES

A. Prior to chlorination, remove by flushing or other means, soil, and debris from water lines.

3.02 INSPECTION

A. Verify that water line system is completed and cleaned.

B. Start disinfection of water lines when conditions are satisfactory.

3.03 SYSTEM TREATMENT

A. Perform disinfection of water lines in accordance with AWWA C 651 and as specified in this Section.

B. Starting at outlet closest to water source, bleed water from each outlet until water produces odor of disinfectant. Repeat process at each outlet throughout system.

C. Test for disinfectant residual at each of following locations and other locations in accordance with submitted disinfection test plan:
   1. Ends of piping runs.
   2. Remote outlets.

D. Maintain disinfectant in system for 24 hours.

E. When disinfectant residual is less than 25 parts per million after 24 hours, repeat system treatment.

3.04 FLUSHING

A. Remove disinfectant from water lines.

B. Flush water lines with potable water containing no more disinfectant residual than the active distribution system or 1.0 parts per million, whichever is greater.

C. Continue flushing until water at designated flushing ports contains disinfectant residual equal to concentrate specified above.

3.05 DISPOSAL OF CHLORINATED WATER

A. For on-site piping, dechlorinate and dispose water into backwash holding tank (on site).

3.06 MICROBIOLOGICAL TEST

A. Advice OWNER to take water samples no sooner than 24 hours after flushing system.

B. At the end of 24 hours and before the water main is placed in service, collect microbiological samples in accordance with the submitted disinfection test plan at each piping run.

C. When microbiological test proves water quality to be unacceptable, repeat disinfection treatment.

END OF SECTION

SECTION 15496

DISINFECTION OF TREATMENT VESSELS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Disinfection of the four new treatment vessels (pressure vessels), bacteriological testing, flushing and disposal of disinfecting water at completion of treatment.

1.02 REFERENCES

A. American Water Works Association (AWWA):
   1. AWWA C 653 - Disinfection of Water Treatment Plants.

B. Standard Methods for Examination of Water and Wastewater.

C. 29 CFR Part 1910.146 - Occupational Safety and Health Administration (OSHA) Permit Required Confined Spaces.

1.03 SUBMITTALS

A. Submit disinfection test plan which details procedure to be utilized to disinfect the adsorption contactor including:
   1. Method and locations of disinfectant application.
   2. Locations of sampling points.
   3. Method of dechlorination.
   4. Disposal location for dechlorinated water.
   5. MSDS for each chemical to be used.

B. Submit disinfection reports and include the following:
   1. Date issued.
   2. Project name and location.
   3. Type and form of disinfectant used.
   4. Time and date of disinfection start.
   5. Time and date of disinfection completion.
   6. Test locations.
   7. Initial and 24-hour disinfectant residuals in part per million for each outlet tested (Engineer may perform sampling and analysis, if desired).
   8. Time and date of flushing start.
   9. Time and date of flushing completion.
   10. Disinfectant residual after flushing in parts per million for each outlet tested.

11. OWNER will perform sampling and analysis. Coordinate microbiological testing with Engineer. OWNER to collect samples for microbiological testing - OWNER to perform all laboratory analyses.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect against damage and contamination.

B. Maintain caution labels on hazardous materials.

C. Maintain storage room dry and with temperatures as uniform as possible between 60 degrees Fahrenheit and 80 degrees Fahrenheit.

1.05 PROTECTION

A. Comply with all applicable regulations, including but not limited to OSHA and COP Combined Space Entry SOP.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Disinfectant: Sodium hypochlorite in liquid form conforming to ANSI/AWWAB300.

PART 3 - EXECUTION

3.01 CLEANING VESSELS

A. Prior to chlorination, remove by flushing or other means, soil, and debris from treatment vessels.

B. Wash Garnet support media, prior to loading, to eliminate fines. Install support media prior to disinfection.

3.02 INSPECTION

A. Verify that adsorption contactor system is completed and cleaned.

B. Start disinfection of adsorption vessel when conditions are satisfactory.

3.03 SYSTEM TREATMENT

A. METHOD: Perform disinfection of the adsorption vessel in accordance with AWWA C 653-97 Sec. 4.4.1 and as specified in this Section.
   1. The treatment vessel shall be filled to the overflow level with potable water to which enough chlorine is added to provide a free chlorine residual in the full facility of not less than 15 mg/L at the end of the appropriate 12-hour period. The Chlorine, Sodium Hypochlorite, shall be introduced into the water as described in section 3.03B.

B. APPLICATION: Sodium Hypochlorite shall be poured into the treatment vessel, manually, and allow the flowing water provide the mixing. The filling of the treatment vessel shall begin as soon as cleaning of the vessel is completed. See Section 3.01. The Sodium Hypochlorite shall be poured through the roof manhole. The Sodium Hypochlorite shall be poured into the water in the treatment vessel when the water is not more than 3 ft (0.9m) in depth, nor less than 1 ft (0.3m) in depth, followed by filling each vessel until water flow is detected in the vent line. The solution shall thoroughly coat all surfaces to be treated, including the inlet and outlet piping, and shall be applied to any separate drain piping such that it will have available chlorine of not less than 2-4 mg/L when filled with water.

C. RETENTION: The disinfected surfaces shall remain in contact with the strong chlorine solution for at least 24 hours, after which each vessel will be drained of the chlorinated water. Bacteriological sampling of the vessel effluent should be performed after the disinfection procedure is complete. Conduct bacteriological testing in accordance with sub-section 3.05.

D. Drain or pump chlorinated water into the Backwash Holding Tank.

E. Test for disinfectant residual at each of following locations and other locations in accordance with submitted disinfection test plan:
   1. Vessel outlets.

F. After successful disinfection testing, load IX and GAC media into each vessel. Special care should be taken to protect the adsorption media from contamination. Any equipment used in placing the adsorption media must be cleaned and disinfected with a 200 mg/L solution of chlorine immediately before use. This includes shovels, spreading devices, or other equipment that comes in contact with the adsorption media. All workers shall wear rubber boots and gloves that have been previously disinfected with a 200 mg/L chlorine solution.

3.04 DISPOSAL OF CHLORINATED WATER

A. Chlorinated water shall be disposed in the backwash holding tank prior to sewer disposal.

3.05 BACTERIOLOGICAL TEST

A. After the chlorination procedure is completed, and before the adsorption vessel is placed in service, water from the adsorption vessel will be sampled and tested for coliform organisms in accordance with the latest edition of Standard Methods for the Examination of Water and Wastewater.

B. At the end of 24 hours and before the water main is placed in service, the OWNER will collect bacteriological quality samples at adsorption vessel outlets in accordance with the submitted disinfection test plan and Standard Methods for the Examination of Water and Wastewater.

C. OWNER will arrange for and pay cost to analyze water samples in accordance with Standard Methods of Water and Wastewater.

D. When bacteriological test proves water quality to be unacceptable, repeat disinfection treatment.

END OF SECTION

DIVISION 16

ELECTRICAL

SECTION 16000

GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes
   1. Work and materials necessary for erecting a complete electrical and instrumentation system, tested and ready for continuous use.

B. Related Sections
   1. Division 0 Bid Requirements, Contract Forms, and Contract Conditions
   2. Division 1 General Requirements
   3. Division 2 Site Construction
   4. Division 3 Concrete
   5. Division 9 Finishes
   6. Division 11 Equipment
   7. Division 13 Special Construction
   8. Division 15 Mechanical
   9. Division 17 Instrumentation

1.02 DEFINITIONS

A. The term “Provide” means “Furnish and Install”.

1.03 SYSTEM DESCRIPTION

A. Design Requirements
   1. If any contradictions, contrasts, or inconsistency appears, the most strict criteria noted and the collective requirements in any and all of the project documents shall apply.

1.04 SUBMITTALS

A. Intent
   1. Organize work so that a complete electrical, instrumentation, and control system for the facility will be provided and will be supported by accurate shop drawings, record drawings, and O&M manuals.
   2. Submit detailed shop drawings and data prepared and organized by the suppliers. Provide quantity of submittal sets in accordance with the requirements of Division 1.
   3. Submittals shall be neatly grouped and organized by specification section number, and sub-section. Related information shall be highlighted, and the specific product shall be marked. All submittals shall be complete, and presented in one package.

Incomplete submittals will be returned without review. If a portion of the project requires a fast track schedule, that portion only may be submitted earlier under a separate cover letter.

4. Work performed or equipment provided without engineer approved submittals is done at contractor's risk. Cost to re-work or re-supply will be born solely by the contractor.

B. Product Data

1. A complete list of the equipment and materials, including the manufacturer's name, product specification, descriptive data, technical literature, performance charts, catalog cuts, installation instructions, and spare part recommendations for each different item of the equipment specified. The above shall clearly show all the specified requirements as described in the Specifications including but not limited to specific UL and NEMA rating, technical capabilities, test result verifications, and acceptance letters.
2. Submittals not in compliance with the specifications must include the following information:
    a. Reason for non-compliance or variance
    b. Calculations and drawings for redesign of related components including detail drawings showing internal and assembly details, with installation instructions.
    c. Proposed layout showing any modifications or exceptions to related work made necessary by this work, with calculations and drawings showing such modifications or exceptions.

C. Shop Drawings

1. Drawings containing complete wiring and schematic diagrams, control diagrams, and any other details required to demonstrate that the system has been coordinated and will operate as intended. Drawings shall show proposed layout, anchoring, support, and appurtenances of equipment, and equipment relationship to other parts of the work including clearances for maintenance and operations.

D. Utility Coordination

1. Submit copies of service entrance shop drawings to the utility, per utility submittal requirements, prior to submittal to the Engineer. Obtain written approval from the power utility company that the service entrance equipment is acceptable prior to release the order to the supplier for fabrication. Provide a copy of the approval letter from the utility with the submittal.

E. Closeout Submittals

1. Provide "Record Drawings" of the electrical, control, and instrumentation work to include:
    a. Step-by-step procedure manuals for the installation, operation start-up, and maintenance of the equipment.
    b. Installation, operating, troubleshooting, and maintenance and overhaul instructions in complete detail.

c. Possible breakdowns and repairs, and troubleshooting guides, as well as simplified wiring and control diagrams of the system installed. This shall provide the Owner with comprehensive information on all systems and components to enable operation, service, maintenance and repair.
d. Exploded or other detailed views of all equipment, devices, assemblies, and accessory components shall be included, together with complete parts lists and ordering instructions.

2. Provide an "As Built" set of Plans to Owner. Maintain at all times a marked up set of Plans showing the following information:
   a. Actual installed circuit numbers, conduit sizes, cable tray routing, number of conductors, conductor sizes (larger than #12 AWG), and all other deviations from the design Plans.
   b. Underground conduit, duct banks, and concealed items dimensioned on the Plans from permanent, visible, building features.
   c. Actual motor size, starter size, and overload heater size, along with all other protective equipment for all 480 V and 4160 V motor circuits.
   d. Conductor identification and panel schedules.

1.05 QUALITY ASSURANCE

A. Regulatory Requirements
   1. Electrical work, including connection to electrical equipment integral with mechanical equipment, shall be performed in accordance with the latest published regulations, codes, and standards, of the following:
      a. National Electrical Code (NEC)
      b. State and local codes
      c. Institute of Electrical and Electronic Engineers (IEEE)
      d. American National Standards Institute (ANSI)
      e. American Society for Testing and Materials (ASTM)
      f. Insulated Cable Engineers Association (ICEA)
      g. National Electrical Manufacturers Association (NEMA) Standards
      h. Federal Occupational Safety and Health Act (OSHA)
      i. National Fire Protection Association (NFPA)
      j. National Electrical Testing Association (NETA)

1.06 DELIVERY, STORAGE, AND HANDLING

A. Electrical panels, switchgear, motor control centers, and other electrical equipment, shall be shipped in sealed dust and moisture proof plastic sheet enclosures, and the seal maintained until units are installed. Said units shall be new and free of any dirt, dust, water, grease, rust, damaged parts or components.

1.07 PROJECT/SITE CONDITIONS

A. Verify site conditions before bidding or performing work.

1.08 SCHEDULING

A. Maintain a work schedule showing work to be performed, sequence of work, major milestones, and manpower loading. Coordinate schedule requirements with other trades. Provide adequate staff to perform the work in the time required by the schedule.

1.09 SYSTEM STARTUP

A. After installation and testing of all electrical and instrumentation equipment and systems, energize all equipment and leave ready for continuous operation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers and model numbers shown on Plans or listed in the specifications are intended to establish a minimum standard of quality and acceptability.

2.02 MATERIALS

A. Materials, equipment, and parts comprising any unit, or part thereof, specified or indicated on the Plans, shall be new and unused, of current manufacture, and of highest grade consistent with the state of the art. Damaged materials, equipment, and parts, are not considered to be new and unused, and will not be accepted.

2.03 MANUFACTURED UNITS

A. The fabricator of major components and manufactured units, such as distribution panel boards, switchgear, and motor control centers, shall also be the manufacturer of the major devices therein.

B. Electrical equipment provided with mechanical equipment assemblies shall be in compliance with this specification.

2.04 EQUIPMENT

A. Minimum sizes of equipment, and electrical devices, are indicated but it is not intended to show every offset and fitting, nor every structural or mechanical difficulty that will be encountered during the installation of the work.

B. Electrical equipment shall be capable of operating successfully at full-rated load, without failure, at an ambient air temperature of 60 degrees C, and specifically rated for the altitude indicated on the Plans. Provide air conditioning to meet the manufacturers' operating temperature for electrical equipment not rated for operation at that temperature.

C. When applicable, the material used in the performance of the electrical work shall be listed by the Underwriters' Laboratories, Inc. (UL) for the class of service for which they are intended.

D. Provide nameplates where indicated elsewhere in these specifications or on the Plans. Nameplates shall be black laminate with white letters and fastened to the various devices with round head stainless steel screws. Provide nameplates for each disconnecting means for service, feeder, branch, or equipment conductors, indicating its purpose.

2.05 FABRICATION

A. Shop Assembly
   1. Equipment assemblies, such as Service Entrance Sections, Switchgear, Switchboards, Control and Distribution Panels, and other custom fabricated electrical enclosures shall bear a UL label as a complete assembly. The UL label on the individual components making up the assembly will not be considered sufficient to meet the present requirement. Whenever a generic UL label does not apply for the assembly, a serialized UL label shall be affixed to the assembly, and the serial number shall be submitted with the assembly record shop drawings.
   2. Custom fabricated electrical control panels, and enclosures, shall bear a UL label affixed by a local UL inspector.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Site Verification of Conditions
   1. Verify site conditions before bidding or performing work.

3.02 INSTALLATION

A. Coordinate work with other trades and with certified vendor shop drawing submittals.

B. Provide equipment in accordance with the manufacturers' requirements.

C. Identify each conductor as required by the Contract Documents.

D. Equipment Access:
   1. Install equipment so it is readily accessible for operation and maintenance.
   2. Equipment shall not be blocked or concealed.
   3. Do not install electrical equipment such that it interferes with normal maintenance requirements of other equipment.

E. Equipment shall be installed plumb, square and true with the building construction, and shall be securely fastened.

F. Outdoor wall-mounted equipment, and indoor equipment mounted on earth, or water bearing walls, shall be provided with corrosion-resistant spacers to maintain ¼-inch separation between the equipment and the wall.

G. Arrange for the building in of equipment during structure construction. Where equipment cannot be built-in during construction, arrange for sleeves, box-outs, and other openings, as required to allow installation of equipment after structure construction is complete.

H. Verify that equipment will fit support layouts indicated.

I. Screen or seal all openings into outdoor equipment to prevent the entrance of rodents and insects.

J. Equipment fabricated from aluminum shall not be imbedded in earth or concrete.

K. Provide all necessary anchoring devices and supports.
   1. Use supports as detailed on the Plans and as specified.
   2. Supports and anchoring devices shall be rated and sized based on dimensions and weights verified from approved equipment submittals.
   3. Hardware shall be stainless steel.
   4. Do not cut, or weld to, building structural members.
   5. Do not mount safety switches and external equipment to other equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.

L. Verify exact rough-in location and dimensions for connection to electrical items furnished by others.
   1. Obtain shop drawings from those furnishing the equipment.
   2. Proceeding without proper information may require the Contractor to remove and replace work that does not meet the conditions imposed by the equipment supplied.
   3. Provide sleeves wherever openings are required through new concrete or masonry members. Place sleeves accurately and coordinate locations with the Engineer.
   4. Do not endanger the stability of any structural member by cutting, digging, chasing, or drilling and shall not, at any time, cut or alter the work without the Engineer's written consent.
      a. Provide additional reinforcing if required.
      b. Use proper tools and methods to cut, core drill, or make other penetrations.
      c. Restore walls, ceilings, or floors to their original condition.

M. Provide concrete foundations or pads required for electrical equipment as indicated or specified.
   1. Provide a 4-inch concrete housekeeping pad for floor mounted electrical equipment. Pour on top of the finished floor or slab. Drill existing slab and epoxy rebar to anchor housekeeping pad in place.

N. Do not use equipment that exceeds the indicated dimensions except as approved in writing by the Engineer.

O. Do not use equipment or arrangements of equipment that reduce required clearances or exceed the space allocation.

P. Work indicated on the Plans is approximately to scale, but actual dimensions and detailed Plans should be followed as closely as field conditions permit. Field verification of scale dimensions on Plans is governed by field conditions. Installation of systems and equipment is subject to clarification as indicated in reviewed shop drawings and field coordination.

Q. Discrepancies indicated on different Plans, between Plans and actual field conditions, or between Plans and Contract Documents shall be promptly brought to the attention of the Engineer for clarification, prior to purchasing and installing equipment.

R. Adjust the alignment of equipment and conduit to accommodate architectural changes or to avoid work of other trades.

S. Provide parts and pieces necessary to the installation of equipment, in accordance with the best practice of the trade, and in conformance with the requirements of these Contract Documents.

T. Items not specifically mentioned in these Contract Documents, or noted on the Plans, or indicated on reviewed shop drawings, but which are obviously necessary to make a complete working installation, shall be deemed to be included herein.

U. Lay out and install electrical work prior to placing floors and walls. Provide sleeves and openings through floors and walls, required for installation of conduits. Sleeves shall be rigidly supported and suitably packed, or sealed, to prevent ingress of wet concrete. Spacers shall be installed in order to prevent conduit movement. Dimensions indicated for electrical equipment and their installation are restrictive dimensions.

V. Provide inserts and hangers required to support conduits and other electrical equipment. Coordinate inserts and hangers with other trades. Replace inserts, hangers, sleeves, or other mounting hardware which are improperly placed.

W. Perform necessary saw cutting, core drilling, excavating, removal, shoring, backfilling, and other work required for the proper installation of conduits, whether inside, or outside of the buildings and structures. Use core drills to make circular holes.

X. 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 elsewhere in the contract documents. Provide the Power System Coordination Study after the electrical equipment submittals have been reviewed and approved. The Coordination Study to be performed using ETAP, SKM or other approved power system analysis software.

B. The final deliverable shall be a certified report summarizing the coordination study.

C. As a minimum, the coordination study for the power distribution system shall include the following:
   1. Time-current curves for each protective relay or fuse showing graphically that the settings will provide protection and selectivity within industry standards. Each curve shall be identified, and the protective device settings shall be specified.
   2. Time-current curves for each device shall be positioned to provide maximum selectivity to minimize system disturbances during fault clearing. Where selectivity cannot be achieved, the ENGINEER shall be notified as to the cause.
   3. Time-current curves and points for cable and equipment damage.
   4. Circuit interrupting device operating and interrupting times.
   5. Indicate maximum fault values on the graph.
   6. Sketch of bus and breaker arrangement.

D. Contractor to field-adjust and set trip settings associated with protective devices per coordination study results.

E. Coordination Study to comply with the provisions and recommendations of IEEE 242-2001, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.

3.06 ADJUSTING

A. Calibrate and set all adjustable electrical equipment including circuit breakers, motor circuit protectors, overload relays. Align photo cells and lights to achieve desired effects.

3.07 CLEANING

A. Relays, starters, circuit breakers, switches, contacts, insulators, mechanisms, and buses shall be free of dust, dirt, oil, moisture, metal shavings, and other debris before testing and energizing equipment. Vacuum and wipe down inside and outside of electrical enclosures and control panels.

3.08 PROTECTION

A. Once equipment is installed, it shall be protected at all times with plastic sheet covers until the area is free of dirt, dust, paint spray, water, and other trades. Provide heat to eliminate condensation.

End of Section

SECTION 16010

ELECTRICAL: BASIC REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Basic requirements for electrical work.

B. Install and wire all equipment, including prepurchased equipment, and perform all tests necessary to assure conformance to the Drawings and Specifications and ensure that equipment is ready and safe before energizing.

C. Related Sections include but are not necessarily limited to:
Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
Division 1 - General Requirements.

D. Drawings Use and Interpretation:
   1. Drawings indicate the location and arrangement of electrical equipment and the approximate location of other equipment requiring electrical work.
      a. For exact locations of building elements, refer to dimensioned architectural/structural drawings.
      b. Field measurements take precedence over dimensioned drawings.

E. Installation of all systems and equipment is subject to clarification as indicated in reviewed shop drawings and field coordination drawings.

1.02 AREA CLASSIFICATIONS

A. Outdoor locations may contain corrosive and hazardous areas:
   1. Reference drawings for identification of Corrosive and hazardous areas.
      a. Areas not identified as such shall be considered wet.

B. Indoor locations may contain damp, wet corrosive and hazardous areas:
   1. Damp, wet, corrosive and hazardous areas are identified on the Drawings.
      a. Areas not identified as such shall be considered unclassified.

1.03 DEFINITIONS

A. Outdoor Areas:
   1. Those locations on the Project site where the equipment is normally exposed to wind, dust, rain, snow, etc.

B. Indoor Areas:
   1. Those locations on the Project site where the equipment is normally protected from wind, dust, rain, snow, etc.

C. Shop Fabricated:
   1. Manufactured or assembled equipment for which a UL test procedure has not been established.

1.04 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Iron and Steel Institute (AISI):
      a. Steel Products Manual - Stainless and Heat Resisting Steel.
   2. American National Standards Institute (ANSI):
      a. C2, National Electrical Safety Code.
   3. American Society for Testing and Materials (ASTM):
      a. A36, Specification for Structural Steel.
      b. A153, Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   4. Factory Mutual System (FM):
      a. A Guide to Equipment, Materials and Services.
   5. Institute of Electrical and Electronics Engineers (IEEE):
      a. 141, Recommended Practice for Electrical Power Distribution for Industrial Plants.
      b. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
   6. National Electrical Manufacturers Association (NEMA):
      a. ICS 6, Enclosures for Industrial Controls and Systems.
   7. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   8. Underwriters Laboratories, Inc (UL):
      a. 508, Safety Industrial Control Equipment.
      b. 698, Industrial Control Equipment for Use in Hazardous Locations.

B. When a specific code or standard has not been cited, the applicable codes and standards of the following code-making authorities and standards organizations shall apply:
   1. American Association of State Highway and Transportation Officials (AASHTO).
   2. American Iron and Steel Institute (AISI).
   3. American National Standard Institute (ANSI).
   4. American Society for Testing and Materials (ASTM).
   5. ETL Testing Laboratories, Inc (ETL).
   6. Insulated Cable Engineers Association (ICEA).
   7. Institute of Electrical and Electronic Engineers (IEEE).
   8. Illuminating Engineering Society of North America (IES).
   9. Instrument Society of America (ISA).
   10. Lightning Protection Institute (LPI).
   11. National Electrical Manufacturers Association (NEMA).

12. National Fire Protection Association (NFPA).
13. Occupational, Health and Safety Administration (OSHA).
14. Underwriters Laboratories Inc (UL).

C. In case of conflict or disagreement between codes, standards, laws, ordinances, rules, regulations, drawings and specifications, or within either document itself, the more stringent condition shall govern.

1.05 SYSTEM DESCRIPTION

A. Provide functional systems in compliance with manufacturer's instructions, performance requirements specified or shown on the Drawings, and modifications resulting from reviewed shop drawings and field coordinated drawings.

1.06 SUBMITTALS

A. Shop Drawings:
1. See Contract Documents for other requirements.
2. Submit shop drawings prior to purchase or fabrication of equipment. See individual Division 16 sections for specific requirements.
3. Prior to submittals of shop drawings, coordinate electrical equipment, particularly service switchboards, motor control equipment, control panels, and instrumentation, with all applicable equipment and systems interfacing with that equipment.
4. For each product, clearly identify manufacturer by name.
5. Provide manufacturer's technical information on products to be used, including:
   a. Product descriptive bulletin.
   b. Electrical data pertinent to the Project and necessary to assure compliance with Specifications and Drawings.
   c. Equipment dimensions, where applicable.
   d. Evidence that the products submitted meet the requirements of the standards referenced.
6. When general data sheets are provided as part of the submittal, specifically identify the products to be used on this Project.
7. Ensure that all submittals clearly indicate the equipment is UL or ETL listed or is constructed utilizing UL or ETL listed or UL recognized components. Where an UL standard has not been established clearly identify that no UL standard exists for that equipment.
8. For all equipment, provide manufacturer's installation instructions.

B. Operation and Maintenance Manuals:
1. See Contract Documents for requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. See Section 01600.

B. Ensure that equipment is not used as steps, ladders, scaffolds, platforms, or for storage-either inside or on top of enclosures.

C. Protect nameplates on electrical equipment to prevent defacing.

D. Repair, restore or replace damaged, corroded and rejected items at no additional cost to the Owner.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Refer to related Division 16 sections.
   1. All equipment of a similar type shall be by one manufacturer unless otherwise noted in the Specifications.

2.02 MATERIALS

A. Trade names and catalog numbers may be used in the Drawings or Specifications to establish quality standards and basics of design.
   1. Other listed manufacturers in the applicable specification sections with equal equipment may be acceptable.
   2. If no other manufacturer is listed, then manufacturers of equal equipment may be acceptable.

B. Listed:
   1. Where UL test procedures have been established for the product type, electrical equipment shall be approved by UL or ETL and shall be provided with the UL or ETL label.

C. Structural Steel Supports:
   1. Galvanized steel: ASTM A36.
      a. PVC coated in Class I and in corrosive areas.
   2. Stainless steel: AISI Type 316.

2.03 FABRICATION

A. When equipment is shop fabricated for the Project, the electrical devices and enclosures utilized shall be UL or ETL listed and labeled or shall be UL recognized.

B. Shop or Factory Finishes:
   1. Interiors of other painted equipment shall be either white or light gray.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment shall be installed in accordance with the requirements of the NEC.

B. Enclosures for Use with Electrical Equipment:
   1. NEMA 12: Use in unclassified indoor locations.
   2. NEMA 3R: Use with HVAC equipment in wet outdoor locations.
   3. NEMA 4:
      a. Use in wet indoor locations.
      b. Use in wet outdoor locations except with HVAC equipment.
   4. NEMA 4X: Use in all corrosive locations.
   5. Exceptions:
      a. As modified in other Division 16 sections.
      b. As otherwise indicated on the Drawings.
   6. Standards:
      a. NEMA ICS-6, Enclosures for Industrial Controls and Systems.
      b. UL 508, Safety Industrial Control Equipment.
      c. UL 698, Industrial Control Equipment for Use in Hazardous Locations.

C. Coordinate the installation of electrical equipment with other trades.
   1. Arrange for the building in of equipment during structure construction.
   2. Where equipment cannot be built-in during construction, arrange for sleeves, box-outs, openings, etc., as required to allow installation of equipment after structure construction is complete.

D. Verify that equipment will fit support layouts indicated.

E. Equipment Dimensions and Clearances:
   1. Do not use equipment that exceeds the indicated dimensions.
      a. Except as approved in writing by the Engineer.
   2. Do not use equipment or arrangements of equipment that reduce required clearances or exceed the space allocation.

F. Install equipment in accordance with the manufacturer's instructions.

G. Equipment Access:
   1. Install equipment so it is readily accessible for operation and maintenance.
   2. Equipment shall not be blocked or concealed.
   3. Do not install electrical equipment such that it interferes with normal maintenance requirements of other equipment.

H. Equipment shall be installed plumbed, square and true with the building construction and shall be securely fastened.

I. Outdoor wall-mounted equipment and indoor equipment mounted on earth or water bearing walls shall be provided with corrosion-resistant spacers to maintain 1/4 IN separation between the equipment and the wall.

J. Screen or seal all openings into outdoor equipment to prevent the entrance of rodents and insects.

K. Equipment fabricated from aluminum shall not be placed in direct contact with earth or concrete.

L. Provide all necessary anchoring devices and supports.
   1. Use supports as detailed on the Drawings and as specified.
      a. Where not detailed on the Drawings or specified, use supports and anchoring devices rated for the equipment load and as recommended by the manufacturer.
   2. Supports and anchoring devices shall be rated and sized based on dimensions and weights verified from approved equipment submittals.
   3. Hardware shall be malleable type, corrosion resistant and shall be supported by heavily plated machine screws or brass, bronze or stainless steel bolts.
   4. Do not cut, or weld to, building structural members.
   5. Do not mount safety switches and external equipment to other equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.

M. Provide concrete foundations or pads required for electrical equipment as indicated or specified.
   1. Floor-mounted equipment shall be mounted on a 4 IN high concrete housekeeping pad. Pad shall be poured on top of the finished floor or slab.

N. Material that may cause rusting or streaking on a building surface shall not be used.

O. To avoid interference with structural members and equipment of other trades, it may be necessary to adjust the intended location of electrical equipment. Unless specifically dimensioned or detailed, the Contractor may, at his discretion, make minor adjustments in equipment location without obtaining the Engineer's approval.

P. Provide tagging of electrical equipment, conduits, and conductors in accordance with the Contract Documents.
   1. Each equipment item shall be provided with a nameplate identifying the equipment by the tag number shown on the Drawings.
   2. Each branch circuit and feeder shall be provided with a nameplate identifying, by name and tag number as shown on the Drawings, the load served.
      a. Do not abbreviate.
   3. Each control device shall be provided with an escutcheon defining the device function and a nameplate identifying the controlled equipment.

Q. Provide electrical danger, caution, warning or safety instruction signs in accordance with applicable safety standards.

R. Conduit and wire between temperature control thermostats and the associated HVAC equipment shall be furnished and installed with the equipment (see Division 15 of the Specifications).
   1. Conduit and wire between alarm or shutdown thermostats and air flow switches and the associated alarm devices or panels shall be furnished and installed as part of Division 16.
   2. Thermostats included as part of a heat trace system shall be installed as part of Division 16.

3.02 FIELD QUALITY CONTROL

A. Do not remove or damage fireproofing materials.
   1. Install hangers, inserts, supports, and anchors prior to installation of fireproofing.
   2. Repair or replace fireproofing removed or damaged.

B. Make all penetrations through roofs prior to installation of roofing.
   1. For penetrations required after installation of roofing:
      a. In built-up roofing (BUR), provide all curbs, cants and base flashings.
      b. In elastic sheet roofing (ESR), arrange and pay for base flashing work by authorized roofer.

C. Make all penetrations of electrical work through walls and roofs water and weather-tight.

D. Equipment furnished under this Contract for use on future work and all concealed equipment, including conduits, shall be dimensioned, on the record drawings, from visible and permanent building features.

E. After installation, test all electrical equipment and systems as recommended by the manufacturer and in accordance with Specification 16920 – ELECTRICAL ACCEPTANCE TESTING.

F. Test Equipment Interface:
   1. Verify systems coordination and operation.

3.03 CLEANING

A. Clean dirt and debris from all surfaces.

B. Apply touch-up paint as required to repair scratches, etc.

C. Replace nameplates damaged during installation.

D. Thoroughly vacuum the interior of all enclosures to remove dirt and debris.

3.04 DEMONSTRATION

A. Demonstrate equipment in accordance with the Contract Documents.

End Of Section

SECTION 16050

BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section consists of general electrical materials and methods. Electrical materials that are a part of equipment specified under other sections shall meet the requirements of this section, unless part of larger factory-assembled equipment.

1.02 SUBMITTALS

A. Submit manufacturer's literature for raceways and fittings, boxes, wires and cables, wiring devices, nameplates, legend plates, labels, panelboards, and safety switches, service entrance equipment, control panels and any other electrical component utilized in this project.

1.03 QUALITY ASSURANCE

A. Refer to Section 16000.

1.04 SPARE PARTS

A. Provide spare components as indicated on drawings and elsewhere herein.

PART 2 - PRODUCTS

2.01 BASIC MATERIALS

A. Electrical safety switches, distribution and control equipment shall be rated for heavy duty service.

B. Wiring devices shall be specifications grade.

2.02 MISCELLANEOUS METAL AND MOUNTING CHANNELS

A. Metal Framing:
   1. Unless otherwise shown, mounting channels shall be cold rolled from mild strip steel, 12-gauge, 1-5/8 inches by 1-5/8 inches, with a galvanized finish by Unistrut, Unistrut P-1000, as manufactured by Unistrut, or equal.
   2. Screws, bolts, washers and nuts shall be stainless steel. Parts and brackets for assembly of channels shall be hot dipped galvanized.

B. Miscellaneous Metal: Galvanized steel, unless otherwise shown.

2.03 NAMEPLATES, LEGEND PLATES, AND LABELS

A. Nameplates: Laminated sheet plastic, approximately 1/16 inch-thick, with engraved white letters on a black background, with adhesive backing and mounting screw holes. Stainless steel or brass screws, minimum height of letters, 5/16 inch. Card holders are not acceptable.

B. Legend Plates: Type KN-3 standard legend plates, Square D, or equal.

C. Control Wire Markers: Heat shrink sleeve types, manufactured by W.H. Brady Company, or equal.

PART 3 - EXECUTION

3.01 BASIC MATERIALS

A. The completed installation shall conform to all applicable federal, state, and local code ordinances and regulations. Contractor shall obtain necessary permits and inspections required by the governing authorities. Work shall be done in a neat, workmanlike, finished and safe manner, according to the latest published N.E.C.A. standards of installation, under competent supervision. Install grounding as required by the National Electrical Code.

3.02 MISCELLANEOUS METAL AND MOUNTING CHANNELS

A. Install where electrical equipment is to be surface mounted to walls and where indicated on Drawings. Where two or more devices are to be installed side by side, support on metal framing, bolt together, and brace as required to form a rigid structure.

B. Clean cuts and welds. Coat unpainted surfaces with cold application zinc galvanizing. Coat cuts and welds on painted surfaces with zinc chromate primer and finish to match existing paint.

3.03 NAMEPLATES, LEGEND PLATES, AND LABELS

A. Nameplates: Identify panels, switchgear, regulators, load-break junction boxes, disconnect switches, and component enclosures. Fasten nameplates with stainless steel, self-tapping screws or rivets.
   1. Panels: Identify panel number, voltage and amperage of panel bus.
   2. Switchgear: Identify equipment, voltage, amperage and phase and number of wires.
   3. Safety Switches and Relays: Identify equipment controlled and circuits from which they are fed.

B. Legend Plates: Install on selector switches, pushbuttons, pilot lights, starters, and other components.

C. Control Wire Markers: Install at both ends of each control wire interconnecting between such items as control panels, sensors, and control devices, and each end of control wires within control panels, and other such enclosures. Wiring markers shall correspond to control wire numbers on approved wiring diagrams.

End of Section

SECTION 16111

CONDUITS

PART 1 - GENERAL

1.01 SCOPE OF WORK

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

1.02 SUBMITTALS

A. Submit product literature including manufacturer part number, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.

B. Shop Drawings shall be submitted for review and acceptance showing routing, conduit size, and number and size of wires in each conduit before installation of conduit and any related work.

C. Proposed routing of conduits buried under floor slabs-on-grade.

D. Identify conduit by tag number of equipment served or by circuit schedule number.

E. Proposed routing and details of construction including conduit and rebar embedded in floor slabs, columns, etc. Identify conduit by tag number of equipment served or by circuit schedule number.

