# TOWN OF KEARNY

# WELL 4 SITE IMPROVEMENTS

VOLUME 2 of 3:

PROJECT TECHNICAL SPECIFICATIONS

FINAL DESIGN SUBMITTAL

JUNE 2026


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# TECHNICAL SPECIFICATIONS

**DRILLING AND INSTALLATION OF**
**Kearny Well #4**
**Kearny, Arizona**

# *Town of Kearny*

## Project Number CC23.1017.00


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**February 14, 2023**


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# PART 1 - GENERAL

## 1.1 DEFINITIONS

Throughout this specification, the term "OWNER" shall be understood to represent the Town of Kearny, Arizona, and the term "DESIGN PROFESSIONAL" shall be understood to represent Clear Creek Associates, LLC. The "ENGINEER" shall be the Narasimhan Consulting Services (NCS Engineers), and the drilling contractor with whom the OWNER will execute an Agreement setting forth the terms and conditions for the work to be performed is defined herein as "DRILLER". The term "SUBCONTRACTOR" will apply to any person, firm, or corporation with whom the DRILLER executes a secondary agreement for a portion of the scope of work.

## 1.2 DESCRIPTION

### A. SCOPE OF WORK

The drilling of the borehole as specified herein consists of the DRILLER drilling to the specified depth using the direct mud or air rotary drilling method and collecting drill cutting samples from the borehole as specified. The boring will be completed as a public supply water well. The scope of work presented herein includes a brief (approximately 10-hour) step-rate pumping test after the well installation and development are complete.

### B. LOCATION AND GEOLOGIC SETTING

The work to be accomplished under the following Specifications consists of the drilling and construction of a one water supply well for the Town of Kearny, Arizona. The proposed well, designated Kearny Well #4 will be located along Hammond Drive, 0.6 miles northeast of Highway 177, in Kearny, Arizona as shown on Figure 1.

The legal location of Kearny Well #4 is the NW ¼ (10-acre) of the SE ¼ (40-acre) of the SW ¼ (160-acre) of Section 23, Township 4 South, Range 14 East of the Gila and Salt River Baseline and Meridian (also designated D(4-14)23cdb). The well is expected to penetrate basin-fill or fluvial deposits that are primarily unconsolidated or semi-consolidated silt, clay, sand and gravel, as well as the Gila Conglomerate which is composed of friable, cemented sand, gravel, and silt/clay.

### C. PERFORMANCE OF WORK

Should the well be lost due to any negligent action on the part of the DRILLER or SUBCONTRACTORS (as determined by the DESIGN PROFESSIONAL), the well shall be abandoned at no cost to the OWNER, in accordance with ADWR Article 8, Rule R12-15-816, and a replacement well shall be constructed in the immediate area. The replacement well location will be selected by the DESIGN PROFESSIONAL,

ENGINEER or OWNER. The replacement well shall be completed in accordance with all the terms and conditions stated herein. The DRILLER shall credit the OWNER for any and all costs associated with the lost well, and this credit shall be applied against any additional DRILLER charges associated with the drilling and completion of the replacement well.

If the loss of the well was not due to any negligent action of the DRILLER or SUBCONTRACTORS, the DESIGN PROFESSIONAL, ENGINEER or OWNER may designate a replacement well location and the OWNER shall provide reimbursement for the replacement well on the basis of the unit costs presented in the DRILLER'S bid schedule.

If a work delay, deficiency of work performance and/or a material's deficiency is caused by the DRILLER or SUBCONTRACTORS failing to comply with any item of these specifications, the DRILLER shall bear the burden of additional expenses, including any additional DESIGN PROFESSIONAL charges assessed to the OWNER as a direct result of the delay or deficiency. This includes delays due to equipment failure, if the DESIGN PROFESSIONAL determines that the equipment failure could have been prevented through proper maintenance.

Access roads to the site and the site itself may be dirt. The DRILLER is responsible to apply water for dust control to work areas and access roads as required to meet State, County, or local dust control ordinances, or as requested by the DESIGN PROFESSIONAL or OWNER. The DRILLER shall meet the requirements for dust control, including permitting, at its own cost. The DRILLER is also responsible to provide any track-out protection that may be required to prevent sediment or mud deposits on adjacent paved surfaces.

D. CONFIDENTIALITY

The DRILLER shall not disclose any information relating to this project or the well site to anyone other than the OWNER or DESIGN PROFESSIONAL without written permission from the OWNER, except as may be required by law. At all times during the performance of the DRILLER'S services, the DRILLER and its employees, SUBCONTRACTORS, and agents shall treat the work conducted by the DRILLER and its SUBCONTRACTORS and the results thereof as confidential and proprietary to the OWNER.

Any questions regarding the purpose or scope of work that are directed to the DRILLER from individuals or entities other than representatives of the OWNER or DESIGN PROFESSIONAL while work is being conducted for this project, should be directed by the DRILLER to the DESIGN PROFESSIONAL or OWNER.

The DRILLER shall inform its employees of this confidentiality requirement, and shall obtain non-disclosure agreements from all SUBCONTRACTORS who will have involvement in the performance of any of the work, and provide DESIGN

PROFESSIONAL with copies of the executed non-disclosure agreements. This provision shall survive the termination of the contracted work tasks.

E. METHODS OF DRILLING

The borehole shall be drilled using either direct mud rotary, reverse circulation rotary, or air rotary drilling method. The DRILLER shall transport drilling make-up water from a source approved by the DESIGN PROFESSIONAL, and the DRILLER shall provide the necessary pump(s) and all other equipment required for its drilling operations. The DRILLER is responsible for designing and controlling a drilling program that conforms to this specification.

F. UTILITIES

1. General

The DRILLER shall provide, at its own expense, all required fuel, power, light, heat, telephone and sanitary facilities for its operations under this specification. The DRILLER shall provide, at its own cost, a portable restroom facility at the well site during all operations of this project. The DRILLER shall also provide, at its own cost, adequate security for the site and drilling equipment.

2. Water

Construction water for the drilling program shall be the responsibility of the DRILLER from a source near the drilling site. The OWNER will provide the water from a source within 200 feet of the well site at no cost, but the DRILLER must meter the water used, and will be responsible for all piping, connections, ancillary equipment, trucking, and labor required to convey the water to the well site for use. The DRILLER will be responsible for maintaining an adequate flow rate of construction water for all operations under this specification.

The DRILLER will also be responsible for any coordination, permits, and/or costs associated with traffic control and road crossings that may be required to convey water to the well site. The DRILLER will be responsible for providing an OWNER-approved water metering device to monitor construction water used throughout the duration of this project. The OWNER will provide the water at its source at no cost, but the DRILLER must meter the water used, and will be responsible for all piping, connections, ancillary equipment, and labor required to convey the water to the well site for use. The DRILLER will be responsible for obtaining an adequate flow rate of construction water for all operations under this specification.

G. EQUIPMENT

The DRILLER shall furnish and maintain in safe and efficient working condition all equipment necessary to perform the specified work, including a drilling rig or rigs capable of performing the specified operations to the specified depths; pumping, testing, sampling equipment; and auxiliary equipment as specified or required to complete the described tasks.

The DRILLER shall submit a statement with their bid indicating the drilling equipment to be used. The drilling rig and support equipment must be capable of the specified drilling, testing, and construction operations. All equipment requirements specified in this Section shall be provided at the DRILLER'S expense. The equipment supplied by the DRILLER shall include, but not be limited to:

- A wireline depth indicator capable of measuring depths equal to the total depth of the borehole, and equipped with a counter device, which provides for a depth measurement accuracy of ± 1 foot;
- An operating and accurate penetration rate indicator (Geolograph or equal). If the drilling rig is not equipped with a penetration rate indicator, the DRILLER shall record and report daily to the DESIGN PROFESSIONAL, the start time and stop time for the drilling of each joint of drill pipe;
- Operating and accurate gauges that indicate the hook load (weight) and torque of the drill string;
- A first aid kit;
- A fully recharged and operable type ABC dry chemical fire extinguisher; and
- An operable mobile telephone located at the well site. The rig mobile phone will be made available to the DESIGN PROFESSIONAL and OWNER personnel for reasonable use, at no charge.

The DRILLER shall also maintain at the well site, or have the ability to rapidly fabricate, commonly used fishing tools (such as overshots, wall hooks, junk baskets, etc.) to accommodate the event that lost tools in the borehole require fishing operations.

The drilling rig used for the installation of Kearny Well #4 shall have a mast capacity no less than 1½ times the string weight of the well casing and screen (approximately 38,300 lb. for the preliminary well design), and the well shall be installed without the use of a float plate. All equipment requirements specified in this Section shall be provided at the DRILLER'S expense. The drilling rig, pumping equipment and auxiliary equipment used for this project shall be well maintained, and shall meet the standards of OSHA. Any rig walkways and stairways shall be guarded with rails to prevent falls, and DRILLER personnel shall utilize a safety harness at all times when ascending the rig derrick. All high-pressure hoses shall be equipped with a safety chain to protect site personnel in the event of hose failure.

Prior to the start of drilling, the DRILLER shall decontaminate the drill rig and downhole tools by steam cleaning. The method and extent of steam cleaning must be approved by the DESIGN PROFESSIONAL. The DRILLER will be required to provide a letter of certification of the decontamination of the DRILLER'S equipment, prior to utilization. The DRILLER may certify, in writing, the decontamination of critical (downhole) pieces of drilling equipment in lieu of actual steam cleaning, provided the downhole pieces of drilling equipment have not been in contact with any

hazardous or toxic materials since the last decontamination. All necessary steam cleaning will be conducted at the DRILLER'S expense.

## 1.3 QUALITY ASSURANCE

### A. PROTECTION OF SITE

The DRILLER will be responsible for any required clearing and grubbing of existing vegetation or debris within the work area. The DRILLER shall take all necessary precautions to preserve the well site, as nearly as practical, in the present condition. The DRILLER shall be responsible for replacing any damaged items.The OWNER will provide a boundary map to designate the working area.

The DRILLER shall provide, at its own cost, an adequate roll-off bin to contain all debris and trash collected at the site. All litter and debris will be cleaned up daily and placed in the roll-off bin for off-site disposal. The DRILLER is responsible for the location and clearance of all underground utilities using Arizona 811 (previously, Blue Stake), a private utility location service, or both.

A plastic tarp and berm shall be placed beneath the drilling rig during mobilization to protect the site against oil or hydraulic fluid spills or leaks, and will remain beneath the rig until demobilization. A plastic tarp and berm shall also be placed beneath other stationary equipment such as air compressors and fuel tanks, and beneath the pump rig during the well testing activities. If compressed air is introduced into the well during drilling, sampling, or well development, it must be treated by passage through a carbon or coalescing filter to remove organic contaminants (e.g., compressor lubrication oil).

The DRILLER is responsible to apply water for dust control to work areas or access roads as required to meet State, County, and/or local dust control ordinances, or as requested by the DESIGN PROFESSIONAL or OWNER. The DRILLER shall meet the requirements for dust control at its own cost.

The work area must be fenced to prevent intrusion to the worksite by people or animals. The DRILLER will provide fencing at its own cost. Only above-ground mud systems will be allowed for this project. Drilled cuttings shall be spread evenly in a thin layer at the well site, such that they do not pose a threat to the existing vegetation or drainage.

Drilling fluids pumped from the mud pits and boring during the initial development must be removed from the site and disposed of properly. Disposal costs associated with these fluids will be the responsibility of the DRILLER and should be included in the mobilization cost. Clear water pumped from the well during development and testing operations shall be conveyed to a location identified by the OWNER or DESIGN PROFESSIONAL, where it will not cause damage to the property, contamination of other wells or waterways, or creation of a nuisance. For bidding

purposes, the DRILLER should plan to contain all fluids and legally dispose of them offsite.