F. Proposed location and details of construction for openings in slabs and walls for raceway runs.

G. Refer to Section 16000 for further submittal requirements.

1.03 REFERENCES

A. American National Standards Institute (ANSI): C80.1, Rigid Steel Conduit - Zinc-Coated.

B. National Electric Manufacturers Association (NEMA): RN-1, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit.

C. Underwriters Laboratories Inc. (UL):

1. 1, Flexible Metal Conduit.

2. 6, Rigid Metal Conduit.
3. 360, Liquid-Tight Flexible Steel Conduit.
4. 467, Grounding and Bonding Equipment.
5. 514, Nonmetallic Outlet Boxes, Flush-Device Boxes and Covers.
6. 651, Schedule 40 and 80 Rigid PVC Conduit.
7. 870, Wireways, Auxiliary Gutters, and Associated Fittings.
8. 884, Underfloor Raceways and Fittings.
9. 886, Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

PART 2 - PRODUCTS

2.01 RACEWAYS

A. Exposed conduit in an unclassified or hazardous area shall be galvanized rigid steel (GRS) unless specifically indicated otherwise on the Drawings. Conduits in the corrosive areas shall be PVC coated GRS unless otherwise indicated. Underground and/or concrete encased conduits shall be PVC, unless otherwise indicated. All wiring, except as otherwise noted, shall be in conduit. Conduit size shall not be less than the National Electrical Code (NEC) size required for the conductors therein and shall not be smaller than 3/4-inch. No underground conduit shall be less than one inch.

B. Condulet type fittings shall be Crouse-Hinds, Appleton, or equal with wedge nut covers. All condulets located outdoors or in wet locations shall be weathertight.

C. In unclassified areas, flexible conduit shall be grounding type, weatherproof, corrosion resistant, and watertight.

D. Couplings, connectors, and fittings shall be standard types specifically designed and manufactured for the purpose. They shall be installed to provide a firm mechanical assembly and electrical conductivity throughout.

E. Expansion fittings shall be OZ type AX with jumper for exposed locations and type DX at structural expansion joints, Spring City, or equal. Conduits shall have expansion fittings in accordance with NEC.

F. The conduits and fittings shall be supported per NEC requirements as a minimum.

2.02 GALVANIZED RIGID STEEL (GRS)

A. Conduit and couplings shall be hot-dipped galvanized with zinc coated threads and outer coating of zinc bichromate, in accordance with ANSI C80.1 standards, as manufactured by Jones & Laughlin Steel Corporation, Allied Tube & Conduit Corporation, Triangle PWC, or equal.

B. Steel conduit shall not be buried in earth without concrete encasement and additional corrosion protection. A half lapped rapping of 20 mil PVC based corrosion protection tape shall be used.

2.03 PVC COATED GALVANIZED RIGID STEEL (PVC-GRS)

A. PVC coated GRS conduit shall be installed where shown on the Drawings or elsewhere specified and shall conform to NEMA RN-1 and ANSI C80.1 standards.

B. The PVC coated galvanized rigid conduit must be UL Listed. The PVC coating must have been investigated by UL as providing the primary corrosion protection for the rigid metal conduit. Ferrous fittings for general service locations must be UL Listed with PVC as the primary corrosion protection. Hazardous location fittings, prior to plastic coating must be UL listed. All conduit and fittings must be new, unused material. Applicable UL standards may include: UL 6 Standard for Safety, Rigid Metal Conduit, UL514B Standard for Safety, Fittings for Conduit and Outlet Boxes.

C. The zinc surface of the conduit shall remain intact on both the inside and the outside of the conduit throughout the preparation and application processing. A Polyvinyl Chloride (PVC) coating shall be bonded to the galvanized outer surface of the conduit. The bond between the PVC coating and the conduit surface shall be greater than the tensile strength of the plastic. The thickness of the PVC coating shall be a minimum of 0.040-inch (40 mil).

D. A loose coupling shall be furnished with each length of conduit. A PVC coating shall be bonded to the outer surface of the coupling and a PVC sleeve equal to the outside diameter of the uncoated conduit shall extend beyond both ends of the coupling approximately one pipe diameter or 1-1/2 inches, whichever is smaller. The wall thickness of the coating on the coupling and the sleeve shall be a minimum of 0.040-inch (40 mil).

E. A PVC coating shall be bonded to the outer surface of all conduit bodies and fittings and a PVC sleeve shall extend from all hubs. A urethane coating shall be uniformly and consistently applied to the interior of all conduit and fittings. This internal coating shall be a nominal 2 mil thickness. Conduit or fittings having areas with thin or no coating shall be unacceptable. The wall thickness of the coating on conduit bodies and fittings and the sleeve walls shall be identical to those on couplings in length and thickness. The covers on all conduit bodies shall be coated on both sides and shall be designed to be

completely interchangeable within size and family of fitting. Form 8 Condulets, 1/2" through 2" diameters, shall have a v-seal tongue-in-groove gasket to effectively seal against the elements. Form 8 condulets shall be supplied with plastic encapsulated stainless steel cover screws.

F. Type 304 stainless steel screws shall be furnished and used to attach the cover to the conduit body. All coated material shall be installed and patched according to the manufacturer's recommended installation and patching instructions.

G. Conduit straps shall be PVC coated or stainless steel.

H. PVC coated conduit and fittings shall be as manufactured by Plasti-Bond, Perma-Cote, KorKap or equal

I. PVC coated flexible conduits shall be liquid and vaportight and manufactured in accordance with UL 360 standards.

J. Installation of the PVC Coated Conduit System shall be performed in accordance with the Manufacturer's recommendations and Installation Manual. Install with manufacturer-approved tools and compounds to prevent damage to the PVC coating. The installer should be certified by Manufacturer to install coated conduit.

2.04 RIGID NONMETALLIC - PVC

A. Where specifically indicated on the Drawings, or elsewhere specified, conduit may be high density Schedule 40, 90 degrees C, heavy-duty PVC. The conduit shall be manufactured from virgin polyvinyl chloride compound which meets ASTM D1784, NEMA TC-2, ANSI C33.91, and UL 651 standards. Smoke emissions shall be limited to less than 6 grams per 100 grams of material tested.

B. Where conduit concrete encasement is indicated on the Drawings, conduit supports shall be installed at five foot intervals. PVC conduit shall be manufactured by Carlon, Triangle Conduit & Cable, or equal.

2.05 INTERMEDIATE METAL CONDUIT

A. Conduit and couplings shall be galvanized intermediate metal conduit manufactured in accordance with UL 1242 and as manufactured by Allied Tube & Conduit Corporation, Jones & Laughlin Steel Corporation, or equal.

B. Intermediate metal conduit shall not be buried without concrete encasement. Threadless couplings and connectors shall not be used.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Liquidtight flexible metal conduit shall be liquid and vaportight, oil and ultraviolet ray resistant and manufactured in accordance with UL 360 standards. Liquidtight flexible metal conduit shall be formed of a continuous, spiral wound, galvanized steel core with an extruded PVC jacket. The PVC jacket shall be rated for high ambient heat applications, 90 degrees Celsius.

B. For corrosive locations, liquidtight flexible metal conduit shall be formed of a continuous, spiral wound, aluminum core with an extruded PVC jacket. The PVC jacket shall be impervious to corrosive liquids and vapors.

C. An external bonding conductor shall be required for flexible conduit connections containing circuits rated at 60 amps or greater and for sizes 1 1/2 " or larger. Flexible conduit and connectors for 1 1/4" and smaller shall be listed for grounding.

D. Connectors for liquidtight flexible conduit shall be galvanized, furnished with a sealing ring and locknut, and suitable for wet locations.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Conduit runs are schematic only, and shall be modified as required to suit field conditions, subject to review and acceptance by the Engineer.

B. Conduit shall run continuously between outlets and shall be provided with junction boxes where connections are made. Couplings, connectors, and fittings shall be acceptable types designed and manufactured for the purpose, and shall provide a firm mechanical assembly, and electrical conductivity throughout.

C. Conduit runs shall be straight and true. Elbows, offsets, and bends shall be uniform and symmetrical. Changes in direction shall be made with long radius bends, or with fittings of the condulet type.

D. Conduit runs in buildings and structures shall be exposed except as specifically noted, or accepted by the Engineer.

E. Conduit runs shall not interfere with the proper and safe operation of equipment, and shall not block or interfere with ingress or egress, including equipment removal hatches.

F. Exposed conduits shall be securely fastened with clamps, or straps, intended for conduit use. All exposed conduit shall be run on the walls and ceiling only and shall be parallel to the planes of the walls or ceiling. No diagonal runs will be permitted. Flexible

conduit shall be used only for short lengths required to facilitate connections between rigid conduit to motors from junction boxes, or control equipment.

G. Conduit runs on water-bearing walls shall be supported one inch away from the wall on an accepted channel. When channel galvanizing, or other coating, is cut or otherwise damaged, it shall be field coated to original condition. No conduit shall be run in water-bearing walls, unless specifically designated otherwise.

H. Conduit shall be thoroughly reamed to remove burrs. IMC or GRS shall be reamed during the threading process, and Rigid Nonmetallic PVC shall be reamed before applying fittings. A zinc rich cold galvanizing shall be used to restore corrosion protection on field cut threads. Bushings and lock nuts or hubs shall be used at conduit termination's. The total number of bends in any run between pull points shall not exceed 360 degrees. Junction boxes and pull boxes shall be installed at points acceptable to the Engineer. Conduit ends shall be plugged to prevent the entrance of moisture or debris during construction. All spare conduits shall be adequately capped and shall contain a suitable pull string.

I. Joints shall be set up tight. Hangers and fastenings shall be secure, and of a type appropriate in design, and dimensions, for the particular application.

J. Conduit runs shall be cleaned and internally sized (obstruction tested) so that no foreign objects, or obstructions remain in the conduit prior to pulling in conductors.

K. After installation of complete conduit runs 2 inches and larger, conduits shall be snaked with a conduit cleaner equipped with a cylindrical mandrel of a diameter not less than 85 percent of the nominal diameter of the conduit. Conduits through which the mandrel will not pass shall not be used.

L. Expansion fittings shall be installed across all expansion joints and at other locations where necessary to compensate for thermal expansion and contraction.

M. Provide trenching, backfill, and compaction for conduits installed underground.

N. Unless approved in advance by the Engineer, all conduits which transition from underground to aboveground will utilize galvanized rigid steel conduit for the bend from horizontal to vertical and for the extension above the ground. Factory 90 degree GRS bends shall be used. GRS bends and conduits shall be half lapped with 20 mil PVC tape in non-corrosive areas and shall be PVC coated rigid steel in corrosive areas. Tape wrapping shall extend a minimum 6 inches above top of slab or above finished grade.

O. Liquid tight flexible metallic conduit 1-1/2 inch and larger shall be provided with grounding style bushings and shall have an external ground wire sized and installed in accordance with the NEC.

End of Section

SECTION 16123

600 VOLT CLASS CABLE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers the furnishing and installation of 600 Volt Class cables and conductors, terminations and splicing, and pulling lubricants.

1.02 SUBMITTALS

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

1.03 REFERENCES

A. Insulated Cable Engineers Association/National Electrical Manufacturers Association (ICEA/NEMA):
   1. S-68-516/WC 8, ethylene-propylene rubber-insulated wire and cable for the transmission and distribution of electrical energy.
   2. S-61-402/WC 5, thermoplastic-insulated wire and cable for the transmission and distribution of electrical energy.
   3. S-66-524/WC 7, cross-linked thermosetting-polyethylene-insulated wire and cable for transmission and distribution of electrical energy.

B. Underwriters Laboratory, Inc.
   1. 44, rubber insulated wires and cables.
   2. 83, thermoplastic-insulated wires and cables.
   3. 486A, wire connectors and soldering lugs for use with copper conductors.
   4. 486B, wire connectors for use with aluminum conductors.
   5. 510, insulating tape.

C. National Electric Code

PART 2 - PRODUCTS

2.01 ACCEPTED MANUFACTURERS

A. Conductors and Multi Conductor Cables (MCC), subject to compliance with Contract Documents, the following manufacturers are acceptable: American Insulated Wire Corporation, Cablec Corporation, Okonite Company, Southwire Company, or equal.

2.02 CONDUCTORS

A. Wire sizes shall be American Wire Gauge (AWG) sizes with Class B stranded construction. Number 2 AWG and smaller shall be factory color coded with a separate color for each phase and neutral, which shall be used consistently throughout the system. Larger cables shall be coded by the use of colored tape. Conductors sized # 1 and larger shall be Type 2, rated for 90 degrees C. All circuit conductors, #6 or smaller shall be "THWN" stranded copper. All other conductors shall be "XHHW-2" stranded copper.

B. Individual or multiple conductor cables for power, control, and alarm circuits of 480 volts or less shall be insulated for not less than 600 volts and shall have insulation type as indicated on the Drawings. "THHW" shall conform to ICEA S-61-402/NEMA WC 5 and UL 83 and "XHHW" shall conform to ICEA S-66-524/NEMA WC 7 and UL 44. Where wire size is not indicated, they shall be of the size required by the NEC, except that no wire external to panels and motor control centers shall be less than No. 12 AWG, unless specifically noted on the Drawings. Panel control wiring shall not be less than No. 14 AWG.

C. All wiring shall be as indicated on the Drawings. Wires shall be new and shall be soft drawn copper with not less than 97 percent conductivity. The wire and cable shall have size, grade of insulation, voltage, and manufacturer's name permanently marked on the outer covering at not more than 2-foot intervals. All wires shall conform to the latest Standards of the ASTM, and ICEA, and shall be tested for their full length by these Standards. Insulation thickness shall be not less than that specified by the National Electrical Code.

D. Power conductors for lighting and receptacles only may utilize "THWN" solid conductors.

2.03 TERMINATIONS AND SPLICES

A. Cable shall be rated 600 volts. Other parts of cable systems such as splices and terminations shall be rated at not less than 600 volts. Splicing shall join conductors mechanically and electrically to provide a complete circuit prior to installation of insulation.

B. Splices in wires No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, Type I, Class 1, Grade B, Style G, or Type II, Class 1 of FS W-S-610 and conforming to the applicable requirements of UL 486A.

C. Splices in wires No. 8 AWG and larger shall be made with non-insulated, solderless, pressure type connector, Type II, Class 2 of FS W-S-610, conforming to the applicable requirements of UL 486A and UL 486B. They shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket.

D. Insulated conductor splices below grade or in wet locations shall be sealed type conforming to ANSI C119.1 or shall be waterproofed by a sealant-filled, thick wall, heat

shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

E. Bare conductor splices in wet locations or below grade shall be of the exothermic type.

2.04 PULLING LUBRICANT

A. All cables shall be properly coated with pulling compound such as ClearGluide, Aqua Gel, Polywater, or equal before being pulled into conduits so as to prevent mechanical damage to the cables during installation. "Yellow 77" is not acceptable.

B. Other lubricants to be substituted must be accompanied by a statement from the cable manufacturer as to its acceptable use with the cable being installed.

2.05 IDENTIFICATION

A. All conductors shall be numbered with "tube sleeve" type tags with heat impressed letters and numbers.

B. Color code all wiring as follows:

1. Lighting and power wiring:

CONDUCTOR	**120/208 VAC**	**480VAC**	**24V DC**	**120 VAC Control/ Power**
Phase 1	Black	Brown	Blue	Red
Phase 2	Red	Orange	(-) Blue w/ white stripe	
Phase 3	Blue	Yellow		
Neutrals	White	White or Gray		White

2. Color code ends of feeder phase conductors only.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The pulling tension and side-wall pressures, as recommended by the cable manufacturer, shall not be exceeded.

B. As far as practical, all circuits shall be continuous from origin to termination without splices in intermediate pull boxes. Sufficient slack shall be left at the termination to make proper connections. In no case shall a splice be pulled into the conduit. Conductor splicing shall not be permitted without the Engineer's approval.

C. Install all cables in conduit.

D. Each feeder and branch circuit shall be installed in its own individual conduit unless combining feeder and branch circuits is permitted as defined in the following:
   1. As specifically indicated on the Drawings.
   2. For lighting, multiple branch circuits may be installed in a conduit as allowed by the NEC and with the wire ampacity derated in accordance with the requirements of the NEC. Conduit fill shall not exceed the limits established by the NEC.
   3. When field conditions dictate and written permission is obtained from the Engineer.

E. Feeder and branch circuits shall be isolated from each other and from all instrumentation and control circuits.

F. Control circuits shall be isolated from all other feeder, branch and instrumentation circuits, except as noted below.
   1. 12 V DC, 24 V DC and 48 V DC control circuits may be combined in common conduit.
   2. 125 V DC control circuits shall be isolated from all other DC and AC control circuits.
   3. 120 V AC control circuits shall be isolated from all DC control circuits.

G. Make splices only at pull or junction boxes.
   1. Crimp or indented-type connectors are not allowed, except for control circuits landed on terminal strips.

3.02 TESTING

A. In accordance with Specification 16920 – ELECTRICAL ACCEPTANCE TESTING.

End of Section

SECTION 16124

INSTRUMENTATION CLASS CABLE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers cable use for process signal and controls.

1.02 SUBMITTALS

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

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with Contract Documents, the instrumentation cable shall be as manufactured by Belden, Okonite, or equal.

2.02 INSTRUMENTATION CABLE

A. Instrument cable shall be Type TC, and have the number of individually shielded twisted pairs indicated on the Drawings and shall be insulated for not less than 600 volts. Unless otherwise indicated, conductor size shall be No. 18 AWG minimum. Shielded, grounded instrumentation cable shall be used for all analog signals.

B. The jacket shall be flame retardant with 90 degrees C temperature rating. The cable shield shall be a minimum of 2.3 mil aluminum or copper tape overlapped to provide 100 percent coverage and a tinned copper drain wire.

C. The conductors shall be bare soft annealed copper, Class B, 7 strand minimum concentric lay with 15 mils nominal thickness, nylon jacket, 4 mil nominal thickness, 90 degrees C temperature rating. One conductor within each pair shall be numerically identified.

D. Pairs shall be assembled with a nominal 2-inch lay and shall then be group shielded with a minimum of 1.3 mil aluminum or copper tape overlapped to provide 100 percent coverage. All group shields shall be completely isolated from each other.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Feeder and branch circuits shall be isolated from each other, and from instrumentation and control circuits. Instrumentation cables shall be installed in separate raceways from other cables and wiring. This includes portions running through manholes. Instrumentation cable shall be continuous between instruments or between field devices and instrument enclosures. There shall be no intermediate splices or terminal boards, unless otherwise shown on the Drawings.

B. Maintain electrical continuity of the shield when splicing twisted shielded pair conductors. Drain wires shall be terminated inside enclosures at grounded terminal blocks. Only one end of each instrument loop cable drain wire shall be grounded. Ground drain wire of shielded conductors at one end only.

C. Terminate instrumentation and control wiring, including spare wires, at control panels and motor control centers on terminal boards mounted inside the equipment.
   1. Contractor shall supply terminal boards as required.
   2. Do not field wire directly to devices.

End of Section

SECTION 16130

OUTLET, PULL, AND JUNCTION BOXES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Outlet, pull and junction boxes.

B. Related Sections include but are not necessarily limited to:
   Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   Division 1 - General Requirements.
   Section 16000 - Electrical: Basic Requirements.
   Section 16111 - Conduits.
   Section 16141 - Wiring Devices.
   Section 16170 - Grounding.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. Refer to Section 16000.

1.03 SUBMITTALS

A. Shop Drawings:
   1. Refer to the Contract Documents and Section 16000.

1.04 DELIVERY, STORAGE, AND HANDLING

A. See Section 16000.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Galvanized steel boxes:
      a. Appleton Electric Co.
      b. Steel City.
      c. Raco.
   2. Sheet metal boxes for non-classified areas:
      a. Hoffman Engineering Co.
   3. Corrosion-resistant boxes:

a. Hoffman Engineering Co.
b. Crouse-Hinds.

4. Hazardous location boxes (Class I, II & III):
   a. Appleton Electric Co.
   b. Crouse-Hinds.
   c. Killark.
   d. O-Z/Gedney.
5. Raintight and watertight boxes:
   a. Appleton Electric Co.
   b. Crouse-Hinds.
6. Terminal boxes:
   a. Hoffman Engineering Co.
7. Boxes in sidewalk:
   a. Appleton Electric Co.
   b. Crouse-Hinds.
   c. O-Z/Gedney.
8. Boxes in earth:
   a. Carlon Electric Products.
9. Exposed switch and receptacle boxes:
   a. Appleton Electric Co.
   b. Crouse-Hinds.
   c. Killark.

B. Submit requests for substitution in accordance with Specification Section 01630.

2.02 MATERIALS

A. Pull and Junction Boxes for Offices and other Dry Architecturally Finished Areas:
   1. Material: 14 GA, galvanized steel.
   2. Concentric knockouts on all four sides.
   3. Flat cover fastened with screws.
   4. NEMA 1 classification.
   5. UL listed.

B. Pull and Junction Boxes for General Use Unclassified Areas Suitable for NEMA 12 Enclosures:
   1. Material: 14 GA galvanized steel with seams continuously welded, ground smooth and no knockouts.
   2. Zinc rich coating on all seams.
   3. Stainless steel captivated cover screws threaded into sealed wells.
   4. Flat door with oil resistant gasket.
   5. NEMA 12 classification.
   6. UL listed.

C. Pull and Junction Boxes for Wet Areas:
   1. Material: 14 GA steel with polyester powder coating inside and out over phosphatized surfaces.

2. Seams continuously welded, ground smooth, no knockouts.
3. Stainless steel clamps on four sides.
4. Flat cover with oil resistant gasket.
5. NEMA 4 classification.
6. UL listed.

D. Pull and Junction Boxes for Corrosive Areas:
1. Material: 304L or 316L stainless steel or fiberglass-reinforced polyester material.
2. Stainless steel boxes:
   a. Seams continuously welded, ground smooth, no knockouts.
   b. Rolled lip around all sides.
   c. Hinged door.
   d. Captivated stainless steel door screws.
   e. Flat door with oil-resistant gasket.
3. Fiberglass-reinforced polyester boxes:
   a. Hinged door with latch and lockout.
   b. Neoprene door gasket.
   c. Grounding bushing(s).
4. NEMA 4X classification.
5. UL listed.

E. Pull and Junction Boxes for Hazardous Areas:
1. Material: Cast gray iron alloy or copper-free cast aluminum.
2. Drilled and tapped openings or tapered threaded hub equipped.
3. Flat bolted-down or threaded cover with neoprene gasket.
4. Stainless steel hex head screws.
5. Explosion proof, UL listed for Class 1 Groups C and D.

F. Pull and Junction Boxes for Sidewalks:
1. Cast-iron box and cover, hot-dip galvanized.
2. Flange for flush mounting.
3. Checkered cover with neoprene gasket, pry bar slots and stainless steel screws.
4. UL listed.
5. Drilled and tapped holes.
6. Watertight NEMA 4 classification.

G. Large Pull and Junction Boxes (100 CU IN and larger):
1. Located in offices and other dry architecturally finished areas where EMT is utilized:
   a. NEMA 1 gasketed without knockouts.
2. Located in general use areas:
   a. NEMA 12 construction:
      1) Welded steel.
      2) Furnished with gray enamel inside and out over phosphatized surfaces.
3. Located in wet and corrosive areas:
   a. NEMA 4X with stainless steel screws.
   b. Type 304 L welded stainless steel:

4. Constructed of 14 GA steel with seams continuously welded, ground smooth, no knockouts.
5. Rolled lip around all sides.
6. Rigid handles for covers larger than 9 SF or heavier than 25 LBS.
7. Split covers when heavier than 25 LBS.

H. Terminal Boxes:
1. Galvanized 16 GA steel box provided with plain blank screw cover, subpanel, and terminal points.
2. Refer to Drawing for dimensions and number of terminals.

I. Fiberglass Cable-Pulling Enclosure:
1. Use: Access points to facilitate pulling of electrical cables in buried conduit runs.
2. Size and quantity: As shown on Drawings.
3. Type: Rectangular fiberglass composite, suitable for direct burial pedestrian traffic on top, -50 DegF, chemical, sunlight, and weather resistant.
4. Provide matching top with "ELECTRIC" logo.

J. Outlet Boxes:
1. Use: Installation of wiring devices.
2. Boxes for exposed wiring:
   a. Cadmium plated, cast, ferrous metal, with threaded hubs.
3. Boxes for concealed wiring:
   a. Code gage, hot-dip galvanized steel.
   b. Include bar hangers for metal stud partitions.
   c. Provide barriers between switches in boxes with 277 V switches on opposite phases.
   d. Use extension and plaster rings where required.
   e. Provide grounding screw.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Use locknut and bushing for boxes in non-classified areas.

B. Use cast metal boxes with threaded conduit hubs in hazardous areas.

C. Use Type FS and FD boxes in wet areas and where exposed rigid steel conduit is required.

D. Fill unused punched-out, tapped, or threaded hub openings with insert plugs.

E. Use outlet boxes sized to accommodate quantity of conductors enclosed.

F. Use boxes sized to accommodate conduit tying into box.

G. Install pull boxes or junction boxes in conduit runs where indicated or required to facilitate pulling of wires or making connections.
   1. Make covers of boxes accessible.

H. Install pull boxes or junction boxes rated for the area classification.

I. Install rigid conduit squarely into boxes which do not have hubs or are drilled and tapped.
   1. Install with locknut on the outside and bushing on inside.

J. Install conduit into boxes with hubs, or that are tapped, using thread lubricant.

K. Do not use back-to-back boxes on this Project.

L. Seal all points of conduit entry into fiberglass cable-pulling enclosures for a waterproof installation.

M. Support outlet boxes for incandescent fixtures and other ceiling-mounted devices in lay-in acoustical tile ceilings by bar hangers anchored to ceiling construction members which do not interfere with tile removal.

End Of Section

SECTION 16141

WIRING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Light switches, receptacles, device plates, dimmers, plug-in strips and tele-power poles.

B. Related Sections include but are not necessarily limited to:
Division 0 -Bidding Requirements, Contract Forms, and Conditions of the Contract.
Division 1 - General Requirements.
Section 16000 - Electrical: Basic Requirements.
Section 16130 -Outlet, Pull, and Junction Boxes.
Section 16170 - Grounding.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. Refer to Section 16000.

1.03 SUBMITTALS

A. Shop Drawings:
   1. Refer to the Contract Documents and Section 16000.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Light switches (except explosion proof):
      a. Hubbell.
      b. Slater.
      c. P&S.
      d. Arrow Hart.
      e. General Electric.
      f. Leviton.
   2. Explosion proof light switches:
      a. Crouse-Hinds.
      b. Appleton Electric Co.
      c. Killark.

3. Door switches:
    a. General Electric.
    b. Slater.
    c. P&S.
    d. Arrow Hart.
    e. Micro-switch.
4. Receptacles (except explosion proof):
    a. Hubbell.
    b. Slater.
    c. P&S.
    d. Arrow Hart.
    e. General Electric.
    f. Leviton.
5. Explosion proof receptacles:
    a. Crouse-Hinds.
    b. Appleton Electric Co.
    c. Killark.
6. Welding receptacles:
    a. Crouse-Hinds.
    b. Appleton Electric Co.
7. Tele-power poles:
    a. Wiremold.
    b. Walker.
8. Dimmers:
    a. Lutron.
    b. General Electric.
    c. P&S.
9. Plug-in strip:
    a. Wiremold.
    b. Walker.

B. Submit requests for substitution in accordance with Specification Section 01630.

2.02 MATERIALS

A. Light Switches for Unclassified Areas:
1. Toggle type, quiet action, specification grade with grounding terminal.
2. Back and side wired.
3. Solid silver cadmium oxide contacts.
4. One-piece switch arm rated 20 A, 120/277 V AC.
5. UL listed.
6. Color: Ivory.
7. Wall plate: Type 304 stainless steel.
8. Type: As indicated on Drawings.

B. Receptacles for Unclassified Areas:
1. Straight blade, grounding type, specification grade.

2. Back and side wired with wrap-around bridge.
3. Rated 20 A, 125 V AC.
4. UL listed.
5. Color:
    a. For use on normal power: Ivory.
    b. For use on UPS systems: Red.
    c. For use on isolated ground systems: Orange.
6. Wall plate: Type 304 stainless steel.
7. Type: As indicated on Drawings.

C. Light Switches for Wet Areas:
1. Presswitch type, quiet action, specification grade, with grounding terminal.
2. Back and side wired.
3. Solid silver cadmium oxide contacts.
4. One-piece switch arm rated 20 A, 120/277 V AC.
5. UL listed.
6. Color: Ivory.
7. Wall plate: Gray weatherproof presswitch type.
8. Type: As indicated on Drawings.

D. Receptacles for Wet Areas:
1. Straight blade, grounding type, specification grade.
2. Back and side wired with wrap around bridge.
3. Rated 20 A, 125 V AC.
4. UL listed.
5. Color: Ivory.
6. Wall plate: Weatherproof, cast aluminum, UL listed, WDL open and closed.
7. Type: As indicated on Drawings.

E. Ground Fault Circuit Interrupter Receptacles:
1. Straight blade, grounding type, specification grade.
2. Rated 20 A, 125 V AC.
3. UL listed.
4. Test and reset buttons.
5. Wall plate: Indoor or weatherproof as required.
6. Feed-through type.

F. Light Switches for Corrosive Areas:
1. Corrosion-resistant NEMA 4X enclosure with switch consisting of:
    a. Fiberglass reinforced polyester enclosure.
    b. Fiberglass reinforced polyester gasketed wall plate with built-in toggle lever switch with stainless steel shaft.
    c. Grounding bushing.
    d. Rated 20 A, 125 V AC.
    e. UL listed.
    f. Type: As indicated on Drawings.
    g. Color: Yellow.

2. Optional: Corrosion-resistant enclosure and switch consisting of:
    a. Cast copper-free aluminum "FS" or "FD" ridge type hub box.
    b. Toggle type, quiet action, specification grade with grounding terminal.
    c. Rated 20 A, 125 V AC with solid silver cadmium oxide contacts.
    d. UL listed.
    e. Neoprene gasket.
    f. Cast aluminum cover with stainless steel screws and lever to activate switch.
    g. Type: As indicated on Drawings.
    h. Color: Yellow.

G. Receptacles for Corrosive Areas:
1. Corrosion-resistant straight blade, grounding type, specification grade.
2. Back and side wired with wrap-around bridge.
3. Rated 20 A, 125 V AC.
4. UL listed.
5. Color: Yellow.
6. Box: "FS" or "FD" ridge type cast hub box of copper-free aluminum.
7. Gasket: Neoprene.
8. Wall plate: Weatherproof, cast aluminum, UL listed, WDL open or closed.
9. Type: As indicated on Drawings.

H. Explosion proof Light Switches for Use in Hazardous Areas:
1. Explosion proof, UL listed for Class I, Division 1 and 2, Groups B, C, and D; and Class II, Division 1 and 2 areas, Groups E, F, and G.
2. EDS factory sealed.
3. Malleable iron body and cover.
4. Aluminum sealing chamber.
5. Front operated handle with stainless steel shaft.
6. Rated 20 A, 125 V AC.
7. With grounding screw.
8. Type: As indicated on Drawings.

I. Explosion proof Receptacles for Use in Hazardous Areas:
1. Explosion-proof, UL listed for Class I, Division 1 and 2, Groups B, C, and D; and Class II, Division 1 and 2, Groups F and G.
2. Factory-sealed malleable iron receptacle with spring-loaded cover.
3. Malleable iron mounting box.
4. Rated 20 A, 125 V AC.
5. "Dead-front" construction requiring plug to be inserted and rotated to activate receptacle.
6. Type: As indicated on Drawings.

J. Welding Receptacles:
1. 60 A, 480 V, 3 pole, 4 wire, grounding type.

K. Plug-In Strip: Surface steel raceway plug-in strip with single 15 A, 125 V, 3 wire grounding-type receptacles spaced 18 IN on center.

1. Prewired with two #12 TW and one #12 TW green insulated ground.
2. Minimum 1-1/4 IN wide x 3/4 IN deep.
3. Suitable fittings and snap-in cover.
4. Finish:
    a. Stainless steel.
5. Receptacle color:
    a. For use on normal power: Ivory.
    b. For use on UPS systems: Red.
    c. For use on isolated ground systems: Orange.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Mount devices where indicated on the Drawings and as scheduled in Section 16010.

B. Surface mount receptacles and light switches in concrete construction.

C. In masonry and metal stud construction, recess mount receptacles and light switches unless device precludes recessed mounting or unless otherwise noted on the Drawings.

D. Where more than one receptacle is installed in a room, they shall be symmetrically arranged.

E. Set switches and receptacles plumb and vertical to the floor.

F. Set recess-mounted switches and receptacles flush with face of walls.

G. Do not connect dimmers to loads in excess of 80 percent of the rating of the dimmer.

H. Provide blank plates for empty outlets.

End Of Section

SECTION 16142

WEATHERPROOF WHILE IN USE OUTLET ENCLOSURES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. These specifications encompass outlet enclosures used on outlet devices where outlets are required to be weatherproof and/or physically protected while in use or idle.

B. These safety outlet enclosures shall be used in locations where attachment plugs will be connected permanently, or for an indefinite period of time, in potentially wet or weather exposed environments.

C. They are also to be used where outlets are subject to contamination, corrosion or damage.

1.02 DESCRIPTION

A. The safety outlet enclosure shall consist of a suitable style outlet/receptacle plate with a hinged safety cover.

B. The safety outlet enclosure shall have cord port(s) capable of allowing an appropriate size electrical cord(s) to pass through when safety cover is closed.

C. The safety outlet enclosure shall have a latching mechanism to allow the enclosure to maintain weatherproof integrity. The latch shall be a tamper resistant (locking/security) style in areas where security is needed.

D. The safety outlet enclosure shall be sufficient depth to allow full closure with attachment plug(s) in use.

1.03 SUBMITTALS

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

1.04 MANUFACTURER

A. Manufacturer shall be Taymac Corporation, or equal.

PART 2 - PRODUCTS

2.01 WEATHERPROOF WHILE IN USE OUTLET ENCLOSURES

A. The enclosures shall be used on outlet devices where outlets are required to be weatherproof and/or physically protected while in use or idle

B. The enclosures shall be used in outdoor locations, where attachment plugs will be connected permanently, or for an indefinite period of time, in potentially wet or weather exposed environments, or where weatherproof outlets are indicated on the Drawings.

C. They are also to be used where outlets are subject to contamination, corrosion or damage.

D. The enclosure shall consist of a suitable style outlet/receptacle plate with a hinged safety cover, and shall be of sufficient depth to allow full closure with attachment plugs in use.

E. The enclosure shall have cord ports capable of allowing an appropriate size electrical cords to pass through when safety cover is closed.

F. The enclosure shall have a latching mechanism to allow the enclosure to maintain weatherproof integrity. The latch shall be a tamper resistant, and locking style, in areas where security is needed, as shown on the Drawings.

G. The enclosure shall be Underwriters Laboratories (UL) listed per UL Standard 514C for non-metallic boxes, flush device boxes and enclosures, and conform to National Electric Code (NEC), Article 406.8 paragraphs a and b, Article 110.3 and Article 110.11, pertaining to damp, wet or possible corrosive installations.

H. Body materials shall be of a flame resistant, self extinguishing, ultraviolet inhibiting, impact resistant, polycarbonate resin such as GE Lexan 943A, or Mobay Makrolon 6457. Material must meet UL Standard 94.

I. Gasket materials shall be of sufficient thickness to form a weatherproof seal under normal mounting conditions. Thicknesses; 3/16” for base plate and 1/8" for covers. Material is to be closed cell neoprene foam by Monarch Rubber A5032, or equivalent, self extinguishing and flame retardant. Material must meet UL Standard 94 HF1.

J. Mounting hardware shall be stainless steel, and of sufficient length to properly secure the device, and ensure seal to mounting surface.

K. The enclosures shall be installed over a weatherproof box and outlet in conformance with the manufacturer's instruction. Cover shall be mounted to insure that access holes for the portable line cords will be located at the lower end of the cover.

PART 3 - EXECUTION

3.01 INSTALLATION

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

End of Section

SECTION 16143

TERMINAL BLOCKS

PART 1 - GENERAL

1.01 SCOPE OF WORK

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

1.02 SUBMITTALS

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

1.03 MANUFACTURERS

A. Terminal blocks shall be Entrelec, Phoenix Contact, Allen-Bradley, or equal.

B. Surge protection blocks shall be MTL, Phoenix Contact, Termatrab, or equal.

C. Power distribution blocks shall be Gould, 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 prepunched, zinc bichromate 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 (8/20µs 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 90º C and CSA Certified.

C. PDBs shall provide flexibility in using the connector as an in line splice or to reduce conductor size.

D. PDBs shall be rated for 600 Volts and dual rated for Copper and Aluminum Conductor.

E. PDBs shall have the sizes and ratings as shown on the Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

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

B. Terminal block and fuse holder markers shall be computer printed plastic-type, with permanent markings.

C. End clamps and end sections shall be installed on each terminal block and fuse holder assembly.

D. Terminal blocks for DC voltages shall be blue, and AC voltages shall be gray.

End of Section

SECTION 16160

ENCLOSURES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This specification includes enclosures to house electrical controls, instruments, terminal blocks, and serve as junction boxes where shown on the Drawings.

1.02 SUBMITTALS

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

1.03 MANUFACTURERS

A. Enclosures shall be manufactured by Hammond, 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):
      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 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.

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. 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, Sides, 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, Tables 3-8,9.
2. Welded construction.
3. Completely enclosed, self-supporting, and gasketed dusttight.
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, Tables 3-8,9.
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, Tables 3-8,9.
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 Tables 307B, C in 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 incandescent 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 fluorescent 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 side 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.

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 ground grid system consisting of the indicated configuration of copper wires, and ground rods, or concrete encased grounding electrodes ("UFERs") shall be provided to minimize station potential gradient irregularities and drain leakage and fault currents to earth.

B. Whether indicated on the Drawings or not, neutral conductors, cable shields, metallic conduits, cable terminations, junction boxes, poles, surge arresters, and other noncurrent-carrying metallic parts of equipment shall be grounded.

1.02 SUBMITTALS

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

1.03 REFERENCES

A. National Electrical Code (NEC) Article 250.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

2.02 GROUND RODS

A. Ground rods shall be copper-clad steel conforming to UL 467, 3/4 inch in diameter by 10 feet in length.

2.03 CONNECTIONS

A. Connections above grade shall be made with bolted solderless connectors, and those below grade shall be made by a fusion-welding process. In lieu of a fusion-welding process, a compression ground grid connector of a type which uses a hydraulic compression tool to provide the correct circumferential pressure may be used. Tools and dies shall be as recommended by the manufacturer. An embossing die code or other standard method shall provide visible indication that a connector has been adequately compressed on the ground wire.

2.04 GROUNDING ELECTRODE CONDUCTOR

A. Service entrance ground wires shall be sized in accordance with NEC Table 250.66, unless otherwise indicated on the Drawings. After being located to provide maximum physical protection, exposed ground wires shall be securely attached to structural supports at not more than 2-foot intervals with suitable fasteners. Bends greater than 45 degrees in ground wires are not permitted. Routing of ground conductors through concrete should be avoided, except where specifically called for in these Documents. When concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit, so as to provide an opening for the ground wire. The opening shall be sealed with a suitable compound after installation of the ground wire.

2.05 EQUIPMENT GROUNDING CONDUCTOR

A. Neutral conductors shall be grounded where indicated. Equipment grounding conductors shall be sized in accordance with NEC Table 250.122, unless otherwise indicated. Ground wires shall be protected by conduit, where such wires run exposed above grade in nonfence-enclosed areas, or are run through concrete construction. Where concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit, so as to provide an opening for the ground wire. The opening shall be sealed with a suitable compound after installation of the ground wire. Bends greater than 45 degrees in ground wire connections to the ground rods, or counterpoises are not permitted.

2.06 EQUIPMENT GROUNDING

A. Equipment frames of motor housings, metallic tanks, metallic equipment enclosures, metal splicing boxes, chain-link fencing, and other metallic noncurrent-carrying metal items, shall be grounded. Connections to earth shall be made in the same manner as required for system grounding. Equipment or devices operating at less than 750 volts may be connected to secondary neutral grounding electrodes.

2.07 SURGE ARRESTER GROUNDING

A. Surge arresters shall be grounded. Resistance to ground for intermediate-class arresters shall be not more than 10 ohms and for distribution-class arresters shall be not more than 25 ohms. Ground wire connections shall be not less than No. 4 AWG for distribution arresters and No. 1/0 AWG for intermediate arresters. Connections to earth shall be made in the same manner as required for neutral conductors. Surge arrester grounds may use the same ground wires provided for equipment operating at more than 750 volts. Surge arrester and secondary neutral grounds shall be separate from and independent of each other but both grounds shall be bonded together below grade at the ground rods or may utilize a common counterpoise.

2.08 LIGHTING POLE GROUNDING

A. Base of lighting poles shall be connected to an adjacent ground rod as indicated on Drawings. A ground connection from poles back to neutral ground points shall also be provided utilizing equipment grounding conductor.

2.09 METALLIC STRUCTURES

A. Metallic structures and buildings shall be grounded per NEC.

2.10 GROUNDING RINGS

A. When required, grounding rings shall be installed using bare copper cable with ground rods at least 25 feet intervals using thermoweld connecting means as indicated on Drawings in accordance with NEC requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

A. It is the intent of these Contract Documents that all device and equipment grounds shall be run as a separate conductor in the conduit from the equipment to the distribution panels or system ground. Wireways and enclosures shall be properly bonded and grounded, and ground conductors shall be run for all circuits.

B. Equipment cases and devices shall be grounded. Ground rods shall be driven, and concrete encased conduits installed, before a building, or structure is built, and ground conductors brought through the concrete to accessible points for grounding equipment. These systems shall be installed at each structure, where transformers, switchboards, panelboards, and MCCs are installed.

C. Duct banks shall contain a concrete encased system bare copper ground conductor. The system ground conductors shall run continuously in duct banks, through handholes and other raceway boxes. The system ground shall be connected to the structure grounding systems to provide a continuous grounding system. Each metallic raceway, panel, switchboard, and other metallic devices associated with the electrical and control systems shall be bonded to this grounding system.

D. Ground rod shall be installed not less than 6 inches below grade. In counterpoise systems, tops of ground rods shall be approximately at elevations of counterpoises. Where the specified ground resistance cannot be met with the indicated number of ground rods, additional ground rods, longer ground rods, or deep-driven sectional rods shall be installed and connected until the specified resistance is obtained, except that not more than three additional ground rods shall be required at any one installation. Ground rods shall be spaced as evenly as possible at least 6 feet apart and connected below grade. Equipment, neutral, and surge arrester ground wires shall be connected to the ground grid as indicated.

E. A resistance of not greater than 25 ohms shall be provided, unless otherwise specified. Ground resistances shall be measured as herein described. Resistances of systems requiring separate ground rods, rather than a counterpoise, shall be measured separately before bonding below grade. The combined ground resistance of separate systems bonded together below grade may be used to meet the specified ground resistance, but the minimum number of rods indicated must still be provided.

3.02 TESTS

A. Test the grounding and bonding system in accordance with Specification 16920 – ELECTRICAL ACCEPTANCE TESTING.

B. No part of the electrical system shall be energized until all station grounding system components have been tested and demonstrated to comply with the requirements specified, and until associated test reports have been submitted and approved.

3.03 TEST RESULTS

A. Perform the above tests and submit a certified test report prior to energizing the equipment.

End Of Section

SECTION 16190

SUPPORTING DEVICES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Supports, anchors, sleeves, and seals, are indicated on the Drawings, schedules, and specified in other sections of these Specifications.

B. Types of supports, anchors, sleeves and seals specified in this section include the following:
   1. One-hole Conduit Straps
   2. One-Hole Conduit Straps with Clamp Backs
   3. Two-Hole Conduit Straps
   4. Conduit Hangers
   5. I-beam Clamps
   6. Channel Clamps
   7. Round Steel Rods
   8. Drop-in Anchors
   9. Wedge Type Anchor Bolts
   10. Lead Expansion Anchors
   11. Toggle Bolts
   12. Wall and Floor Seals
   13. Cable Supports
   14. U-Channel Strut System
   15. Sleeves

1.02 SUBMITTALS

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

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following: Abbeon Cal Inc., Ackerman Johnson Fastening Systems Inc., Elcen Metal Products Co., Ideal Industries, Inc., Josyln Mfg and Supply Co., McGraw Edison Co., Rawlplug Co. Inc., Star Expansion Co., U.S. Expansion Bolt Co., Allied Tube and Conduit Corp., B-Line Systems, Inc., Greenfield Mfg Co., Inc., Midland-Ross Corp., O-Z/Gedney Div; General Signal Corp., Power-Strut Div.; Van Huffel Tube Corp., and Unistrut Div; GTE Products Corp., and Robroy Industries.

2.02 GENERAL

A. Provide supporting devices that comply with manufacturers' standard materials, design, and construction, in accordance with published product information, and as required for complete installations, and as specified herein.

2.03 SUPPORTS

A. Provide supporting devices of types, sizes, and materials indicated, and having the following construction features:
   1. One-Hole Conduit Straps: For supporting electrical metallic tubing, and liquidtight flexible conduit; zinc plated steel, stainless steel or galvanized steel; snap-on, heavy duty.
   2. One-Hole Conduit Straps with Clamp Backs: For supporting rigid metal conduit, and intermediate metal conduit; cast galvanized steel.
   3. Two-Hole Conduit Straps: For supporting electrical metallic tubing, rigid metal conduit, and intermediate metal conduit; zinc plated steel, stainless steel or galvanized steel.
   4. Conduit Hangers: For supporting electrical metallic tubing, rigid metal conduit, and intermediate metal conduit; zinc plated steel, stainless steel or galvanized steel.
   5. I-Beam Clamps: Electroplated zinc or hot dipped galvanized malleable iron.
   6. Channel Clamps: Electroplated zinc or hot dipped galvanized steel.
   7. Round Steel Rod: National coarse thread, electroplated.

2.04 ANCHORS

A. Provide anchors of types, sizes, and materials indicated, with the following construction features:
   1. Lead Expansion Anchors: For CMU walls, 1/4"-20 threads, set tool required.
   2. Toggle Bolts: Electroplated steel, size as required.
   3. Drop-in Anchors: Stainless steel, size as required.
   4. Anchor Bolts: Stainless steel, size as required.
   5. Half-round head, non-removable anchor bolts shall not be used.

2.05 SEALS

A. Provide seals of types, sizes and materials indicated; with the following construction features:
   1. Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals, of types and sized indicated; suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.
   2. Conduit sealing bushings shall be manufactured by O-Z/Gedney, Model CSMI, or equal.
   3. The conductor sealing bushings shall be manufactured by O-Z/Gedney, Model CSBG, or equal.

2.06 CONDUIT CABLE SUPPORTS

A. Provide cable supports with insulating wedging plug for non-armored type electrical cables in risers; construct 2" rigid metal conduit; 3-wires, type wire as indicated; construct body of malleable-iron casting with hot-dip galvanized finish.

2.07 U-CHANNEL STRUT SYSTEM

A. Provide U-channel strut system for supporting electrical equipment, 12-gage hot-dip galvanized steel, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with the following fittings that mate and match with U-Channel:
   1. Fixture hangers
   2. Channel hangers
   3. End caps
   4. Beam clamps
   5. Wiring stud
   6. Thinwall conduit clamps
   7. Rigid conduit clamps
   8. Post Bases
   9. U-bolts

2.08 PIPE SLEEVES

A. Provide pipe sleeves from the following:
   1. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.

2.09 PVC COATED U-CHANNEL STRUT SYSTEM

A. Provide PVC Coated U-channel strut system for supporting electrical equipment, 20 mil PVC coated steel, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with all Stainless Steel hardware, and the following fittings that mate and match with PVC Coated U-Channel:
   1. PVC Coated Strut nut
   2. PVC Coated Pipe straps
   3. Touch up compound (Gray)

2.10 STAINLESS STEEL U-CHANNEL STRUT SYSTEM

A. Provide Stainless Steel U-channel strut system for supporting electrical equipment, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with all stainless steel hardware, and the following stainless steel fittings that mate and match with Stainless Steel U-Channel:
   1. Fixture hangers
   2. Channel hangers
   3. End caps
   4. Beam clamps
   5. Wiring stud

6. Post bases
7. Rigid conduit clamps
8. U-bolts

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installation of supporting devices.

B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

C. Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of 2 or more parallel runs of conduits to be supported together on channel type hangers where possible. Install supports with spacing indicated and in compliance with NEC requirements.

D. Torque sleeve seal nuts, complying with manufacturer's recommended values. Ensure that sealing grommets expand to form watertight seal.

E. Comply with manufacturer’s recommendations for touch up of field cut ends or damaged PVC coated U-channel and fittings.

F. Remove burrs and apply a cold zinc galvanizing paint to field cut galvanized U-channel strut.

End of Section

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Electrical identification work specified in this section covers the following:
   1. Buried cable warnings
   2. Electrical power, control and communication conductors
   3. Operational instructions and warnings
   4. Danger signs
   5. Equipment/system identification signs

1.02 SUBMITTALS

A. Submittals to the engineer shall include the following:
   1. Manufacturers data on electrical identification materials and products
   2. Samples of each color, lettering style and other graphic representation required for each identification material or system

1.03 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering electrical identification products maybe incorporated in the work include, but not limited to, the following:
   1. Brady, W.H. Co.
   2. Ideal Industries, Inc.
   3. Panduit Corp.
   4. or, equal

1.04 QUALITY COMPLIANCE

A. Comply with applicable requirements of UL Std. 969, "Marking and Labeling Systems", pertaining to electrical identification systems.

B. Comply with applicable requirements of NEMA Std. No's WC-1 and WC-2 pertaining to identification of power and control conductors.

PART 2 - PRODUCTS

2.01 GENERAL

A. Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an

application, selection is Installer's option, but provide single selection for each application.

2.02 CONDUIT MARKERS

A. Conduit tags shall be 1-1/2-inch diameter, round, brass tags, punched or stamped with conduit number. Font shall be 1/4-inch Arial or Helvetica. The conduit tags shall be as manufactured by Brady or equal.

B. Each tag shall be attached with nylon-coated 48-mil stainless steel wire and fasteners, as manufactured by Brady, Catalog No. 38091, and brass wire clamps, double ferrule design, as manufactured by Brady Catalog No. 38090 to secure the stainless steel wire or equal.

C. Unless otherwise indicated or required by governing regulations, provide white markers with black letters.

2.03 CABLE AND CONDUCTOR WIRE MARKERS

A. Cable and conductor wire markers shall be self laminating vinyl on white background, printed using a Brady TLS2200 printer, Seton printer, or equal. Handwritten wire markers are not acceptable.

2.04 SELF-ADHESIVE PLASTIC SIGNS

A. Provide manufacturer's standard, self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application, e.g., 208V, EXHAUST FAN, RECTIFIER.

B. Unless otherwise indicated or required by governing regulations, provide white signs with black lettering.

2.05 LETTERING AND GRAPHICS

A. Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of electrical systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install electrical identification products as indicated, in accordance with manufacturer's written instructions, and requirements of NEC.

B. Where identification is to be applied to surfaces that require finish, install identification after completion of painting.

C. Comply with governing regulations and requests of governing authorities for identification of electrical work.

3.02 CONDUIT IDENTIFICATION

A. Where electrical conduit is exposed in spaces with exposed mechanical piping that is identified by a color-coded method, apply color-coded identification on electrical conduit in manner similar to piping identification. Except as otherwise indicated, use white as coded color for conduit.

3.03 CABLE/CONDUCTOR IDENTIFICATION

A. Apply cable/conductor identification, including voltage, phase and feeder number, on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work.

3.04 EQUIPMENT/SYSTEM IDENTIFICATION

A. Install engraved plastic-laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system including communication-control-signal systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, 1/2” high lettering on 1-1/2” high sign (2” high where 2 lines are required), white lettering in black field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work:
   1. Panelboards, electrical cabinets and enclosures.
   2. Access panel/doors to electrical facilities.
   3. Major electrical switchgear.

B. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of

equipment. Secure to substrate with brass or stainless steel screws, except use adhesive where screws should not or cannot penetrate the substrate.

3.05 CIRCUIT IDENTIFICATION

A. The 3-phase wires shall be identified at the switchgear, panelboards and motor control centers as Phases A, B, and C. At 277/480V, Phase A shall be brown, Phase B shall be orange, and Phase C shall be yellow. The neutral shall be gray or white.

B. In addition to color coding all conductors, each conductor shall be identified in each pull box, manhole, panelboard, cable tray, or termination with circuit identification markers. This identification is applicable to all power, control, alarm, and instrumentation conductors and these markings shall be recorded on the Record Documents. Markers shall be slip-on PVC sleeve type as manufactured by Brady, Seton, or equal.

C. Markers for other cabling shall be B-292 vinyl as manufactured by Brady, Seton, or equal.

D. Exposed medium voltage conduits shall be labeled at 50-foot intervals with 1-inch letters stating the voltage - example - “12,470 volts”. Labels shall be vinyl plastic as manufactured by Brady, Seton, or equal.

3.06 AUTOMATIC EQUIPMENT WARNING SIGNS

A. Permanent warning signs shall be mounted at all mechanical equipment that may be started automatically or from remote locations. Signs shall be in accordance with OSHA regulations and shall be suitable for exterior use. The warning signs shall be fastened with round head brass screws or bolts, located and mounted in a manner acceptable to the Engineer.

B. Warning signs shall be 7 inches high by 10 inches wide, colored yellow and black, on not less than 18 gauge vitreous enameling stock. Sign shall read:

CAUTION
THIS EQUIPMENT STARTS
AUTOMATICALLY
BY REMOTE CONTROL

3.07 HIGH VOLTAGE WARNING SIGNS

A. Permanent and conspicuous warning signs shall be mounted on all equipment, doorways to equipment rooms, pull boxes, manholes, where the voltage exceeds 600 volts.

B. Signs shall be in accordance with OSHA regulation, and shall be suitable for exterior use. The warning signs shall be fastened with round head brass screws or bolts, located and mounted in a manner acceptable to the Engineer.

C. Signs shall be 7 inches high by 10 inches wide, colored red and white, on not less than 18 gauge vitreous enameling stock. Sign shall read:

WARNING
HIGH VOLTAGE
KEEP OUT

3.08 CONDUCTOR FASTENERS

A. Glue-on type conductor fasteners shall not be used in any panels, panelboards, switchboards, switchgear, motor control centers, or other enclosures containing electrical devices and/or conductors.

End of Section

SECTION 16420

SERVICE ENTRANCE SECTION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers the service entrance section and related service equipment.

1.02 SUBMITTALS

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

B. The contractor shall submit shop drawings, catalog cuts, single line diagrams, component layout drawings and equipment elevation. Shop drawings must indicate all ratings, bus bracing, phasing, and utility requirements.

C. Catalog cuts must be submitted for the service entrance section and components within. Each catalog cut must be properly identified with catalog number and indexed for easy reference.

D. Single line diagrams must be complete with circuit numbers to match the Drawings. Components must be sized and shown in a bill of materials.

E. A wiring diagram must be submitted to show connection and control of devices such as ground fault protection, phase protection relays, and other components. Wiring diagram must include component numbers, matching the bill of materials.

F. Service entrance section must be approved for connection by the serving utility company prior to Engineer's review.

G. The SES must be UL listed as a complete assembly suitable for Service Entrance Duty.

PART 2 - PRODUCTS

2.01 SERVICE ENTRANCE SECTION (SES)

A. The SES shall be a single panel, frame or assembly of panels on which shall be mounted on a deadfront mounting plate, circuit breakers or fused switches, metering equipment and any monitoring or protection devices as indicated on the drawings.

B. The SES shall be a one-piece enclosure with front accessibility unless otherwise required. The SES shall have a metered distribution section complete with meter socket and factory installed test blocks, customer power metering, Surge Protective Device

(SPD) and a pull section, overhead or underground, as indicated on the drawings; all of which shall comply with the requirements of the serving utility.

C. The enclosure shall be zinc coated steel, minimum 12 gauge thickness. Cabinet shall be protected against corrosion in accordance with U.L. 50, Cabinets and Boxes, Section 13. Exterior covers to be minimum 14 gauge steel, and shall have padlocking provisions. Deadfront shall be a hinged type, 16 gauge minimum, and shall not require the use of a tool to expose interior components for installation or servicing. Factory installed components shall be U.L. listed. Factory installed conductors shall be copper, size and type to conform to NEC and U.L. requirements (minimum size #14 AWG). Construction shall be such to prevent the entry of rodents into the interior. Ventilation openings shall be provided.

D. Unless otherwise indicated on the Drawings, the enclosure shall be rated NEMA 3R for outdoor use, or NEMA 1A for indoor use.

E. Bus bars (including neutral and ground) shall be silver or tin plated solid copper and braced to withstand short circuit amps as indicated on the Drawings.

F. The SES shall have a steel nameplate stamped indicating the equipment voltage, amperage and short circuit withstand rating, mounted on the outside of the enclosure.

G. Padlocking provisions shall be provided to lock the device in the “OFF” position.

H. The overcurrent protection shall be rated as indicated, and as specified elsewhere herein.

I. Metering and instrumentation shall be as indicated, and as specified elsewhere herein.

J. On circuit breakers 800 amps and larger, a trip button shall be provided.

K. The Service Entrance Section shall be as manufactured by Eaton, Square D, or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The Service Entrance Section shall be installed per manufacturer's instructions, as indicated on the drawings, per all applicable NEC and local codes and regulations, and shall comply with serving utility's requirements.

B. Grounding shall be provided as required by the NEC, and as indicated on the Drawings.

3.02 TESTING

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

B. The Short Circuit Calculations, Coordination Study and Arc Flash Study will be performed by the contractor. The labeling will be supplied and installed as per the latest version of NFPA 70E Standard for Electrical Safety in the Workplace.

End of Section

SECTION 16430

CUSTOMER POWER METERING SYSTEM

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This specification covers the customer power monitoring system installed on the service entrance section(s), motor control center(s), and other distribution panel(s) as indicated on Plans.

1.02 SUBMITTALS

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

B. Submit manufacturer's catalog cut sheet indicating all options to be supplied as specified herein.

C. Submit shop drawing indicating wiring connection diagram and elevation drawing indicating location of component(s) on the service entrance section.

1.03 MANUFACTURERS

A. Acceptable manufacturers subject to compliance with the specifications herein are as follows:
   1. Eaton
   2. Square D
   3. Allen Bradley

PART 2 - PRODUCTS

2.01 GENERAL

A. The system shall consist of electronic circuit monitors as required to obtain signals as specified herein. Components shall include CT's, PT's, CPT, etc. and other devices as required.
   1. The electronic Circuit Monitors shall report metering values such as frequency, temperature, current, voltage, power factor, power, demand current, and real power, and accumulated energy.
   2. Each Circuit Monitor shall retain historical circuit data, time and date, setup and configuration values, and diagnostics data in the event of a control power failure without the need for an internal battery.

3. Each Circuit Monitor shall be capable of capturing current and voltage waveforms which may be exported to a personal computer where waveform or other power quality analysis may be performed.
4. The Circuit Monitor shall include an LED readout which will allow local display of the following electrical parameters:
    a. Current, per phase RMS
    b. Voltage, phase-to-phase & phase-to-neutral
    c. Real power, 3-phase total
    d. Reactive power, 3-phase total
    e. Apparent power, 3-phase total
    f. Power factor, 3-phase total & per phase
    g. Frequency
    h. Peak demand current, per phase
    i. Peak demand, real power
    j. Accumulated Energy, (MWH and MVARH)
5. Reset the following electrical parameters shall also be allowed from the front of the Circuit Monitor:
    a. Peak demand current
    b. Peak demand power
    c. Energy (MWH)
    d. Reactive energy (MVARH)
6. Circuit Monitor setup for system requirements shall be allowed from the front of the Circuit Monitor. Setup provisions shall include:
    a. CT rating (xxxx:5)
    b. PT rating (xxxxx:120)
    c. System type (3-wire and 4-wire)
    d. Demand interval (5-60 min.)
7. All reset and functions shall be keyswitch protected to prevent unauthorized/accidental changes.
8. Unit shall be equipped with a communications adapter/module so as to facilitate communications with a remote PLC via the Ethernet/IP protocol.

B. The system shall have System Display units which display data from the Circuit Monitors. The display unit shall contain the following:
1. Each System Display shall provide real-time access to all metering data available for each circuit (present as well as historical data).
2. Each System Display unit shall access and display the data available from selected electronic Circuit Monitors connected on the individual data transfer network.
3. The System Display unit shall utilize a 4 line by 20 character, high contrast LCD technology display with backlighting to provide high reliability and superior readability in all light conditions.
4. The level of backlighting as well as the contrast shall be adjustable.
5. The System Display unit shall allow for easy operation by providing a keypad with large keys for operator selections.
6. The keys shall have a raised perimeter and tactile feedback to ensure a positive response even with gloved hand operation.

7. The keys shall be clearly marked to indicate the function and separated into meaningful groups with display prompting to assist the user in operation.
8. Each System Display unit shall be configured by the manufacturer with all necessary data such as CT ratios, PT ratios, main and feeder device nameplates, demand alarm set points, etc.
9. It shall be possible to change the configuration for each System Display unit using the keypad provided on each display.
10. This capability shall be password protected to prevent unauthorized modification of the configuration.
11. All data with the exception of the captured waveform shall be accessible by the System Display unit.
12. Data shall be displayed in a logically organized manner complete with the proper scaling and units.
13. It shall be possible to sequentially view all available data from a selected Circuit Monitor by single keystroke advancing through the various display pages.
14. It shall be possible to view the same pages of data from other Circuit Monitors by single keystroke advancing back and forth from Circuit Monitor to Circuit Monitor.

C. Software for a personal computer shall be provided as specified herein:
1. The Metering System Software to be supplied shall be suitable for operation on a personal computer.
2. System Software shall be capable of alarm reporting, event logging, data logging, on-line monitoring of instrumentation/status/alarms, waveform analysis, manual control of circuit breakers or other selected devices and shall include sufficient levels of password protection.
3. The software shall be capable of performing background activities such as alarms and automatic logging while the computer is used for other programs such as word processing, spreadsheet, etc.
4. Software shall be supplied by switchgear manufacturer which will display all information available from the Circuit Monitors. This software shall include the following characteristics/capabilities:
    a. MicroSoft windows based with mouse
    b. View & log instrumentation data
    c. View voltage/current waveforms and analyze waveform data
    d. Perform diagnostics/setup
    e. Display tables, charts & graphs
    f. Display meters, meter panels graphically
    g. Event logging
    h. Alarm reporting
    i. Reset energy alarms/historical data
    j. Background data logging
    k. Three level password protection
    l. Manual control of Circuit Monitor outputs
    m. Display status (circuit breakers, relays, trip units, etc.)

PART 3 - EXECUTION

3.01 INSTALLATION

A. System Display units shall be installed by the manufacturer in the switchgear as indicated on the plans.

B. The System Display units shall be flush mounted on switchgear door panels.

C. Electronic Circuit Monitors shall be installed by the switchgear manufacturer for all circuits as indicated by the project drawings.

D. All control power, CT, PT, and communications wire shall be factory wired and harnessed within the switchgear lineup.

E. Where external circuit connections are required, terminal blocks shall be provided and the manufacturer's drawings must clearly identify the interconnection requirements including wire type to be used.

F. The metering components included within the service entrance sections shall be factory installed, wired and tested prior to shipment to the job site.

G. All wiring required to externally connect the personal computer shall be installed by the Contractor per manufacturer's requirements and per other portions of these specifications.

H. Contractor interconnection wiring requirements shall be clearly identified on the metering system drawings to be submitted for approval.

3.02 TESTING

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

3.03 TRAINING

A. On-site start-up and training of the metering system shall be included in the project bid.

B. Start-up shall include a complete working demonstration of the system with simulation of possible operating conditions which may be encountered.

C. Training shall include any documentation and hands-on exercises necessary to enable operations personnel to assume full operating responsibility for the system after completion of the training period.

D. The project bid shall include 2 days start-up assistance and 1 day training.

End of Section

SECTION 16440

DISCONNECT SWITCHES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers electrical disconnecting switches.

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 DISCONNECT SWITCHES

A. Disconnect switches shall be heavy-duty safety switches with a quick-make, quick-break operating mechanism, with full cover interlock, and indicator handle. The disconnect switches shall be furnished with fuses of the size indicated on the Drawings. One set of spare fuses shall be furnished for each fused disconnect switch. Disconnect switches shall be NEMA type HD heavy duty construction, UL 98 listed.

B. Enclosures shall be rated NEMA 12 for indoor use, and NEMA 3R for outdoor use, unless otherwise indicated on the Drawings.

C. Disconnect switch handle shall be padlockable.

D. Disconnect switches in the corrosive areas as indicated on the Drawings, shall be NEMA 4X, 304 stainless steel.

E. Disconnect switches shall be as manufactured by Square D, Eaton, or Allen-Bradley.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Disconnect switches shall be installed as indicated on the Drawings.

B. Provide grounding per NEC, and Section 16170.

3.02 TESTING

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

End of Section

SECTION 16461

TRANSFORMERS - DRY TYPE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers dry type transformers used for low voltage, single and three phase, power distribution and lighting.

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. ANSI C57.12.01, dry-type transformers

B. ANSI C89.2, dry-type transformers

C. NEMA ST-20, dry-type transformers

D. UL-506, specialty transformers

PART 2 - PRODUCTS

2.01 DISTRIBUTION - LOW VOLTAGE LIGHTING AND POWER

A. Transformers shall be premium high efficiency quiet type, and shall be installed where indicated on the Drawings. The primary winding of the transformers shall have two 2-1/2 percent taps above, and below normal.

B. The transformers shall have a BIL of 10 KV with a temperature class of 185 degrees C for transformers up to 25 KVA, and a temperature class of 220 degrees C for larger transformers.

C. The sound level shall not exceed 44 dBa measured at 5 feet from the transformer after installation. Core and coil assemblies 30 KVA and larger, shall be mounted on rubber vibration isolators, designed to reduce harmonics generated noise.

D. Transformer size shall be as indicated on drawings and shall be provided and installed by MCC manufacturer.

2.02 FERRO RESONANT ISOLATION TRANSFORMERS

A. Ferro resonant isolation transformers shall be provided where indicated on the Drawings. Regulation shall be +3 percent for an input range of +10 percent. Common mode noise rejection shall be better than 120 dB with transverse mode noise rejection better than 60 dB. Voltage spike attenuation shall be better than 250:1.

B. Isolation transformers shall be as manufactured by Shape Magnetronics, Control Concepts, Inc., or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Transformers shall be installed as indicated on the Drawings, and in accordance with the manufacturer's instructions and recommendations. Contractor shall provide painted metal wall brackets, when required.

B. Grounding shall be provided per NEC, and Section 16170.

3.02 TESTING

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

End of Section

SECTION 16470

PANELBOARDS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. MCC panelboard (distribution panel)

1.02 RELATED SECTIONS

A. Section 16000 – General Electrical Requirements

B. Section 16195 - Electrical Identification

C. Section 16505 – Transient Voltage Surge Suppression (SPD)

1.03 CODES, STANDARDS, AND REGULATORY REQUIREMENTS

A. All parts, materials, assembly, installation, testing and commissioning shall meet the requirements of the latest edition of the following Codes and Standards, and Regulatory agencies. In case of the conflict between the codes' requirement, the most stringent shall apply.
   1. Underwriters' Laboratories:
      a. Panelboards: UL 67
      b. Enclosures for Electrical Equipment: UL 50
      c. Molded Case Circuit breakers and Circuit Breaker Enclosures: UL489
   2. FS W-C-375 - Circuit Breakers, Molded Case, Branch Circuit and Service.
   3. FS W-P-115 - Power Distribution Panel.
   4. NEMA AB 1 - Molded Case Circuit Breakers.
   5. NEMA PB 1 - Panelboards.
   6. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
   7. NEMA PB 1.2 - Application Guide for Ground-fault Protective Devices for Equipment.
   8. NFPA 70 - National Electrical Code.
   9. UBC - Uniform Building Code.
   10. NETA - International Electrical Testing Association.

1.04 SUBMITTALS

A. Shop drawings for equipment and component devices.

B. Include outline, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker arrangement, sizes and numbering system.

C. Include information on all the accessories, locking hardware, shunt trip, under-voltage release mechanism, typical thermal magnetic curves for each size and type.

1.05 SPARE PARTS

A. N/A

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. To be provided and installed by MCC manufacturer.

2.02 BUS AND HARDWARE

A. Panelboards shall be completely factory assembled and equipped with the type, size and number of branch circuit breakers, arranged and numbered as shown on the Plans. Panelboards shall be fully rated. Series rated panelboards are not acceptable.

B. All multi-pole breakers shall be common trip. Branch circuits shall be arranged using double row construction. Bus sequence shall be ABC top to bottom, left to right for both top and bottom fed panels. Provisions or space for future breakers shall be located at the bottom of the panel and be fully bussed, complete with all necessary mounting hardware. Use at least 100 ampere breaker-connecting bus straps and mounting hardware.

C. Where SPARE is indicated on the panel schedule(s), the specified circuit breaker and at least 100 ampere branch-circuit busing and mounting hardware shall be installed.

D. Where SPACE is indicated on the panel schedule(s), 100 ampere branch-circuit busing and mounting hardware shall be installed, ready for future installation of circuit breakers, furnished by others. At least 20% spare pole spaces, grouped in multiples of three, shall be provided in each panelboard, for future installation by the Owner. Provide single pole filler plates in the spaces, as required.

E. A nameplate shall be provided, and located near the top of the front trim on the exterior surface, listing panel type and ratings, as required by UL. Each circuit shall be permanently numbered to agree with the panel schedule, using plastic or metal buttons mounted adjacent to the breaker and secured by rivets or grommets with an engraved or depressed number. Adhesive numbering tape, painted numbers, or use of more than one number per breaker is not acceptable.

F. Main vertical bus bars shall be copper and silver or tin plated per UL requirements. Bus bars shall be supported by glass-filled polyester-type insulators. All bolts, used to connect current-carrying parts together, shall be accessible for tightening from the front of the panel. Bus bars shall be factory drilled and tapped with spacing arranged to permit breaker interchange, from the front, while the panel is energized.

G. Neutral bus shall be copper and insulated from the cabinet and all other parts. It shall be rigidly mounted in the panel and shall be provided with a solderless cable connector for each circuit breaker and each space in the panelboard and the main connecting lug(s).

H. A 1/4-inch (8mm) thick copper equipment ground bus, of sufficient width and length, shall be solidly bolted and grounded to the enclosure at the bottom and shall leave clear space for the bottom cable entries. The bus shall be drilled and tapped for 1/4" (8mm) - #20 machine screws in number to agree with branch circuits and spaces. A solderless connector, for No. 2 to No. 4/0 cable size, shall be bolted to the ground bus.

I. Copper bus bars shall be of sufficient size to provide a current density of not more than 1000 amperes per square inch of cross section, and not more than 200 amperes per square inch at bolted connections.

J. Minimum Short Circuit Rating for Bus Bracing: The bus shall be braced for the minimum symmetrical short circuit rating of the panel, as shown on the panel schedule.

K. Provide main bus pressure connectors (main lugs) and separately supported sub-feed pressure connectors (lug landings) where noted. Provide additional bottom raceway space to accommodate pressure connectors and lug landings. In no instance shall the gutter space be less than required by NFPA-70.