After completion of the work, the DRILLER shall remove and dispose in a proper manner, all debris; waste; oil-stained dirt; trash; and unused materials or supplies. The DRILLER shall obliterate all temporary construction facilities such as temporary work areas, temporary structures, and stockpiles of excess or waste materials, and shall restore the site as nearly as possible, to its original condition. The DESIGN PROFESSIONAL or OWNER must approve the cuttings disposal and site cleanup.

B. LICENSURE

The DRILLER shall hold: (1) a valid Arizona Department of Water Resources (ADWR) Well Driller's License in the mud rotary, air rotary, or reverse circulation category (as applicable); (2) an Arizona Registrar of Contractor License type A, A-4, or A-16; and (3) all other licenses required by Federal, State, County, or Municipal rules and regulations. SUBCONTRACTORS may also hold a valid Arizona Well Driller's License in addition to that of the DRILLER, but not in lieu of the DRILLER'S ADWR Well Driller's License. In addition, the DRILLER shall be named as "Principal" on the Performance Bond and Payment Bond. The DRILLER shall provide a copy of their Arizona Well Driller's License and a copy of their Arizona Registrar of Contractor License with the bid submittal.

## 1.4 SUBMITTALS

A. GENERAL

The DRILLER shall keep an accurate and legible daily log and record of all drilling, testing, and construction, describing all geologic material encountered during drilling, the depths at which changes in formation occur, and all difficulties or unusual conditions encountered. The log and record shall also show the method of completing the well, including the lengths of the well casing and well screen installed and the volume of all annular fill and seal materials. The forms for penetration rate log, the daily driller's report, and the drilling fluid control log must be approved by the DESIGN PROFESSIONAL.

B. PENETRATION RATE LOG

During the drilling of the borehole, a time log shall be kept showing the actual penetration time required to drill each foot of the borehole. If the drilling rig is not equipped with a Geolograph-type penetration rate indicator, the DRILLER shall record on the penetration rate log, and report daily to the DESIGN PROFESSIONAL, the start time and stop time for the drilling of each joint of drill pipe, as well as the actual length of each joint of drill pipe. The types of bits used in each interval of the borehole shall be noted on this log and whether designed for soft, medium, or hard formations, including approximate weight on the bit and rotation speed (RPM) of the bit, and any other information that may be requested by the DESIGN

PROFESSIONAL. This log shall be available for review by the DESIGN PROFESSIONAL throughout the drilling program, and a copy of the log shall be delivered to the DESIGN PROFESSIONAL daily.

C. DAILY DRILLER'S REPORT

During the drilling of the borehole, a detailed driller's report shall be maintained and provided daily to the DESIGN PROFESSIONAL at the well site. The daily driller's report shall be recorded on forms approved by the DESIGN PROFESSIONAL. The daily driller's report shall also be provided electronically to the DESIGN PROFESSIONAL on a daily basis, via email, text message, or purpose-built smartphone application (such as, *Crew*, *Slack*, or approved equal). The report shall give a complete description of all formations encountered; number of feet drilled; number of hours on the job; shutdown due to breakdown; any occurrence of lost circulation conditions or hard drilling conditions; drilling fluid additives used; length and type of casing set; volumes of filter pack and annular seal installed, and such other pertinent data as may be requested by the DESIGN PROFESSIONAL. DRILLER personnel will submit the report to the DESIGN PROFESSIONAL daily.

D. DRILLER'S LOG

During the drilling of the borehole, the DRILLER shall prepare a detailed driller's log in compliance with the requirements of the Arizona Department of Water Resources (ADWR). The log shall include the reference point for all depth measurements, a generalized description of each formation encountered, the depth at which each formation is encountered and the thickness of each formation. The lithologic log prepared by the DESIGN PROFESSIONAL will be made available to assist the DRILLER in the preparation of the driller's log. A copy of the driller's log shall be furnished to the DESIGN PROFESSIONAL upon completion of drilling and filed with ADWR as required by the rules and regulations of ADWR.

E. Drilling Fluid Record

During the drilling of the borehole, a log of drilling fluid properties shall be maintained by the DRILLER. The drilling fluid record will be recorded on an American Petroleum Institute (API)-approved form, and shall document all information referenced in Section 3.2(B). The drilling fluid record shall be available for review by the DESIGN PROFESSIONAL, ENGINEER, and OWNER throughout the course of drilling, and the log shall be delivered to the DESIGN PROFESSIONAL upon completion of each day's work activities.

## 1.5 HEALTH AND SAFETY

The DRILLER must provide a Site Safety Plan for this project, in accordance with applicable Occupational Safety and Health Administration (OSHA) requirements. The DRILLER is responsible for assuring that DRILLER personnel and SUBCONTRACTORS are thoroughly familiar with the Site Safety Plan for the proposed work. DRILLER personnel are required to have been trained in the use of

personal safety equipment required by the Site Safety Plan. A copy of the Site Safety Plan must be kept at the well site, and shall be available to all DRILLER personnel for review. The DRILLER shall be responsible for having sufficient personal safety equipment at the work site for each of the DRILLER personnel to comply with provisions of the Site Safety Plan. The DRILLER shall meet the requirements of the Site Safety Plan at its own cost.

## PART 2 - PRODUCTS

### 2.1 DESCRIPTION

#### A. GENERAL

The DRILLER shall be responsible for the timely delivery of the well casing, well screen and other materials to the drilling site, as determined by the DESIGN PROFESSIONAL, and as required to complete the well installation program. The well casing and screen materials must be approved by the DESIGN PROFESSIONAL prior to installation. The final length of the well casing and screen may be adjusted by the DESIGN PROFESSIONAL based on analyses of the borehole data. Prior to installation, the DRILLER shall submit certified test reports of the surface casing, blank casing and well screen to the DESIGN PROFESSIONAL to demonstrate compliance with the physical and chemical properties of the well casing that are specified herein.

#### B. SURFACE CASING

The surface casing material shall be new low-carbon steel (LCS), and manufactured in accordance with American Society for Testing and Materials (ASTM) Specification A53 Grade B steel, ASTM Specification A139 Grade B steel, or American Petroleum Institute (API) 5L Grade B steel. This casing shall have a 20-inch outside diameter and have a minimum 0.3125-inch wall thickness. The minimum length of the surface casing shall be 40 feet, to allow for a minimum 1-foot stickup above land surface. Prior to casing installation, the DRILLER shall submit certified test reports to the DESIGN PROFESSIONAL to demonstrate compliance with the physical and chemical properties of the surface casing steel that are specified herein.

#### C. CEMENT GROUT SEAL

The cement grout seal material for the surface casing shall consist of cement slurry containing 5.2 to 6.0 gallons of water per 94-pound sack of Portland cement or Portland-Limestone cement. Any Portland cement used shall conform to ASTM Standard C150, Type II, and any Portland-Limestone cement used shall conform to ASTM Standard C595, Type 1L. The cement grout weight shall be measured prior to installation, as an indicator of the cement-water ratio. The cement grout slurry shall not exceed 17.0 pounds per gallon (lb/gal) (approximately 127 pounds per cubic foot, $lb/ft^3$). The cement grout slurry may contain sand, which shall not exceed 50 percent

by volume of the cement. Bentonite may be used as an additive, and must be in powder form and shall not exceed 4 percent by volume of the cement, or cement and sand. Water added for bentonite shall not exceed 1.3 gallons per 1.88 pounds of bentonite (2 percent by weight in cement).

Accelerator additives, such as calcium chloride, shall not exceed 2 percent by weight of the cement. Water used for preparing the grout slurry shall be potable. The water source and specific constituents of the cement grout must be approved by the DESIGN PROFESSIONAL. If the cement grout is not mixed on site, the DRILLER must provide the specific constituents of the cement grout to the DESIGN PROFESSIONAL prior to placement of the grout. The cement grout slurry shall be mixed thoroughly and must be free of lumps to the satisfaction of the DESIGN PROFESSIONAL. Cement grout that does not comply with this specification will be rejected.

D. WELL CASING

Upon completion of the borehole drilling and geophysical logging, the DRILLER shall commence well installation operations as directed by the DESIGN PROFESSIONAL. The blank low-carbon steel casing for the well shall be new, and manufactured in accordance with ASTM Specification A139 Grade B, or ASTM Specification A53 Grade B steel. The well casing shall be factory assembled in not less than 20-foot long sections. The well casing shall have an 8-inch outside diameter and have a minimum 0.250-inch wall thickness. The total length of the blank low-carbon steel well casing (including the bottom sump and 2-foot stickup) for the well will be 732 feet (Figure 2).

Low-carbon steel centralizers shall be installed every 80 feet, from the base of the surface casing to bottom of the well. Prior to casing installation, the DRILLER shall submit certified test reports to the DESIGN PROFESSIONAL to demonstrate compliance with the physical and chemical properties of the well casing, as specified herein.

E. WELL SCREEN

The well screen for Kearny Well #4 shall be new mill slotted casing that is manufactured in accordance with ASTM Specification A139 Grade B or ASTM Specification A53 Grade B steel, with vertical mill slots. The mill slotted interval of the well shall extend from 700 to 1,220 feet below land surface (bls) (Figure 2). The slotted low-carbon steel well casing will be perforated with 2-inch long by 0.070-inch wide vertical mill slots.

The anticipated length of the well screen (mill slotted casing) shall be 520 feet (Figure 2). The DRILLER shall obtain from the well screen manufacturer the well screen tensile strength (pounds), collapse strength (psi), screen weight (pounds per linear foot), and maximum recommended hang weight (pounds). This information shall be provided to the DESIGN PROFESSIONAL upon delivery of the well screen

to the site. Prior to installation, a steel "rabbit" with a diameter no less than ½ inch smaller than the inside diameter of the well screen shall be passed through the well screen to remove any slivers or obstructions that may have resulted from cutting the mill slots. Screen sections shall be provided in minimum 20-foot joint lengths.

Prior to the well screen installation, the DRILLER shall submit certified test reports to the DESIGN PROFESSIONAL to demonstrate compliance with the physical and chemical properties of the well screen steel, as specified herein.

F. FILTER PACK AND DISINFECTANT MATERIAL

The filter pack shall be Tacna ¼'' x #8 or equivalent, consisting of clean, rounded to subrounded grains that are smooth and uniform. The filter pack shall be siliceous with a limit of 2 percent by weight, calcareous material. The filter pack material shall be obtained from a source that has been approved by the DESIGN PROFESSIONAL, and shall be free of shale, mica, clay, dirt, loam, organic impurities of any kind, and shall not contain iron or manganese in a form or quantity that will adversely affect the water quality. The DESIGN PROFESSIONAL reserves the right to amend the filter pack grain size design, based on sieve analysis results of drilled cuttings.

Samples of the filter pack and a sieve analysis (percent retained through U.S. Standard sieve numbers 4, 8, 10, 16, 30, 40, 50, 100, and 200) of the filter pack material shall be submitted to the DESIGN PROFESSIONAL for approval, a minimum of 3 days prior to delivery of the filter pack to the well site. The filter pack material shall be contained in a temporary storage area at the well site in such a manner as to prevent contamination. The filter pack material shall be bagged in approximately 3,000-pound (about one cubic yard) "super sacks". Each bag must be labeled with its actual weight. Any filter pack material delivered unbagged or unlabeled will be rejected.

G. BENTONITE ANNULAR SEAL AND FORMATION STABILIZER

The bentonite seal material shall contain no hazardous materials or gypsum. For bidding purposes, a 50-foot thick bentonite seal shall be installed above the filter pack and there shall also be 5-foot bentonite seals at approximately 100-foot intervals within the formation stabilizer, from the top of the bentonite seal at 620 feet bls up to 39 feet bls (Figure 2). A sample of the bentonite material shall be provided to the DESIGN PROFESSIONAL for approval no less than 24 hours prior to installation.

The formation stabilizer material shall consist of clean 3/8-minus crushed gravel, pea gravel, or equivalent. A 5-foot thick layer of bentonite pellets or bentonite chips shall be installed at 100-foot intervals, as indicated on Figure 2.