L. Provide Transient Voltage Surge Suppression (SPD) where required on Plans.

M. Where required on Plans, provide re-installed locking devices for locking each circuit breaker in the OPEN position, by means of a padlock. Locking devices shall not be removable from the front of the panel with the trim in place. Attachment of the locking device to the panel with adhesives is not acceptable.

2.03 CIRCUIT BREAKERS

A. Molded Case Circuit Breakers: NEMA AB 1; provide bolt-on type circuit breakers with integral thermal and instantaneous magnetic trip in each pole and common trip handle for all poles. Provide circuit breakers, UL listed as Type HACR, for air conditioning equipment branch circuits. Provide circuit breakers, UL listed as Type SWD, for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where shown on Plans.

B. Instantaneous magnetic trips shall be accessible and adjustable from the front of the breaker on frame sizes above 100 amperes.

C. All breakers shall be rigidly mounted, separately removable and independent of trim plates for their support. Breakers shall be bolt on type.

D. The minimum width of one pole shall be 1-3/8 inches. The breaker shall be "E" frame minimum.

E. The minimum symmetrical interrupting rating for molded-case circuit breakers shall be as specified on the panel schedule(s). Series rated breakers are not acceptable.

2.04 CABINETS (BOXES)

A. All details of construction and methods of assembly shall meet the requirements of the "Enclosures for Electrical Equipment" of the Underwriters' Laboratories. The panel box shall not be less than 20” wide, 4.5” deep and of sufficient height to enclose the specified main and branch circuit breakers, buses, metering equipment and wire gutter. The panelboard enclosure shall be fabricated from code-gauge galvanized or galvanized-annealed steel without knockouts and with full front flange. The panel front shall be as shown on the plans and fabricated from cold rolled steel. Surface mounted panel boxes shall be finished with an ANSI-61 light grey baked enamel. There shall be no screws projecting into the wiring raceways. The panelboard enclosure type shall be coordinated with the environment and location shown on the plans. Unless noted otherwise on the panel schedule, provide NEMA 3R for panelboards located out of doors and NEMA 12 elsewhere.

B. The front trim shall have full-length hinged outer door designed to expose the wiring raceways and breakers, when open. Another, inner hinged door shall expose breakers only, when open, making this a door-in-door construction. Both doors shall open to the right.

C. Both doors shall be provided with concealed butt or piano hinges. A suitable latch, which can be operated without tools, shall be provided to properly hold the inner door closed. For doors 30 inches (765mm) high or less, a flush-type latch is satisfactory. For doors more than 30 inches (765) high, a vault-type handle shall be provided with a three-point latch that holds the door closed at the top and bottom. The outer door shall be secured with at least four (4) captured oval head machine screws.

D. A sturdy metal frame, with a clear plastic cover, for an 8-1/2 inch x 11 inch panel schedule, shall be attached inside of the panel door with the RTV adhesive.

E. Panel trim and doors, and surface mounted cabinets shall be thoroughly cleaned, given a rust-inhibiting treatment, and finished with an ANSI-61 light grey baked enamel.

F. All panelboards shall bear the Underwriters' Laboratories label.

2.05 EXCEPTIONS

A. The bidders shall list all the exceptions taken from the specification with their quote. If no exceptions are listed with the bid, it is understood that the bidder shall meet all the requirements of this specification and applicable Codes and Standards.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Provide filler plates for unused spaces in panelboards.

B. Provide typed or neatly hand printed 8-1/2x11-inch circuit directory for each panelboard, in the format as shown on the drawings. Revise directory to reflect circuiting changes required to balance phase loads.

3.02 QUALITY CONTROL

A. Owner reserves the right to witness any of the following tests conducted by the contractor and shall be notified in advance of these tests. Test in accordance with Specification 16920 – ELECTRICAL ACCEPTANCE TESTING.

B. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Maintain proper phasing for multi-wire branch circuits.

3.03 FINAL SUBMITTALS

A. After completion of the installation, wiring and testing, submit the following information within two weeks of the equipment acceptance.
   1. As-Built Panel Schedules.
   2. Copy of the certified test report described in Section 3.02.

END OF SECTION

SECTION 16475

MINI POWER CENTERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers electrical Mini Power Centers.

PART 2 - PRODUCTS

2.01 MINI POWER CENTERS

A. The contractor shall furnish and install Mini Power Centers, as indicated on the Electrical Drawings.

B. Single phase transformers shall be 480 volt primary and 240/120 volt secondary. Three phase transformers shall be 480 volt primary and 208 Y/120 volt secondary.

C. All transformers shall have a minimum of 2-5% full capacity primary taps below normal and shall be rated 115 degree temperature rise above 40 degree maximum ambient. All insulating materials are to be in accordance with current ANSI C89.2 and NEMA ST20 standards for a 185 degree UL component recognized insulation system. Transformers are to be encapsulated using a sand-epoxy resin mixture to provide maximum protection against moisture, dust and corrosive environments.

D. Enclosures shall be cleaned, phosphatized and electrostatically powder coated and shall be UL Listed for indoor and outdoor use.

E. Mini Power Center Units shall include integrally mounted and wired primary and secondary main circuit breakers in accordance with National Electrical Code requirement. These breakers and all branch circuit breakers shall be bolt-on type and as specified elsewhere within these specifications. Minimum AIC rating shall be as indicated on Drawings.

F. A hinged access door shall be provided which maintains itself in the open position when desired, and which has padlock provisions to prevent unauthorized entry. All live parts are to be fully enclosed for personnel protection when installation is completed. The transformer and panelboards shall be constructed with separate enclosures capable of being assembled or disassembled as independent units.

G. The Mini Power Centers shall be UL Listed for use as service equipment.

H. The Mini Power Centers shall be as manufactured by Square D or Eaton.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Mini Power Centers shall be installed as indicated on the drawings and per manufacturer's instruction.

3.02 TESTING

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

End of Section

SECTION 16476

LOW VOLTAGE CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

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

1.02 SUBMITTALS

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

1.03 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.01 GENERAL

A. Circuit breakers shall be as manufactured by Square D, Eaton, or Allen-Bradley.

B. Circuit breaker frame, trip, short circuit, and interruption ratings shall be as indicated on the Drawings, except that they shall be coordinated with the ratings of the equipment actually furnished, and shall be modified where necessary to suit the equipment. Circuit breakers to be used in motor control centers shall be as indicated on the Drawings. Where no indication of type is given on the Drawings circuit breakers protecting motors shall be motor circuit protectors, and other circuit breakers shall be molded case type.

C. Circuit breaker for mounting in motor control centers, or for separate mounting shall be of the air-break type, quick-make and quick-break, 600 volt, with number of poles as indicated on the Drawings.

D. Each pole of the circuit breaker shall provide inverse time delay, and instantaneous circuit protection.

E. The breakers shall be operated by a handle, and shall have a switching mechanism that is mechanically trip free from the handle, so that the contacts cannot be held closed against short circuits, and abnormal currents. Tripping due to overload, or short circuit shall be clearly indicated by the handle automatically assuming a position between the manual ON and OFF positions. Latch surfaces shall be ground and polished. Poles shall be constructed so that they open, close, and trip simultaneously.

F. Breakers must be completely enclosed in a molded case. Non-interchangeable trip breakers shall have their covers sealed; interchangeable trip breakers shall have the trip unit sealed to prevent tampering. Ampere ratings shall be clearly visible. Contacts shall be non-welding silver alloy. Arc extinction must be accomplished by means of arc chutes. The minimum interrupting ratings of the circuit breakers shall be at least equal to the available short circuit current at the line terminals.

G. Circuit breakers shall conform to the applicable requirements of NEMA Standards Publication No. AB1.

H. Molded case circuit breakers shall be ambient temperature compensating that provides inverse time delay overload and instantaneous short circuit protection by means of a thermalmagnetic element. Compensation shall be accomplished by a secondary bi-metal that will allow the breaker to carry rated current between 25 degrees C and 50 degrees C with tripping characteristics that are approximately the same throughout this temperature range.

I. On breakers with interchangeable, thermal, adjustable magnetic trip, the accessibility and position of the adjustment knob shall not be changed from those on the standard breaker.

J. Unless mounted in a switchboard, or panelboard, circuit breakers shall be housed in a NEMA rated enclosure as described elsewhere in these specifications.

K. Provide circuit breakers with shunt trip mechanisms where shown on the Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

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

End of Section

SECTION 16477

600 V FUSES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers the requirements for protective fusing on this project. The Contractor shall furnish and install fuses and fuse holders per the Drawings and equipment manufacturers' recommendations.

B. This specification includes the general requirements for various types of fuses whether they are shown on the Drawings or not. If fusing is required by codes or manufacturers recommendations, but not shown on the Drawings, this specification shall apply to the type of fusing provided by the Contractor.

C. Types of fuses specified in this section include the following:
1. Class L time-delay.
2. Class L fast-acting.
3. Class RK1 time-delay.
4. Class RK1 and Class J current-limiting.
5. Class RK5 time-delay.
6. Class K5 time-delay, noncurrent-limiting.
7. Class T current-limiting.

1.02 QUALITY ASSURANCE

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

1.03 CODES AND STANDARDS

A. UL Compliance and Labeling: Comply with applicable provisions of UL 198D, "High-Interrupting-Capacity Class K Fuses". Provide over-current protective devices which are UL-listed and labeled.

B. NEC Compliance: Comply with NEC as applicable to construction and installation of fusible devices.

C. ANSI Compliance: Comply with applicable requirements of ANSI C97.1 "Low-Voltage Cartridge Fuses 600 Volts or Less".

1.04 SUBMITTALS

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

addition, include voltages and current ratings, interrupting ratings, current limitation ratings, time-current trip characteristic curves, and mounting requirements.

1.05 MANUFACTURERS

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

PART 2 - PRODUCTS

2.01 GENERAL

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

2.02 CLASS L TIME-DELAY FUSES

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

2.03 CLASS L FAST-ACTING FUSES

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

2.04 CLASS RK1 TIME-DELAY FUSES

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

2.05 CLASS RK1 CURRENT-LIMITING FUSES

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

2.06 CLASS J CURRENT-LIMITING FUSES

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

2.07 CLASS RK5 TIME-DELAY FUSES

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

2.08 CLASS K5 ONE-TIME FUSES

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

2.09 CLASS T FUSES

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

PART 3 - EXECUTION

3.01 INSTALLATION

A. Fuse types and sizes shall be as indicated on the Drawings. If size and type isn't indicated on drawings, size and type is to be per associated equipment manufacturers recommendations. 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 16481

MOTOR CONTROL CENTERS (MCC)

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall furnish and install, ready to use, motor control centers for use as indicated on the Drawings and specified herein.

B. Circuit breaker ratings, and modifications, shall be as indicated on the Drawings.

C. MCP ratings and starter sizes shall be as indicated on the Drawings.

1.02 SUBMITTALS

A. The motor control centers shall meet the requirements of the latest edition of Standards for Industrial Control No. ICS published by the National Electrical Manufacturers Association. The following minimum information and drawings shall be submitted for review:

1. Plan, front, side views and overall dimension of each motor control center.
2. Weight.
3. Internal wiring diagram of each plug-in unit.
4. Internal wiring diagram of the motor control centers.
5. External connection diagram showing the wiring to the external controls and devices associated with the motor control center.
6. A one-line and a schematic diagram for each motor control center.
7. Bill of material list and Manufacturer's Product Data.
8. Installation instructions.
9. Manufacturer's certification that the following items are capable of interrupting and/or withstanding the specified short circuit condition:
    a. Bus bar bracing
    b. Feeder tap units
    c. Starter units

B. Product information shall be submitted in accordance with Section 16000, and elsewhere in the Contract Documents.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

1. Eaton
2. Square D
3. Allen Bradley

2.02 MOTOR CONTROL CENTERS (MCC)

A. The motor control center fabricator shall be the manufacturer of the major components therein, such as circuit breakers and starters. Engineered motor control centers shall be by the component and housing manufacturer. The manufacturer shall comply with equipment specifications contained elsewhere in these Contract Documents.

B. Each component, as well as the complete assembly, shall be constructed and tested in accordance with latest NEMA Standards for Industrial Control. The type of construction of the control centers shall be NEMA Class II, Type B. Lifting eyes shall be provided on each section to facilitate handling.

C. Unit doors shall be mounted on the stationary structure and hinged on the side away from the vertical wireway. They shall be held closed with slotted thumbscrews.

D. Unit doors shall have positive action linkage with disconnect operating mechanism. Mechanism shall be designed so that it can be locked in the OFF position with up to 3 padlocks. When the handle is not padlocked, it shall be possible to open the door by releasing the door interlock with a small tool. The control units shall be of the plug-in type. When doors are closed, the operating mechanism shall clearly indicate the ON or OFF position of the disconnect, and the door interlock mechanism shall engage. The disconnect operating mechanism shall be designed against inadvertent operation when the door is open. Each plug-in unit door shall be provided with a nameplate, specified elsewhere herein, that indicates the circuit number and circuit name. The nameplate shall be attached to the door with brass or stainless screws.

E. It shall be possible to install up to 6 NEMA size one units in one vertical section. Units shall be completely enclosed with sheet steel. A small wireway shall be provided inside the unit, so all wiring can be laid in place without removing barriers or plates. Each vertical section that holds the units shall be rigidly formed of minimum 12 gauge, cold-rolled sheet steel. The vertical front-of-board-construction shall be supplied with minimum 20-inch depth.

F. Continuous horizontal wiring troughs shall be provided at both top and bottom of each section. These troughs shall line up to form a continuous wireway for the full length of the MCC. A large continuous, full-height vertical wiring trough shall be provided in the right side of each section.

G. All starter wiring, control, and power shall be terminated in terminal strips in this trough for size 2 and smaller starters. Size 3 and larger starters shall have control leads terminating on the terminal strips in the trough. Terminal strips shall be split-type to facilitate wiring connections without disconnecting factory or field conductors. Terminal strips shall be rated to accept conductor sizes as indicated on the Drawings.

H. Bus bars shall be silver plated copper, and shall be of the ampacity indicated on the Drawings. Unit bus bar stabs shall insure high contact pressure. The vertical bus bars shall be effectively isolated from accidental contact by plastic insulating medium.

Horizontal bus shall be silver-plated at every joint. The entire vertical bus shall be silver-plated copper.

I. Bus bar supports shall be of high impact strength, non-carbonizing insulating material mounted on padded steel brackets and shall provide adequate dielectric strength and creepage distance. The bus structure shall be capable of withstanding short circuit current in accordance with NEMA standards, and as indicated on the Drawings.

J. Horizontal bus amperage rating shall be as indicated on the Drawings.

K. Each section shall be equipped with horizontal ground bus that shall be continuous across the MCC.

L. The MCCs shall be supplied as indicated on the Drawings, and as specified herein and in accordance with NEMA Standard Pub. IS 1.1, latest edition. The MCCs shall be enclosed in NEMA Type 1 gasketed industrial use enclosures, unless otherwise shown. NEMA 3R enclosures shall provide sufficient depth for air conditioning units to be mounted on the end of the structures. If the MCCs contain VFDs or Solid State Starters that require cooling, their respective sections shall be louvered top and bottom, and fans shall remove heat from within the sections.

M. All metal surfaces and structural parts shall be given a phosphatizing, or equal, treatment prior to painting. The control centers shall then be given a gun-metal gray undercoat which is equal to zinc chromate. The exterior of the enclosure shall be finished in standard ANSI Grey.

N. Spaces for future combination starters shall have all the hardware necessary so that a future plug-in control unit can be installed without having to modify the vertical sections. The number of spaces for future control units shall be as indicated on the Drawings.

O. Devices, such as, but not limited to, starters, circuit breaker, relays, timers, conductors, shall conform to other sections of these Contract Documents.

P. Provide customer metering instruments, as indicated on the Drawings. Unless otherwise indicated on the Drawings, metering units shall be electronic, capable of displaying volts line-to-line and line-to-neutral, and amps per phase.

Q. Ethernet/IP Communication
   1. MCC’s shall have Ethernet wiring incorporated into its design.
      a. MCC’s shall have factory installed industrial Ethernet cabling incorporated throughout the vertical section across the entire lineup.
      b. Each motor starter shall be supplied with a means to communicate via Ethernet/IP network.
      c. Plug-in units should be able to move around without impacting the network.
      d. Maintenance activities should be able to be performed without impacting the network.

2. Industrial Ethernet Switches
    a. MCC's shall be equipped with managed industrial Ethernet switch(s) to connect each Ethernet/IP enabled devices.
3. Industrial Ethernet Cabling
    a. Ethernet cabling within MCC shall be 600V UL Category 5e PLTC rated; 300V rated cable is not acceptable.
    b. Ethernet switch-to-device cable labels shall be located on both ends of the cable to specify where the cable is connected to on both ends.
    c. A detailed Ethernet network table and Ethernet network diagram specifying IP addresses, subnet masks, device locations, cable label details, and 24VDC capacities shall be included in MCC documentation.
4. Power Supplies
    a. MCC's shall be equipped with industrial rated, 24VDC power supplies to provide power to Ethernet enabled devices within MCC that require it.
5. Ethernet/IP Interface for Motor Starter Units
    a. All FVNR motor starter units shall be equipped with an overload relay that incorporates the following features:
        1) Built-in Ethernet/IP communication
        2) Overload relay shall be powered by 24VDC
        3) Status indicators for status indication
        4) Up to six (6) inputs and three (3) outputs of direct I/O. Additional I/O can be provided with an add-on module to the overload relay if required.
        5) Protective functions shall include:
            a) Thermal overload
            b) Phase loss
            c) Underload
            d) Current Imbalance
        6) Current monitoring functions shall include phase current, average current, full load current and current imbalance percent.

R. 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.

PART 3 - EXECUTION

3.01 GENERAL

A. The MCCs shall be erected in accordance with the recommendations of the manufacturer and with the details specified herein.

B. Cables larger than No. 6 AWG, which hang from their vertical connections, shall be supported within 2 feet of the connection.

C. The motor overload relays shall be provided and sized based on the actual full load amperes of the motor connected to the starter.

D. The motor circuit protectors shall be adjusted to the lowest settings that do not cause false tripping.

3.02 TESTING

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

B. The Short Circuit Calculations, Coordination Study and Arc Flash Study will be performed by the contractor. The labeling will be supplied and installed as per the latest version of NFPA 70E Standard for Electrical Safety in the Workplace.

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.

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. Verification that unit is listed by an independent testing laboratory in accordance with Electric Industrial Control Equipment Specification UL508.
   6. 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 1 year warranty on materials and workmanship from date of start up or 18 months from date of shipment.

B. An optional extended warranty shall be available for up to an additional two years.

PART 2 - PRODUCT

2.01 MANUFACTURERS

A. Square D

B. Eaton

C. Allen-Bradley

D. No 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 over a minimum ambient temperature range 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.

F. 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. Disconnect may be either fused or circuit breaker style as shown on the contract drawings.

B. Provide lights, pushbuttons, 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 (min.), 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.

H. Soft starts shall be equipped with an Ethernet communications adapter/module that is capable of communicating via the 'EtherNet/IP' communications protocol.

2.07 BYPASS/SHORTING CONTACTOR

A. Starters shall be equipped with either integral or external bypass/shorting contactors.

B. A microprocessor shall control the operation of the shorting contactor via an output relay (external contactor).

C. 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.

D. 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 CONTACTORS

A. As recommended by soft start manufacturer, provide NEMA rated three-pole isolation contactor or shunt trip breaker so as to completely isolate the SSMC from the incoming power in the event of a shorted SCR or another defined fault condition.

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

Test in accordance with Specification 16920 - ELECTRICAL ACCEPTANCE TESTING.

End Of Section

SECTION 16495

AUTOMATIC TRANSFER SWITCH

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Automatic transfer switch shall be furnished and installed, as indicated on the Drawings, with full load current rating as indicated on the Drawings. The switch shall be capable of switching all classes of load, and shall be rated for continuous duty when installed in a non-ventilated enclosure. Withstand current rating shall be as indicated on the Drawings.

1.02 SUBMITTALS

A. Contractor shall submit shop drawings, manufacturer's data sheets, and a complete wiring diagram detailing all connections to the electrical system in accordance with Section 16000, and other requirements of the Contract Documents.

PART 2 - PRODUCTS

2.01 AUTOMATIC TRANSFER SWITCH

A. The automatic transfer switch shall be of the time delay neutral, open transition, break-before-make type. The automatic transfer switch shall have the following capabilities:
   1. Adjustable time delay for generator start
   2. Adjustable time delay transfer to generator
   3. Adjustable time delay in “off” position
   4. Adjustable time delay re-transfer to normal power
   5. Adjustable time delay for generator stop
   6. The switches shall be capable of transferring successfully in either direction with 70 percent of rated voltage applied to the terminals.
   7. Have a weekly exercise programmable time set point.

B. The normal and standby contacts shall be positively interlocked mechanically and electrically to prevent simultaneous closing. Main contacts shall be mechanically locked in position in both the normal and standby positions without the use of hooks, latches, or magnets, and shall be silver alloy protected by arcing contacts, with magnetic blowouts on each pole. Parallel main contacts are not acceptable.

C. The transfer switch shall be equipped with a manual operator that is designed to prevent injury to personnel if the electrical operator should become energized during manual transfer.

D. The transfer switch, complete with all accessories, shall be listed by UL under Standard UL-1008.

E. The transfer switch shall be compatible with the standby generator.

F. The transfer switch operation shall be selectable by the Operator. In the Manual mode, the Operator shall be able to transfer the load to the generator using a selector, toggle, or pushbutton switch. In the Automatic mode, the internal logic shall sense loss or presence of utility power, and transfer the load to or from the generator.

G. Transfer switch shall be as manufactured by ASCO (Square D).

2.02 ACCESSORIES

A. The transfer switch shall be equipped with the following:
   1. Nominal 0.5 to 5 second time delay to override momentary normal source outages and delay all transfer and generator starting signals.
   2. An adjustable time delay with a minimum of 5 minutes for controlled timing of transfer of loads to standby power source to allow for adequate motor shutdown.
   3. Field adjustable 0 to 31 minutes time delay to retransfer to normal source with 5 minute unloaded running time of standby plant. A switch shall be provided to bypass this feature with transfer to normal source made manually. Time delay shall be nullified if standby power fails and normal power is available.
   4. Differential protection on 3 phases. Dropout and pickup.
   5. Test switch.
   6. Auxiliary contacts which close in normal position. Two sets of Form C contacts shall be provided.
   7. Auxiliary contacts which close in standby position. Two sets of Form C contacts shall be provided.
   8. Pilot lights: indicating normal and standby switch position.
   9. Manual and automatic selector switch.
   10. Manual and automatic pilot lights with push-to-test.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Transfer switch shall be installed, in accordance with the manufacturer's recommendations.

3.02 INSTALLATION TESTING

A. When conducting temperature rise tests in accordance with UL-1008, the manufacturer shall include post-endurance temperature rise tests to verify the ability of the switches to carry full rated current after completing the overload and endurance tests.

B. On completion of the installation, start-up shall be performed by a factory-trained service representative in the presence of the Owner and the Engineer.

End of Section

SECTION 16500

LIGHTING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The Contractor shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install lighting fixtures.

1.02 QUALITY ASSURANCE

A. Reference Standards:
   1. National Electrical Code (NEC)
   2. UL Standard #57, Electric Lighting Fixtures
   3. Illuminating Engineering Society (IES)
   4. All applicable local lighting ordinances

B. Miscellaneous:
   1. Lamps are identified for each luminaire in the Lighting Fixture Schedule on the Drawings.
   2. Lighting fixtures and electrical components:
      a. UL labeled, complete with lamps.
      b. Rated for area classification as indicated.
   3. Location of lighting fixtures on Drawings are intended to be used as a guide.
      a. Field conditions may affect actual locations.
      b. Coordinate with other trades to avoid conflicts in mounting of fixtures and other equipment.
   4. The quality standard is established by the fixture listed in the Lighting Fixture Schedule.
      a. This quality standard includes, but is not necessarily limited to construction features, materials of construction, finish, and photometrics.

1.03 SUBMITTALS

A. The following shall be submitted to the Engineer for review:
   1. Acknowledgment that products submitted meet requirements of standards referenced.
   2. Manufacturer's technical information on products to be used including photometric performance curves for the fixture and ballast data.
   3. Acknowledgment that products submitted are UL or ETL listed.
   4. When general data sheets constitute part of the submittal, identify the products to be used on this project.
   5. Manufacturer's installation instructions.
   6. Identification of fixtures by Lighting Fixture Schedule.

7. UL nameplate data (Voltage, wattage, etc.).
8. Finishes, colors, and mounting type.
9. Pole, fixture, and accessories.
10. Pole wind loading.

B. Contractor shall submit shop drawings, manufacturer's data sheets, and a complete wiring diagram detailing all connections to the electrical system in accordance with Section 16000, and other requirements of the Contract Documents.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Lighting fixtures shall be provided as indicated on the Lighting Fixture Schedule on the Drawings.

B. Light poles shall be as indicated on the Drawings. Include base template, anchor bolts, cadmium-plated hardware and pole grounding lug, handhole, anchor base and bolt covers. Pole foundations shall be as indicated on the Drawings.

2.02 MATERIALS

A. General:
   1. Lamps:
      a. See lighting fixture schedule on Drawings for wattage, voltage and number required.
   2. All Fixtures:
      a. There shall be no live parts normally exposed to contact.
      b. When intended for use in wet area:
         1) Mark fixtures “suitable for wet locations.”
      c. When intended for use in damp areas:
         1) Mark fixtures “suitable for damp locations” or “suitable for wet locations.”
      d. In wet or damp area, install fixtures so that water cannot enter or accumulate in the wiring compartment, lampholder, or other electrical parts.
      e. Gasket seals: Urethane foam
      f. Diffusers: UV stabilized acrylic plastic
   3. Underground wiring:
      a. Provide all wiring runs with separate green grounding conductor.
      b. Ground all pole bases.
   4. Pole wiring from base to ballast:
      a. No. 12 type XHHW.
      b. Each phase shall be protected by a 30A, 600V, type Tron waterproof fuseholder, Bussman “Limitron” type fuse, size rating 3-times load current.

2.03 FIXTURES

A. LED Lamps:
   1. Indoor:
      a. Fiberglass housing with self-extinguishing plastic.
      b. Watertite hub for ½" conduit entry at each end of fixture.
      c. Polyurethane gasketing.
      d. Long-Life LED system with projected life of 60,000hrs. (min.) at 91% lumen output (min.).
      e. UL listed
   2. Outdoor:
      a. Full cut-off (pole mounted and wall-pack style)
      b. To utilize extruded aluminum integral thermal radiation fins for thermal management.
      c. Class 1 LED system
      d. UL listed for wet locations.
      e. Rated for 50 Deg. C operation

2.04 MISCELLANEOUS ELECTRIC DEVICES

A. PHOTOELECTRIC CONTROL UNITS shall meet the following requirements:
   1. Cadmium sulfide photocell
   2. Aluminum weatherproof enclosure
   3. 30 amp rated contacts
   4. 120-volt AC power
   5. The Photoelectric control unit shall be Tork Model 2100, or equal.

B. MOTION SENSORS shall meet the following requirements:
   1. 110 degrees field of view, 60 foot range
   2. Adjustable time setting from 15 seconds to 15 minutes
   3. Operating temperature of -20 to + 130 degrees F.
   4. Complete outdoor, weather proof sensor with complete mounting hardware
   5. UL listed
   6. The motion sensor(s) shall be manufactured by Leviton Model 50500-H or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install lamps in all luminaires.

B. Replace all failed lights prior to final acceptance by Owner.

C. Surface and flush mounted fixtures shall be solidly connected to a junction box. Suspended fixtures shall be hung utilizing pendant mounting or stainless steel chains and hooks. Each suspended fixtures, shall be electrically connected by a length of Type SO

flexible cord. 3 conductor No. 14 AWG, minimum, with a twist-lock receptacle mounted in an individual junction box. Plugs and receptacles shall be as manufactured by Hubbell, General Electric Company, or equal.

D. Provide mounting brackets and/or structural mounting support for fixtures.
   1. Do not support fixture from conduit system.
   2. Do not support fixture from outlet boxes.

E. Install with approved mounting hardware following manufacturer's recommendations.

F. Pole mounted fixtures shall be mounted on steel or aluminum poles as indicated on the Drawings. All metal poles shall be bonded to the facility ground system. Poles shall have adequate handholes and weatherproof receptacles where indicated.

G. All anchor bolts and nuts shall be stainless steel. Contractor shall paint all steel poles with aluminum paint or other color in accordance with these Contract Documents.

H. Fixture mounting heights and locations indicated on the Drawings are approximate and are subject to revision in the field where necessary to avoid conflicts and obstructions.

3.02 ADJUSTING AND CLEANING

A. Wipe all lighting fixture reflectors, lenses, lamps, and trims clean after installation and prior to acceptance of Project by Owner.

End of Section

SECTION 16505

TRANSIENT VOLTAGE SURGE SUPPRESSION SYSTEM (SPD)

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section specifies Transient Voltage Surge Suppression (TVSS) System(s) or as also referred to, Surge Protective Devices (SPD).

1.02 SUBMITTALS

A. Submit manufacturer's data demonstrating compliance with this specification and the Drawings. Information shall include, but not be limited to:
   1. An equipment manual with installation, operation, and maintenance instructions for the specified unit.
   2. A list of customer-replaceable spare parts.
   3. Electrical and mechanical drawings which show unit dimensions, weights, mounting provisions, connection details and layout diagram of the unit.
   4. Certification of the MCOV 1-hour burn-in.
   5. Certification from an independent laboratory of single-pulse surge current ratings.
   6. A copy the UL 1449 compliance document showing UL 1449 Suppression Ratings.
   7. Certification of life-expectancy testing.

1.03 QUALITY ASSURANCE

A. Comply to the following Codes and Standards:
   1. ANSI/IEEE (C62.41-1991 and C62.45-1987);
   2. NFPA (70 [NEC], 75 and 78);
   3. NEMA (LS-1-1992);
   4. NEC (240-21 and 110-9);
   5. All units shall be UL 1449 and UL 1283 Listed.

B. The specified system(s) shall be manufactured in the USA by a manufacturer engaged in the design and manufacture of the specified system for a minimum of 5 years.

1.04 WARRANTY

A. The manufacturer shall provide a Limited Five (5) Year Warranty from date of shipment against failure when installed in compliance with applicable national and local electrical codes and the manufacturer's Installation, Operation and Maintenance Instructions.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable.
   1. Current Technology
   2. Liebert
   3. Advanced Protection Technologies
   4. or Equal.

2.02 ELECTRICAL REQUIREMENTS

A. Provide TVSS units as indicated on the Drawings and specified herein.

B. The maximum continuous operating voltage (MCOV) of all suppression components utilized in all units shall not be less than 115 % of the nominal operating voltage for 277/480 volt nominal systems.

C. In accordance with NEMA Standard LS 1-1992, the unit shall provide protection in all modes. The primary mode of protection shall be line-to-neutral. The secondary modes of protection shall be line-to-ground and neutral-to-ground.

D. Based on ANSI/IEEE C62.41-1991's 8 x 20 microsecond current waveform, and in accordance with NEMA Standard LS 1-1992, the tested single-pulse surge current capacity for each mode of protection of the units (in amps) shall be no less than as follows:

SURGE CURRENT CAPACITY				
PRODUCT	AMP CLASS (L-L + L-G)	L-L	L-G	N-G
MAIN TVSS	240,000 (min.)	100,000 (min.)	100,000 (min.)	N/A
SURGE CURRENT CAPACITY				
PRODUCT	AMP CLASS (L-N + L-G)	L-N	L-G	N-G
PANELBOARD TVSS	160,000 (min.)	80,000 (min.)	80,000 (min.)	80,000 (min.)

E. The unit's published performance ratings shall be the UL 1449 Listed suppressed ratings. The UL 1449 suppressed rating shall be, for each mode of protection, as follows:

PRODUCT	VOLTAGE	UL 1449 SUPPRESSION RATING		
		L-L	L-G	N-G
MAIN TVSS	480	1,800	1,800	N/A
PRODUCT	VOLTAGE	UL 1449 SUPPRESSION RATING		
		L-N	L-G	N-G

PANELBOARD TVSS	277/480 Three Phase	1,000	1,000	800
PANELBOARD TVSS	120/208 Three Phase	500	500	500
PANELBOARD TVSS	120/240 Single Phase	500	500	500

F. The system shall be tested and capable of protecting against and surviving at least 6,000 ANSI/IEEE C62.41-1991 Category C3 surges without failing or degrading the UL 1449 Surge Suppression Ratings by more than 5%.

2.03 PRODUCT

A. Each unit shall include solid-state suppression system, utilizing a multitude of selenium cells, avalanche diodes, or arrays of fused non-linear voltage dependent metal oxide varistors (MOVs) with similar operating characteristics.

B. The suppression system's components shall optimally share surge currents in a seamless, low-stress manner assuring maximum, non-degrading voltage clamping and surge current diversion performance and proven reliability. The suppression system shall contain field replaceable fuses.

C. The unit shall include a high-frequency extended range tracking filter and shall be UL 1283 Listed as an Electromagnetic Interference Filter. The filter shall reduce fast rise-time, high-frequency, error-producing transients and electrical line noise to harmless level, thus eliminating disturbances which may lead to system upset. Standardized insertion loss data shall be obtained using MIL-STD-E220A 50 ohm insertion loss methodology. The filter shall provide attenuation throughout the frequency spectrum of 100 kHz to 100 MHz.

D. All internal connections associated with the suppression and filter system and subject to surge currents shall be made with compression solderless-type lugs. No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be hardwired with connections utilizing low impedance conductors and compression fittings. Internal wiring associated with the suppression/filter system and subject to surge currents shall utilize low-impedance copper bus bar and #4 AWG copper conductor or larger.

E. Field Connections: The TVSS shall include mechanical lugs for each phase, neutral and ground. The lugs shall accommodate the conductor sized indicated on the Drawings.

F. Each unit shall include solid-state, long-life, externally mounted LED visual status indicators that indicate the diagnostic status of the following groups of suppression modules:

1. Line to Neutral (where applicable)
2. Line to Line (where applicable)
3. Line to Ground
4. Neutral to Ground (where applicable)

G. Each TVSS shall include a disturbance counter for both common mode (L-G) and normal mode either (L-L) or (L-N). The Disturbance Counters shall contain-lithium batteries and a reset function.

H. Each current-carrying ungrounded circuit conductor connected to the facility's distribution system shall be individually fused with 200,000 AIC rated fuses (One 200,000 AIC Fuse Per Phase) in order to provide maximum fault current protection.

PART 3 - EXECUTION

3.01 FIELD INSTALLATION

A. Each unit shall be installed adjacent to the electrical equipment as indicated on the Drawings, avoiding unnecessary bends, in accordance with applicable national and local electrical codes, and the manufacturer's recommended installation instructions.

3.02 CERTIFICATION OF ON-LINE STATUS AND SUPPRESSION LEVELS

A. The Contractor shall submit the test results to the Engineer.

End of Section

SECTION 16622

STANDBY DIESEL ELECTRIC GENERATOR

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. The outdoor standby electric generating system shall be rated for standby service and sized as shown on the Drawings.

B. The Contractor shall be responsible for obtaining any required air quality permits on behalf of the Owner, posting all public notices, and shall include all associated fees in their bid, listed as separate line items in the schedule of values. The generator vendor shall provide the Contractor with the documentation required for permitting, showing published proof of EPA certification on the engine specified and furnished herein.

1.02 SUBMITTALS

A. Submit product data in accordance with Section 16000, and the Contract Documents.

B. Submit shop drawings containing actual dimensions, 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. Shop drawings shall show proposed layout, anchoring, support and appurtenances, including clearances for maintenance and operations. Shop drawings shall show details of piping connections for fuel.