## PART 3 - EXECUTION

### 3.1 VISITATION AND INSPECTION

The DESIGN PROFESSIONAL, ENGINEER, and OWNER representatives shall, at any reasonable time during the term of work, be entitled to review the DRILLER'S

facilities, its program operation, and the records that pertain to the program.

The DRILLER agrees that the DESIGN PROFESSIONAL, ENGINEER or OWNER, or any of their duly authorized representatives, shall have access to the DRILLER'S facilities and have the right to examine books, documents, and records of the DRILLER involving transactions related to these specifications.

The DRILLER further agrees to include in all subcontracts hereunder, if any, a provision that the SUBCONTRACTOR agrees that the DESIGN PROFESSIONAL, ENGINEER or OWNER, or any of their duly authorized representatives, shall have access to the SUBCONTRACTOR'S facilities and have the right to examine any books, documents, and records of the SUBCONTRACTOR involving transactions related to the subcontract and these specifications.

## 3.2 INSTALLATION

A. GENERAL
The DRILLER shall install and develop the well to the anticipated depth shown on Figure 2.

B. DRILLING FLUID CONTROL PROGRAM

1. General
A drilling fluid control plan is required to document drilling fluid additives and procedures used during the drilling, construction and development of the Kearny Well #4. The DRILLER shall provide a drilling fluid control plan to the DESIGN PROFESSIONAL prior to the start of drilling. The plan will outline specific drilling fluid additives the DRILLER plans to use, how anticipated changes in the drilling conditions will affect the drilling fluid control plan, fluid testing procedures, and equipment that will be used. The drilling fluid control plan must be approved by the DESIGN PROFESSIONAL prior to the start of drilling. Drilling fluid additives should be certified by the National Sanitation Foundation.

The DRILLER shall maintain current records at the site at all times to show: (1) the time, depth, and results of all drilling fluid tests; (2) all materials added to the system (including type, amount, time, and depth); (3) variances or modifications from the approved drilling fluid control plan, such as time, depth, reason, and authorization.

2. Drilling Fluid Testing
The DRILLER shall retain an experienced drilling fluid engineer as a SUBCONTRACTOR. The DRILLER'S selection of a drilling fluid engineer will be subject to approval by the DESIGN PROFESSIONAL. The drilling fluid engineer will be available within a 4-hour travel time of the site during all drilling and well construction operations. Drilling fluid tests will be required during periods when any drilling fluid additives (not only clear water) are being circulated in the borehole. Physical and chemical properties of the drilling fluid are to be measured in accordance with the procedures of the API Standard RP 13B-1, "Standard Procedures

for Testing Drilling Fluids", and shall include at a minimum fluid weight, viscosity, sand content, filtrate loss, wall cake thickness, gel strength, pH, alkalinity, hardness, chloride ratio, and free chlorine. Samples tested are those collected at the rig discharge line, with care taken to assure a true and representative sample. Drilling fluid tests shall be conducted at a minimum of (1) every 24 circulating hours; (2) when significant changes to the drilling fluid are made; (3) whenever conditions appear to have changed or when problems arise; or (4) at the request of the DESIGN PROFESSIONAL. A Marsh-type viscosity funnel and a mud scale shall be available at the well site during all well construction operations and, upon request, will be made available to the DESIGN PROFESSIONAL.

The DRILLER is responsible for maintaining an adequate supply of drilling fluid additives at the drilling site and for the removal of all drilling fluids and additives from the borehole during development of the well.

3. Drilling Fluid Requirements

During the drilling of the borehole and the installation of the water supply well, the DRILLER will be responsible to minimize the chemical and biological disturbance of the vadose zone and saturated alluvial matrix. The use of certain organic drilling fluid materials (such as starch, guar, or cottonseed hulls) will not be accepted for drilling, although some organic polymer additives may be allowed. Safety Data Sheets (SDSs) from the manufacturer for all drilling fluid additives must be provided to the DESIGN PROFESSIONAL for review prior to their use. The DESIGN PROFESSIONAL reserves the right to reject any and all proposed additives.

The DRILLER shall be responsible for maintaining the quality of the drilling fluid to ensure:

1. Protection of water-bearing and potential water bearing formations exposed to the borehole;

2. Representative samples of the formation materials and groundwater;

3. Maximum development capacity and optimum potential yield of the completed well;

4. Inhibition of the formation and prevention of formation-caused drilling problems (e.g., heaving sands, swelling clays, lost circulation); and

5. Protection of the integrity of the boring during drilling, construction, and testing operations.

C. DRILLING METHODS

1. General

The well borehole shall be drilled by direct mud rotary, reverse circulation rotary, or air rotary drilling method. The surface casing borehole may be drilled using any of the methods above, or alternatively, using the solid stem auger (bucket

auger) drilling method or other viable drilling method. The DESIGN PROFESSIONAL must approve the specific borehole drilling method to be used. The DRILLER shall be responsible for designing and controlling a drilling program that conforms to this specification. All drilling will be conducted on a 24-hour per day, 7-day week basis unless otherwise approved by the DESIGN PROFESSIONAL and OWNER.

2. Borehole Drilling

The well borehole shall be drilled from a depth of approximately 39 feet below land surface (bls) to the total borehole depth of 1,250 feet as shown on Figure 2. The DESIGN PROFESSIONAL reserves the right to drill beyond the specified depth, or to stop at a lesser depth, depending on subsurface conditions. The borehole shall be drilled to a 14-inch diameter. The boring shall be drilled using the direct mud rotary, air rotary, or reverse circulation rotary drilling method. The DRILLER shall be responsible for designing and controlling a drilling program that conforms to this specification. During the drilling of the borehole, the DRILLER shall collect and preserve for the DESIGN PROFESSIONAL samples of the drilled cuttings at 10-foot intervals from the land surface to the total depth of the borehole. Each cutting sample shall be carefully collected from a cutting sample location approved by the DESIGN PROFESSIONAL.

The drilled cuttings samples shall be placed in 4½-inch x 6-inch cloth sacks (HUBCO or equal) furnished by the DRILLER. Additionally, each sample shall be laid out in a sample storage area on a waterproof tarp or ground cloth, in descending order, for a visual record of the borehole stratigraphy. The storage area must allow samples to be maintained in sequence and unmixed until they have been examined and logged by the DESIGN PROFESSIONAL. After examination by the DESIGN PROFESSIONAL, the drilled cuttings shall be spread evenly in a thin layer at the well site, such that they do not pose a threat to the existing vegetation or drainage.

3. Lost Circulation

During drilling operations, if Lost Circulation Conditions occur, then the OWNER will compensate the DRILLER for the period of drilling under Lost Circulation Conditions at the DRILLER'S hourly rate indicated in the Bid Schedule (Rig Hourly Rate with Crew), in lieu of footage compensation. The OWNER will also provide compensation at a rate of cost plus 10 percent markup to the DRILLER for all drilling fluid materials and additives used during the period of Lost Circulation Conditions. If lost circulation is the result of the DRILLER'S operations or activities (e.g., excessive fluid weight) as determined by the DESIGN PROFESSIONAL, all costs to regain circulation shall be borne by the DRILLER.

"Lost Circulation Conditions" under this Section shall apply only when there is a loss of drilling fluid to the formation within the borehole, to the extent that the fluid level in the annulus outside the drill pipe cannot be maintained to a level

above the base of the surface casing for at least one (1) hour, due to no fault of the DRILLER, as determined by the DESIGN PROFESSIONAL.

The DRILLER is responsible to notify the DESIGN PROFESSIONAL immediately upon the occurrence of Lost Circulation Conditions, and to document the times, quantities, and circumstances of Lost Circulation Conditions during each occurrence. Failure of the DRILLER to promptly notify the DESIGN PROFESSIONAL of Lost Circulation Conditions will void the DRILLER'S opportunity to implement this clause, but will not affect the DRILLER'S responsibility to maintain the integrity of the borehole, as required in Part 3, Subpart 3.2, Section B.3.

The conditions of this Section shall apply from the beginning of the period of lost circulation, and shall continue only until such time that the drilling fluid level can be maintained within the surface casing. After an initial Lost Circulation Conditions event has occurred, should circulation be lost again, the conditions of this paragraph will go into effect immediately after the DRILLER has notified the DESIGN PROFESSIONAL, and continue until such time as drilling fluid circulation is regained, as described in this paragraph.

4. Low Penetration Rate

During drilling or reaming operations, if a formation is encountered that results in a penetration rate of less than 4.0 feet per hour for a period of at least two (2) continuous hours, while at least 1,500 pounds per diameter inch is applied to the drill bit, then the OWNER will compensate the DRILLER for the period of Low Penetration Rate Conditions at the DRILLER'S hourly rate indicated in the Bid Schedule (Rig Hourly Rate with Crew), in lieu of footage compensation. The OWNER will also provide compensation at cost plus 10 percent markup to the DRILLER for all drilling bits used during Low Penetration Rate Conditions. During Low Penetration Rate Conditions, the DRILLER will credit the prorated values of used drilling bits to the OWNER.

The DRILLER is responsible to notify the DESIGN PROFESSIONAL immediately upon the occurrence of Low Penetration Rate Conditions, and to document the times, quantities, and circumstances of Low Penetration Rate Conditions during each occurrence. Failure of the DRILLER to promptly notify the DESIGN PROFESSIONAL of Low Penetration Rate Conditions will void the DRILLER'S opportunity to implement this clause. The conditions of this Section shall apply from the beginning of the time period of Low Penetration Rate Conditions (less than 4.0 feet per hour), and shall continue only until such time as drilling is resumed at a rate of 4.0 feet per hour or greater.

Upon invocation of this Section, if requested by the DESIGN PROFESSIONAL, the DRILLER will trip the drill string out of the hole for inspection of the drill bit by the DESIGN PROFESSIONAL. The conditions of this Section shall apply only if the DESIGN PROFESSIONAL'S inspection of the drill bit does not indicate excessive bit wear, or improper bit type, that would substantially

decrease the penetration rate. In the event that the drill bit inspection indicates that this Section applies, the time expended for drill bit removal will be paid by the OWNER under the conditions of this Section. If the DESIGN PROFESSIONAL is not notified during the initial 2-hour period of low penetration, or if bit inspection reveals excessive wear or improper type, the provisions of this clause will not be invoked.

5. Unexpected Problems

In the event the DRILLER encounters unexpected drilling or well installation problems that are not otherwise addressed by the Lost Circulation or Low Penetration portions of this technical specification (Part 3, Subpart 3.2, Sections C.3 and C.4, respectively), and provided that it is determined, at the sole discretion of the DESIGN PROFESSIONAL that the DRILLER is not responsible for the unexpected problem, then the DRILLER shall provide written Weekly Cost Increase Reports to the DESIGN PROFESSIONAL and OWNER, itemizing all additional costs that have resulted from DRILLER efforts to resolve the unexpected problem. Each Weekly Cost Increase Report will include:

- Itemized additional costs, with backup documentation where appropriate;
- All additional materials and rental equipment charges (at cost plus 10%);
- Additional time expended by the drilling rig and crew to resolve the problem (charged at the rig rate indicated in the bid schedule).

Conditions within the DRILLER's control, including but not limited to equipment failure, insufficiently plumb and aligned borehole, and inadequate drilling fluid properties will be considered indications of DRILLER responsibility for the unexpected problem. If it is determined, at the sole discretion of the DESIGN PROFESSIONAL, that the DRILLER is not responsible for the unexpected problem, then the DRILLER may pursue appropriate cost recovery actions with the OWNER in accordance with the Contract Documents.

D. GEOPHYSICAL LOGGING

Geophysical logging from a depth of 39 feet to the total depth of the boring shall be conducted at the cessation of drilling of the borehole. The geophysical logging company will be subcontracted by the DRILLER for the logging of the pilot boring. The geophysical logging shall be conducted under the observation of the DESIGN PROFESSIONAL.

The geophysical logging suite will include the following logs:

- Spontaneous Potential and Resistivity Logs (Electric Log);
- Acoustic Log (Sonic Log);

- Natural Gamma Ray Log;
- 3-Arm Caliper Log; and
- Focused Guard Log.

Geophysical logging shall be conducted in a continuous manner throughout the entire length of both the pilot and reamed borings. For the focused guard log, the tool shall be decentralized to maintain a minimum standoff distance of one and one-half (1½) inches. A maximum standoff distance of two and one-half (2½) inches must be available upon request by the DESIGN PROFESSIONAL.

The DRILLER shall keep the borehole full of drilling fluid at all times during geophysical logging, to stabilize the borehole and provide log integrity. The DRILLER shall ensure that the logging tools can be run to the total depth of the borehole without interference by obstructions or tight sections in the boring.

A minimum of three (3) field copies shall be provided to the DESIGN PROFESSIONAL upon completion of logging. In addition, a total of six (6) final paper copies of all logs and an electronic copy of all logs in Microsoft Windows© metafile (*.wmf) format, or other DESIGN PROFESSIONAL-approved format, and shall be provided to the DESIGN PROFESSIONAL no later than 10 working days after completion of logging.

At the request of the DESIGN PROFESSIONAL, the geophysical logging SUBCONTRACTOR shall conduct repeat sections in intervals of the borehole selected by the DESIGN PROFESSIONAL. The repeat logging intervals will not exceed 100 feet per log. All costs associated with logging of repeat sections will be the sole responsibility of the DRILLER.

E. WELL CASING AND SCREEN INSTALLATION

1. Surface Casing Installation

The surface borehole shall be drilled to a minimum 26-inch diameter, to a depth of approximately 39 feet bls (Figure 2). The DESIGN PROFESSIONAL reserves the right to direct the drilling of the surface borehole to a greater depth depending on geologic formations and other subsurface conditions at the well site.

Cement grout slurry complying to Section 2.1(C) shall be placed in the annulus between the surface casing and borehole wall from the base of the surface casing to the ground surface. The DRILLER shall be responsible for maintaining an equalization of pressures inside and outside of the casing to the extent necessary to prevent collapse of the surface casing. The grout seal shall completely fill the annular space and form a continuous seal between the surface casing and the wall of the borehole. The grout shall be allowed to cure for a minimum of 12 hours prior to commencing borehole drilling.

2. Well Casing and Screen Installation

During the installation of the well casing and screen, the boring shall be free from any obstructions detrimental to completing the casing and screen installation. The well casing and screen shall be set centered in the hole using Low-carbon steel centralizers, such that they do not to interfere in any way with the installation of the bentonite annular seal and filter pack, or maximum efficient operation of 6-inch diameter pumping equipment within the well casing or screen.

During the installation and completion of the well, all operations shall be conducted during daylight hours only, on a 24-hour per day, 7-day per week basis, unless otherwise authorized by the DESIGN PROFESSIONAL or OWNER. The well casing and well screen shall be set by the DRILLER at the depth intervals specified by the DESIGN PROFESSIONAL.

3. Joints in the Well Casing and Well Screen

Joints in the low-carbon steel well casing and screen shall be field welded in accordance with applicable provisions of the AWWA Standard C206 for welded joints. A welding sequence will be followed which will avoid excessive distortion. All well casing joints or overlaps shall be made watertight and as strong as the casing itself. All welding shall be performed by an experienced welder. All joints shall have a minimum tensile strength equivalent to that of well casing described in Part 2, Subpart 2.1 C and D of this Section. An affidavit of compliance with the welding provisions of this Section shall be provided by the DRILLER to the DESIGN PROFESSIONAL prior to the acceptance of the water supply well. The affidavit of compliance will certify that all welding conducted during this project was performed in accordance with all applicable provisions of this Section.

If the casing or screen sections are butt-welded without the use of welding rings, the ends of the casing lengths shall be ground, or sufficiently scarfed, to remove sharp edges or burrs. The ends of each casing section shall not vary more than 0.010 inch at any point from a true plane at right angles to the axis of the casing. Each casing and screen end shall be beveled at one end to allow complete penetration of the welds. If the casing or screen sections are connected with welding rings, the ends of the casing lengths shall be ground or sufficiently scarfed to remove sharp edges or burrs. One end of each casing section shall be furnished with a welding collar of the same wall thickness and have the same physical and chemical properties as the corresponding casing sections. The welding collars shall be delivered to the well site connected to the casing sections at one end with factory-welded connections. The specific material and design of the welding rings must be approved by the DESIGN PROFESSIONAL.

F. ANNULAR MATERIALS INSTALLATION

1. Filter Pack and Disinfectant Installation

Filter pack conforming to Section 2.1 F, shall be placed through a tremie pipe to completely fill the annulus from the total depth of 1,250 feet up to 670 feet bls

(Figure 2). Drilling fluid shall be maintained throughout the full depth of the well to the land surface and the well casing and screen shall be maintained in tension, until the filter material placement has been completed to the specified level. Care shall be taken to avoid bridging during installation of the filter pack beads.

In accordance with applicable provisions of the AWWA Standard A100 for water wells, before the introduction of filter pack into the well annulus, the drilling fluid shall be reconditioned until it has the following properties:

- Weight – no greater than 9.1 lb/gal (68 lb/ft$^3$);
- Viscosity – no greater than 30 seconds per quart; and
- Sand content – no greater than 1 percent by volume.

At the discretion of the DESIGN PROFESSIONAL, the above standards may be exceeded in cases where different drilling fluid properties are required to protect or stabilize the well due to unstable borehole conditions, or other site-specific circumstances. The DRILLER shall adhere to the standards listed above, unless otherwise approved by the DESIGN PROFESSIONAL.

The filter pack shall be installed by use of a tremie pipe. At no time shall the bottom of the tremie pipe be located at a distance of greater than 30 feet above the interval being filled during filter pack placement. The level of the filter pack shall be measured periodically during placement with a wire line sounder, as required by the DESIGN PROFESSIONAL. Placement of the filter pack will be continuous, except when additional precautions are necessary to prevent bridging, or while a measurement of the filter pack level is being conducted.

The quantity of filter pack material placed in the annulus shall not be less than that of the calculated volume. Upon completion of the filter pack placement, excess filter pack material will be judged an indication of voids in the sand envelope and corrective measures shall be undertaken at the DRILLER'S expense. The specific method of filter pack placement and the filter pack material must be approved by the DESIGN PROFESSIONAL.

During installation of the filter pack, NSF 60-approved, 12% by weight sodium hypochlorite solution or similar disinfectant approved by the DESIGN PROFESSIONAL shall be added to the filter pack at the rate of ⅓ gallon per cubic yard of filter pack material. The DRILLER must provide the DESIGN PROFESSIONAL with documentation that the sodium hypochlorite solution does not exceed a 60-day shelf life (unless otherwise documented by the supplier), in order to prevent deterioration of hypochlorite concentration. If a lesser strength hypochlorite or other chlorine product that has been approved by the DESIGN PROFESSIONAL is used, the quantity shall be adjusted accordingly. The sodium hypochlorite solution shall contain 5 percent to 15 percent available chlorine, in accordance with AWWA Standard C654 for disinfection of wells, and shall be installed in such a way as to produce a chlorine concentration of not less than 50 mg/L in the entire volume of fluid within the well.

Installation of liquid sodium hypochlorite solution shall be accomplished by flushing it into the well through a closed system that will prevent workers from exposure to chlorine vapors, in accordance with OSHA protocol. Solid calcium hypochlorite may be used in equivalent concentrations in lieu of sodium hypochlorite, only if no partially hydrolyzed polyacrylamide (PHPA) polymers such as Baroid's EZ-Mud were used during drilling or reaming of the borehole, and only if approved by the DESIGN PROFESSIONAL. The DRILLER is responsible for the uniform application of the disinfecting agent throughout the filter pack interval, without relying on subsequent mechanical surging action for dispersing the disinfectant. The specific method and materials used to disinfect the filter pack must be approved by the DESIGN PROFESSIONAL.

2. Bentonite Seal and Formation Stabilizer Installation
   A minimum 50-foot thick bentonite seal conforming to Section 2.1 G shall be installed in the well annulus immediately above the top of the filter pack interval, from 670 feet to 620 feet bls (Figure 2). The bentonite seal shall be installed in such a manner as to completely fill and seal off the specified interval.

   The formation stabilizer shall consist of gravel conforming to Section 2.1 G. The formation stabilizer and bentonite seals (at 100-foot intervals) shall be placed to completely fill the annular space outside the well casing from the top of the bentonite annular seal at 620 feet bls, up to the base of the cement seal at 39 feet bls (Figure 2).

3. Cement Grout Seal Installation
   The well casing cement grout seal shall consist of cement slurry conforming to Section 2.1 C of this specification. The grout seal shall be placed to completely fill the annular space between the well casing and the surface casing, from the top of the formation stabilizer at 39 feet bls, to the land surface.

   The cement grout shall be placed by pumping through a tremie pipe. Prior to installation, the cement grout shall be passed through a ½-inch slotted bar strainer to remove any unmixed lumps. The DRILLER is responsible for preventing excessive differential pressures that may cause casing collapse during the grouting operations. The well casing shall be hung in tension throughout the initial grouting operation, until the cement grout has cured sufficiently. The minimum curing time for the cement grout seal shall be 8 hours or the cement grout obtaining a compressive strength of 500 psi. The specific method of installation must be approved by the DESIGN PROFESSIONAL.

G. WELL DEVELOPMENT

Well development shall be accomplished by simultaneously swabbing and airlift pumping. Upon completion of the well construction, a swab tool composed of two rubber swabs spaced no more than 20 feet apart, with a closed bottom cap, shall be reciprocated throughout the screened interval, beginning at the bottom of the well screen working upward to the top. The swab rubbers shall have a diameter no more than ½-inch less than the inside diameter well screen, to accommodate thorough

development without introducing risk of well screen collapse. The DRILLER is responsible for maintaining the structural integrity of the well throughout the development process. During swab-and-airlift development, a discharge rate of no less than 50 gpm must be maintained (unless limited by aquifer characteristics).

Well development is not anticipated to exceed 6 minutes per linear foot of well screen. No water shall be introduced into the well during development operations without prior approval from the DESIGN PROFESSIONAL. A non-phosphoric dispersant (such as Baroid PFD, Johnson Screen product NW-220, or equal) shall be added to the well bore in accordance with the manufacturer's recommendations during development operations. Costs for chemical additives, dry swabbing, and reaction times, as recommended by the manufacturer shall be included in the hourly rate for well development.

The DRILLER shall provide the DESIGN PROFESSIONAL with an SDS for all chemical additives used for well development at least 3 days prior to their use. The DESIGN PROFESSIONAL must approve the specific type and placement method of all chemical additives prior to their use. Development water shall be contained and/or disposed of by the DRILLER as specified in Sections 1.3(A) and 3.2(G). Re-use of discharge water will not be allowed. The specific methods, chemical additives, and equipment used for well development must be approved by the DESIGN PROFESSIONAL prior to commencement of development operations.

Payment for well development by swabbing and airlift pumping will be based on the unit price per hour shown on the bid schedule and shall apply only to those hours that the development tools are being operated for swabbing and/or airlifting and will not apply to other time such as trip time. After swabbing is complete, all sand, sediment, and foreign material shall be removed from the bottom of the well. The DRILLER shall provide the necessary equipment and air compressor capable of performing the required swabbing and airlifting without artificially raising the water level in the well boring.

After all sediment is removed from the bottom of the well, the well shall be chlorinated in accordance with AWWA Standard A100, through the drill string and surge block with the end open, starting at the bottom and working up. Approximately 1 gallon of 12 percent sodium hypochlorite per 30-foot interval shall be placed into solution and injected down the drill string and into the formation, then briefly surged into place. This procedure shall be repeated for each section throughout the screened interval. The concentration of chlorine in the well shall be at least 50 milligrams per liter (mg/L), and the chlorine shall remain in the well for a period of at least 24 hours after its installation. Costs for chlorine additives, dry swabbing, and reaction times, as specified in this Section shall be provided as a lump sum.