C. Submit a complete list of equipment and material, including manufacturer's specifications, performance charts, catalog cuts and installation instructions, and recommended spare parts list. Submit data for each different item of equipment specified, including but not limited to engine, generator, switchgear, automatic transfer switch, vibration isolators, radiator, and other components. The data shall include a complete list of parts and source of supply.

D. Submit performance test reports in booklet form showing all field tests, and adjustments performed to prove compliance with specified criteria.

E. Operation and maintenance (O&M) manuals shall describe the step-by-step procedure required for system start-up, operation and routine maintenance. The O&M manuals shall include troubleshooting and repair guidelines, as well as wiring diagrams of the system as installed.

F. Miscellaneous:
   1. Manufacturer’s kilowatts output curve and fuel consumption.

2. Manufacturer's transient response data of the complete engine generator set upon 50%, 75%, and 100% block loads at 1.0 pf. Data shall include maximum voltage dips, maximum frequency dips, and recovery time periods.
3. Engine altitude duration curve.
4. Generator motor starting curves showing the voltage dips versus starting KVA.
5. Prototype test certifications showing all components comply with specifications.
6. The following spare parts for the engine generator shall be supplied to the OWNER prior to acceptance of work.
    a. Two sets of oil filters
    b. Two sets of heavy duty air filters
    c. One dozen spare lamps
    d. Two fuses (for each control circuit)

1.03 MANUFACTURERS

A. Generator set shall be manufactured by Cummins or Caterpillar.

PART 2 - PRODUCTS

2.01 ENGINE GENERATOR SET

A. The provision of a standby electric generating system shall be rated for standby service as indicated on Drawings and as described in these Specifications, delivered at 0.8 power factor, 480 volts, three phase, four wire, 60 hertz, for ambient air temperature of 50 degrees C, and specifically rated for the operating altitude shown on the Drawings, without exceeding NEMA MG1 - temperature rise limits.

B. The system shall be a package of:
1. A diesel engine driven electric plant to provide standby electric power.
2. Engine mounted control system.
3. An automatic load transfer switch for switching of the load and control to provide automatic starting and stopping of the engine generator system, as specified in Section 16495 of these Specifications
4. Mounted accessories as specified
5. Integral fuel and exhaust systems.
6. All other equipment as required to provide a complete and operable system.

C. The engine-generator set and all its accessories shall be constructed for outdoor installation and operation all electrical components shall be housed in NEMA 3R enclosures.

D. All materials, equipment, and parts comprising the units specified herein, shall be new and unused, or current manufacture and of the highest grade.

E. The engine, generator and all major items of auxiliary equipment shall be manufactured in the U.S. by manufacturers currently engaged in the production of such equipment.

The unit shall be factory assembled and tested by the engine manufacturer and shipped to the job site by his authorized dealer having a parts and service facility in the area. The performance of the electric plant shall be certified by manufacturer as to the plant's full power rating, stability and voltage and frequency regulation, and field load tested at site.

F. The units offered under these Contract Documents shall be covered by the manufacturer's standard warranty, or guarantee, on new machines, and shall be a minimum of two years after the date of substantial completion.

2.02 ENGINE

A. The engine shall be water cooled in-line, or Vee-type compression ignition diesel, designed to operate on No. 2 fuel oil. Diesel engines requiring premium fuels will not be considered. The engine shall be equipped with fuel, lube oil, and intake air filters; lube oil coolers, fuel transfer pump, fuel priming pump, and gear driven water pump.

B. The engine governor shall maintain frequency regulation not to exceed 1 percent from no load to full rated load.

C. The unit shall be mounted on a structural steel sub-base and shall be provided with suitable vibration isolators.

D. Safety shut-offs for high water temperature, low oil pressure, overspeed, and engine overcrank shall be provided. An engine-mounted radiator with blower type fan shall be sized to maintain safe operation at specified ambient temperature. The radiator shall be equipped for a duct adapter flange. Air flow restriction from the radiator shall not exceed 0.5 inch of water.

E. The engine cooling system shall be filled with a solution of 30 percent ethylene glycol.

F. Provide a Critical Grade type silencer as manufactured by Kittel, Maxim, or GT Exhaust Systems, including stainless steel flexible exhaust fitting, properly sized and installed, according to the manufacturer's recommendation. Mounting shall be provided as part of the generator set assembly. Silencer shall be mounted so that its weight is not supported by the engine. Exhaust pipe size shall be sufficient to ensure that measured exhaust back pressure does not exceed the maximum limitations specified by the generator set manufacturer.

G. Exhaust piping shall have stainless steel automatic exhaust cap, and shall be coated with not less than 6 mils of inorganic zinc after sandblasting to "white metal".

H. Generator shall be configured to operate from a separate double contained fuel storage tank (convault) supplied by Others.

I. An engine-mounted fuel filter, fuel pressure gauge, and engine fuel priming pump shall be provided.

J. A DC electric starting system with positive engagement drive shall be furnished.

K. Fully automatic generator set start-stop controls in the generator control panel shall be provided. Controls shall provide two auxiliary contacts for activating accessory items. Controls shall include a 30 second cranking cycle limit with lockout. (Three 10 second cranks or a single 30 second crank.)

L. A unit mounted thermal circulation type water heater shall be furnished to maintain engine jacket water to 90 degrees F in an ambient temperature of zero degrees F. The heater shall be single phase, 60 hertz, 120/240 volts. Heater shall be Chromalox, General Electric, or equal.

M. A lead-acid storage battery set of the heavy-duty diesel starting type shall be provided. The battery set shall be of sufficient capacity to provide for 1-1/2 minutes total cranking time without recharging and shall be rated no less than 220 amp-hours. A battery rack and necessary cables and clamps shall be provided as part of the generator set.

N. A current limiting battery charger shall be furnished to automatically recharge the batteries. The charger shall float at 2.17 volts per cell and equalize at 2.33 volts per cell. It shall include overload protection, silicon diode full wave rectifiers, voltage surge suppressers, DC ammeter, DC voltmeter and fused AC input. Amperage output shall be no less than 10 amperes.

2.03 GENERATOR

A. The generator shall be a 4-pole or 6-pole revolving field type with static exciter and magnetic amplifier or SCR voltage regulator. No commutator or commutator brushes shall be allowed. Class F insulation shall be used on the stator and rotor, and both shall be further protected with 100 percent epoxy impregnation and an overcoat of resilient insulating material to reduce possible fungus and/or abrasive deterioration. The starter shall be directly connected to the engine flywheel housing, and the rotor shall be driven through a semi-flexible driving flange to insure permanent alignment. Voltage regulation shall be within plus or minus 2 percent of rated voltage, from no load to full-load. The instantaneous voltage dip shall be less than 15 percent of rated voltage when full load and rated power factor is applied to the generator. Recovery to stable operation shall occur within 5 seconds. Stable or steady-state operation is defined as operation with terminal voltage remaining constant within plus or minus one percent of rated voltage. A rheostat shall provide a minimum of plus or minus 5 percent voltage adjustment from rated value. Temperature rise at full-load determined by resistance shall be within rating as defined by NEMA MG-1.

B. The specified standby kW shall be for continuous electrical service during interruption of the normal utility source.

C. These ratings must be substantiated by manufacturer's standard published curves. Special ratings or maximum ratings are not acceptable.

D. A generator mounted vibration isolated 14 gauge steel control panel shall be provided.

E. Control panel shall be microprocessor-based, and shall provide the following features:
   1. Voltmeter, 3-1/2 inch, 2 percent accuracy
   2. Ammeter, 3-1/2 inch, 2 percent accuracy
   3. Voltmeter/Ammeter phase selector switch
   4. Frequency meter, 3-1/2 inch, dial type
   5. Automatic starting controls
   6. Panel illumination lights and switch
   7. Voltage level adjustment rheostat
   8. Engine oil pressure gauge
   9. Engine water temperature gauge
   10. Dry contacts for remote alarms wired to terminal strips for the following:
      a. Run status
      b. Trouble alarm
      c. Fault alarm
      d. Low Fuel Alarm
      e. Fuel Leak Alarm
   11. Fault indicators for low oil pressure, high water temperature, overspeed, and overcrank
   12. Four position function switch marked AUTO, MANUAL, OFF/RESET, and STOP
   13. Battery charge rate ammeter if not furnished on separate charger
   14. Running time meter
   15. Shall be equipped with necessary communications modules/adapters so as to allow system parameters (alarms, statuses, values etc.) to be communicated to site PLC/SCADA via the Ethernet/IP protocol.

F. A generator mounted main line molded case circuit breaker shall be installed as a load circuit interrupting and protection device. It shall operate both manually for normal switching function and automatically during overload and short circuit conditions.

G. Generator exciter field circuit breakers do not meet the above electrical standards and are unacceptable for line protection.

H. Provide a sign at the service entrance equipment indicating type and location of standby power generator per NEC.

2.04 PANELBOARD

A. The generator system shall be equipped with a 120/240 volt, single phase, 50 amps minimum distribution panelboard. Higher amperage rated panelboards shall be provided if required by the system. The panelboard shall be UL67 listed. Buses shall be copper.

B. The panelboard shall be mounted where fully accessible. The panelboard enclosures shall be NEMA 3R unless installed inside the generator system's weatherproof housing. The minimum interrupting capacity of any device shall be 10,000 minimum unless indicated otherwise on Drawings.

C. All devices requiring power inside the generator system shall be prewired to the panelboard in accordance with NEC requirements. Provide grounding per NEC, and Section 16170 of the Specifications.

D. Panelboards shall be as manufactured by Square D, Eaton or equal

2.05 WEATHERPROOF SOUND ATTENUATING ENCLOSURE

A. Provide a weatherproof sound attenuating enclosure for the engine, and associated components.
   1. Enclosure shall have fully gasketed doors for access to all portions of the generator that required any maintenance. All doors to have rain molding above door opening, stainless steel hinges and a two point latch to allow the doors to be completely removed. Handles to be the key locking type.
   2. Enclosure roof, walls and doors shall contain ½ inch deep support ribs with 16 gauge minimum exterior steel with interior sound attenuating insulation. Insulation shall consist of a minimum #6 density wool held in place with a perforated liner.
   3. Provide fixed louvers with a screened cover over air openings sized as required for proper air flow.
   4. The enclosure shall have a steel base channel constructed to drop over the generator set with anchor boltholes for fastening to a concrete slab.
   5. Maximum sound levels emitted from the generator set shall not exceed the requirements of all local governing authorities or 75 dBA at 7m (23 feet) from center of generator, whichever is the most stringent.
   6. Provide a stainless steel exhaust flex.
   7. Provide a roof mounted critical silencer, tail pipe, rain cap.

B. All seams shall be caulked with a sealer prior to painting. Paint exterior surfaces of equipment with two coats of acceptable UV, oil, and heat-resistant paint, applied after surfaces have been thoroughly cleaned and prepared with suitable priming coat.

PART 3 - EXECUTION

3.01 FACTORY TESTS

A. Before the equipment is installed, a factory certified test log of the generator set showing a minimum of ¾ hour testing with ½ hour at 100 percent rated load, continuously, shall be submitted to the ENGINEER.

3.02 FIELD TESTS

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

3.03 INSTALLATION

A. The generating system shall be installed as indicated on the Drawings, per manufacturer's recommendations and shall meet all applicable codes and regulations.

3.04 START-UP

A. On completion of the installation, start-up shall be performed by a factory-trained dealer service representative.

B. This generating system shall be full-load tested at site in the presence of the ENGINEER for a period of 8 hours, with supplier providing necessary resistive load banks. Any defects which become evident during this test shall be corrected by the CONTRACTOR at his own expense.

C. After installation the tank shall be filled with No. 2 fuel oil. The tank shall be refilled after the 8-hour on-site test.

3.05 GROUNDING

A. Provide grounding as shown on the Drawings, and as per NEC.

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 - General Standards for Industrial Control Systems.

B. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers and Assemblies.

C. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

D. NEMA ST 1 - Standard for Specialty Transformers (Except General purpose Type).

1.04 SUBMITTALS

A. Data - a complete list of equipment and material including manufacturer's descriptive data and technical literature, performance charts, catalog cuts and installation instructions, spare parts data for each different item of equipment specified. The data shall include a complete Bill of Materials.

B. Drawings - containing complete wiring and schematic diagrams, control diagrams, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout, anchorage, support and appurtenances of equipment and equipment relationship to other parts of the work including clearances for maintenance and operations.

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

1.05 PROJECT RECORD DOCUMENTS

A. Submit record documents in accordance with the Contract Documents.

B. Accurately record actual locations of control equipment. Revise diagrams included in Drawings to reflect actual control device connections.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit operation data in accordance with the Contract Documents.

B. Include instructions for adjusting and resetting time delay relays, timers, and counters.

C. Submit maintenance data in accordance with the Contract Documents.

D. Include recommended preventative maintenance procedures and materials.

PART 2 - PRODUCTS

2.01 PUSHBUTTONS AND SELECTOR SWITCHES

A. Pushbuttons, pilot lights and selector switches shall be of the full size, heavy-duty industrial, oil tight, 120 volt, with interchangeable pilot lights, plug-in construction, double break silver contacts, chrome plated lock rings, with modular contacts, and NEMA rating equal to that of the enclosure on which devices are installed. All components shall be flush mounted on front of panel, unless otherwise noted.

B. Provide individual legend plates for indication of switch, pushbutton, and light function (e.g., Open, Closed, Hand-Off-Auto). A list shall be submitted for review and approval.

C. Pilot lights shall be high intensity LED type. Pilot lights shall have clear lenses and LED lamps colored as shown on the Drawings. Common, remote push-to-test circuitry shall be provided for each control panel to simultaneously test all indicating lights on the panel using a single pushbutton when there are 10 or more lights on the panel. Control panels with less than 10 lights shall utilize individual push-to-test lights and control circuitry.

D. Pushbuttons shall be maintained or momentary as required and as shown on the Drawings. Provide extended head pushbutton for all stop functions, mushroom head for emergency stop functions, and flush head pushbuttons for all other functions. Where indicated on the Drawings pushbuttons shall be illuminated type. Provide locking mechanism for all lock out functions. Selector switches shall have black knob operator, be maintained contact type unless noted otherwise, number and arrangement as required

to perform intended functions specified but not less than one double pole, double throw, double break contact per switch. Contact rating shall be compatible with AC or DC throughput current of devices simultaneously operated by the switch contact but not less than 10 amperes resistive at 120 volts AC or DC continuous.

E. Potentiometers shall be provided with operators and resistive elements of the type and quantity indicated on the Drawings and as required with legend plates indicating percent of span.

F. The above devices shall be manufactured by Square D, Allen Bradley, General Electric, or equal.

2.02 RELAYS

A. TIMING RELAYS shall be heavy duty, have 250V/5A rated contacts, solid state design, poles as required per application, -10°C to +60°C, have timing repeatability of ±2.0% of setting, and be UL listed. The range shall be determined from the control descriptions and or schematic drawings. Provide mounting accessories, as required. The timing relays shall be manufactured by Allen Bradley, Square D, Cutler Hammer, or equal.

B. CONTROL RELAYS shall be of the plug-in socket base type with dust-proof plastic enclosures, with silver-cadmium oxide contacts rated 250-volt, 10 amperes, with contact arrangement and operating coils of the proper voltage as required by the control circuit sequence. Relays shall have indicating lamp to show energized state. Each relay shall have a minimum of two double pole, double throw contacts, or as required. Control relays shall be Allen Bradley, Square D, Cutler Hammer, or equal.

C. ALTERNATING RELAYS shall be UL listed, 120 VAC, with contacts rated for 10 amperes at 250 VAC, life expectancy of 100,000 operations, load indicating LEDs, and switch for load locking and load selecting options. Alternating relays shall be manufactured by TimeMark models 261, 271, and 471, Diversified Electronics model ARA, A.T.C. model “AR”, or equal.

2.03 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, with motor and cooling fan, rotating lights at 60 times per minute minimum, capable of producing 36000 candlepower with required mounting hardware. Lens color shall be verified at the time of construction. The rotating beacons shall be manufactured by Federal Signal model 371L 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 capable of producing 36000 candlepower with required mounting hardware. Lens color shall be verified at the time of construction. The rotating beacons shall be manufactured by Edwards model 52EX or equal.

D. STROBE BEACONS shall be UL listed, NEMA 4X, 120 VAC, 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, Edwards model 92EX, 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, 10 to 35 V dc, 35 mA output current, hazardous area terminals identified by blue labels, terminals accommodating conductors up to 12 AWG, ambient temperature rating of –20 to +60°C. The intrinsic safety barriers shall be manufactured by MTL Inc., Ronan Engineering Co., R. Stahl Inc., A.T.C., 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, 0-10 mA to 0-10 A input current, 0-10 V to 0-600 VAC input voltage, 16-500 Hz selectable frequency. The watthour transducers shall be manufactured by Sineax model PQ502, or equal.

2.07 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 50,000 hour minimum display life and indication of sufficient battery power. The elapsed time meters shall be manufactured by Durant, Automatic Timing and Controls a Division of Sycon Corp., or equal.

B. TIME CLOCKS shall be microprocessor based, have 24 hour time control, up to 24 operations per day, programmable from panel face keys, skip-a-day feature allowing schedule to be skipped for one to seven days, SPDT switch contact rated at 15 amps at 120 V AC, with battery carryover to maintain time and program during power outage for 275 hours. The time clocks shall be manufactured by Tork, Paragon Electric Company, or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Fasteners shall be type 304 stainless steel.

B. Install devices in strict accordance with NEC requirements and per manufacturers recommendation.

C. Coordinate with other trades as necessary during installation of these devices.

3.02 ACCEPTANCE

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

End of Section

SECTION 16904

VARIABLE FREQUENCY DRIVES – LOW VOLTAGE

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes
   1. Variable Frequency Drive (VFD) systems rated 480 VAC or lower.

1.2 VFD FEATURES

A. The VFDs shall be provided with the following features:
   1. Fused control circuit transformer.
   2. Provision for 4 to 20 mA input speed reference signal.
   3. Electrically isolated auxiliary contacts for ready, running, and trouble status.
   4. Adjustable minimum/maximum frequency limits.
   5. Independent timed linear acceleration and deceleration.
   6. Adjustable motor slip compensation based on motor current.
   7. Terminal blocks for control and signal wires entering and leaving the controller.
   8. Output transistors shall be insulated gate bipolar transistors (IGBT) type, or Darlington pair.
   9. Current limit.
   10. **Provided with Ethernet communications adapter capable of communicating via the Ethernet/IP protocol**.
   11. Programmable automatic restart.
   12. 4 to 20 mA output signal proportional to VFD output frequency.
   13. Digital keypad for configuration, programming, local control, and monitoring.
   14. Microprocessor-based control for system logic sequencing functions.
   15. **VFD shall be either 18-pulse or 6-pulse equipped with harmonic filter(s) as necessary to ensure compliance with harmonic mitigation requirements defined elsewhere in this specification**.

1.3 FUNCTIONAL REQUIREMENTS

A. SUPPLY POWER: The VFD shall operate continuously with supply power of 460 volts plus or minus 10 percent, 60 hertz plus or minus 3 percent. The VFD shall remain on line and operate without damage to either the VFD or its connected load during a supply power variation of plus 50 percent lasting for a period of up to 0.01 seconds and minus 100 percent lasting for a period of up to 0.5 seconds.

B. AMBIENT CONDITIONS: The VFDs shall operate continuously as specified in an ambient temperature of 0 to +40 degrees C for indoor based VFD's (0 to +50 degrees C for outdoor based VFD's) and an ambient humidity of 0 to 90 percent, non-condensing. **VFD's installed outdoors shall be upsized as necessary so as to meet operating temperature requirements (+50 degrees C) without the use of an A/C unit**.

C. LOAD: The VFD system shall be capable of 110% continuous current overload. Variable torque inverters shall be capable of delivering 120 percent of the specified load for up to 60 seconds, and constant torque inverters shall deliver 150 percent overload current for 120 seconds.

D. POWER FACTOR: Displacement power factor shall be not less than 0.95 at rated full speed and load. Overall power factor, including harmonic distortion, shall be 0.85, or greater. Contractor shall provide power factor correction components as necessary to meet this requirement.

E. EFFICIENCY: Efficiency of VFD systems shall be at least 96 percent at 60 hertz output driving the specified maximum load.

F. FREQUENCY AND VOLTAGE REGULATION: VFD output frequency shall be regulated to within 0.6 hertz of the frequency set point. VFD output voltage shall be regulated to within ±1.0 percent of that value which will produce minimum motor heating at any operating frequency within the specified range.

G. FREQUENCY RANGE: VFD shall be capable of continuous operation with the specified load at any frequency between 0.1 hertz and 60 hertz.

H. SPACE: VFD system size shall not exceed the size allotments specified on the Drawings, nor shall any portion of the VFD system exceed a height of 90 inches. VFD system shall be front accessible and shall not require rear access. The VFD equipment shall be suitable for mounting directly against the wall without any clearance for ventilation or other purposes. VFD units shall be arranged as required for entry of incoming line cables and as required for entry of load cables.

I. AMBIENT NOISE: Free field noise generated by the VFD shall not exceed 85 dBA at 3 feet out from any point on the VFD cabinet under any normal operating condition.

1.4 PROTECTION AND ANNUNCIATION

A. OVERCURRENT PROTECTION: The VFD system shall provide electronic current limit at 150 percent of motor nameplate current. Current limit shall be accurate to within 1.0 percent and shall smoothly limit motor speed at whatever value is necessary to limit motor current to that value.

B. The VFD shall also provide motor running overcurrent protection in compliance with NFPA 70.

C. SHORT CIRCUIT PROTECTION: The VFD shall be fully protected against load faults. Bolted faults, phase to phase, or phase to ground shall not damage the unit. Any impedance or other current limiting necessary to meet this requirement shall be provided as part of the VFD system, and any losses caused by current limiting devices shall be included in efficiency calculation for the VFD system.

D. LINE VOLTAGE: The VFD shall be protected against high and low line voltage on one or more phases.

E. INTERNAL FAULTS: The VFD shall incorporate an internal fault monitoring system to detect malfunctions. This system shall be designed to protect the VFD from transient and sustained faults, and to limit damage that may be caused by these faults.

F. OVERTEMPERATURE: Overtemperature circuitry shall shut down the VFD upon overheating, and display an overtemperature alarm, or message.

G. DIAGNOSTICS: The VFD shall be provided with a fault diagnostics system that indicates the cause of any shutdown. The system shall store faults in memory and discard the oldest faults as new ones fill the memory. Faults shall be accessible via a digital keypad, also used for local control and programming.

1.5 EXTERNAL CONTROL AND MONITORING

A. SPEED REFERENCE: The VFD shall accept a 4 to 20 milliampere direct current speed reference signal. Speed reference input shall be galvanically isolated and input resistance shall not exceed 250 ohms.

B. READY SIGNAL: The VFD shall provide a contact closure that indicates that the controller line power supply is within acceptable tolerances, the control circuits are normal, and there are no internal or external fault conditions that have not been reset. Presence of this signal indicates that the controller should start normally.

C. RUNNING SIGNAL: The VFD shall provide a contact closure which indicates that the controller is running.

D. SYSTEM TROUBLE: Isolated normally open contacts for remote fault annunciation shall be provided and wired to terminal blocks, which shall be labeled and identified. Contact shall close under fault conditions. Fault conditions that drive the outputs shall be selectable from the digital keypad.

E. The VFD control circuitry shall shutdown the VFD if the motor overheats. Motor winding temperature switches, or RTDs, shall be connected if provided by the motor manufacturer.

1.6 QUALITY ASSURANCE

A. This section contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

Reference	Title
IEEE 519-1992	Guide for Harmonic Control in Electric Power Systems
NEMA 250-85	Enclosures for Industrial Control and Systems
NEMA ICS 2-83	Industrial Control Devices, Controllers and Assemblies
NEMA ICS 3-83	Industrial Systems
NFPA 70-87	National Electrical Code (NEC)
Underwriters Laboratories	UL 508

B. The VFD shall comply with the applicable requirements of NEMA ICS 3 and additional standards referenced by ICS 3.

C. The VFDs specified in this section shall be the product of a single vendor. The Contractor shall assign unit responsibility for the adjustable frequency drives in this section. The Contractor shall submit letters of certification with the shop Drawings from the VFD manufacturer, the motor manufacturer, and the driven equipment manufacturer stating that they have reviewed each application and that the combination will satisfy the application duties required, for the actual motor sizes required, regardless of deviations from the scheduled "nominal horsepower".

D. VFD manufacturing facility shall be ISO 9001 certified.

1.7 SUBMITTALS

A. The following information shall be provided in accordance with the Contract Documents:
   1. Catalog and technical data.
   2. Outline dimensions, shipping section dimensions, weight, and foundation requirements for all assemblies.
   3. External connection wiring diagram showing function and identification of all terminals requiring field connections.
   4. Line harmonic distortion calculations and filter design if applicable.
   5. Component fabrication Drawings consisting of detailed circuit schematics, printed circuit board Drawings, and chassis layouts for all electrical and electronic components.

6. Manufacturer's certification that VFD can withstand fault conditions specified in paragraph 16904-1.04.
7. Manufacturer's certification that VFD can withstand environmental conditions specified in paragraph 16904-1.04.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The VFDs shall be manufactured by Allen Bradley or Yaskawa.

B. AC reactors shall be TCI, MIRUS, Powersmiths, or equal.

2.2 ENCLOSURES

A. Enclosures shall be as shown on the Drawings, with force ventilated gasketed enclosures. UL approved Class 1 filters shall be provided on ventilation openings. Cabinets shall be fabricated from 14 gauge minimum thickness sheet steel. Cabinet shall be provided with an interior frame or otherwise formed so as to provide a rigid structure. Doors shall be hung on removable-pin hinges and equipped with vault-type latch capable of accepting a 3/8-inch-shackle padlock. Three-point latch hardware shall be provided. Door width shall not exceed 30 inches.

2.3 INVERTER

A. A door interlocked power disconnecting means shall be provided to protect the inverter against internal faults and as a backup for external load faults. Load faults shall normally be cleared by the inverter assembly.

B. 18-pulse drives or 6-pulse drives equipped with Harmonic filters shall be utilized as necessary to reduce total harmonic distortion (THD) of the voltage and current power source. Total voltage and current harmonic distortion, including contribution of notching, and with all VFDs in operation shall not exceed the limits set forth for a general system in IEEE 519-1992, Tables 10.2 and 10.3. The voltage THD shall not exceed 5% and the current TDD shall not exceed 8%, as measured at the point of common coupling. The point of common coupling (PCC) is defined herein as the primary side of the utility transformer.

C. AC reactor coils in output circuitry of the VFD shall be provided to limit inductive switching surges such that the measured RMS voltage at the motor terminations does not exceed 480 VAC line to line.

D. Provide EMI/RFI filtering to eliminate radio interference between 10KHZ and 30MHZ.

2.4 CONTROL DEVICES

A. The following control devices shall be front mounted on the VFD enclosure:
   1. Digital keypad.

2. Manual/remote speed control selector switch.
3. VFD run light.
4. Inverter ready light.
5. Inverter fault light

B. Control devices shall be as specified herein. Indicating lamps shall be high intensity colored LED type with clear lenses.

PART 3 - EXECUTION

3.1 FIELD INSTALLATION

A. Each VFD shall be installed and tested by the Contractor with the assistance of factory-trained engineers in accordance with the manufacturer's specifications and the Contract Documents. The installation shall be certified on forms provided in the Contract Documents.

3.2 TESTING

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

3.3 TRAINING

A. Provide four (4) hours of VFD training for the Owner's Operations and Maintenance Staff. Training shall be certified on forms provided in the Contract Documents. Training shall cover VFD theory of operation, features and functions available, normal operation, troubleshooting, and routine maintenance. The Contractor shall submit a syllabus for the training session for approval, within 3 weeks of conducting the class. Provide each attendee with a class syllabus detailing each topic to be discussed.

3.4 SPARE PARTS

A. The following spare parts shall be supplied with each type, or frame size, of VFD:
   1. Three sets of all replaceable fuses
   2. One of each type of replaceable printed circuit board
   3. Two of each type of output power transistor

B. Provide 3 spare air conditioner filters for each type and size of air conditioner installed.

+ + END OF SECTION + +

SECTION 16906

PLC AND REMOTE I/O CABINETS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes
   1. Requirements for Well site 24 RTU, Well site 25 RTU and Site 12 RTU and associated RIO cabinet.

1.02 REFERENCES

A. Not required for this specification.

1.03 DEFINITIONS

A. PLC Programmable Logic Controller

B. SCADA Supervisory Control and Data Acquisition System

C. HMI Human Machine Interface

D. FAT Factory Acceptance Test

E. RIO Remote I/O

1.04 SYSTEM DESCRIPTION

A. Provide a fully functional system for monitoring and controlling the process including PLC cabinet, RIO cabinet, all system programming and configuration, and required communications with remote control stations via radio or land lines in accordance with the details and information shown in the contract drawings. Furnish and install all system components necessary for a complete and operable system. Any components required, but not shown on the Drawings, shall be furnished as needed to construct a fully operational system.

1.05 SUBMITTALS

A. Manufacturer's data on electrical characteristics, system component catalog information, system component specifications and warranty data, capabilities and physical properties.

B. Terminal block wiring diagrams showing connections to all devices; input and output (I/O), analog and discrete. The wiring diagrams shall indicate the I/O address point to be used in the PLC programs.

C. 11”x17” PLC cabinet and RIO cabinet shop drawings shall include:

1. Control system block diagram showing all major control components, the communication paths, and the means of communication.
2. Internal power distribution wiring
3. I/O wiring
4. Scaled physical component and PLC/RIO layout.
5. Cable and connector details for all communication cables including Ethernet, RS-232, RS-485, vendor proprietary (DH+, Modbus+, etc…), and radio-to-antenna cabling.
6. Comprehensive bill of materials complete with manufacturer, model, and quantities.

D. Calculations for all power supply ampacity requirements for all utilization voltages.

E. Calculations for maximum I/O which may be supported by the power supplies or by the processor addressing limitations.

F. List of recommended spare parts.

G. Factory acceptance procedure and schedule

H. Operations and Maintenance Manual
1. Provide 3 copies in 3-ring binders. Binder to include dividers, table of contents or index, manufacturer's literature for all components provided, list of recommended spare parts, and factory acceptance test certification.
2. Label binder with OWNER's project name, number, the name, address, phone number, and shop order of the PLC and RIO cabinet fabricator.
3. Manuals must be complete prior to shipment and be shipped with the PLC and RIO cabinets.

1.06 QUALITY ASSURANCE

A. Work to be performed by qualified contractor having extensive experience in the design, fabrication, installation, and programming of PLC's and control systems.

1.07 DELIVERY, STORAGE, HANDLING

A. PLC and RIO cabinets and all related hardware are to be protected from moisture and weather until installed. Repair or replace, at Owners option and at no cost to Owner, any component damaged during delivery, storage, or handling.

1.08 PROJECT/SITE CONDITIONS

A. Contractor is to familiarize himself with any and all site conditions which may affect performance of the work. These include requirements for support, ventilation, sufficient working clearances, and radiant heating situations.

1.09 SEQUENCING

A. Contractor is to develop a construction sequencing document for review and approval by owner and/or owner's engineer. Document is to include strategic approach for transitioning plant from existing controls system to new Main PLC, so as to ensure impact to site operations is minimized. Plant controls system transitioning is not to commence until proposed construction sequence document has been approved.

1.10 SCHEDULING

A. Coordinate supply, installation, and commissioning with other trades.

1.11 WARRANTY

A. All parts and components of the PLC and RIO cabinets are to be warranted for a period of 12 months starting the day the system is fully operational and accepted as complete by owner. Repair or replace components within 5 working days of notification by OWNER. If OWNER uses a provided spare part and makes the repair themselves, replace the component within the same time period.

B. PLC programming issues/problems - If the programming problem prevents the facility from operating in automatic mode, correct the problem within 2 working days of notification by OWNER. Other programming corrections are to be made within 10 working days of notification by OWNER.

1.12 SYSTEM STARTUP

A. Energize all system components, install programming, test operations, demonstrate successful operation to OWNER, provide training to OWNER's personnel, and leave the system fully operational.

1.13 OWNERS INSTRUCTIONS

A. Not required for this specification.

1.14 COMMISSIONING

A. Provide personnel, tools, equipment, and accessories to fully test, debug, and commission the PLC and RIO cabinets and associated components. Specifically:
   1. Validate that each I/O point is properly terminated and wired to the correct card and channel within PLC and RIO.
   2. Validate that all I/O is properly addressed and represented within PLC and RIO.
   3. Validate that all PLC programming functions as intended (ref. Section 16907).
   4. Validate that all HMI programming functions as intended as it relates to interface with PLC and RIO.
   5. Validate that all communication paths including radio, telephone, and hard-wired function as intended.
   6. Demonstrate to OWNER that these requirements have been met.

1.15 MAINTENANCE

A. Not required for this specification.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. PLC
   1. Allen-Bradley CompactLogix (Well sites)
   2. Allen-Bradley ControlLogix (Site 12)

B. REMOTE I/O
   1. Allen-Bradley Point I/O or FLEX I/O
   2. Approved equal

C. ETHERNET SWITCH
   1. Site 12 - Cisco IE3000 series, layer 3 managed Ethernet switch
   2. Wells 24 & 25 – Cisco IE3000 series, layer 2 managed Ethernet switch

D. HMI
   1. 15” industrial touch screen, fanless PC as manufactured by Advantech or equal.

E. Cellular Modem
   1. Cradlepoint 4G LTE / 3G or approved equal.

F. Radio
   1. TBD
   2. Approved equal

G. Antenna
   1. TBD

H. Coaxial Surge Protector
   1. Polyphaser model 103-0324A-A
   2. Or equal

I. Power Supplies - Enclosed
   1. Sola
   2. PULS
   3. Approved equal

J. Power Supplies – Open frame
   1. Not allowed

K. Terminal Blocks
   1. Allen-Bradley
   2. Phoenix Contact
   3. Weidmuller

4. Entrelec
5. Approved equal

L. Relays
1. Allen-Bradley
2. Cutler-Hammer
3. Phoenix Contact
4. IDEC
5. Approved equal

M. Signal Conditioners
1. Moore Industries
2. Phoenix Contact
3. Action Instruments
4. Approved equal (AGM is not approved)

N. Surge Protectors
1. MTL Surge Technologies
2. Phoenix Contact
3. Approved equal.

O. Enclosures
1. Hoffman
2. Rittal
3. Approved equal.

P. Uninterruptible Power Supplies
1. Powerware
2. APC
3. Approved equal

2.02 EXISTING SYSTEMS

A. PLC and RIO cabinets must be consistent and compatible with OWNERS existing equipment.

2.03 MATERIALS

A. All materials shall be new and the manufacturers most current model.

2.04 MANUFACTURED UNITS

A. The PLC and RIO cabinets shall be constructed with off-the-shelf components, available from local venders and Factory tested as a complete unit.

B. Provide ventilation or air conditioning to maintain the internal temperature of the PLC and RIO cabinet enclosures below the maximum recommended operating temperature of any of its components.

1. If PLC and RIO cabinets are located indoors in an environmentally controlled room, flow through ventilation is acceptable.
2. Non ventilated enclosures are allowed if the interior of the PLC and RIO cabinets cannot exceed the manufacturer's recommended operating temperature for any of the components contained within.
3. In all cases, provide a high temperature switch set at 90 degrees F within PLC and RIO cabinets and wire to a digital input so that over temperature conditions may be remotely monitored.

2.05 EQUIPMENT

A. Not required for this specification.

2.06 COMPONENTS

A. PLC
1. Rack or DIN rail mounted with sufficient space for an additional 25% I/O cards.
2. Provide with power supply.
3. The CPU shall have EEPROM storage for user-programmed instructions. The memory capacity shall be large enough to store the ladder logic program and for 100% growth in programming size.
4. Communication ports as required to communicate with devices identified on System Network Communications Diagram.
5. Remote I/O communication modules if remote I/O is used.
6. Digital input cards shall be 24 volts DC, 16 channel, sinking style.
7. Digital outputs shall be 24 volts DC, 16 channel, directly wired to panel mounted relays so as to provide true dry contact outputs for field devices.
8. Analog inputs shall be 4-20 maDC, 4, 6, or 8 channel capable of accepting a mix of both single ended and double ended analog signals.
9. Analog outputs shall be 4-20 maDC, 4, 6, or 8 channel.
10. Swing arms, end caps, blank slot covers, and other accessories required to make a complete system.
11. Total I/O cards provided must be able to support 25% future I/O growth.