H. WELL TESTING

1. <u>General</u>

The well testing shall consist of a 10-hour step-rate pumping test. The DESIGN PROFESSIONAL reserves the right to extend or shorten the test duration. Discharge rates for each pumping step shall be designated by the DESIGN PROFESSIONAL.

2. Test Equipment

During the step-rate pumping test, the DRILLER shall furnish pumping equipment capable of pumping at a rate of at least 100 gpm (notwithstanding aquifer characteristic limitations) with a pumping lift (not including pipe friction losses) of 700 feet bls. The test pump setting shall be determined by the DESIGN PROFESSIONAL, based on the water level encountered. The anticipated setting of the test pump inlet for the well is 680 feet bls. The test pumping unit shall be complete with an ample power source and shall be capable of being operated without interruption for a period of 10 hours.

The pumping equipment shall include satisfactory throttling devices, valves or variable frequency drive (VFD) devices such that the discharge can be adjusted to various rates, potentially below 20 gpm. The test pump setting shall be determined by the DESIGN PROFESSIONAL, based on the final well design. The anticipated setting of the test pump inlet is at a depth of 680 feet bls. The pumping unit shall be complete with an ample power source and shall be capable of being operated without interruption for a period of 10 hours.

The DRILLER shall provide a magnetic Induction-type or propeller-type flow meter, or a calibrated orifice and monometer to monitor discharge flow rates. The pump equipment shall be equipped with a sample port for water quality sample collection during testing. The DESIGN PROFESSIONAL must approve the test pump, motor, metering equipment, and accessories.

A PVC sounding tube (with a minimum 1.5-inch ID) shall be installed with the test pumping equipment for sounder or transducer access during testing. The bottom of the sounding tube shall be capped, with perforations in the lower 20 feet. Sounding tube materials and installation must be approved by the DESIGN PROFESSIONAL.

Near the end of the pumping period, the DESIGN PROFESSIONAL will collect a New Source groundwater sample for laboratory analysis. The DRILLER is responsible for providing an adequate method for the water sample collection by the DESIGN PROFESSIONAL.

3. Pump Discharge

The DRILLER shall operate the test pump at the discharge rate that has been directed by the DESIGN PROFESSIONAL. The discharge water from the well shall be directed to a point of discharge that has been approved by the OWNER and DESIGN PROFESSIONAL. The DRILLER is responsible for providing adequate piping for the actual distance to the discharge point. The DESIGN PROFESSIONAL shall provide logistical coordination of the discharge of the water from the well site in accordance with any discharge permit issues or limitations that have been identified. The DRILLER is responsible for coordination of any required permits, traffic

control, and other considerations that may be required to address potential flooding or pipeline roadway crossings that result from the discharged water.

I. WELL VIDEO SURVEY

Upon completion of well installation and testing, the DRILLER shall conduct a downhole color video survey of the water supply well to document the well's structure and integrity. The video survey camera shall include both downward-looking and side-view capabilities, and the video survey shall be conducted under the observation of the DESIGN PROFESSIONAL. Both the quality and clarity of the well video must be acceptable to the DESIGN PROFESSIONAL. Prior to acceptance of the well, two copies of the final well video shall be provided to the DESIGN PROFESSIONAL by the DRILLER in USB format.

## 3.3 MEASUREMENT AND PAYMENT

A. GENERAL

Payment for the lengths, areas, volumes, weights, or times shall be compensation in full for the furnishing of all overhead, labor, materials, tools, equipment, and appurtenances necessary to complete the work in a satisfactory manner as specified with all connections, testing and related work completed. Each item, fixture, piece of equipment, etc., shall be complete with all necessary connections and appurtenances for the satisfactory use of and/or operation of said item. No additional payment will be made for work related to each item unless specifically noted or specified. Additions to, omissions from, or alterations of any payment item listed in this Section or on the Bid Schedule (Appendix A) will result in the bidder being disqualified as nonresponsive.

B. BASIS OF MEASUREMENT AND PAYMENT

Compensation for all work specified to be performed under this specification will be made under the payment items presented in this Section. The prices for the said payment items shall be full compensation for all costs in connection therewith. Principal features of the work to be included under the various payment items will be on a linear foot, hourly, per ton, per cubic foot, per cubic yard, or lump sum basis, as designated. Measurement of completed work will be made in place, with no allowance for waste. Measurement of lengths, areas, volumes, weights, or time will be based on the dimensions indicated in this Section, unless altered by the DESIGN PROFESSIONAL to accommodate field conditions.

C. BID SCHEDULE PAYMENT ITEMS

The payment schedule for drilling, well construction and development of the water supply well is presented in the Bid Schedule (Appendix A). A detailed description of each item of the payment schedule is presented below. Items and prices in the Bid

Schedule include all applicable federal, state, and local taxes. No additional taxes may be charged.

1. Item 1 – Mobilization and Demobilization
   Item 1 consists of moving and assembling all drilling, testing, and support equipment to the job site, removing the equipment from the job site when the work is completed, and job site cleanup. This shall also include site security as necessary. Payment will be made on a lump sum basis.

2. Item 2 – Surface Casing Construction
   Item 2 consists of all labor, equipment, material costs associated with drilling the surface boring, and placement of the surface casing and surface grout seal in accordance with this specification. Payment will be made on a linear foot basis.

3. Item 3 – Borehole Drilling
   Item 3 consists of all labor, equipment, and material costs associated with drilling a 14-inch diameter borehole in accordance with this specification. Payment will be made on a linear foot basis.

4. Item 4 – Geophysical Logging
   Item 4 consists of all labor, equipment, material, and subcontractor costs associated with geophysical logging of the borehole in accordance with Section 3.2(D). Payment will be made on a lump sum basis.

5. Item 5 – Casing and Screen Cost
   Item 5 consists of the material cost of the well casing and screen, as described in Sections 2.1(D) and 2.1(E). Payment will be made on a linear foot basis.

6. Item 6 – Casing and Screen Installation
   Item 6 consists of all labor and equipment costs required for the installation of the casing and well screen as described in Section 3.2(E). Payment will be made on a linear foot basis.

7. Item 7 – Annular Material Installation
   Item 7 consists of all labor, equipment, and material costs to furnish and install the filter pack and disinfectant material, bentonite annular seal, and formation stabilizer in the well, in accordance with the requirements of Sections 2.1(F), 2.1(G), and 3.2(F). The Item 7 annulus material volumes as indicated in the Bid Schedule are based on the calculated volume plus a 30 percent overage. Payment will be made on a cubic foot or per ton basis.

8. Item 8 – Cement Grout Installation
   Item 8 consists for all labor, equipment and material costs to furnish and install the cement grout seal in accordance with the requirements of Sections 2.1(C) and 3.2(F). The Item 8 cement grout material as indicated in the Bid Schedule is based on the calculated volume. Payment will be made on a per cubic yard basis.

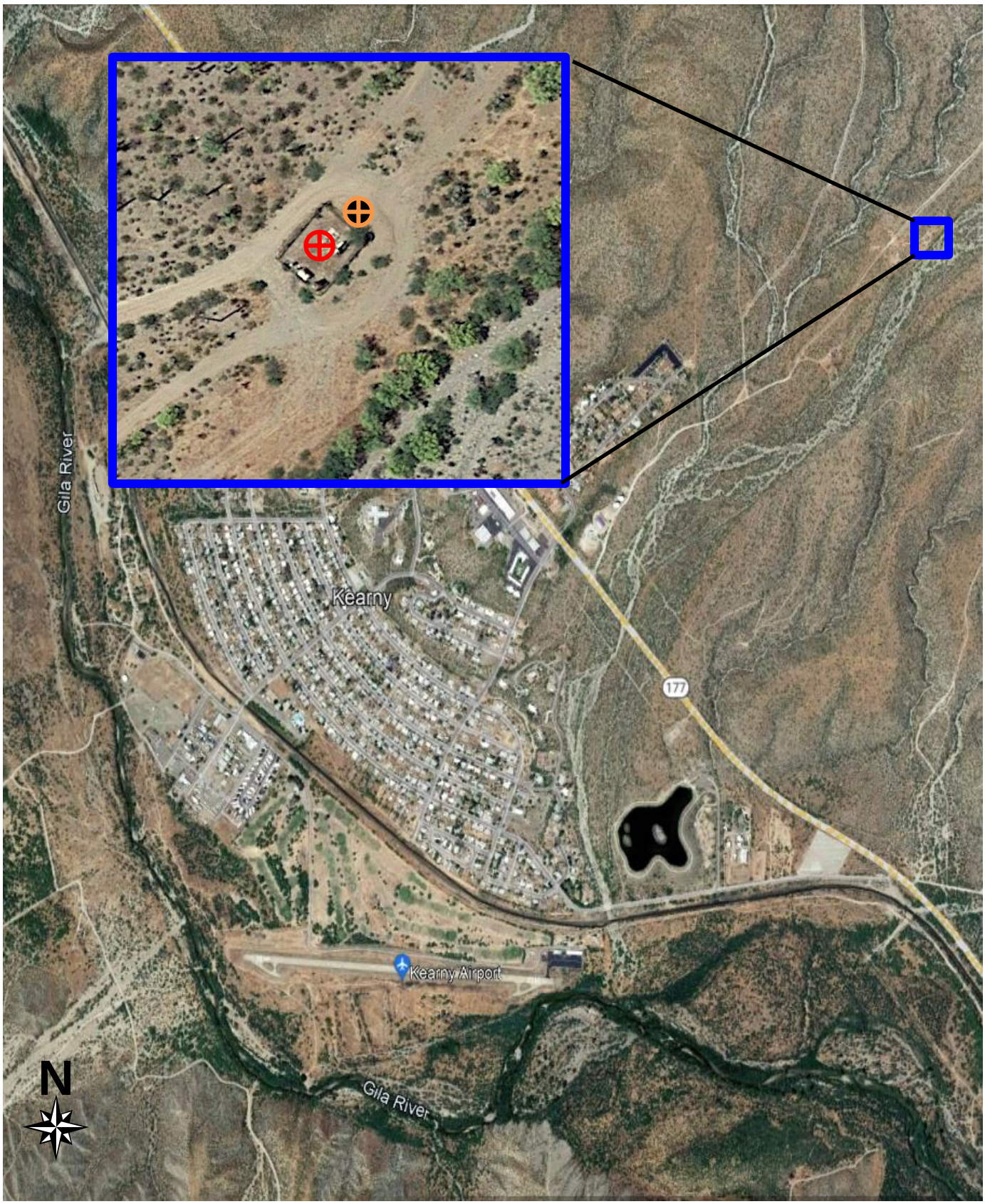
9. Item 9 – Well Development
   Item 9 consists of all labor, equipment, and material costs associated with well development by swab and airlift techniques as specified in Sectioin 3.2(G). Payment will be made on an hourly basis.

10. Item 10 – Well Testing
    Item 10 consists of all labor, equipment, and materials associated with the well testing requirements as described in Section 3.2(H). Payment will be made on a lump sum and hourly basis.

11. Item 11 – Well Video Survey
    Item 11 consists of all labor and equipment costs required for the completion of a color well video survey for the completed well and providing electronic deliverables, as specified in Section 3.2(I). Payment will be made on a lump sum basis.

12. Item 12 – Rig Hourly Rate (Allowance Item)
    Item 12 consists of the cost of maintaining equipment and personnel if a work stoppage occurs at the well, which is not due to any fault of the DRILLER or SUBCONTRACTORS. Payment for any standby time is subject to prior approval by the DESIGN PROFESSIONAL and OWNER. Payment will be made on an hourly basis.

# Figures




CLEAR CREEK ASSOCIATES
a Geo-Logic Company

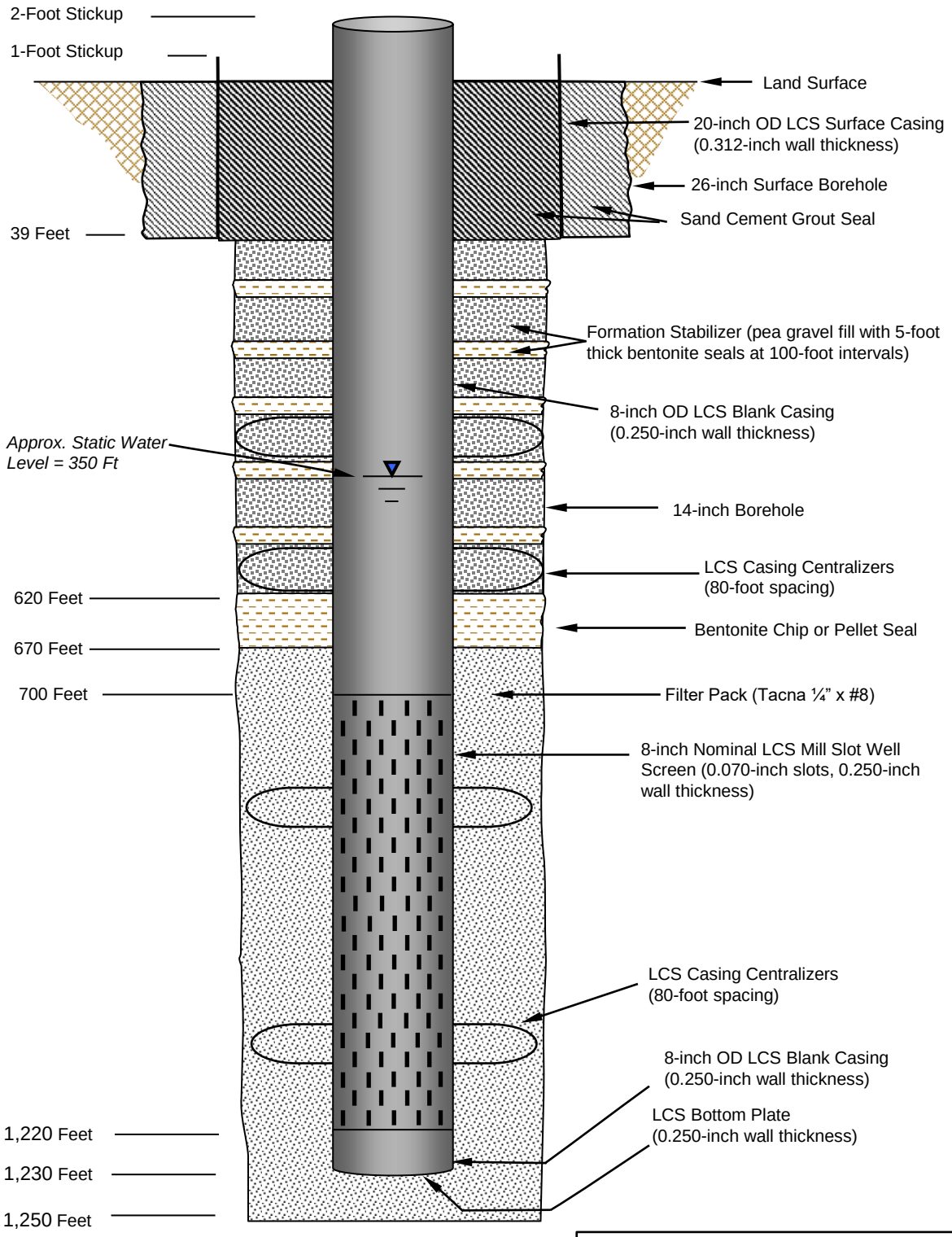
Well #4 Approximate Location

Existing Well Location

Project Area

**FIGURE 1**
**LOCATION MAP**
**Kearny Well #4**
**Kearny, Arizona**

Well Location: D(4-14)23CDB




**Not To Scale**

CLEAR CREEK ASSOCIATES
a Geo-Logic Company

**Notes:** 1. LCS = Low Carbon Steel

2. OD = Outside Diameter

All diameters are O.D. except well screen, which is nominal.

# FIGURE 2

**PRELIMINARY WELL DESIGN**
**Kearny Well #4**
**Town of Kearny**
**Kearny, Arizona**

# Appendix A

## Bid Schedule

# BID SCHEDULE[a]

**Drilling and Installation of**
**Kearny Well #4**
**Kearny, Arizona**

Company Name: _____

**NCS Engineers**
**202 E Earll Drive, Ste 110**
**Phoenix, AZ 85012**

| Item | Description | Unit | Number of Units[b] | Unit Price ($) | Total Price ($) |
|---|---|---|---|---|---|
| 1. | Mobilization and Demobilization | Lump Sum | 1 | | |
| 2. | Surface Casing Construction | Linear Foot | 39 | | |
| 3. | Borehole Drilling | Linear Foot | 1,211 | | |
| 4. | Geophysical Logging | Lump sum | 1 | | |
| 5. | Casing and Screen Material | | | | |
| | A. 8-inch Nominal LCS Well Casing[b] | Linear Foot | 712 | | |
| | B. 8-inch Nominal Slotted LCS Casing (0.070-inch slots) | Linear Foot | 520 | | |
| 6 | Casing and Screen Installation | Linear Foot | 1,232 | | |
| 7. | Annular Material and Installation[c] | | | | |
| | A. Tacna Filter Pack (1/4" x #8) | Ton | 28 | | |
| | B. Formation Stabilizer (Pea Gravel)[c] | Ton | 25 | | |
| | C. Formation Stabilizer (Bentonite)[c] | Cubic Foot | 75 | | |
| 8. | Furnish & Install Cement Grout Seal | Cubic Yard | 3 | | |
| 9. | Swab and Airlift Development | Hourly | 52 | | |
| 10. | Well Testing | | | | |
| | A. Furnish, Install and Remove Test Pump | Lump Sum | 1 | | |
| | B. Pumping Tests | Hourly | 10 | | |
| 11. | Well Video Survey | Lump Sum | 1 | | |
| 12. | Rig Hourly Rate[d] | | | | |
| | A. With Crew | Hourly | 0 | | |
| | B. Without Crew | Hourly | 0 | | |
| | | | | **Total** | $ |

**Grand Total in Written Words:**_____
_____

# BID SCHEDULE[(a)]

**Drilling and Installation of**
**Kearny Well #4**
**Kearny, Arizona**

Company Name: _____

**NCS Engineers**
**202 E Earll Drive, Ste 110**
**Phoenix, AZ 85012**

**Notes:**

a The Contractor's Total Bid is based upon unit prices and allowances. Bid amounts shall include all costs for the required labor, equipment, and materials, but bid amounts shall **include** all federal and state sales/contracting taxes.

b Quantities are not guaranteed. Final payment will be based on actual quantities installed and approved. If the required quantities of the items listed above are increased or decreased by Change Order, the unit prices set forth above shall apply to such increased or decreased quantities unless the change is greater than 25 percent, at which point the prices may be renegotiated.

c The filter pack, formation stabilizer bentonite and gravel, and cement grout volume estimates are based on 30 percent over the calculated annular volume in cases where they will be placed adjacent to an open borehole (excluding intervals between two casing sections.

d Standby time is not gaurenteed and any hourly time is subject to the approval of the DESIGN PROFESSIONAL, ENGINEER, and OWNER.

**Bidder Acknowledges the following addenda: _____**

Company:_____

Signed by:_____

Print Name:_____

Date: _____

# TOWN OF KEARNY

## Project Specifications
## 100%


EXPIRATION DATE: 06/30/2028


EXPIRATION DATE: 12/31/27

## Well Site 4 Improvements

**TOWN OF KEARNY**
**WELL SITE 4 IMPROVEMENTS**

**PROJECT SPECIFICATIONS**
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# DIVISION 1

# GENERAL REQUIREMENTS

SECTION 01030

SUMMARY OF WORK

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Identification and summary description of the Project, the Work, location, OWNER furnished equipment, Work by OWNER, activities by others, and coordination.

B. The Project consists of
   1. The scope includes removal of existing chain-link fences and gates, demolition of well header equipment and associated piping, concrete structures, and wood shade structures. It also involves the removal of the existing bladder tank, storage tank, booster pumps, and all related piping and electrical equipment.
   2. New construction includes a site enclosure and access gate along with installation of new well, well header equipment, well pump, sand separator and pump-to-waste piping. New electrical components includes Automatic transfer switch (ATS), mini power centre, distribution panels and a new generator as a standby power supply for the well site. Equipment shall be installed on concrete pad per drawings.

C. All iron and steel construction materials shall comply with the Build America, Buy America (BABA) domestic preference requirements.
   1. The Build America, Buy America (BABA)Act (2 CFR Part 184) requires USDA Rural Utilities Service (RUS) Water and Environmental Programs (WEP) assistance recipients to use iron and steel, manufactured products, and construction materials that are produced in the United States. This requirement applies to the construction, alteration, maintenance, or repair of water and wastewater infrastructure. WEP has developed guidance on implementation and compliance with this requirement.
   2. The Contractor shall not furnish, approve, or install any iron, steel, manufactured product, or construction material for use in this Project unless such materials are produced in the United States, unless a waiver has been granted.
   3. The Contractor shall obtain, maintain, and provide documentation and certifications demonstrating compliance with BABA requirements for all applicable materials incorporated into the Work. Such documentation shall be made available for review by the Owner or Engineer upon request prior to installation.
   4. The Contractor shall ensure that all subcontractors, suppliers, and manufacturers comply with BABA requirements. Compliance shall be reflected in all submittals, shop drawings, substitutions, and materials incorporated into the Project.
   5. Materials that do not comply with BABA requirements shall not be incorporated into the Work unless approved through the waiver process. Any non-compliant materials installed without approval shall be removed and replaced at no additional cost to the Owner.

1.02 LOCATION OF PROJECT

A. The Project is located at the following addresses:
   1. 33°03’57.8”N 110°53’26.7”W.

1.03 WORK BY THE OWNER

A. Concurrent to this Project, the OWNER will:
   1. Provide site access.
   2. Provide water needed for construction.
   3. Coordinate startup and shutdown of facilities.
   4. Drain water tank to approximately 1’ from floor. CONTRACTOR to pump and drain remainder of water tank and dispose to adjacent wash.
   5. Collect water samples after the CONTRACTOR has completed disinfection of the temporary storage tank and 0.25MG tank and conduct bacteriological tests. ENGINEER to provide De Minimus Permit for tank discharge.

1.04 ACTIVITIES BY OTHERS

A. OWNER, utilities, and others may perform activities within Project area while the Work is in progress:
   1. Schedule the Work with OWNER, utilities, and others to minimize mutual interference.

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

1.05 OPERATION OF EXISTING FACILITIES

A. All work must be scheduled with the OWNER to avoid interference with existing facilities. Refer to Section 01040 for additional requirements.

B. The Contractor shall follow a phased approach for constructing the new well site as follows:
   1. The existing well site with the booster pumps is taken out of service and all the well column piping and submersible pumps shall be taken out from the well and salvaged for reuse per owner prior to the construction and installation of new well site. The existing well shall be abandoned per A.C.C. R12-15-816 requirements.
   2. Demolish existing hydropneumatics tank, bladder tank, existing shade structure, fence and electrical panels.
   3. Install a temporary fence for new well site construction.
   4. A new well shall be drilled and installed according to the Clear Creek Associates Drilling and Installation report dated February 14, 2023.
   5. Well header piping and concrete pads for the header piping shall be constructed.
   6. Concrete pad for generator, electrical equipment shall be constructed per drawings.

7. Install header piping, valves, sand separator and pump to waste piping per drawing and complete all yard piping.
8. Install site enclosure (fence) and Access gates per drawings.
9. Construct new electrical service panels, complete testing and establish electrical service to new panels (to be coordinated with Owner).
10. Conduct hydrostatic pressure testing of all the new piping.
11. Disinfect new water main and connect to the existing water main as per drawings and (coordinated with owner about the tie into the existing water main)
12. Any damage to existing property/equipment must be replaced with the original working conditions.