B. RIO
1. Rack or DIN rail mounted with sufficient space for an additional 25% I/O capacity.
2. Provide with power supply.
3. Communication ports as required to communicate with devices identified on System Network Communications Diagram.
4. Digital inputs shall be 24 volts DC, sinking style.
5. Digital outputs shall be 24 volts DC, directly wired to panel mounted relays so as to provide true dry contact outputs for field devices.
6. Analog inputs shall be 4-20 maDC, 4, 6, or 8 channel capable of accepting a mix of both single ended and double ended analog signals.
7. Analog outputs shall be 4-20 maDC, 4, 6, or 8 channel.
8. Total I/O provided must be able to support 25% future I/O growth.

C. Ethernet Switch
   1. As listed in section 2.01.C.

D. Radio
   1. As listed in section 2.01.F.
   2. Provide a shelf for mounting radio.

E. Coaxial Surge Protector
   1. Bulkhead and Flange Mounting
   2. Frequency range: DC-3000MHZ
   3. Connectors: N Female

F. Power Supplies
   1. DIN rail mounted, fully encapsulated, finger-safe construction providing 24 volts DC for I/O card and analog transmitter requirements. Supply to be sized for 100% future growth. Open frame style power supplies are not allowed.

G. Terminal Blocks and Accessories
   1. DIN rail mounted.
   2. Minimum .24" width.
   3. Rated for 300 volts at 20 amps minimum.
   4. Screw clamp style, spring clamp style not allowed.
   5. Provide fuses, disconnect plugs, end caps, spacers, jumper bars, identification labels as required by contract drawings and as required to form a complete system.

H. Relays
   1. DIN rail socket mounted so that relay may be removed without disturbing wiring.
   2. Single 300 volt, 5 amp form "C" contact or as required by circuit requirements.
   3. Indicating light which illuminates when relay is energized.

I. Surge Protectors
   1. DIN rail mounted.
   2. 32 VDC nominal operating voltage and capable of suppressing reasonable voltage surges on analog signal lines.
   3. Damage caused to internal PLC or RIO cabinet components due to failure or inadequacy of the surge protector to be remedied by contractor at no additional cost to OWNER.

J. Enclosures
   1. Sized to adequately house all PLC or RIO cabinet components with reasonable room for future growth.
   2. Provide as non-ventilated or with ventilation or air conditioning as required by site environment and location.
   3. Provide with lockable latch or handle.

4. NEMA rating in accordance with environment. Indoors shall be NEMA 12. Out of doors under weather protection may be NEMA 12 or NEMA 4. Out of doors and not under weather protection must be NEMA 3R. In wet and/or corrosive environments, must be NEMA 4X stainless steel construction.
5. Provided with sub-panels and swing-panels as required by contract drawings or by component mounting requirements.

K. Wireway
1. Panduit or approved equal plastic wiring duct with cover sized per NEC to hold all internal wiring with room for 100% growth in conductor count.
2. Securely attach to sub-panel or side-panel with screws.
3. Allow a minimum of 2.5" between edge of wireway and terminal blocks for labeling conductors.

L. Conductors
1. 300 volt, flexible, stranded, minimum AWG #18, sized per NEC based on over current protection. Types MTW, SIS, or approved equal.
2. Color coded to identify specific voltages as follows:
   a. Black - 120 VAC hot
   b. White – 120 VAC neutral
   c. Green – Ground
   d. Red – 120 VAC signals
   e. Orange – +24 VDC power
   f. Brown – 24 VDC common
   g. Blue – 24 VDC signals
3. Internal 4-20 maDC wiring to be 2-conductor AWG #18 non-shielded cable.
4. Conductors between field terminal blocks and I/O cards may be multi-conductor or multi-pair AWG #18.

M. Uninterruptible Power Supply (UPS)
1. Capable of supporting associated cabinets (PLC or RIO) operation for a period of not less than 60 minutes after loss of normal 120 VAC power.
2. Equipped with communications adapter/module that allows UPS to communicate alarm and status information via the Ethernet/IP protocol.

N. Radio Cable Surge Protectors
1. Securely mount to subpanel
2. Provide flexible coaxial cable with appropriate connectors to connect radio to surge arrestor.

2.07 ACCESSORIES

A. Internal light with door mounted switch.

B. Isolated ground bus.

C. Service receptacle rated 125 volts at 15 amps for connection of programming terminals.

D. Surge arrestor on incoming power.

E. Circuit breakers and fuses rated for available fault current and sized per NEC for the supplied load.

2.08 SPARES

A. Furnish a minimum of one (1) spare I/O module of each type, and one (1) power supply module.

B. Furnish twelve (12) fuses of each type and size, used in the power supply and I/O modules.

2.09 MIXES

A. Not required for this specification.

2.10 FABRICATION

A. PLC and RIO cabinets shall be UL listed as an assembly at the Factory.

2.11 FINISHES

A. Unless specified otherwise in this document, standard factory finish is acceptable.

2.12 SOURCE QUALITY CONTROL

A. Contractor to have a documented Quality Assurance/Quality Control program and to validate that the PLC and RIO cabinets were fabricated and tested in accordance with this program.

PART 3 - EXECUTION

3.01 ACCEPTABLE INSTALLERS

A. Project contractor.

3.02 EXAMINATION

A. Contractor to inspect the site for conditions which will affect the performance of this work and to coordinate activities with other trades.

3.03 ERECTION

A. In accordance with contract drawings and manufacturers recommendations.

3.04 INSTALLATION

A. Provide housekeeping pad or other means of support.

B. Firmly anchor PLC and RIO cabinets to housekeeping pad or support structure.

C. Ground PLC and RIO cabinets in accordance with requirements defined in NEC.

D. Pull and terminate all conductors.

E. Pull and terminate radio cable, mate to existing antenna.

F. Energize, test, leave ready for operation.

3.05 APPLICATION

A. Not required for this specification.

3.06 CONSTRUCTION

A. All equipment, components, and accessories to be installed in accordance with manufacturers recommendations.

B. Mount all components to sub-panels so as to allow sufficient room for wire terminations, labeling, and ventilation.

C. Provide separate terminal block groupings as follows:
   1. 120 VAC main incoming power. Provide terminals to land incoming power and to provide sufficient terminations for all neutral and ground conductors. Provide a single circuit breaker to disconnect incoming power. Provide circuit breakers for panel light, receptacles, UPS, and other loads. Provide a minimum of 2 spare breakers for future loads.
   2. 120 VAC UPS power. Provide circuit breakers, neutral and ground terminals for all UPS loads. UPS will provide all power for the PLC components and other control devices and equipment. Provide a minimum of 2 spare circuit breakers for future loads.
   3. 24 VDC power distribution.
   4. Field wiring terminal blocks for all I/O cards. Wire I/O cards to these terminal blocks. In no instance may field wiring be terminated directly to I/O cards. Each digital and analog input channel must be protected by a fuse on the field termination blocks.

D. Each analog input field termination block grouping must support distribution of 24 volt DC power for 2-wire instruments or direct connection of 4-wire instruments. In addition, provide a means of disconnecting the AI+ signal. Generally, this requires a fused terminal for the +24 VDC, a terminal for the DC COMMON, a switched terminal for the AI+ connection, and a terminal for the AI- connection. Double high terminals with fuses and disconnects may be used.

E. Wire digital outputs directly to interposing relays. Wire the relay dry contact to field termination blocks.

F. Provide surge protectors for all analog inputs whose transmitters exist outside of the building that the PLC or RIO cabinets are located in.

G. Provide shelf or other means of support for the radio.

H. Provide shelf for UPS.

I. Run all conductors in plastic wiring duct or neatly bundle where not possible to run in wiring duct.

J. Label all conductors.

K. Label and identify all sub-panel components.

L. Ground all panel and sub-panel components in accordance with the NEC. Terminate all shield grounds to the isolated ground bus.

3.07 REPAIR/RESTORATION

A. Touch up any paint or damage to enclosure, sub-panel, or components.

3.08 RE-INSTALLATION

A. Not required for this specification.

3.09 FIELD QUALITY CONTROL

A. Not required for this specification.

3.10 ADJUSTING

A. Not required for this specification.

3.11 CLEANING

A. Wipe down enclosure, sub-panel, and components.

B. Vacuum loose debris or blow out with low pressure air.

3.12 DEMONSTRATION

A. Conduct a Factory Acceptance Test (FAT) at location of fabrication. Provide OWNER and ENGINEER with 2 weeks notice prior to conducting this test. Demonstrate that fabrication is in accordance with specification and contract documents. Energize PLC and RIO cabinets and test for short circuits and incorrect wiring. Test every I/O point

using a circuit simulator to demonstrate that wiring is correct. Correct all deficiencies and provide OWNER with test results.

B. If FAT is held more than 100 miles from OWNER's location, provide lodging and transportation for a minimum of 4 people to the FAT site location for the duration of the FAT.

C. After field installation, energize PLC and RIO cabinets and demonstrate proper operation of all components, communication systems, and programming.

D. Upon completion of the installation, start-up shall be performed by a factory-trained manufacturer representative. Operating and maintenance instruction books shall be supplied upon delivery of the unit and procedures explained to operating personnel.

E. Thoroughly test the PLC program and I/O. Each input and output signal shall be tested for correct indication and control function.

F. Program changes made as a result of start up testing and debugging shall be fully documented. Submit the latest program changes to the logic for review, and update the operation and maintenance manuals with the latest program print-out and diskette.

G. Proportional-Integral-Derivative (PID) loops shall be tested and tuned to provide a stable control over the process variable.

H. Install and complete any programming and demonstrate to OWNER proper interface with HMI.

I. Turn over to OWNER all software licenses, documentation, shop manuals, and spare parts.

J. Provide document certifying successful PLC and RIO cabinet testing to OWNER.

K. Training: Refer to HMI training requirements defined in Section 17501.

3.13 PROTECTION

A. Protect all equipment against damage from weather and other trades. Repair or replace any damaged components or systems.

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. Main Distribution Panel
      c. Motor Control Centers
      d. Panelboards, Power and Lighting/Receptacle
      e. Transformers, Dry Type and Oil Filled
      f. Feeders
      g. Transfer Switches, Manual and Automatic
      h. Transient Voltage Surge Suppression Systems
      i. Grounding and Bonding System
      j. Lighting Fixtures and associated controls
      k. Other systems as listed under Part 3 of this specification

C. Related Documents
   1. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 1 Specification sections, apply to the work of this section.
   2. All work performed under this Section of the work is subject to all requirements contained under Section 16000 "General Electrical Requirements".
   3. All Division 16 specifications for electrical equipment provided for this project that requires electrical acceptance testing.

1.02 REFERENCES

A. NETA ATS – Acceptance Testing Specifications, 2003 Edition

B. NFPA 70 – National Electrical Code, Latest Adopted Edition

C. Incorporated by reference all Codes, Standards, and Specifications referred to in the "APPLICABLE REFERENCES" section of NETA ATS-2003.

1.03 DEFINITIONS

A. NETA InterNational Electrical Testing Association Inc.

B. NEC National Electrical Code

1.04 SYSTEM DESCRIPTION

A. Conditions
   1. Provide all items, articles, materials, operations or methods listed, mentioned or scheduled on drawings and/or herein including all labor, materials, equipment and incidentals necessary and required for Electrical Acceptance Testing.
   2. Following established procedures, equipment shall be energized after certification by the testing organization that the installation is satisfactory.
   3. Correct or replace any current-carrying circuit, electrical equipment, or system which is defective or grounded and correct all other troubles encountered by these tests. All defects, whether through faulty workmanship or materials furnished, shall be corrected under this Section at the Contractors expense.

1.05 SUBMITTALS

A. Test Report Forms
   1. All test reports shall be submitted using NETA or approved similar format and, where appropriate, test forms. Reports shall be legible using permanent ink. Pencil is not acceptable.
   2. Provide for engineers review and approval a copy of each test form to be used on the project. No testing shall be started prior to approval of all test forms.
   3. All test reports shall include the following information:
      a. Summary/Description of the Project
      b. Description of equipment tested.
      c. Description of the tests.
      d. Test data and analysis of the data indicating whether the equipment passed or failed the test.
   4. All test data records shall include the following minimum requirements:
      a. Equipment identification including tag numbers.
      b. Humidity, temperature, and other conditions that may affect the results of the tests and/or calibrations.
      c. Date of inspections, tests, maintenance, and/or calibrations.

d. Identification of the testing technician and their employer.
e. Indication of inspections, tests, maintenance, and/or calibrations to be performed and recorded.
f. Indication of expected results when calibrations are to be performed.
g. Indication of "as-found" and "as-left" results, as applicable.
h. Sufficient spaces to allow all results and comments to be indicated..

B. Closeout Submittals
1. Provide one copy each to engineer and owner of all testing reports organized as follows:
a. Bind report in 3-ring binder(s).
b. Identify project name, description, testing organizations name, and submittal date on front face and back cover of binder.
c. Provide all test reports, organized by equipment tag number.
d. Separate different equipment numbers with colored or numbered tabs.
e. Provide an index/table of contents.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Any materials provided as part of the testing shall be new, unused, and in manufacturer's original packing.

2.02 TEST INSTRUMENT CALIBRATION

A. Contractor performing the testing shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy for each test instrument calibrated.

B. Contractor performing the testing shall maintain up-to-date instrument calibration instructions and procedures for each test instrument calibrated.

C. It is preferred that instrument calibration accuracy be directly traceable to the national Institute of Standards and Technology (NIST).

D. 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 2 days prior to testing so that they may be present during testing.

3.03 SAFETY AND PRECAUTIONS

A. Safety practices shall include, but are not limited to, the following requirements:
   1. Occupational Safety and Health Act OSHA
   2. Accident Prevention Manual for Industrial Operations, National Safety Council, Chapter 4

3. Applicable State and Local safety operating procedures
4. NETA Safety/Accident Prevention Program
5. National Fire Protection Association –NFPA 70E
6. ANSI Z244.1 American National Standards for Personnel Protection

B. All tests shall be performed with apparatus de-energized except where otherwise specifically specified.

C. The testing firm shall have a designated safety representative on the project to supervise operations with respect to safety.

3.04 EQUIPMENT TESTING REQUIREMENTS

A. The intent of this specification is not to duplicate testing performed at the point of manufacture or to impose additional burden on the contractor which does not benefit the project. The intent is to verify that electrical equipment has been securely fastened down, supported, and installed in accordance with the manufacturer's requirements. The intent is also to verify that all electrical connections are correctly torqued, properly aligned, properly insulated, and properly supported and that equipment is clean and ready for operation.

B. Except as noted below or as approved by engineer, test the following equipment and assemblies in full accordance with NETA-ATS 2003.

C. Cables, Low-Voltage, 600 Volt Maximum
1. Perform tests only on cables size #4 AWG and larger.

D. Switches, Air, Low-Voltage
1. Perform tests only on switches rated 100 amps or higher.

E. 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.

F. Metering Devices

G. Grounding Systems

H. Ground-Fault Protection Systems, Low-Voltage

I. 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.

J. Motor Control, Motor Starters, Low-Voltage

K. Adjustable Speed Drive Systems

L. Surge Arresters, Low-Voltage Surge Protection Devices

M. Emergency and Standby Power Systems, Engine Generator

N. Emergency and Standby Power Systems, Automatic Transfer Switches

O. 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

INSTRUMENTATION 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:
      a. Provide all instruments.
      b. Provide all control panels, PLC panels, SCADA consoles.
      c. Provide all communication equipment required to make the control system fully operational including but not limited to radios, antennas, switches, routers, hubs, protocol converters, communication cables, and communication racks and power supplies.
      d. Provide all conduit, conductors, enclosures, materials, and labor to fully interconnect and make operational all control system components.
      e. Provide power at proper voltage and ampacity to all system components.
      f. Provide programming for the PLC and SCADA components.
      g. Provide startup and commissioning assistance
      h. Train Owner's personnel on proper use and maintenance of the control systems
      i. 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.

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

E. Allowances
   1. Not applicable this section.

F. Unit Prices
   1. Not applicable this section.

G. Measurement Procedures
   1. Not applicable this section.

H. Special Payment Procedures
   1. Not applicable this section.

I. Alternates/Alternatives
   1. All alternates, alternatives, or proposed substitutions of materials or equipment must be approved by ENGINEER.

1.02 REFERENCES

1.03 DEFINITIONS

A. The word “provide” means “furnish and install”.

B. PLC means Programmable Logic Controller

C. SCADA means Supervisory Control and Data Acquisition System

1.04 SYSTEM DESCRIPTION

A. Design Requirements
   1. Using sound engineering principals and current best design practices, provide engineering drawings and design documents specifying system components and detailing their interconnection and installation.

B. Performance Requirements
   1. The instrumentation and control systems shall be furnished and installed complete and ready to operate, including all necessary interconnections and connections to sources of electrical power, air, water, drains and vents, with all required valves, switches and accessories as specified or as recommended for best operation by the manufacturer of the equipment furnished.

1.05 SUBMITTALS

A. General
   1. Submittals for the equipment shall be provided in accordance with Section 16000, and as required elsewhere in the Contract Documents.

B. Product Data
   1. Detailed catalog information for all system components in sufficient detail so that

ENGINEER has sufficient information to determine if the equipment is acceptable for the intended purpose. Minimum information shall be:

a. Instrument or Equipment tag number
b. Manufacturer
c. Model number
d. Materials of construction
e. Materials in contact with process fluids
f. Dimensional information
g. Weight
h. Power consumption with required voltage and ampacity
i. Heat dissipation if greater than 200 watts
j. Process connection information detailing connection size, type (threaded, flanged, socket weld, etc…)
k. Recommended mounting details
l. Recommended spare parts for one year of operation

2. Instrument Data Sheets in ISA S20 format for all instruments.

C. Shop Drawings

1. For complex control systems consisting of mechanical, electrical, and control components, provide the following:
   a. A Piping and Instrument Diagram in ISA format
   b. Electrical load calculations with conduit and conductor sizing
2. For integrated control panels or control assemblies, provide the following:
   a. Dimensioned layout of the control enclosure and mounted equipment and instruments.
   b. Full bill of material for all components with detailed catalog information on all components.
   c. 11”x17” fully developed schematic diagram(s) showing power and control wiring, terminal block assignments, and identifying field and enclosure wiring. Provide a drawing index and symbols and legend sheet with all schematics. Show all I/O card details including rack, slot, channel numbers, field termination points, and control power wiring. Label all conductors and identify conductor size and color. Identify all field devices by tag number and by description. Provide over current protection in accordance with NEC requirements.
   d. 11”x17” instrument loop drawings in ISA format for all analog control loops. Alternatively, multiple loops may be combined on a single analog input or analog output I/O card schematic diagram.
   e. Nameplate legend
   f. Paint color and type for painted assemblies
3. Any special installation details.

D. Samples

1. Not applicable for this section

E. Quality Assurance/Control Submittals

1. Design Data, Test Reports

a. Submit calibration sheets for all field instruments containing the following information:
    1) Instrument tag number
    2) Instrument manufacturer and model number
    3) Person who performed the calibration
    4) Manufacturer, model and serial number of the calibrating device
    5) Date that calibrating device was last calibrated
    6) For analog instruments, process range and associated analog signal in at least 5 increments (For example: 4.00 maDC/0 psig, 8.00 maDC/25 psig, 12.00 maDC/50 psig, 16.00 maDC/75 psig, 20.00 maDC/100 psig)
    7) For switches, process values at which the switch changes state and at which the switch resets.
    8) For instruments calibrated by manufacturer, manufacturer's calibration report is acceptable as proof of calibration.
b. Factory acceptance test reports on all fabricated control panels or assemblies containing the following information:
    1) Date of test
    2) Test participants
    3) Visual inspection of components
    4) Successful application of power
    5) Validation of all internal wiring
    6) Validation of correct control operation
    7) Validation of screen graphics or alarm operation (if applicable)
    8) Validation of program installation into PLC's and that I/O is functioning properly (if applicable)

2. Certificates, Manufacturer's
    a. UL 508 certification for all assembled control panels and assemblies
3. Instructions, Manufacturer's Field
    a. Furnish a complete Operations and Maintenance Manual for all assembled control panels and assemblies
4. Reports
    a. Not applicable to this section

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

g. Furnish the written warranty

2. Turn over all spare parts to owner with documentation showing which instrument or control system the spare parts are for.

G. Schedule

1. Submit a detailed work schedule showing start/finish dates, task duration, task sequencing, critical path, and available float. Identify task predecessors and identify coordination activities with other trades.

H. Startup and Commissioning Plan

1. Submit a detailed startup and commissioning plan for review by Owner and Engineer. Plan should include the following information:
   a. The order in which the various plant systems will be started up
   b. What work must be performed prior to the startup
   c. What documentation will be maintained by the contractor and provided to the owner validating that the startup was performed in a safe and efficient manner.

1.06 QUALITY ASSURANCE

A. Qualifications

1. Contractor performing the work shall have a minimum 5 years experience performing similar work in similar industries. All contractors' personnel shall be trained and experienced in best current construction practices.

B. Regulatory Requirements

1. Perform all work in accordance with all applicable national and local codes.

C. Certifications

1. Not applicable this section

D. Field Samples

1. Not applicable this section

E. Mock-Ups

1. Not applicable this section

F. Pre-Installation Meetings

1. Not applicable this section

1.07 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading

1. Perform these activities in a manner which assures instruments and equipment will arrive undamaged and in proper working order. Replace any instrument or equipment damaged upon arrival at no additional cost to owner.

B. Acceptance at Site

1. Maintain a comprehensive log by instrument or equipment tag number of all received instruments or equipment

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

1.08 PROJECT/SITE CONDITIONS

A. Environmental Requirements
   1. Follow any and all environmental requirements pertaining to the site
   2. Maintain a safe and clean job site
   3. Dispose of all trash and construction debris in an approved manner

B. Existing Conditions
   1. Contractor is to examine the site and be thoroughly familiar with any site requirements which may affect the work or storage of instruments or equipment.

1.09 SEQUENCING

A. Coordinate all work with other trades.

1.10 SCHEDULING

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

1.11 WARRANTY

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

unsafe operating conditions.

1.12 SYSTEM STARTUP/COMMISSIONING

A. General

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

B. System Startup Sequence

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

constants to achieve critically damped operation.

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

C. Remedies for Damages

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

1.13 OWNER'S INSTRUCTIONS

A. Not applicable this section

1.14 MAINTENANCE

A. Extra Materials

1. Not required this section

B. Maintenance Service

1. Not required this section

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

2.02 EXISTING PRODUCTS

A. Not applicable this section

2.03 MATERIALS

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

2.04 MANUFACTURED UNITS

A. Manufactured units are to be fully assembled and tested at the point of manufacture and delivered to the job site ready for installation and start-up.

B. Regulated dc power supplies for instrument loops shall be designed and arranged so that loss of one supply does not affect more than one instrument loop or system. Power supplies shall be suitable for an input voltage variation of plus or minus 10 percent, and the supply output shall be fused or short circuit protected. Output voltage regulation shall be as required by the instrumentation equipment being supplied. Multi-loop, or multi-system power supplies, will be acceptable if backup power supply units are provided which will automatically supply the load upon failure of the primary supply. The backup supply systems shall be designed so that either the primary or backup supply can be removed, repaired, and returned to service without disrupting the instrument system operation.

C. The power distribution from multi-loop supplies shall be selectively fused such that a fault in one instrument loop will be isolated from the other loops being fed from the same supply. Fuses shall be clearly labeled and located for easy access. Multi-loop supply systems shall be oversized for an additional 10 percent future load. Failure of a multi-loop supply shall be indicated on the respective instrument panel or enclosure.

2.05 EQUIPMENT

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

2.06 COMPONENTS

A. Not applicable this section

2.07 ACCESSORIES

A. Not applicable this section

2.08 MIXES

A. Not applicable this section

2.09 FABRICATION

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

2.10 FINISHES

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

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

2.11 SOURCE QUALITY CONTROL

A. Fabrication/Tolerances
   1. In accordance with generally accepted manufacturing standards

B. Tests, Inspections
   1. In accordance with generally accepted manufacturing standards

C. Verification of Performance
   1. Not applicable this section

PART 3 - EXECUTION

3.01 ACCEPTABLE INSTALLERS

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

3.02 EXAMINATION

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

3.03 PREPARATION

A. Protection
   1. Not applicable this section

B. Surface Preparation
   1. Not applicable this section

3.04 ERECTION

A. Provide 4 inch tall reinforced concrete housekeeping pads for all control panels and floor mounted fabricated control assemblies and consoles. Dowel into concrete base and extend a minimum of 2" past edges of equipment.

B. Provide unistrut or fabricated structural supports for heavy equipment or assemblies. Prime and paint supports so that they are unaffected by the environment in which they are installed.

C. Securely fasten all panels and assemblies to their housekeeping pads or structural supports.

D. All interconnecting wiring shall be run in conduit in accordance with the division 16 sections requirements.

3.05 INSTALLATION

A. Install all instruments and controls in accordance with manufacturer's recommendations and all applicable electrical codes and standards. Connect all required utilities including electrical power, air, hydraulics, etc…

B. Provide stainless steel tags for each instrument engraved with instrument tag number. Attach to instrument with stainless steel wire.

C. Provide engraved nameplates for all panel mounted instruments. Attach to panel with stainless steel screws.

3.06 APPLICATION

A. Not applicable this section

3.07 CONSTRUCTION

A. Special Techniques
   1. In accordance with manufacturers recommended installation procedure

B. Interface with Other Work
   1. Coordinate with all other trades

C. Sequences of Operation
   1. Not applicable this section

D. Site Tolerances
   1. Not applicable this section

3.08 REPAIR/RESTORATION

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

3.09 RE-INSTALLATION

A. Not applicable this section.

3.10 FIELD QUALITY CONTROL

A. Site Tests
   1. Test and calibrate instrumentation in accordance with other parts of this section

B. Inspection
   1. Not required this section

C. Manufacturer's Field Services
   1. If recommended by manufacturer, have equipment/control systems inspected, tested, and started up by manufacturer's representative.

3.11 ADJUSTING

A. Not required this section

3.12 CLEANING

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

3.13 DEMONSTRATION/TRAINING

A. In accordance with the Startup part of this section.

B. Provide training of personnel in the operation and maintenance of the furnished control systems.

C. Training shall be provided as required elsewhere in the Contract Documents, but shall consist of at least eight hours, in a single, or multiple sessions, to accommodate the personnel schedules.

D. Coordinate with the Engineer, and the Owner, to schedule the training sessions at least 5 workings days in advance.

3.14 PROTECTION

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

3.15 SCHEDULES

A. Not applicable this section.

End of Section

SECTION 17052

RADAR LEVEL TRANSMITTER

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers Radar Level Transmitters to be provided where indicated on the Drawings.

B. Related work specified elsewhere includes, but is not limited to section 16000 Electrical. Also, refer to requirements of Contract Documents for testing, adjusting and balancing of systems.

1.02 QUALITY ASSURANCE

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

1.03 SUBMITTALS

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

PART 2 - PRODUCTS

2.01 RADAR LEVEL TRANSMITTER

A. The radar level controller system shall be comprised of a transmitter in a NEMA 4X housing, an radar 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, 4 line LCD display, scaleable in engineering units. The transmitter shall provide a 4-20 mA DC analog output signal which is proportional to level. The transmitter shall be designed to operate from -20 degrees C to +50 degrees C (min.).

C. Enclosure shall be die cast aluminum, powder coated, NEMA 4X rated and shall be equipped with a weather protective cover.

D. The transducer shall be capable of measuring a span of up to 98 feet. The span and range shall be set in the field.

E. The system shall be 24VDC loop powered.

F. Shall be an Endress Hauser Micropilot FMR56 or approved 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 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 17112

ELECTRODE TYPE LEVEL CONTROL

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section includes furnishing all Electrode Type Level Controls 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 General Conditions for testing, adjusting and balancing of systems.

C. Equipment listed for this section includes Electrode Type Level Control where indicated elsewhere on the Drawings.

1.02 QUALITY ASSURANCE

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

PART 2 - PRODUCTS

2.01 ELECTRODE TYPE LEVEL CONTROL

A. Rigid electrodes shall be 316 stainless steel rods, 1/4-inch diameter and length as required. They shall be threaded at one end to fit the electrode holder threads and insulated with 1/32-inch poly vinyl chloride sheath down to 1 inch from their other end.

It shall have the number of probe relays and transformers required for the use indicated and the probes therein. The electrodes shall be Warrick, B/W, or equal.

B. The electrode holder shall be provided with a standard pipe flange to mate with a companion flange on the mounting surface. The holder shall accept 1/4-inch diameter rod electrodes or wire suspended electrodes, with a suitable adapter. The holder shall have a stainless steel flange, MSS flat faced, with teflon insulation sleeves. The holder shall be sized to accommodate the number of electrodes indicated on the Drawings. The terminal housing shall be rated NEMA 4 integrity and an NPT tapped boss for conduit. The electrode holder shall be Warrick Series 3F, B/W Type KF, or equal.

C. Suspended electrodes shall be 303 stainless steel contained within a protective molded plastic shield, approximately 4 inches long. Length of suspension wire shall be as required. Suitable adapters shall be used for fastening the upper end of the suspension wires to the couplings of the electrode fittings. Electrodes shall be Warrick Series 3W with Type 3Z1A suspension wire and 3Z1B adapters, B/W Type E-1P with Type SW suspension wire, or equal.

D. Control relays shall be solid state, plug-in type. Relay sensitivity shall be selected for the type of fluid, as recommended by the manufacturer. Relay sensitivity shall be available from 4.7K to 1 million OHMS per centimeter. Relay contacts shall be rated for 5 amps, minimum for DPDT units, and 10 amps for SPDT units. Relay sockets shall mount on standard DIN rail and shall be rated for 300V, minimum. Relays shall be capable of single-level, or differential level service. Relays shall have time delay on increasing or decreasing level as indicated on drawings. Relays shall be Warrick Series 16, or equal.

E. The Contractor shall provide a complete and functioning electrode level control system with ground to tank or grounding electrode, as required by installation.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment and materials specified in this section shall be installed and connected as specified and as shown on the Drawings. Contractor shall coordinate with mechanical to insure a proper fit of electrodes and electrode holder. The Contractor shall field verify the electrodes and cable lengths.

3.02 ACCEPTANCE

A. Prior to final acceptance, 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 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. Manufacturer shall assume responsibility for, and guarantee performance of equipment furnished. However, this shall not be construed as relieving the Contractor from responsibility for the proper installation and functioning of the work.

1.03 SUBMITTALS

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

1.04 MANUFACTURERS

A. Pressure transmitters shall be an Endress Hauser Cerebar S PMC71, or approved equal.

PART 2 - PRODUCTS

2.01 PRESSURE TRANSMITTER

A. Provide pressure transmitters with 1/2 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 500 ohm loop load.

C. Instrument accuracy shall be within plus or minus 0.5 percent of span, and a 0.2 percent repeatability. Dead band shall be within 0.1 percent of span.

D. Transmitters shall have external zero and span adjustment for field calibration. Instrument enclosure shall be NEMA 4, with 316 stainless steel wetted parts.

E. Diaphragm seals shall be manufactured by Ashcroft, or equal.

F. Shall be provided with block and bleed valves.

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, and as shown on the Drawings. Contractor shall coordinate with other trades to insure 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 on 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. Manufacturer 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:

NEC
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. Pressure switches shall be as manufactured by Dwyer or approved equal.

G. Differential pressure switches shall be as manufactured by Barksdale Controls Series DPD1T, Mercoid Controls Series DPAW, Ashcroft Instruments GDA-Series, or equal.

H. 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 insure 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 17124

SUBMERSIBLE LEVEL TRANSMITTER

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers the Submersible Level Transmitters to be provided where indicated on the Drawings.

B. Related work specified elsewhere includes, but is not limited to section 16000 Electrical. Also, refer to requirements of General Conditions for testing, adjusting and balancing of systems.

1.02 QUALITY

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

B. Reference standards. Standards shall be the latest edition, including addenda, supplements, and revision. Applicable reference publications include the following:

NEC
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 SUBMERSIBLE LEVEL TRANSMITTER

A. The submersible level transmitter system shall be designed for total submersion, and shall have the following features:
1. Accuracy of +/-0.1% of full scale.
2. Titanium construction.
3. Two-wire, 4 mA output at zero pressure, 20 mA output at full range pressure.

4. Operating pressure ranges from 1 psi to 900 psi, as required by the application.
5. Overpressure rating shall be 4 times the operating pressure range from 1 to 5 psi, and 2 times the range for 10 psi and above.
6. Pressure transducer shall be of the integrated silicon strain gauge bridge type.
7. Transmitter supply voltage shall be 9-30 VDC.
8. Operating temperature shall be -20 to +60 degrees C.
9. Transmitter shall be provided with sufficient cable length to reach terminations point shown on the Drawings.

B. Submersible level transmitter shall be an Endress Hauser Waterpilot fmx 21, or approved 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 transmitter, and associated conduit and cables.

B. The instrument shall be factory calibrated 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.

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. The flowmeters shall consist of two parts with manufacturer supplied interconnecting wiring, the field installed flow element and the flow indicating transmitter.

B. Related work specified elsewhere includes, but is not limited to section 16000 Electrical. Also, refer to requirements of Contract Documents for testing, adjusting and balancing of systems.

1.02 QUALITY ASSURANCE

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

1.03 SUBMITTALS

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

PART 2 - PRODUCTS

2.01 MAGNETIC FLOWMETERS:

A. Acceptable Manufacturers:
   1. Endress Hauser Proline Promag
   2. Or Approved Equal.

B. Materials:
   1. All mounting hardware shall be 316 stainless steel, the instrument enclosure shall be rated NEMA 4X, the flow sensor liner shall be Polyurethane lined, and the electrode material shall be 316 stainless steel.

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 rated for piping system operating and test conditions.
   3. Operating pressure: 100 psi.
   4. Operating temperature: 122 DegF.
   5. 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.
   6. Provide cable between magnetic flowmeter and transmitter.
   7. Pulsed DC magnetic field excitation.
   8. Automatic zero
   9. Adjustable low flow cutoff.
   10. 16-character alphanumeric display shall indicate user-defined flow units and total flow. All menu advice and commands shall be viewed on this display.
   11. Minimum signal lock (empty tube zero) to prevent false measurement when tube is empty.
   12. Accuracy:
      a. +/- 0.5 percent of rate above 1 fps.
      b. +/- 0.01 fps below 1.0 fps.
   13. Shall be capable of communicating parameters via Ethernet/IP protocol.
   14. Power supply: 117 V +/- 10 percent, 60 HZ.
   15. Meter operable as specified in liquids with 5.0 micromho/cm or more conductivity.
   16. Electrodes shall be self-cleaning.