## 1.06 COORDINATION OF WORK

A. Maintain overall coordination of the Work:
   1. As more fully set forth in the General Conditions, CONTRACTOR shall be solely responsible for coordination of all of the work. Supervise, direct and cooperate fully with all subcontractors, manufacturers, fabricators, suppliers, distributors, installers, testing agencies and all others whose services, materials or equipment are required to ensure completion of the work within the Contract time.
   2. As more fully set forth in the General conditions, CONTRACTOR shall cooperate with and coordinate work with the work of any other contractors, utility service companies or OWNER's employees performing additional work related to the Project site.
   3. CONTRACTOR shall coordinate work with the work of others to assure compliance with schedules.
   4. CONTRACTOR shall attend and participate in all project coordination or progress meetings and report on the progress of all work and compliance with construction schedule.

## 1.07 POTABLE WATER SUPPLY PROTECTION

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

## 1.08 PERMITS

A. CONTRACTOR shall include the cost for and obtain all construction-related permits, except permits described in Paragraph 1.08.B. These permits include, but are not limited to:
   1. Necessary ADEQ De Minimus permits for discharge of hydrostatic test water and chlorinated water used to disinfect piping and equipment.
   2. Building and Electrical permits from Pinal County.

B. OWNER will pay for and provide the following permits to the CONTRACTOR: Arizona Department of Environmental Quality's Approval to Construct (ATC) and Approval of Construction (AOC), if needed.

1.09 CONTRACTOR'S USE OF PREMISES

A. CONTRACTOR shall limit his use of the premises for Work and storage, and allow for work by other contractors/subcontractors.

B. CONTRACTOR assumes full responsibility for the protection and safekeeping of products and materials CONTRACTOR has stored on the site.

C. CONTRACTOR shall move any stored products, or materials, under CONTRACTOR's responsibility, which interfere with operations of OWNER and separate contractors/subcontractors.

D. CONTRACTOR shall obtain and pay for the use of any additional storage or work areas if needed for CONTRACTOR's operations.

E. CONTRACTOR shall restore any areas used for materials storage, equipment storage, or employee and subcontractor parking to their original condition or better, unless specified otherwise.

1.10 MAINTENANCE OF TRAFFIC

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01040

ORDER OF CONSTRUCTION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

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

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

1. Division 1.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

A. Milestone Dates - The construction duration to reach substantial completion shall not exceed 365 calendar days. CONTRACTOR shall also comply with the following interim dates of completion:

| **Task** | **Interim Completion Date (days after NTP)** | |
|---|---|---|
| | **Well Site Improvements** | **Demolition of Existing Well site** |
| Demolish existing well pump, well piping, valves and disconnect and demolish all electrical equipment. site fence, hydro tanks, booster pump | | 60 |
| Submit Shop Drawings for System Components | 45 | - |
| Installation of New Well and well header piping and yard piping, new water main and associated facilities. | 150 | - |
| Complete new electrical, instrumentation and control wiring and reminder of site work. | 200 | - |
| Install New fence and access gates | 235 | - |
| Initiate Startup and Commissioning of well pump Facility and pressure test all piping and disinfect all piping that's in contact with drinking water. | 300 | - |
| Complete tie-in of the new water line to the existing water line. | 350 | - |

| | | |
|---|---|---|
| Substantial Completion | 365 | 365 |

1. CONTRACTOR shall include sufficient and complete overhead costs in base Bid for a 365 calendar day construction duration to reach substantial completion at each site as listed above. No change orders or claims for extended overhead will be considered unless the actual duration to reach substantial completion exceeds 365 calendar days and OWNER was responsible for extending the timeline:
   a. No credit or refund will be given to CONTRACTOR if the work is substantially completed sooner than 365 calendar days.

B. Tie-ins shall be coordinated with the OWNER and shall be scheduled to minimize the disruption of services:
1. Thirty calendar days before start of tie-ins between new and existing facilities and shutdown of facilities, CONTRACTOR shall provide a written proposed maintenance of plant operation (MOPO) for tie-in activities and shutdowns for review by the OWNER.
2. CONTRACTOR, with input from OWNER, can identify the timeframe and duration of facility shutdowns.
3. At no time shall CONTRACTOR or his employees modify operation of the existing facilities or start construction modifications without approval of the OWNER.
4. CONTRACTOR shall plan his work to allow OWNER access to existing facilities to perform maintenance and repair work.
5. Operation of existing valves shall only be performed by OWNER's personnel.

C. The following is a suggested construction sequence for the project which the CONTRACTOR should consider in developing his overall plan of construction. This is not intended to release the CONTRACTOR from the responsibility to coordinate the work in any manner which shall ensure project completion within the time allowed:
1. Abandon the existing well per A.C.C R12-15-816 by a licensed driller.
2. Remove 20ft of well casing and fill the well with cement grout or other materials per A.A.C R12-15-816(I).
3. All existing booster pumps, the well pump, header piping, and the hydropneumatic tank, fence shall be salvaged and turned over to the Owner for future reuse.
4. Existing concrete and shed shall be demolished.
5. Prepare new site and complete site grading.
6. Complete drilling and installing new well casing by a licensed driller.
7. Complete concrete pads.
8. Install new well header, pump and motor.
9. Install new well header piping, valves, sand separator.
10. Install shade structures for electrical equipment.
11. Conduct hydrostatic pressure testing of all piping and disinfect all piping in contact with drinking water.
12. Complete special coatings as required.
13. Install yard piping and conduits.
14. Install electrical and instrumentation and controls wiring.
15. Conduct point to point and loop check for instrumentation and controls.
16. Tie in new piping to the existing piping (co-ordinate with owner).
17. Conduct startup of facilities.

18. Work with ENGINEER to conduct commissioning. Conduct training of OWNER'S staff. The training shall be videotaped and provided to the OWNER on a CD.
19. Complete remaining work and punch list items.

END OF SECTION

SECTION 01072

PROJECT RECORD DOCUMENTS

## PART 1 - GENERAL

### 1.01 SUMMARY

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

### 1.02 MAINTENANCE OF RECORD DOCUMENTS

A. The CONTRACTOR shall maintain at the project site one copy each of the following record documents:
   1. Contract Drawings.
   2. Specifications.
   3. Design addenda.
   4. Reviewed shop drawings.
   5. Contract Change Orders and field orders.
   6. Supplemental drawings and written material provided by the ENGINEER to clarify the Contract Documents.
   7. Other contract modifications.
   8. Approved samples and/or sample results.

B. The CONTRACTOR shall store the project record documents on-site in an approved location apart from other documents. Record documents are not to be used for construction purposes. The CONTRACTOR shall provide files and racks as needed for orderly storage of the documents, maintain the documents in clean, dry, legible condition, and make the documents and samples available at all times for inspection by the ENGINEER.

### 1.03 MARKING DEVICES

A. Mark all changes with red pencil or pen.

### 1.04 RECORDING

A. The CONTRACTOR shall keep the record documents current with construction in progress. Completed construction work shall not be permanently concealed until required information has been recorded.

B. The CONTRACTOR shall provide a rubber stamp (all similar electronic stamp) for use in marking all project record documents. The stamp shall have a line border of approximately 4" x 1" with the words "PROJECT RECORD" printed inside the border.

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

D. The red line as-builts shall also include buried conduit in yard.

1.05 SUBMITTAL

A. Red line record drawings shall be available for review by the ENGINEER whenever an application for a monthly progress payment is made. The partial record drawings shall be up-to-date through the end of the progress payment application period.

B. At completion of construction, and prior to the final inspection and final acceptance of the project by the OWNER, the CONTRACTOR shall deliver the project record documents to the ENGINEER bound into rolls of convenient size for ease of handling and properly labeled.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01325

CONSTRUCTION PHOTOGRAPHS

PART 1 - GENERAL

1.1 Summary

This Section specifies administrative and procedural requirements for construction photographs.

1.2 Submittals

A. Provide a link to download the photographs specified in Section 01340, Submittals and in PART 3 - this Section.

B. Photographer shall submit a digital sample set of the type and quality required during construction, for review and acceptance by Engineer.

1.3 Quality Assurance

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

PART 2 - PRODUCTS

2.1 Photographic Requirements

Specified in PART 3, this Section.

PART 3 - EXECUTION

3.1 Project Site Photographs

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

1. Site clearing
2. Demolitions
3. Excavations
4. Installation
5. Final completion

B. Photographs shall be taken of the following areas and at the following times at a minimum.

1. Existing Site conditions before Site work is started. Number of views shall be adequate to cover the Site.
2. Finished Project after completion of Work. Number of views shall be adequate to show the finished Work. It is particularly important to provide a view of the restoration of each property upon completion of construction.
3. If Project is not completed during the Contract Time or authorized extensions, photographs shall continue to be taken at no increase in Contract Price.

C. The principal reason for obtaining photographs is to document the existing condition of items not scheduled for replacement or items to be removed and replaced in kind such as landscaping, privacy walls, wash locations, etc., as may be necessary for the completion of the WORK. The photographs may, in some degree, preclude the possibility of post construction litigation between CONTRACTOR, adjacent property owners, and the OWNER.

D. Digital Images

1. Submit one (1) complete set of digital image electronic files for each area of work prior to starting work.

a. Provide images in JPEG format, with minimum sensor size of 5.0 mega pixels.
b. Submit images that have same aspect ratio as the sensor, uncropped.
c. The photos of each residence and areas adjacent shall be labeled electronically on each photograph by address.
d. Any media submitted shall be labeled with Project name, area and street. Station and/or address shall be included as applicable.
e. Identify electronic media with date digital photographs were taken.

E. Deliver to Engineer/Owner

1 PROPERTY PHOTOGRAPHS FOR WORK ON PRIVATE PROPERTY

a. Photographs shall be taken at each residential property in sufficient

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

2 Additional Photographs

a. From time to time Engineer/Owner may issue requests for additional photographs, in addition to periodic photographs specified
b. Engineer will give the contractor notice, where feasible.
    i. In emergency situations, the contractor shall take additional photographs within 24 hours of Engineer's request.
c. Substantial Completion of major phase or component of Work.
    i. Owner's request for special publicity photographs.
    ii. Special events planned at Project Site.
    iii. Immediate follow-up when on-site events result in construction damage or losses
    iv. Special events planned at Project Site.
    v. Photographs to be taken at fabrication locations away from Project Site.
    vi. Extra record photographs at time of final acceptance

4 MEASUREMENT AND PAYMENT - Not Applicable.

END OF SECTION

SECTION 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:

| | Title |
|---|---|
| 1. | Request for Information |
| 2. | Contractor's Daily Construction Report |
| 3. | Shop Drawing Transmittal Form (See Section 01340) |
| 4. | Work Change Directive (See Bid Documents) |
| 5. | Change Order (See Bid Documents) |
| 6. | Field Order (See Bid Documents). |

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

**REQUEST FOR INFORMATION**

Project Name:

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

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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)

SECTION 01340

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

## PART 1 - GENERAL

### 1.01 DESCRIPTION

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

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

### 1.02 SUBMITTALS: GENERAL

A. Transmit all technical submittals electronically to:

Ken Hebert (or other designated representative)
kenhebert@ncseng.com

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

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

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

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

E. Assure submittals meet the following schedule:
   1. Shop drawings:
      a. Submittal and approval prior to that portion of work being installed and prior to 50 percent overall completion.
      b. ENGINEER will attempt to return all submittals to CONTRACTOR within 14 calendar days of receipt.
   2. Operation and Maintenance Manuals and Data Record Sheets:
      a. Initial submittal within 45 days after date shop drawings are approved.

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

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

H. Provide schedule of submittals with anticipated submittal dates within two weeks after the preconstruction conference.