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

APPENDIX A

GEOTECHNICAL REPORT

GEOTECHNICAL INVESTIGATION REPORT

FOR

PROPOSED NEW CONSTRUCTION
CITY OF GOODYEAR WELL SITE 12
(33.419207^0 N, 112.430848^0 W)
GOODYEAR, ARIZONA

PREPARED FOR:

MR. THOMAS BAYLES, P.E.
NCS ENGINEERS
202 E. EARLL DRIVE, SUITE 110
PHOENIX, ARIZONA 85021

PREPARED BY:

COPPER STATE ENGINEERING, INC.
16621 N. 91ST STREET, SUITE 104
SCOTTSDALE, ARIZONA 85260
TELEPHONE: (480) 368-1551

March 26, 2018 **JOB NO. CSE-4391**

COPPER STATE ENGINEERING, INC.
C I V I L / G E O T E C H N I C A L
S E R V I C E S

March 26, 2018

Mr. Thomas Bayles, P.E.
NCS Engineers
202 E. Earl Drive, Suite 110
Phoenix, Arizona 85021

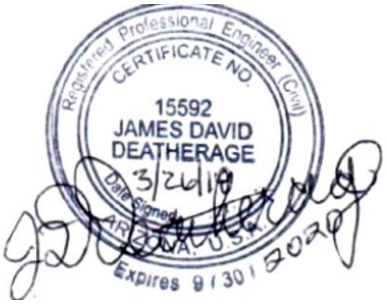
Subject: **Revised Geotechnical Investigation and Percolation Testing**
Goodyear Well Site 12 (33.419207^0 N, 112.430848^0 W)
Goodyear, Arizona
CSE-4391

Dear Mr. Bayles,

COPPER STATE ENGINEERING, INC. (CSE) herewith submits our report summarizing the geotechnical investigation and percolation testing conducted in the above referenced location. The report includes the results of subsurface explorations and laboratory testing along with our discussion and recommendations. Based on the results of the field investigation and laboratory testing, the site contains loose to very dense, silty sand with some gravel. Layers of poorly graded sand were encountered interbedded within the silty sand. Detailed descriptions of the subsurface materials encountered at the test locations are included in this reporting. This report provides foundation, lateral earth pressures and drainage recommendations, and requirements and procedures for site preparation, grading, excavation and material suitability. In addition the result of the percolation test is presented. Careful control of soil moisture changes and site preparation per CSE recommendations will reduce future moisture induced movement of the soil under the structures. With consideration for the recommendations for site preparation, the site can be suitable for the proposed construction. CSE should be notified for additional evaluations and/or recommendations if the site conditions, use or the proposed construction differ from those presented herein. Please contact CSE with questions or comments.

Respectfully submitted,
Copper State Engineering, Inc.

Moges Gebregiorgis, P.E.
Senior Project Engineer



J. David Deatherage, P.E.
Senior Geotechnical Engineer

16621 N. 91st Street, Suite 104, Scottsdale, AZ 85260
Phone (480) 368-1551 Fax (480) 368-1556

TABLE OF CONTENTS

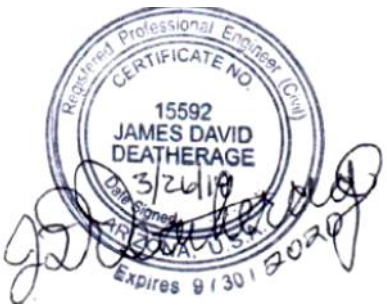
REPORT			PAGE NO.
1.0	Introduction		1
2.0	Purpose and Scope of Service		1
3.0	Proposed Construction		1
4.0	Site and Geological Conditions		1
5.0	Geotechnical Investigations		3
	5.1	Field Exploration	
	5.2	Laboratory Testing	
	5.3	Percolation Testing	
6.0	Discussion		5
7.0	Recommendations		6
	7.1	Foundation	
	7.2	Lateral Pressure	
	7.3	Seismic Design Considerations	
	7.4	Drainage	
	7.5	Pavement	
8.0	Material Suitability and Requirements		10
	8.1	Engineered Fill	
	8.2	Corrosion Consideration	
9.0	Site Preparation and Grading		12
10.0	Slopes and Excavations		13
11.0	Limitations and Concluding Remarks		13
12.0	Selected References		14

FIGURES (Figures follow Report Text)

FIGURE 1 Vicinity Map
FIGURE 2 Site Map

APPENDIX (Appendix follows Figures)

CSE Boring Logs and Laboratory Testing Results
Seismic Coefficient Worksheet



Geotechnical Investigation and Percolation Testing
Goodyear Well Site 12 (33.419207^0 N, 112.430848^0 W)
Goodyear, Arizona
CSE-4391

1.0 Site Location

This report presents the results of CSE's geotechnical investigation for the proposed construction of two new water tanks and associated equipment. The project site is located inside an existing water well facility for the City of Goodyear situated approximately 1,500 feet southwest of the intersection of W. Lower Buckeye Road and S. Cotton Lane. The approximate location of the new well site is shown on the attached Vicinity Map (Figure 1). The project site is located within a portion of the NE quarter of Section 23, Township 1 North, and Range 2 West, of the Gila and Salt River Base and Meridian, Maricopa County, Arizona.

2.0 Purpose and Scope of Services

The purpose of the geotechnical investigation is to characterize the subsurface conditions at the project site and provide foundation design and other geotechnical engineering recommendations. The scope of services included:

1. General reconnaissance of the project site.
2. Exploration of the subsurface conditions using four bore holes.
3. Visual classification and continuous logging of material encountered during the subsurface exploration.
4. Percolation testing.
5. Laboratory testing of selected soil samples.
6. Evaluation of pertinent engineering characteristics of the subsurface site soils.
7. Preparation of this report.

3.0 Proposed Construction

CSE was provided with conceptual site plans for the proposed construction. The plans show that a two-million gallon capacity water tank will be constructed just south of the existing tank. The new tank will be 156 feet diameter and 16 feet high. A second smaller tank is also proposed northeast of the existing tank. It is our understanding that slab on grade pads for the generator and electrical panel and small facility building may also be constructed.

4.0 Site and Geological Condition

The project site is situated inside an existing facility. The proposed larger water tank construction area is located on the southern portion of the facility where excavation of the ground outside the block fence and demolishing of the block fence were ongoing at the time our site visit. The ground elevation outside the fence was eight to ten feet higher

than inside (see photos below). The new larger water tank will be constructed just south an existing water tank. The location of the second new smaller tank has not been finalized.

South of the existing tank- looking east.

Aerial view of the existing facility.

On the northern portion of the facility, the site contains slab on grade pads, below ground and above ground pipes, smaller tanks and a facility building. The existing tank appeared to have been constructed by lowering the original ground and hence the ground elevation drops from north to south of the facility.

Arizona is divided into three major physiographic provinces; 1) Colorado Plateau Province that covers northern Arizona, 2) Basin and Range Province that covers southern Arizona and 3) Central Highlands Province which is the transitional zone and lies between the Colorado Plateau and Basin and Range Provinces. The site is situated in the Basin and Range Province characterized by unconsolidated to weakly consolidated alluvial fan, terrace, and basin-floor deposits of late and middle Pleistocene Epoch. These deposits are mainly gravel and sand in the fan and terraces and sand, silt and clay in the basin floor. Silty sand underlain by poorly sand with gravel was encountered during our subsurface investigation in the upper 11.5 feet.

The Natural Resources Conservation Service (NRCS) soil mapping suggests the site is underlain with two soil map units – GgA and LcA. Soil map unit GgA contains loam in the upper 37 inches and sandy loam from 37 to 60 inch. Soil map unit LcA contains loam in the upper 50 inches and gravelly loam between 50 and 72 inches. NRCS defines loam as a soil that is 7 to 27% clay particles, 28 to 50% particles, and less than 52% sand particles.

Arizona Department of Water Resources (ADWR) registers groundwater wells and compiles the installation data. ADWR's well registries in close proximity of the site reveals that the ground water table was encountered at a depth of 68 to 127 feet below the surface.

5.0 Geotechnical Investigation

5.1 Field Exploration

The field exploration was planned to obtain soil and geotechnical information for the design of the proposed construction. CSE representatives visited the site on February 5, 2018 and drilled three bore holes to a depth of 30 feet below existing grade. A truck mounted CME-75 drill rig with hollow stem auger was used to drill the bore hole. The subsurface site soil was sampled by driving a Standard Penetration Test (SPT) sampler and a 3-inch outside diameter split spoon sampler lined with one-inch brass rings. Both samplers were driven using a 140-pound hammer, dropped 30 inches. The number of drops it took to drive the SPT sampler 18 inches at six inch increments were counted and recorded to estimate the firmness of the soil. The drops for the last two six-inch increments were added and reported on the boring log. Continuous and detailed log of the materials and conditions encountered and other pertinent information were documented. The boring location is shown on the attached Figure 2. Our subsurface exploration revealed the following materials;

Silty SAND: The silty sand native soil was encountered in the upper ten feet of existing grade. The native soil was described as brown, slightly moist to moist, silty sand with gravel. The relative density of the silty sand range from loose to medium dense. A layer of poorly graded sand was encountered at a depth of three feet in boring B-2.

Sand, Gravel and Silt: Below a depth of ten feet and to a depth of 30 feet, the site is underlain with alternating layers of poorly graded sand, gravelly sand and/or silty sand. The proportion of gravel, sand and silt varies with depth and from one bore hole to the other. The soil becomes dense to very dense with increasing SPT numbers. The SPT numbers decrease at a depth of 30 feet for B-1 and B-2

Ground water was not encountered. After completion of the drilling the hole caved in to a depth of 15.5 feet in B-2. The boring was backfilled using the cuttings. The boring log is attached to this reporting.

5.2 Laboratory Testing

CSE obtained disturbed bulk and relatively undisturbed ring samples from the borings for laboratory testing and soil identification. Sieve analysis (ASTM D6913), Atterberg Limits (ASTM D4318), One-Dimensional Consolidation (ASTM D4546), Expansion

Index (ASTM D4829), moisture and density testing were conducted. The results of laboratory testing of the soils are attached.

The one-dimensional consolidation test was done to estimate the compression of the site soil due anticipated surcharge loading and saturation of the soil under the anticipated surcharge load. Sieve analysis of the site soil was conducted to estimate the percentage (by weight) of the different grain sizes of the soil. Atterberg Limits testing was conducted on the material passing the #40 sieve to estimate the Plasticity Index (PI) and Liquid Limit (LL) of the portion of the soil that is finer than the #40 sieve.

The soil sample obtained from B-3 from a depth of 10 to 20 feet was tested to estimate the expansion potential. The soil samples were sieved through the No. 4 sieve and the material smaller than the No. 4 sieve was compacted in accordance with ASTM D4829. The sample was then inundated at 144 psf surcharge load to estimate the expansion potential. The ratio of the change in sample height to original height of the sample multiplied by 1000 and corrected to 50% saturation of the sample provides the EI_{50} value (the expansion potential at 50% saturation). ASTM classifies the soil's expansion potential according the following table.

Expansion Index (EI)	Potential Expansion
0–20	Very Low
21–50	Low
51–90	Medium
91–130	High
>130	Very High

A bulk soil sample was sent to Motzz Laboratory, Inc. (Motzz) for pH, minimum resistivity, chloride and sulfate tests.

5.3 Percolation Testing

CSE used 12-inch auger to excavate to a depth of three feet below existing grade south of the existing water tank. The bottom of the excavation was carefully cleared to a 12 inch diameter hole with a flat undisturbed bottom. CSE place 3/8 inch thickness of sand and placed a perforated bucket into the excavation, then presoaked the excavation with 9 inches of water for four hours and ran percolation tests with six inches of water depth in the excavation with the following results:

Run No.	Start Time (H:M:S)	End Time (H:M:S)	Elapsed Time (min.)	Measured Water Drop (inch)	Percolation Rate (min/in)
1	12:24:00	12:30:00	6.0	1	6.0
2	12:31:00	12:36:50	5.8	1	5.0
3	12:37:00	12:42:45	5.75	1	5.75

For design of a retention basin at the project site, CSE suggests that twice the measured rate would be the percolation rate (12.0 inch/min) under ideal conditions. We recommend that a factor of safety be added to this rate depending on the anticipated amount and frequency of maintenance of the detention basin, and control of sediment accumulation in the detention basin.

6.0 Discussion

Sieve analysis of the native, silty sand soil was conducted. The silty sand is made up (by weight) of 5.3% gravel in B-1 and 27% gravel in B-2, 56.8% sand in B-1 and 46.4% sand in B-2 and 37.9% and 26.6% finer than #200 sieve in B-1 and B-2 respectively. Based on the results of the Atterberg Limits testing, the soil passing #200 sieve was described largely silt. The soil portion passing #40 sieve made up 68.4% and 57.1% in B-1 and B-2 respectively and was used for Atterberg Limits testing. Atterberg limits testing indicated that the native soil is non-plastic. Generally non-plastic soils exhibit low expansion potential with increased soil moisture.

The remolded sample of the site soil obtained from ten to twenty feet deep in B-3 was tested to estimate the expansion potential under light loading. The remolded soil showed no swell upon wetting and under 144 psf vertical loading. The silty sand is considered to possess a very low expansion potential according to the ASTM classification.

Four one-dimensional consolidation tests were conducted of the site soil collected from depths that ranged from one foot to ten feet. All the samples compressed due to the anticipated building load and saturation. The samples were loaded incrementally and the amount of compression was recorded. The percent compression range from 0.1 to 3.2 percent when given free access to water at 1,074 psf surcharge load. The sample with the largest compression was obtained at a depth of one foot. Some of the compression at low vertical loading may have been caused by sample disturbance.

Imported and reworked onsite material that may be used as engineered fill should be properly moisture conditioned and compacted to reduce future settlements. Recommendation for proper placement and compaction of engineered fill are provided in

the site preparation and grading section of this report. It is important that the site preparation and grading recommendation of this report be followed to decrease soil movements due to increased loading and/or increases in soil moisture.

Foundation recommendations are presented in the following section. Elastic and compression settlement under the larger loaded tank constructed according to the recommendations of this report should be on the order of one inch on the circumference and two inches in the center, provided that moisture changes in the foundation onsite soils and any new engineered fill are minimized.. Movement under footings and slabs constructed according to the recommendations of this report will be less than 0.75 inch provided that moisture changes in the foundation onsite soils and any new engineered fill are minimized. Movements under footing and slabs bearing on new engineered fill or compacted native soil may be higher if the soils become wetted or significantly dried. Much of this movement would be differential in nature. Structural design for the interior and exterior concrete slabs should consider this potential movement. Particular attention should be directed to the site grading and drainage requirements discussed in the following sections, in order to reduce the possible future wetting of the fill soils.

7.0 Recommendations

7.1 Foundations

The following recommendations are presented for shallow spread footings bearing on compacted onsite soil or engineered fill. The allowable bearing pressures should be applied to the maximum dead plus live loads. The allowable bearing pressure may be increased by one-third when considering wind or seismic forces.

	Foundation Loading	Allowable Bearing Pressures
Compacted native	Dead plus live loads	1,250 psf
Engineered fill	Dead plus live loads	1,500 psf

Square or round footings should have a minimum width of two feet, and continuous footings should be a minimum of 1.3 feet wide. Footings should have a minimum depth of 1.5 feet below the final site grade. Final site grade is defined as the lowest adjacent finished grade within five feet of the perimeter of the structure. The base of the footings should bear on properly moisture conditioned and compacted native or imported engineered fill. Engineered fill recommendations should be confirmed with compaction testing. Footing trenches for foundations should be inspected by representative of the Geotechnical Engineer. As deemed necessary by the representative of the

Geotechnical Engineer, pockets of excessively moist, loose or unstable soil should be either compacted to the requirements of engineered fill, or removed and replaced with cement slurry or the footing extended down to competent material.

7.2 Lateral Pressures

The table below lists the lateral earth pressure values described as equivalent fluid pressure and coefficient of base friction values that should be used for the proposed construction at the project site. For design of retaining walls CSE observes that a limited allowable amount of retaining wall tilt reduces the wall pressures from at-rest pressure to the active state. The amount of tilt to reach the active state, expressed as a ratio of the total height of the wall, depends on the type of the backfill soil. For a dense cohesionless backfill allowing the wall to tilt 0.0005 H, where H is the height of the wall, will reduce the design wall pressures from the at-rest to active condition. More cohesive soil may require greater tilt to reach the active state.

Backfill Pressures	At-rest (Restrained wall and fully drained backfill)		60 pcf
	Active (Unrestrained retaining wall)	Onsite soil	50 pcf
		Imported, fully drained clean sand backfill	35 pcf
Passive pressures (compacted backfill)			350 pcf
Coefficient of base friction	Concrete to AB fill		0.45
	Concrete to compacted native		0.35
	Concrete to engineered fill		0.35

The above values are for vertical retaining walls with horizontal backfills. Additional loading imposed by construction equipment or permanent loads resulting from backfill swell pressures, hydrostatic pressures or surcharge loads may increase the lateral pressure on retaining walls above and beyond the values listed above. Proper drainage should be provided behind the retaining walls to prevent a buildup of hydrostatic pressures. Surface drainage measures to direct water away from the top of the retaining should also be considered.

Care must be exercised during compaction of backfill against the wall. Hand operated equipment and thin backfill lifts are suggested to reduce the buildup of additional and possibly excessive wall pressures due to compaction effort. Fill placed behind the retaining wall should be compacted per site soil compaction recommendations, with

compaction equipment that will not induce large lateral pressures against the retaining wall.

All retaining walls and slopes should be adequately designed and constructed to drain rainfall runoff away from structures and retaining walls.

7.3 Seismic Design Considerations

Subsurface explorations at the site were not advanced to depth of 100 feet below existing grade. However, based on our review of the regional geology and in general conformance with site classification procedure outline in ASCE 7, the site was classified as "site class D". Using site class D and the Unites States Geological Survey (USGS) seismic design map application, the various seismic design parameters were estimated and attached to this reporting.

7.4 Drainage

The site drainage design and construction of the proposed improvements must accommodate the interception, routing and mitigation of storm runoff. Care should be taken to prevent significant changes in the moisture content of the onsite soil and engineered fill, which will help reduce possible future foundation movements. Roof and surface drainage must be diverted away from the slab and foundation of the structures, including tanks and retaining walls. The ground immediately adjacent to the foundation shall be sloped away from the structures at a slope of not less than one vertical unit in 20 horizontal units (5-percent slope) for a minimum distance of 10 feet, measured perpendicular to the face of the wall, or an engineer approved alternate method of diverting water away from the foundation shall be used. A positive grade must be maintained away from the structures, to a point of discharge off the property or an engineered approved retention system. Design of retention basin should be based on the percolation rate provided in this report with a factor of safety modification as discussed.

Storm water drainage above cut slopes, fill slopes and retaining walls should be intercepted uphill from the slopes and diverted around the slopes. The site civil grading and drainage design must consider and accommodate this storm water diversion.

Planting and landscaping should be constructed so that water does not pond adjacent to the structures, and positive drainage is not impeded. Vegetation requiring deep watering must not be planted within 10 feet of any structure. Air conditioning

condensate discharge pipes, and/or above ground or subgrade vaulted landscape irrigation valves must be located at least 10 feet away from any structure.

CSE recommends that positively graded subsurface drainage be constructed behind all retaining walls. CSE recommends that a vapor barrier be used under interior floor slabs if flooring material sensitive to elevated levels of moisture vapor will be used in the structures.

7.5 Pavement

The subgrade soils are predominantly sand and silt. The site soil has a low plasticity index with up to 38% of the soil passing the No. 200 sieve. We understand that sporadic heavy trucks will be travelling and parked on the proposed driveway. Based on the type of the traffic, the site soil and site drainage system which will prevent accumulation of water on the subgrade, and adequate preparation of the subgrade material, the pavement design section of asphaltic concrete (AC), aggregate base (AB), and subgrade is summarized below. AB thickness can be reduced three inches for one-inch of additional asphalt pavement, if desired.

AC Thickness (inch)	AB Thickness (inch)	Compacted Subgrade (inch)
3.0	10	12

Pavement should be constructed in accordance with Maricopa Association of Governments (MAG 2017) specifications, and consist of a minimum 3.0 inches of 19 mm (3/4 inch) asphalt surface course. Asphalt surface course shall meet the Table 710 criteria in the MAG 2017 specifications. AB shall meet the Table 702 AB course criteria in the MAG specifications. The aggregate material under the top 4 inches of AB can be either AB or select material, in accordance with Table 702 in the MAG Specifications. AB shall be compacted to a minimum of 100 percent of the ASTM D-698 maximum dry density, within three percent of the optimum moisture content.

The upper one foot of the subgrade shall be moisture conditioned and compacted to a minimum of 95 percent of the ASTM D-698 maximum density, within two percent of the optimum moisture content.

Prevention of aggregate base wetting is essential for pavement durability, and efforts should be made to limit the amount of water entering the aggregate base layer. Positive methods to control water include placement of curbing to divert pavement

surface water, not extending aggregate base beneath planters or landscaped areas, and maintaining a positive grade on the pavement surfaces to prevent ponding**.**

8.0 Material Suitability and Requirements

8.1 Engineered Fill

Engineered fill should consist of native site soil and/or imported soil that conform to the following specification.

- Predominately sand, gravel and silt soils.
- 3-inch maximum allowable particle size.
- Low plasticity soil (PI less than 5 and LL less than 35).
- Low swell potential soil (less than 1.0% remolded swell).

Engineered fill should be placed in 12-inch maximum horizontal lifts, with lift thickness not to exceed the compaction limits of the compaction equipment, and the engineered fill should be compacted to the percent of the maximum dry density and within the range of moisture as follows:

	Minimum Percent Compaction (ASTM D-698)	Moisture Content (ASTM D-698)
Aggregate Base		
Below floor slab	95	Optimum ± 2%
Below paving	100	Optimum ± 2%
Building Areas		
Onsite soil	95	Optimum ± 2%
Imported soil (less than 5 feet thick)	95	Optimum ± 2%
Imported soil (more than 5 feet thick)	98	Optimum ± 2%
Pavement Subgrade or Fill	95	Optimum ± 2%
Utility Trench Backfill	95	Optimum ± 2%

Confirmatory testing of moisture conditioning and compaction for all site fill should be performed by a representative of the geotechnical engineer.

CSE recommends a four-inch thickness of Aggregate Base (AB) material placed as engineered fill under concrete slabs. AB material should meet the requirements of Section 702 of Maricopa Association of Governments Uniform Standard Specifications and details for Public Works (MAG).

Sampling and testing by a representative of the geotechnical engineer should be performed during construction to confirm the above recommendations.

8.2 Corrosion Consideration

Chemical properties of the site soils impact the durability of metals and concrete in contact with the soils. The results of soil chemical testing conducted on selected site soil samples are attached to this reporting. Soil chemical testing included sulfate, chloride, pH and minimum resistivity. The chemical testing results were compared with the corrosion guidelines.

- Resistivity- A low resistivity value for a soil sample indicates the presence of high quantities of soluble salts and a greater chance of possible future corrosion. According to the CALTRAN corrosion guidelines, soil samples with a resistivity of less than 1,000 ohm-cm indicates the presence of high quantities of soluble salts and should be tested for chloride and sulfate contents. The site soil has 3358 ohm-cm minimum resistivity and is considered non-corrosive according to the CALTRAN corrosion guidelines.

- Chloride- High amounts of chloride ions can lead to corrosion of steel in contact with the soil and steel reinforcement in concrete. A chloride concentration greater than 500 ppm is considered to be corrosive. The site soil has 9 ppm of chloride concentration and is considered non-corrosive according to the CALTRAN corrosion guidelines.

- Sulfate- High amounts of sulfate ions can lead to the deterioration of concrete. Sulfate ions react with the cement in the concrete and can cause the concrete to weaken. According to the CALTRAN corrosion guidelines soils with a sulfate concentration greater than 2,000 ppm are considered to be corrosive. The site soil has 24 ppm of sulfate concentration and is considered non-corrosive according to the CALTRAN corrosion guidelines.

- pH- Low pH (acidic) is considered to be a corrosive condition. According to the CALTRAN corrosion guidelines, soils with a pH of 5.5 or less are considered to be highly acidic and corrosive. The site soil has pH of 9.4 and doesn’t indicate corrosive environment.

9.0 Site Preparation and Grading

Recommendations presented in the previous sections of this reporting are based upon following site preparation and grading recommendations.

- The site areas receiving fill and/or new construction should be stripped of vegetation, debris, rubble and loose surface soils.

- For all structures except the water tank and site masonry walls, the foundations should bear on a minimum of one foot of engineered fill. To achieve this, the site soil within and extending 1.3 feet from the center of the foundation should be over-excavated to minimum depth of one foot below the bottom of the foundation. The upper six inches of the exposed surface of the excavation should be scarified; moisture conditioned and compacted to a minimum of the 95 percent of the maximum dry density (ASTM D-698) at ± 2% of the optimum moisture. Confirmatory testing of the compaction should be performed for scarified and engineered fill soils.

- The foundation for the proposed water tank should bear on a minimum of three feet of engineered fill. To achieve this, the site soil within and extending five feet from the outside perimeter of the tank foundation should be over-excavated to minimum depth of two feet below the bottom of the foundation. The upper six inches of the exposed surface of the excavation should be scarified; moisture conditioned and compacted to a minimum of the 95 percent of the maximum dry density (ASTM D-698) at ± 2% of the optimum moisture. Confirmatory testing of the compaction should be performed for scarified and engineered fill soils.

- For masonry wall foundations, the upper six inches of the exposed surface of the footing excavation should be scarified; moisture conditioned and compacted to a minimum of the 95 percent of the maximum dry density (ASTM D-698) at ± 2% of the optimum moisture. Confirmatory testing of the compaction should be performed for scarified and engineered fill soils.

- Concrete utility pads should be constructed on a four-inch thick compacted AB placed over twelve inches of engineered fill. The upper six inches of the excavated surface should be scarified and properly compacted prior to placement of the engineered fill. The AB and engineered fill should be placed in accordance with the requirements of this reporting. The finish grade around the utility pads should be sloped away from the concrete pads for a minimum of ten feet at slope not less than five percent.

- Over-excavated site soil meeting the engineering fill requirement can be used as engineered fill soils pursuant to placement and compaction recommendation of this reporting.

- Fill materials to achieve specified grades should be moisture conditioned, placed and compacted in horizontal lifts, with lift thickness not to exceed the compaction limits of the compaction equipment.

10.0 Slopes and Excavations

The borings were drilled to the desired depths using a truck mounted CME-75 drill rig. The site soils to the depth explored by CSE may be excavated using standard soil excavation machine such as backhoe. CSE recommends that the contractor evaluate the difficulty of excavation of the material by performing test excavations with the type and size of excavation equipment that will be used.

It is recommended that permanent slopes constructed of compacted fill be designed at 3H:1V (horizontal to vertical) or flatter in the engineered fill areas. Temporary excavations requiring worker access in site native or fill soils should be braced or sloped to meet OSHA trench safety criteria, under review of a qualified geotechnical engineer.

Open permanent structures located more than a few feet beneath existing site grades should have a positive seepage collection system and be provided with either positive gravity drainage or a dedicated electric pump to remove perched water that can accumulate under structures during periods of excessive rainfall.

11.0 Limitations and Concluding Remarks

The recommendations made in this report are based on the assumption that the subsurface conditions do not vary appreciably between the testing locations. The subsurface information presented in this report does not constitute a direct or implied warranty that the conditions between testing locations can be directly interpolated or extrapolated, or that the subsurface conditions and/or variations different from those disclosed will not be revealed. CSE prepared this report to aid in the evaluation of the site and to assist in foundation design for this project. We have developed our recommendations in accordance with generally accepted professional engineering principles and practices. We make no warranty either expressed or implied.

Our conclusions are based on the results of the field explorations and on our interpretations of subsurface conditions between and beyond these explorations. If the contractor encounters conditions that appear different from those described in this report, we should be notified so that we may review and verify or modify our recommendations.

Reliance on this reporting is subject to the terms and conditions of the contract General Provisions.

12.0 Selected References

Arizona Geological Survey and Arizona Geological Society, 1998, Geologic Highway Map of Arizona.

Bowles, Joseph E., 1997, "Foundation Analysis and Design", McGraw Hill, New York.

Day, Robert W., 2005, “Foundation Engineering Handbook”, McGraw Hill Construction, New York.

MAG, 2015, “Uniform Standard Specifications for Public Work Construction” Maricopa Association of Governments - with revisions through 2017.

NCS Engineers, 12/12/2017, Preliminary for Goodyear Site 12 Expansion, Arizona

2012 International Building Code.

2012 International Residential Code.

N

SCALE 1" = 1000'

0 500 1000

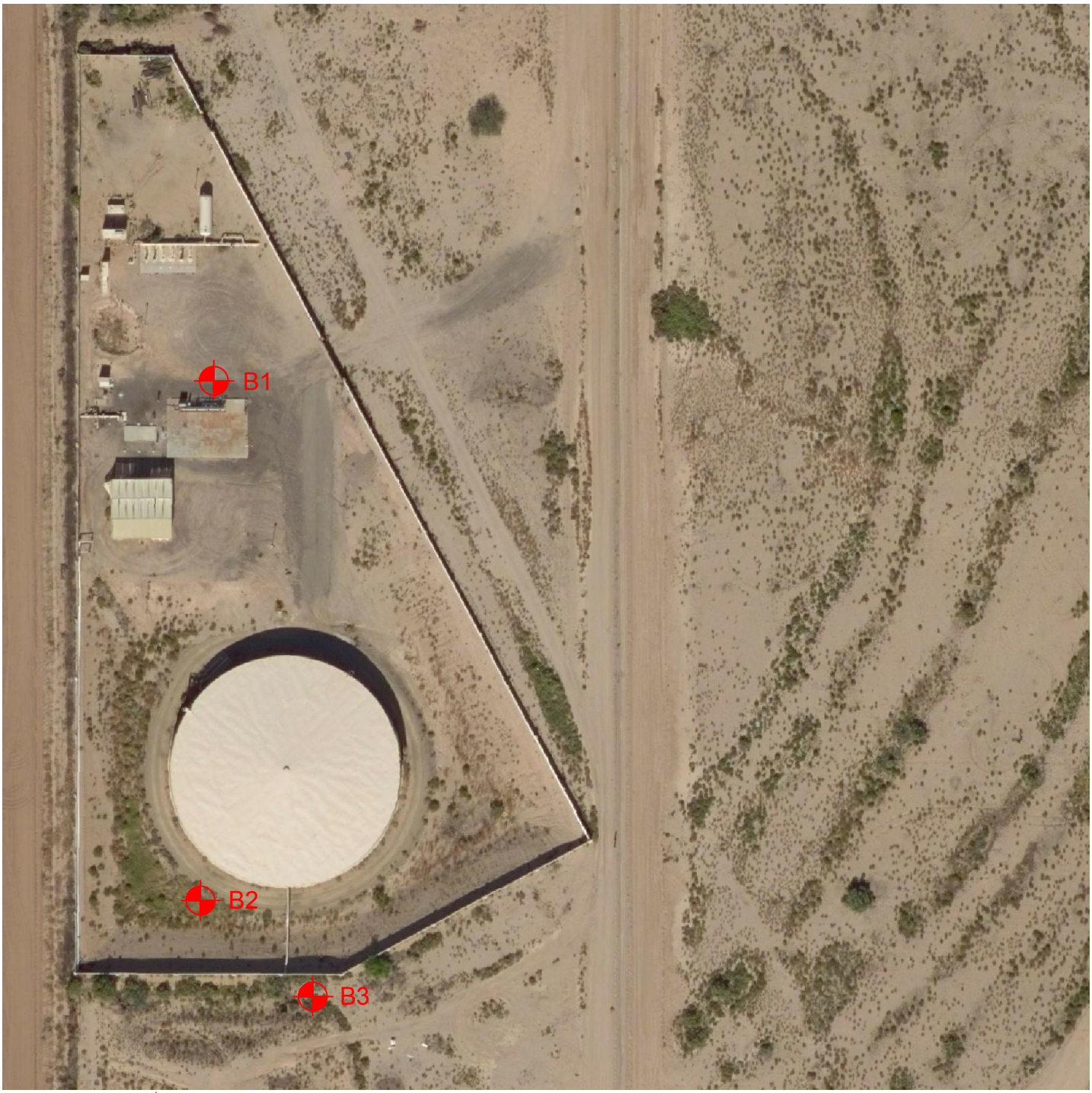
FEET

FIGURE 1

VICINITY MAP
GOODYEAR WELL SITE 12, AVONDALE, AZ

PROJECT NO.	DATE:	PREPARED BY:	REVIEWED BY:
CSE-4391	3/12/18	JHS	JDD

Copper State Engineering, Inc.
16621 N. 91st Street, Suite 104, Scottsdale, Arizona 85260 (480) 368-1551 FAX (480) 368-1556



LEGEND: B3 = BORING LOCATION

N

SCALE 1" = 100'

0 50 100

FEET

FIGURE 2

SITE PLAN - GEOTECHNICAL INVESTIGATION
GOODYEAR WELL SITE 12, AVONDALE, AZ

PROJECT NO.	DATE:	PREPARED BY:	REVIEWED BY:
CSE-4391	03/12/18	JHS	JDD

Copper State Engineering, Inc.
16621 N. 91st Street, Suite 104, Scottsdale, Arizona 85260 (480) 368-1551 FAX (480) 368-1556

Criteria for Assigning Group Symbols and Group Names using Laboratory Tests[A]				Soil Classification	
				Group Symbol	**Group Name[B]**
Coarse-Grained Soils More than 50% retained on No. 200 sieve	**Gravels** - More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels** Less than 5% fines[C]	Cu ≥ 4 and 1 ≤ Cc ≤ 3[E]	GW	Well-graded gravel[F]
			Cu < 4 and/or 1 > Cc > 3[E]	GP	Poorly-graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH	GM	Silty Gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey Gravel[F,G,H]
	Sands - 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands** Less than 5% fines[D]	Cu ≥ 6 and 1 ≤ Cc ≤ 3[E]	SW	Well-graded sand
			Cu < 6 and/or 1 > Cc > 3[E]	SP	Poorly-graded sand[I]
		Sands with Fines More than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines classify as CL or CH	SC	Clayey sand[G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	**Silts and Clays** Liquid limit less than 50	**Inorganic**	PI > 7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI < 4 or plots below "A" line[J]	ML	Silt[K,L,M]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay[K,L,M,N]
					Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	**Inorganic**	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic silt[K,L,M]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay[K,L,M,P]
					Organic silt[K,L,M,Q]
Highly Organic Soils	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] Gravels with 5 to 12 % fines require dual symbols:
GW-GM Well-graded gravel with silt
GW-GC Well-graded gravel with clay
GP-GM Poorly-graded gravel with silt
GP-GC Poorly-graded gravel with clay
[D] Sands with 5 to 12 % fines require dual symbols:
SW-SM Well-graded sand with silt
SW-SC Well-graded sand with clay
SP-SM Poorly-graded sand with silt
SP-SC Poorly-graded sand with clay
[E] $Cu = D_{60}/D_{10}$ $Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
[F] If soil contains ≥ 15% sand, add "with sand" to group name.
[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[H] If fines are organic, add "with organic fines" to group name.
[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.
[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel", whichever is predominant.
[L] If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI ≥ 4 and plots on or above "A" line.
[O] PI < 4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.

Copper State Engineering, Inc.

Project:	Well Site 12 Geo	Project No.:	4391	Client:	NCS Engineers	Boring No.	**B-1**
Location:	Goodyear well site 12 Goodyear, Arizona			Drilling Contractor:	Resilient Drilling	Drill Rig Type:	CME -75
GPS:	33.419207^{0}N, 112.430848^{0}W	Date Started:	2/5/2018	Bit Type:	Bullet cutter head	Diameter:	7.25" O.D.
Logged By:	MG	Date Completed:	2/5/2018	Hammer Type:	Automatic slider	Hammer Drop:	30"
Drill Crew:	Ramon	Backfill:	2/5/2018	Hammer Weight:	140 lb	Total Depth of Boring	30 feet
Surface condition:	Dry natural ground			Elevation:	N/A		

Depth (feet)	Sample Type	Sample Number	Blow Counts (blows/foot)	USCS	Lithology **Soil Description**: Modifier, Color, soil type, grain size, density/consistency, plasticity, moisture, other descriptors. **Rock Description:** Modifier, Color, hardness/degree of weathering, bedding and joint characteristics.	Dry Density (pcf)	Moisture Content (%)	Additional Test
			18	SM	Brown, silty SAND with gravel, medium dense, no PI, slightly moist to dry, sub-angular to sub-rounded	118.1	7.6	CO
			8					
5			23		Note: decrease in gravel content	95.9	4.9	AL, SA
10			51		Note: no recovery, becomes very dense			

Spilt Barrel Ring sampler

Standard Penetration Test sampler (SPT)

Bag Sample

Bulk Sample

AMS 3/4" soil probe

Stabilized Groundwater

Groundwater at the time of drilling

Type of Tests

AL - Atterberg Limit
CO - Consolidation
CT - Chemical
DS - Direct Shear
EI - Expansion Index
HY - Hydrometer
SP - Standard Proctor
SA - Sieve Analysis
TR - Triaxial

Boring Log: Sheet _1_of _2_

Note: This log contains observations and interpretations that are valid only for a specific date and location of the boring. Subsurface conditions vary between borings and with time.

Copper State Engineering, Inc.

Project:	Well Site 12 Geo	Project No.:	4391	Client:	NCS Engineers	Boring No.	**B-1**
Location:	Goodyear well site 12 Goodyear, Arizona			Drilling Contractor:	Resilient Drilling	Drill Rig Type:	CME -75
GPS:	33.419207^{0}N, 112.430848^{0}W	Date Started:	2/5/2018	Bit Type:	Bullet cutter head	Diameter:	7.25" O.D.
Logged By:	MG	Date Completed:	2/5/2018	Hammer Type:	Automatic slider	Hammer Drop:	30"
Drill Crew:	Ramon	Backfill:	2/5/2018	Hammer Weight:	140 lb	Total Depth of Boring	30 feet
Surface condition:	Dry natural ground			Elevation:	N/A		

Depth (feet)	Sample Type	Sample Number	Blow Counts (blows/foot)	USCS	Lithology **Soil Description**: Modifier, Color, soil type, grain size, density/consistency, plasticity, moisture, other descriptors. **Rock Description:** Modifier, Color, hardness/degree of weathering, bedding and joint characteristics.	Dry Density (pcf)	Moisture Content (%)	Additional Test
			16/ 50-5"	SM	Note: grades to silty sand, decrease in gravel content			
					Note: increase in gravel and cobble content			
20			50-5"	SP	Yellowish brown, gravelly SAND, very dense, no PI, moist subrounded			
25			51	SM	Whitish brown, silty SAND with clay and gravel, very dense, no PI, moist, moderately cemented,			
					Note: decrease in clay content, becomes medium dense			
			22		**No groundwater encountered**			

Spilt Barrel Ring sampler

Standard Penetration Test sampler (SPT)

Bag Sample

Bulk Sample

AMS 3/4" soil probe

Stabilized Groundwater

Groundwater at the time of drilling

Type of Tests

AL - Atterberg Limit
CO - Consolidation
CT - Chemical
DS - Direct Shear
EI - Expansion Index
HY - Hydrometer
SP - Standard Proctor
SA - Sieve Analysis
TR - Triaxial

Boring Log: Sheet _2_of _2_

Note: This log contains observations and interpretations that are valid only for a specific date and location of the boring. Subsurface conditions vary between borings and with time.

Copper State Engineering, Inc.

Project:	Well Site 12 Geo	Project No.:	4391	Client:	NCS Engineers	Boring No.	**B-2**
Location:	Goodyear well site 12 Goodyear, Arizona			Drilling Contractor:	Resilient Drilling	Drill Rig Type:	CME -75
GPS:	33.418230^{0}N, 112.430872^{0}W	Date Started:	2/5/2018	Bit Type:	Bullet cutter head	Diameter:	7.25" O.D.
Logged By:	MG	Date Completed:	2/5/2018	Hammer Type:	Automatic slider	Hammer Drop:	30"
Drill Crew:	Ramon	Backfill:	2/5/2018	Hammer Weight:	140 lb	Total Depth of Boring	30 feet
Surface condition:	Dry natural ground			Elevation:	N/A		

Depth (feet)	Sample Type	Sample Number	Blow Counts (blows/foot)	USCS	Lithology **Soil Description**: Modifier, Color, soil type, grain size, density/consistency, plasticity, moisture, other descriptors. **Rock Description:** Modifier, Color, hardness/degree of weathering, bedding and joint characteristics.	Dry Density (pcf)	Moisture Content (%)	Additional Test
				SM	Brown, silty SAND with gravel, dense, no PI, moist			
			56			105	16.9	CO
					Note: grades to SAND, poorly graded		6.5	AL, SA
			16					
5					Note: piece rock in the sampler	96.4	4.9	CO
			49					
10			50-6"		Note: becomes very dense			

Spilt Barrel Ring sampler

Standard Penetration Test sampler (SPT)

Bag Sample

Bulk Sample

AMS 3/4" soil probe

Stabilized Groundwater

Groundwater at the time of drilling

Type of Tests

AL - Atterberg Limit
CO - Consolidation
CT - Chemical
DS - Direct Shear
EI - Expansion Index
HY - Hydrometer
SP - Standard Proctor
SA - Sieve Analysis
TR - Triaxial

Boring Log: Sheet _1_of _2_

Note: This log contains observations and interpretations that are valid only for a specific date and location of the boring. Subsurface conditions vary between borings and with time.

Copper State Engineering, Inc.

Project:	Well Site 12 Geo	Project No.:	4391	Client:	NCS Engineers	Boring No.	**B-2**
Location:	Goodyear well site 12 Goodyear, Arizona			Drilling Contractor:	Resilient Drilling	Drill Rig Type:	CME -75
GPS:	33.418230^{0}N, 112.430872^{0}W	Date Started:	2/5/2018	Bit Type:	Bullet cutter head	Diameter:	7.25" O.D.
Logged By:	MG	Date Completed:	2/5/2018	Hammer Type:	Automatic slider	Hammer Drop:	30"
Drill Crew:	Ramon	Backfill:	2/5/2018	Hammer Weight:	140 lb	Total Depth of Boring	30 feet
Surface condition:	Dry natural ground			Elevation:	N/A		

Depth (feet)	Sample Type	Sample Number	Blow Counts (blows/foot)	USCS	Lithology **Soil Description**: Modifier, Color, soil type, grain size, density/consistency, plasticity, moisture, other descriptors. **Rock Description:** Modifier, Color, hardness/degree of weathering, bedding and joint characteristics.	Dry Density (pcf)	Moisture Content (%)	Additional Test
			29/ 50-4"		Note: very dense, some gravel encountered			
				GP	Note: @18.5' poorly graded gravel			
20				ML	Brown, sandy SILT with little clay, hard, low PI, moist			
			58					
					Note: some fine gravel encountered			
25			8/ 50-1"	GP	Note: grades to Gravel, very dense, moist, poorly graded, subrounded to subangular			
					Note: piece of rock encountered in sampler			
			31		**No groundwater encountered, caving to a depth of 15.5 feet**			

Spilt Barrel Ring sampler

Standard Penetration Test sampler (SPT)

Bag Sample

Bulk Sample

AMS 3/4" soil probe

Stabilized Groundwater

Groundwater at the time of drilling

Type of Tests

AL - Atterberg Limit
CO - Consolidation
CT - Chemical
DS - Direct Shear
EI - Expansion Index
HY - Hydrometer
SP - Standard Proctor
SA - Sieve Analysis
TR - Triaxial

Boring Log: Sheet _2_of _2_

Note: This log contains observations and interpretations that are valid only for a specific date and location of the boring. Subsurface conditions vary between borings and with time.

Copper State Engineering, Inc.

Project:	Well Site 12 Geo	Project No.:	4391	Client:	NCS Engineers	Boring No.	**B-3**
Location:	Goodyear well site 12 Goodyear, Arizona			Drilling Contractor:	Resilient Drilling	Drill Rig Type:	CME -75
GPS:	33.418050^{0}N, 112.430619^{0}W	Date Started:	2/5/2018	Bit Type:	Bullet cutter head	Diameter:	7.25" O.D.
Logged By:	MG	Date Completed:	2/5/2018	Hammer Type:	Automatic slider	Hammer Drop:	30"
Drill Crew:	Ramon	Backfill:	2/5/2018	Hammer Weight:	140 lb	Total Depth of Boring	30 feet
Surface condition:	Dry natural ground			Elevation:	N/A		

Depth (feet)	Sample Type	Sample Number	Blow Counts (blows/foot)	USCS	Lithology **Soil Description**: Modifier, Color, soil type, grain size, density/consistency, plasticity, moisture, other descriptors. **Rock Description:** Modifier, Color, hardness/degree of weathering, bedding and joint characteristics.	Dry Density (pcf)	Moisture Content (%)	Additional Test
				SM	Whitish brown, silty SAND, medium dense, no PI, slightly moist			
			19					
			16		Note: grades to brown color, little gravel			
5			16		Note: piece of rock in the sampler			
10			22	SP	Note: grades SAND, fine grained, poorly graded	107.7	3.5	CO

Spilt Barrel Ring sampler

Standard Penetration Test sampler (SPT)

Bag Sample

Bulk Sample

AMS 3/4" soil probe

Stabilized Groundwater

Groundwater at the time of drilling

Type of Tests

AL - Atterberg Limit
CO - Consolidation
CT - Chemical
DS - Direct Shear
EI - Expansion Index
HY - Hydrometer
SP - Standard Proctor
SA - Sieve Analysis
TR - Triaxial

Note: This log contains observations and interpretations that are valid only for a specific date and location of the boring. Subsurface conditions vary between borings and with time.

Copper State Engineering, Inc.

Project:	Well Site 12 Geo	Project No.:	4391	Client:	NCS Engineers	Boring No.	**B-3**
Location:	Goodyear well site 12 Goodyear, Arizona			Drilling Contractor:	Resilient Drilling	Drill Rig Type:	CME -75
GPS:	33.418050^{0}N, 112.430619^{0}W	Date Started:	2/5/2018	Bit Type:	Bullet cutter head	Diameter:	7.25" O.D.
Logged By:	MG	Date Completed:	2/5/2018	Hammer Type:	Automatic slider	Hammer Drop:	30"
Drill Crew:	Ramon	Backfill:	2/5/2018	Hammer Weight:	140 lb	Total Depth of Boring	30 feet
Surface condition:	Dry natural ground			Elevation:	N/A		

Depth (feet)	Sample Type	Sample Number	Blow Counts (blows/foot)	USCS	Lithology **Soil Description**: Modifier, Color, soil type, grain size, density/consistency, plasticity, moisture, other descriptors. **Rock Description:** Modifier, Color, hardness/degree of weathering, bedding and joint characteristics.	Dry Density (pcf)	Moisture Content (%)	Additional Test
			19	SP				EI
20			35		Note: SAND, poorly graded, becomes dense			
25			11/ 50-5"		Note: grades SAND, fine to medium sand, poorly graded, very dense Note: becomes gravelly sand, hard to drill			
			50-5"		Note: rock encountered at tip of SPT sampler **No groundwater encountered**			

Spilt Barrel Ring sampler

Standard Penetration Test sampler (SPT)

Bag Sample

Bulk Sample

AMS 3/4" soil probe

Stabilized Groundwater

Groundwater at the time of drilling

Type of Tests

AL - Atterberg Limit
CO - Consolidation
CT - Chemical
DS - Direct Shear
EI - Expansion Index
HY - Hydrometer
SP - Standard Proctor
SA - Sieve Analysis
TR - Triaxial

Boring Log: Sheet _2_of _2_

Note: This log contains observations and interpretations that are valid only for a specific date and location of the boring. Subsurface conditions vary between borings and with time.

TABULATION OF LABORATORY TEST DATA

Project : NCS Well Site 12 Geo
Number : CSE 4391
Date : 2/23/2018

Test Boring #	Sample Depth (ft.)	Moisture Content (%)	Dry Density (pcf)	Expansion Index (EI)	Swell %	Consol.		Gravel		Coarse Sand	Med. Sand	Fine Sand		Clay & Silt	LL	PL	PI	ASTM Classification
						Load @wetting (psf)	Change due to wetting* (%)	< 3" %	< 1" %	< # 4 %	< # 10 %	< # 40 %	< # 100 %	< # 200 %				
B-1	1-2	7.6	118.1			1074	-3.23											
B-1	5-6	4.9	95.9					100.0	100.0	94.7	88.4	68.4	56.1	37.9	NP	NP	NP	SM
B-2	1-2	14.9	91.7															
B-2	1-2	16.9	105			1074	-0.4											
B-2	0-5	6.5						100.0	93.6	73.0	67.2	57.1	39.3	26.6	NP	NP	NP	SM
B-2	5-6	4.9	96.4			1074	-0.1											
B-3	10-11	3.5	107.7			1074	-1.0											
B-3	10-20			0	0													

* - indicates settlement and + indicated swell due to wetting

Copper State Engineering, Inc.
16621 N. 91st Street, Suite 104
Scottsdale, Arizona 85260

Copper State Engineering Inc.
Laboratory Test Results

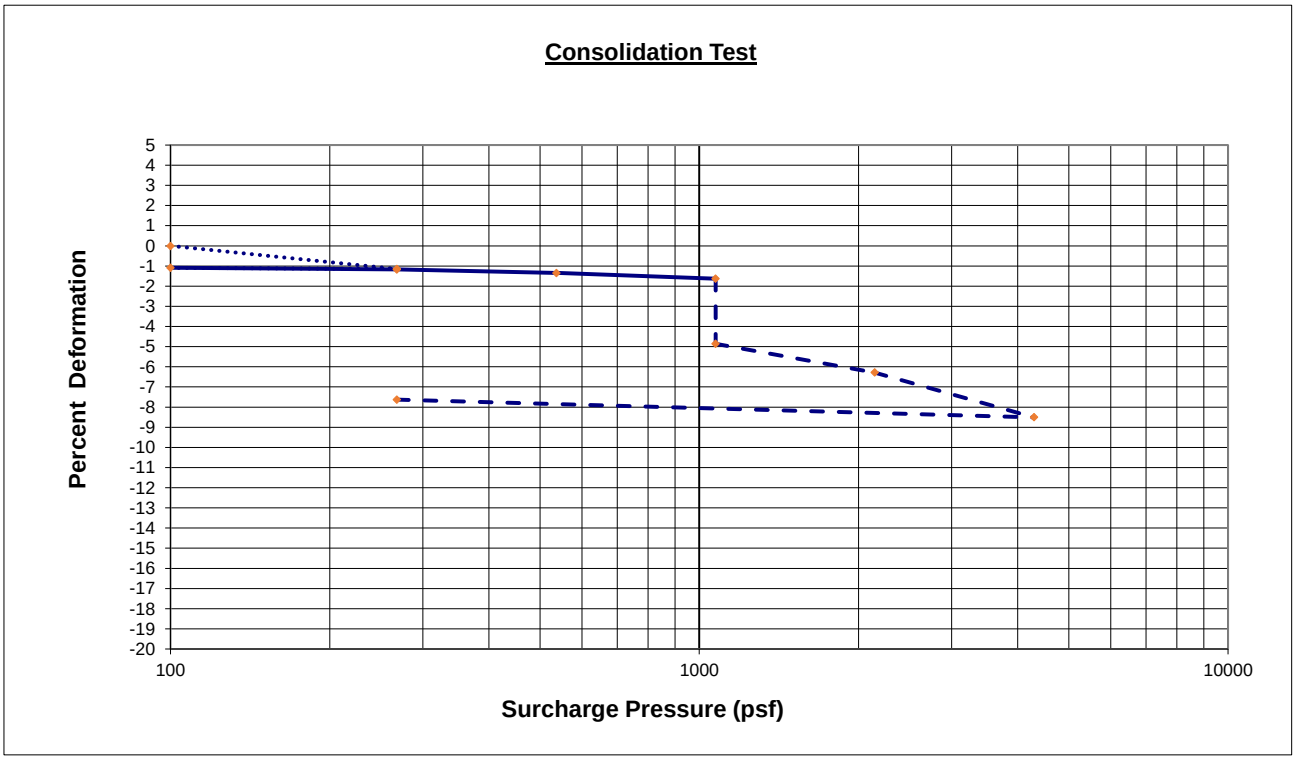
CSE Project Number: CSE-4391 **Date:** 2/7/2018

Sample No. : Site 12 B1(1-2')

Testing Performed: Consolidation (ASTM D4546)

Sampled By: MG

Results: Dry Density (pcf): 118.1 Moisture Content (%): 7.62



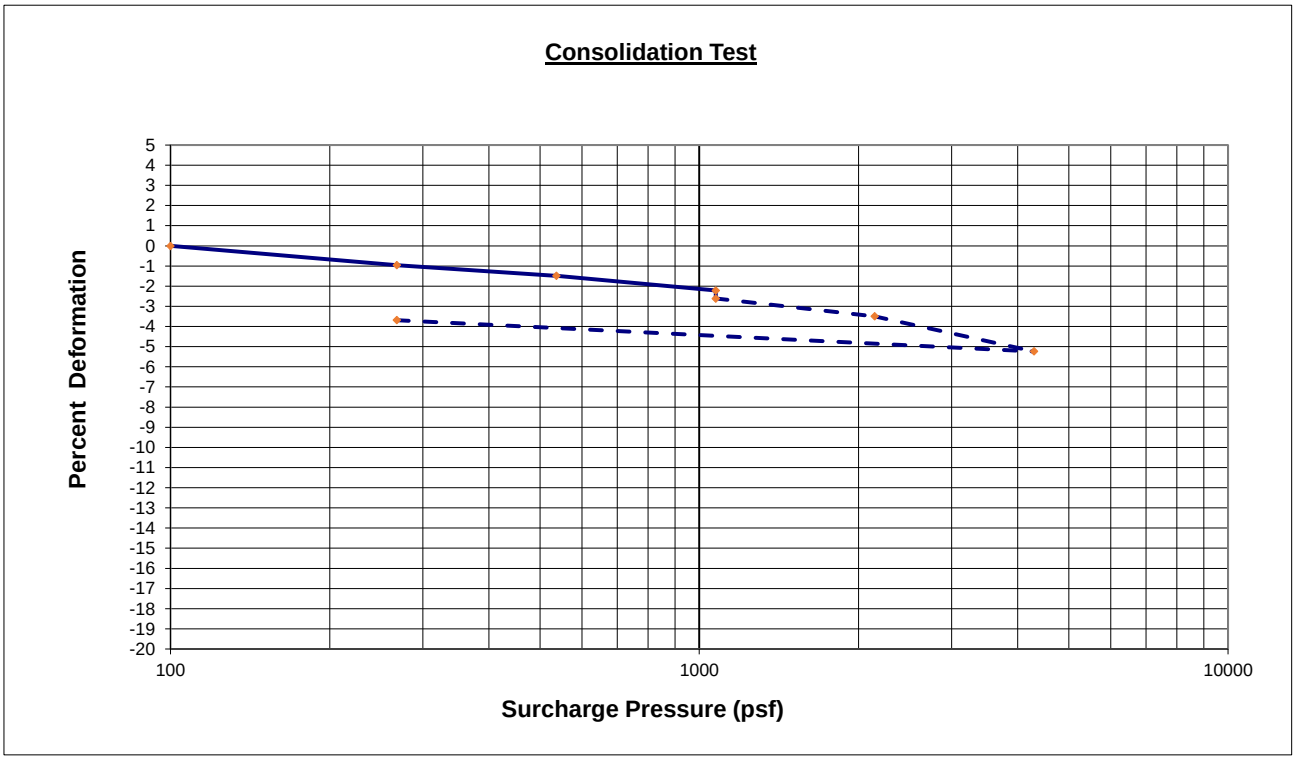
Remarks: Sample submerged at 1074 psf.

Job No.: CSE-4391
Boring: Site 12 B1(1-2')

Pressure Applied	Dial Reading	Dial Reading	Individual deformation (in.)	Cumulative	
				Deformation (in.)	Deformation (%)
100	7	65	0	0	0
268	7	180	0.0115	0.0115	-1.15
100	7	174	-0.0006	0.0109	-1.09
268	7	182	0.0008	0.0117	-1.17
537	7	199	0.0019	0.0134	-1.34
1074	8	28	0.0029	0.0163	-1.63
1074	9	151	0.0323	0.0486	-4.86
2148	10	94	0.0143	0.0629	-6.29
4297	11	116	0.0222	0.0851	-8.51
268	11	28	-0.0088	0.0763	-7.63

Copper State Engineering Inc.
Laboratory Test Results

CSE Project Number:	CSE-4391	**Date:**	2/7/2018
Sample No. :	site 12 B-2 (1-2)		
Testing Performed:	Consolidation (ASTM D4546)		
Sampled By:	MG		
Results:	Dry Density (pcf): 105.0	Moisture Content (%):	16.90



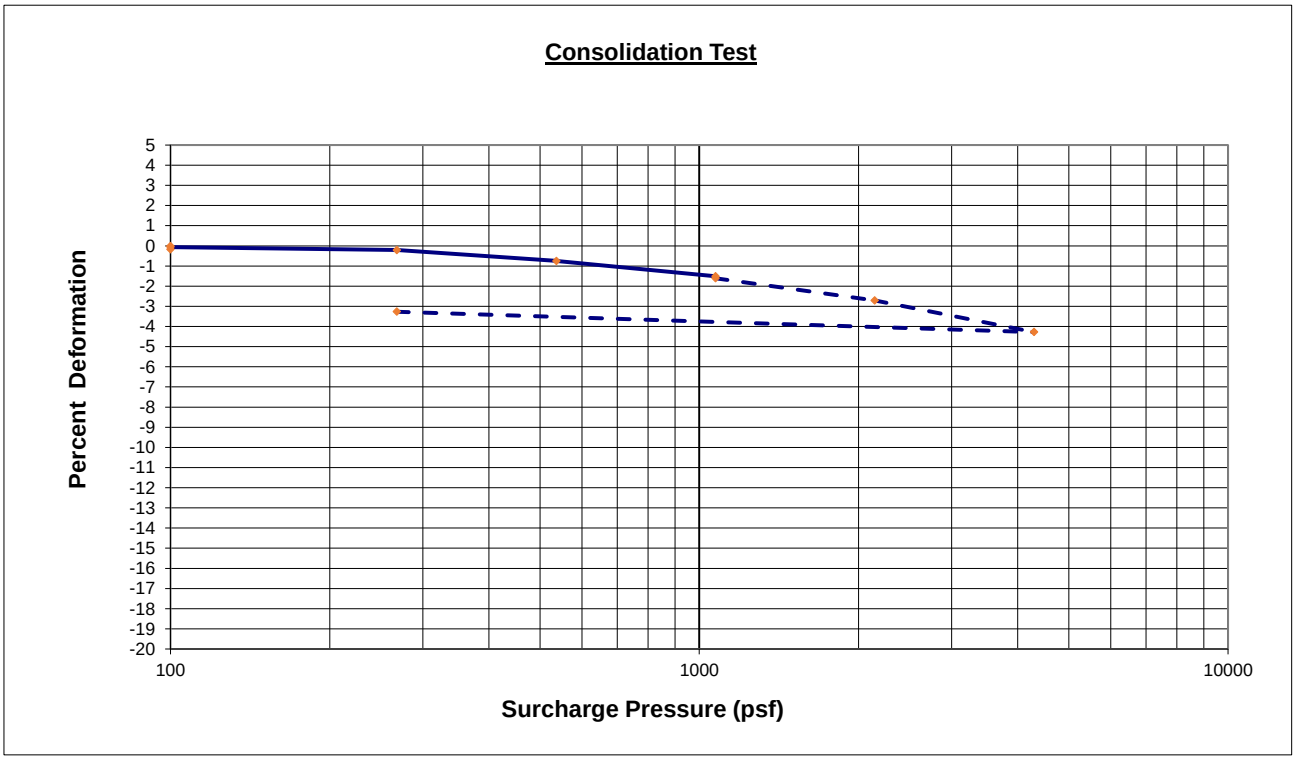
Remarks: Sample submerged at 1074 psf.

Job No.: CSE-4391
Boring: site 12 B-2 (1-2)

Pressure Applied	Dial Reading	Dial Reading	Individual deformation (in.)	Cumulative	
				Deformation (in.)	Deformation (%)
100	8	53	0	0	0
268	8	149	0.0096	0.0096	-0.96
537	9	2	0.0053	0.0149	-1.49
1074	9	74	0.0072	0.0221	-2.21
1074	9	114	0.0165	0.0261	-2.61
2148	10	3	0.0089	0.035	-3.5
4297	10	177	0.0174	0.0524	-5.24
268	10	22	-0.0155	0.0369	-3.69

Copper State Engineering Inc.
Laboratory Test Results

CSE Project Number:	CSE-4391	**Date:**	2/13/2018
Sample No. :	Site 12 B2(5-6')		
Testing Performed:	Consolidation (ASTM D4546)		
Sampled By:	MG		
Results:	Dry Density (pcf): 99.9	Moisture Content (%):	17.55



Remarks: Sample submerged at 1074 psf.

Job No.: CSE-4391
Boring: Site 12 B2(5-6')

Pressure Applied	Dial Reading	Dial Reading	Individual deformation (in.)	Cumulative	
				Deformation (in.)	Deformation (%)
100	8	97	0	0	0
100	8	115	0.0018	0.0018	-0.18
100	8	103	-0.0012	0.0006	-0.06
268	8	118	0.0015	0.0021	-0.21
537	8	172	0.0057	0.0075	-0.75
1074	9	48	0.0076	0.0151	-1.51
1074	9	58	0.001	0.0161	-1.61
2148	9	168	0.011	0.0271	-2.71
4297	10	125	0.0157	0.0428	-4.28
268	10	24	-0.0101	0.0327	-3.27

Copper State Engineering Inc.
Laboratory Test Results

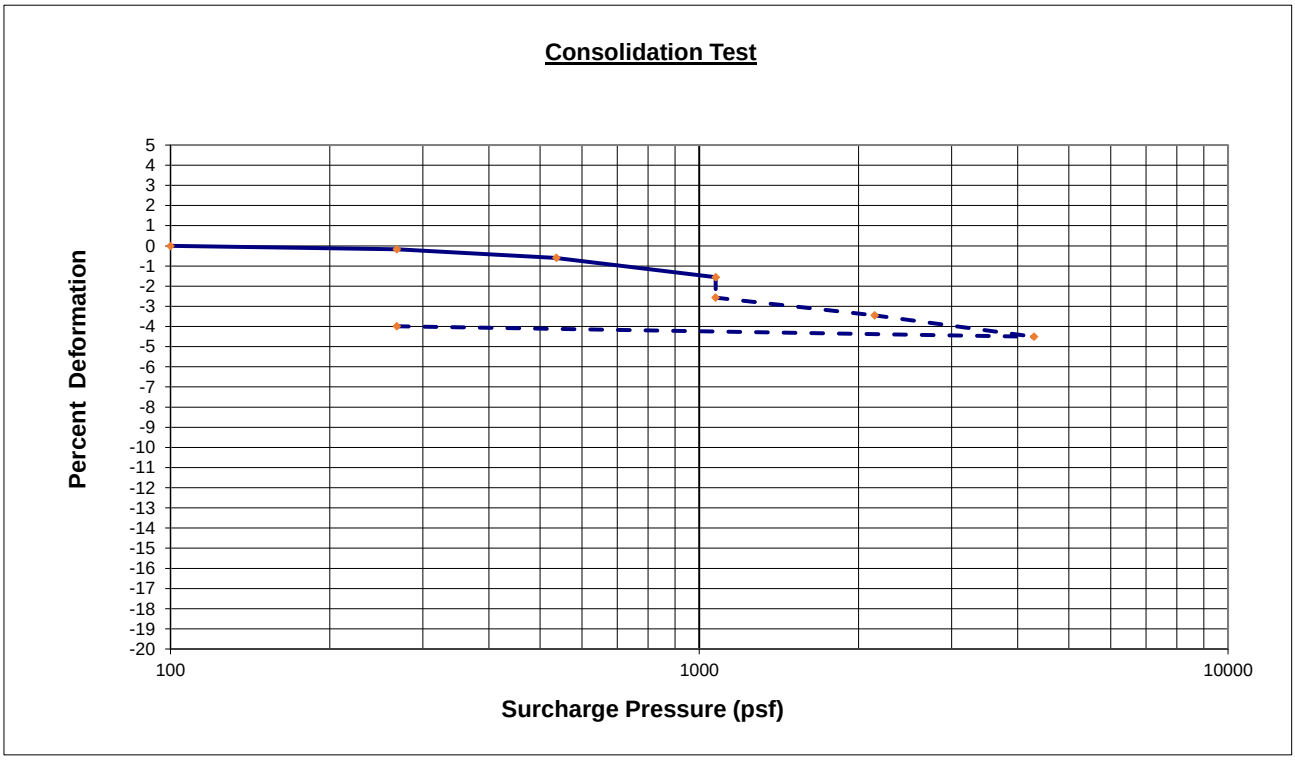
CSE Project Number: CSE-4391 **Date:** 2/13/2018

Sample No. : Site 12 B3(10-11')

Testing Performed: Consolidation (ASTM D4546)

Sampled By: MG

Results: Dry Density (pcf): 110.9 Moisture Content (%): 4.35



Remarks: Sample submerged at 1074 psf.

Job No.: CSE-4391
Boring: Site 12 B3(10-11')

Pressure Applied	Dial Reading	Dial Reading	Individual deformation (in.)	Cumulative	
				Deformation (in.)	Deformation (%)
100	9	143	0	0	0
268	9	160	0.0017	0.0017	-0.17
537	10	3	0.0043	0.006	-0.6
1074	10	99	0.0096	0.0156	-1.56
1074	11	0	0.0101	0.0257	-2.57
2148	11	88	0.0088	0.0345	-3.45
4297	11	194	0.0106	0.0451	-4.51
268	11	142	-0.0052	0.0399	-3.99

SEISMIC COEFFICIENT WORKSHEET
2015 INTERNATIONAL BUILDING CODE

CSE Project No. 4391 **March** 1, 2018

Is a site specific evaluation necessary?

• Are soils vulnerable to potential failure or collapse under seismic loading?	No
• Is there greater than 10 feet of peat or other highly organic clay?	No
• Is there more than 25 feet of clay with a PI greater than 75?	No
• Is there more than 120 feet of soft to medium stiff clay?	No
	No

If no, then continue, if yes, then site is Site Class F, and a site specific evaluation is necessary.

Is there more than 10 feet of soft clay? If so, site is Site Class E.	No
Are soils medium dense in upper 100 feet? If so, site is at least Site Class D.	Yes
Are soils very dense or soft rock in upper 100 feet? If so, site is Site Class C.	Yes
Is there rock in upper 100 feet? If so, site is Site Class B.	Unknown
Is there hard rock in upper 100 feet? If so, site is Site Class A.	Unknown

The short period (0.2 second) Spectral Response Acceleration parameter, S_s	0.158
The 1- second period Spectral Response Acceleration parameter, S_1	0.054

SITE CLASS: **D**

Site Class	Site Coefficient, F_a					Site Coefficient, F_v				
	$S_s \le 0.25$	$S_s = 0.50$	$S_s = 0.75$	$S_s = 1.00$	$S_s \ge 1.25$	$S_1 \le 0.1$	$S_1 = 0.2$	$S_1 = 0.3$	$S_1 = 0.4$	$S_1 \ge 0.5$
A	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0	1.7	1.6	1.5	1.4	1.3
D	1.6	1.4	1.2	1.1	1.0	2.4	2.0	1.8	1.6	1.5
E	2.5	1.7	1.2	0.9	0.9	3.5	3.2	2.8	2.4	2.4
F	*	*	*	*	*	*	*	*	*	*

* = Values shall be determined in accordance with Section 11.4.7 of ASCE 7.

F_a = 1.6

F_v = 2.4

The S_s and S_1 parameters were determined using U.S. Seismic Design Map (see attached)
http://geohazards.usgs.gov/designmaps/us/application.php

USGS Design Maps Summary Report

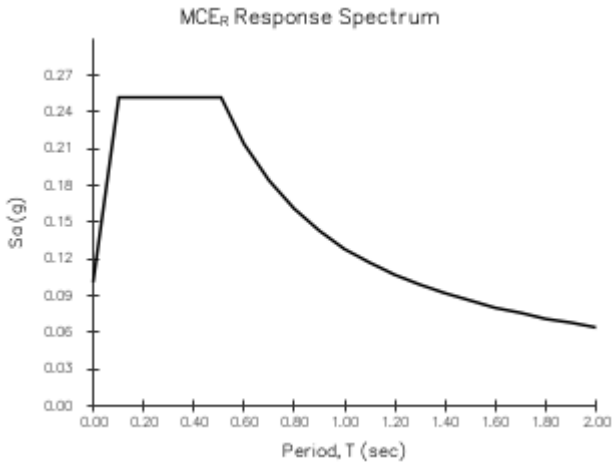
User–Specified Input

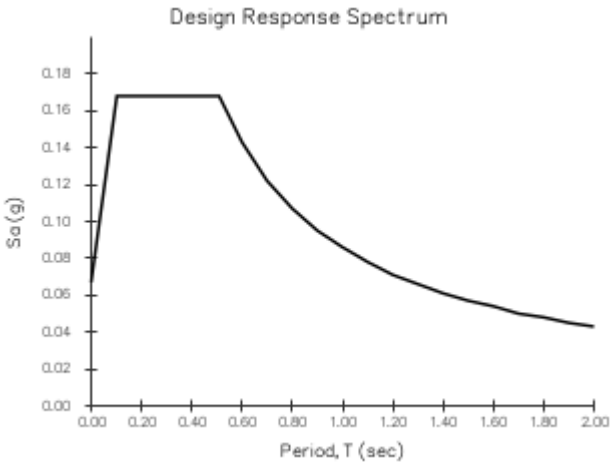
Report Title	CSE 4391 - NCS Well Sites Geo Fri February 23, 2018 17:22:59 UTC
Building Code Reference Document	2012/2015 International Building Code (which utilizes USGS hazard data available in 2008)
Site Coordinates	33.41921°N, 112.43085°W
Site Soil Classification	Site Class D – "Stiff Soil"
Risk Category	I/II/III

USGS–Provided Output

S_S =	0.158 g	S_{MS} =	0.252 g	S_{DS} =	0.168 g
S_1 =	0.054 g	S_{M1} =	0.128 g	S_{D1} =	0.086 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.





MOTZZ LABORATORY, INC.

Soil Analysis Report

Copper State Engineering, Inc.
David Deatherage
16621 N. 91st St.,
Suite 104
Scottsdale AZ 85260

Project: CSE 4391
Date Received: 2/16/2018
Date Reported: 2/19/2018
PO Number: CSE 4391

Lab Number: 923932-1 **Site 12 B1 (0-10')**

pH & Minimum Resistivity Box	Method	Result	Units	Levels
pH (ARIZ 236b)	ARIZ 236b	9.4	SU	
Minimum Resistivity, Box	ARIZ 236b	3358	ohm-cm	

Sulfate & Chloride	Method	Result	Units	Levels
Sulfate, SO4	ARIZ 733	24	ppm	
Chloride, Cl	ARIZ 736	9	ppm	

Lab Number: 923932-2 **Site 24 B1 (0-5')**

pH & Minimum Resistivity Box	Method	Result	Units	Levels
pH (ARIZ 236b)	ARIZ 236b	8.3	SU	
Minimum Resistivity, Box	ARIZ 236b	1064	ohm-cm	

Sulfate & Chloride	Method	Result	Units	Levels
Sulfate, SO4	ARIZ 733	166	ppm	
Chloride, Cl	ARIZ 736	142	ppm	

Lab Number: 923932-3 **Site 25 B1 (0-5')**

pH & Minimum Resistivity Box	Method	Result	Units	Levels
pH (ARIZ 236b)	ARIZ 236b	8.2	SU	
Minimum Resistivity, Box	ARIZ 236b	533	ohm-cm	

Sulfate & Chloride	Method	Result	Units	Levels
Sulfate, SO4	ARIZ 733	769	ppm	
Chloride, Cl	ARIZ 736	182	ppm	