1.03 SUBMITTALS: SHOP DRAWINGS

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

B. Transmittal Contents:

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

C. All submittals for materials incorporated into the Work shall include documentation demonstrating compliance with Build America, Buy America (BABA) requirements. Documentation shall include manufacturer certification identifying materials subject to BABA and confirming that applicable iron and steel, manufactured products, and construction materials are produced in the United States. Submittals that do not include required BABA documentation may be rejected.

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.

G. All submittals for materials incorporated into the Work shall include documentation demonstrating compliance with Build America, Buy America (BABA) requirements. Documentation shall include manufacturer certification identifying materials subject to BABA and confirming that applicable iron and steel, manufactured products, and construction materials are produced in the United States. Submittals that do not include required BABA documentation may be rejected.

## 1.05 SUBMITTALS: OPERATION AND MAINTENANCE MANUALS

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

B. Transmittal Content:

1. Submission of Operation and Maintenance Manuals is applicable to but not necessarily limited to:
    a. Equipment such as meters, valves, pumps and feed system controls, electrical panels, and instrumentation.
    b. Equipment used with electrical motor loads (pumps).
    c. Specialized equipment including valves and instrumentation and control system components for process systems such as meters, recorders, and transmitters.
    d. Valves and actuators.
2. Prepare operation and maintenance manuals which include, but are not necessarily limited to the following detailed information, as applicable:
    a. Equipment function, normal operating characteristics, limited operations.
    b. Assembly, disassembly, installation, alignment, tolerances, adjustment, and checking instructions.
    c. Operating instructions for start-up, routine and normal operation, regulation and control, shutdown, and emergency conditions.
    d. Lubrication and maintenance instructions (including schedules).
    e. Guide to “troubleshooting”.
    f. Parts list (including material of construction) and predicted life of parts subject to wear.
    g. Outline, cross-section, and assembly (exploded view) drawings; engineering data; and electrical diagrams, including elementary diagrams, wiring diagrams, connection diagrams, word description of wiring diagrams and interconnection diagrams.
    h. Test data and performance curves.
    i. A list of recommended spare parts with a price list.
    j. Copies of installation instructions, parts lists or other documents packed with equipment when delivered.
    k. Tag numbers relating the equipment back to the Contract Documents.
    l. Safety instructions.
    m. ISO identification numbers for bearings.
    n. List of specialty tools required and availability.
    o. List weight of overall assemblies and individual weights of major individual components.
    p. List of vendors and who to contact for warranty work.
    q. List of fastener grades.
    r. Copy of warranty, if applicable.

C. All submittals for materials incorporated into the Work shall include documentation demonstrating compliance with Build America, Buy America (BABA) requirements. Documentation shall include manufacturer certification identifying materials subject to BABA and confirming that applicable iron and steel, manufactured products, and construction materials are produced in the United States. Submittals that do not include required BABA documentation may be

rejected.

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: | From: | Job No.: |
| | | Reviewed By: |
| | | Date Reviewed: |
| Attn: | Attn: | Spec. Section: |
| Date Transmitted: | Previous Transmittal Date: | 1st. Sub.☐ ReSub.☐ |

| No. Copies | Description | Manufacturer | Drawing or Data No. | Action Taken* |
|---|---|---|---|---|
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Submitter's Remarks:

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* 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:

| |
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| |
| |

Returned by (NCS) : Date:

| | | | | |
|---|---|---|---|---|
| Distribution: | Supplier (if applicable) | ____ Copies | OWNER: | ____ Copies |
| | Sub Consultant 1: | ____ Copies | ENGINEER: | ____ 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 Arizona Department of Environmental Quality (ADEQ) requirements.

B. CONTRACTOR shall not cause or allow any dust generating operation, earthmoving operation, use of property, or any other operation which causes fugitive dust emissions that exceed the 20 percent visible emission opacity limit in ADEQ requirements.

C. If requested by the OWNER, ENGINEER, or ADEQ representative, CONTRACTOR shall conduct opacity observations for visible emissions of fugitive dust in accordance with techniques specified in USEPA Reference Method 9.

D. In addition to earthmoving permits, CONTRACTOR shall obtain approval of CONTRACTOR developed Dust Control Plan from ADEQ. At a minimum, the Dust Control Plan shall include the following information:

1. Name(s), address(es) and phone number(s) of the person(s) responsible for the preparation, submittal, and implementation of the Dust Control Plan and responsible for the dust generating operations.
2. A site plan that describes the total area of land surface to be disturbed (in acres); the operations and activities to be performed on the site; actual and potential sources of fugitive dust emissions; and the delivery, transportation, and storage areas for the site (including types of materials stored and appropriate size of material stock piles).
3. Description of the Reasonably Available Control Measures (RACM) to be applied during all periods of dust generating operations at all actual and potential sources of fugitive dust.
4. Description of dust suppressants to be applied including product specifications; method, frequency, and intensity of application; type, number, and capacity of application equipment; and certifications related to the suppressant’s appropriate and safe use.
5. Description of specific surface treatment(s) or RACM used to control material track-out where unpaved or access points join paved surfaces.
6. Description of at least one alternative RACM for each actual and potential fugitive dust source shall be designated as a contingency measure.

E. CONTRACTOR shall post a copy of all earthmoving permits as well as the approved Dust Control Plan in a conspicuous location at the worksite and provide a copy of each to the ENGINEER.

F. CONTRACTOR shall maintain a daily written log that records the actual application or implementation of the RACMS described in the approved Dust Control Plan. CONTRACTOR shall maintain this written log and supporting documentation on site and shall make available for review on request by ENGINEER, OWNER, or Maricopa County representative. CONTRACTOR shall retain copies of the Dust Control Plan, RACM implementation records, and all supporting documentation for a minimum of three years.

G. CONTRACTOR, at a minimum, shall provide all necessary equipment and materials to apply sufficient dust suppressants (e.g., water, etc.), properly clean (sweep, etc.) all track-out areas, and provide adequate physical stabilization (e.g., gravel, recycled asphalt, etc.) to meet all requirements of the earthmoving permit and approved Dust Control Plan. CONTRACTOR shall use these methods to control fugitive dust generation from all CONTRACTOR operations on all CONTRACTOR areas including, but not limited to:
   1. Construction areas.
   2. Vehicle and equipment parking areas.
   3. Material storage areas.
   4. Office and trailer areas.
   5. Haul and access roadways.
   6. Track-out areas.
   7. All other areas where CONTRACTOR shall be working, storing, or parking vehicles, equipment, and materials.

H. CONTRACTOR shall pay all fines issued ADEQ, due to violation of CONTRACTOR'S earthmoving permit and Dust Control Plan.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01423

REFERENCE STANDARDS

PART 1 - GENERAL

1.01 DESCRIPTION

A. When a reference standard is specified, comply with requirements and recommendations stated in that standard, except when they are modified by the Contract Documents, or when applicable laws, ordinances, rules, regulations or codes establish stricter standards. The latest provisions of applicable standards shall apply to the Work, unless otherwise specified. Reference standards include, but are not necessarily limited to, the following:

1. American Association of State Highway and Transportation Officials (AASHTO).
2. American Concrete Institute (ACI).
3. American Gear Manufacturers Association (AGMA).
4. American Institute of Steel Construction (AISC).
5. American Iron and Steel Institute (AISI).
6. American National Standards Institute (ANSI).
7. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
8. American Society of Mechanical Engineers (ASME).
9. American Society for Testing and Materials (ASTM).
10. American Water Works Association (AWWA).
11. American Welding Society (AWS).
12. Build America, Buy America (BABA).
13. Concrete Reinforcing Steel Institute (CRSI)
14. Factory Mutual (FM).
15. Institute of Electrical and Electronics Engineers (IEEE).
16. National Electrical Manufacturer's Association (NEMA).
17. Occupational Safety and Health Administration (OSHA).
18. National Fire Protection Association (NFPA).
19. Underwriters' Laboratories, Inc. (UL).
20. All other applicable standards listed in the Specifications and the standards of utility service companies, where applicable.
21. National Sanitation Foundation International (NSF).
22. State Division of Industrial Safety (DIS)
23. Institute of Makers of Explosives (IOMOE)
24. Enclosures for Industrial Controls and Systems (ICS)
25. (ISA) See 13329-3
26. National Association of Corrosion Engineers (NACE)

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01450

MEASUREMENTS AND PAYMENTS

PART 1 - GENERAL

1.01 SCOPE

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

A. The following describes the measurements and payments of the Work performed in this Contract:
   1. Bid Item No. 1 - Mobilization, Demobilization, and Project Closeout: Mobilization shall include but not be limited to, all preparatory work; preliminary operations; movement of personnel, equipment, and supplies to project site; establishment of field offices and other facilities needed prior to beginning construction. Demobilization shall include but not be limited to, removal of equipment of materials, equipment, and temporary facilities. Project closeout shall include but not be limited to, correction of incomplete or deficient items identified in the final inspection, final cleaning, submittal of red line record drawings, warrantees, and other project records and documents, and completion of closeout procedures and requirements. Bid Item shall not exceed 10% of the total of Bid Items No. 1 to 19. CONTRACTOR shall receive payment in three (3) equal amounts. The first payment request can include 1/3 of this Item. At 50% completion of the project, the second 1/3 can be requested. The last payment request shall include the final 1/3. Payment for mobilization, demobilization, and project closeout shall be made at the lump sum price submitted on the Price Sheet.
   2. Bid Item No. 2 – Surface Casing Construction: Consists of all labor, equipment, material costs associated with drilling the surface boring, and placement of the surface casing and surface grout seal in accordance with Drilling and Installation technical specifications by clear creek associates, LLC. Payment will be made on a linear foot basis.
   3. Bid Item No. 3 – Borehole Drilling: consists of all labor, equipment, and material costs associated with drilling a 14-inch diameter borehole in

accordance with Drilling and Installation technical specifications by clear creek associates, LLC.. Payment will be made on a linear foot basis.

4. Bid Item No. 4 – Geophysical Logging: Consists of all labor, equipment, material, and subcontractor costs associated with geophysical logging of the borehole in accordance with Drilling and Installation technical specifications by clear creek associates, LLC. Payment will be made on a lump sum basis.
5. Bid Item No. 5 – Casing and Screening Material: Item 5 consists of the material cost of the well casing and screen, as described in with Drilling and Installation technical specifications by clear creek associates, LLC. Payment will be made on a linear foot basis.
6. Bid Item No. 6 – Casing and screening Installation: Consists of all labor and equipment costs required for the installation of the casing and well screen as described in Drilling and Installation technical specifications by clear creek associates, LLC. Payment will be made on a linear foot basis.
7. Bid Item No. 7 – Consists of all labor, equipment, and material costs to furnish and install the filter pack and disinfectant material, bentonite annular seal, and formation stabilizer in the well, in accordance with the requirements of Drilling and Installation technical specifications by clear creek associates, LLC. The Item 7 annulus material volumes as indicated in the Bid Schedule are based on the calculated volume plus a 30 percent overage. Payment will be made on a cubic foot or per ton basis.
8. Bid Item No. 8 – Consists for all labor, equipment and material costs to furnish and install the cement grout seal in accordance with the requirements of with Drilling and Installation technical specifications by clear creek associates, LLC. The Item 8 cement grout material as indicated in the Bid Schedule is based on the calculated volume. Payment will be made on a per cubic yard basis.
9. Bid Item No. 9 – Well Development: Consists of all labor, equipment, and material costs associated with well development by swab and airlift techniques as specified in with Drilling and Installation technical specifications by clear creek associates, LLC. Payment will be made on an hourly basis.
10. Bid Item No. 10 - Well Testing: Consists of all labor, equipment, and materials associated with the well testing requirements as described in with Drilling and Installation technical specifications by clear creek associates, LLC. Payment will be made on a lump sum and hourly basis.
11. Bid Item No. 11 – Well Video Survey: Consists of all labor and equipment costs required for the completion of a color well video survey for the completed well and providing electronic deliverables, as specified in with Drilling and Installation technical specifications by clear creek associates, LLC. Payment will be made on a lump sum basis.
12. Bid Item No. 12 – Rig Hourly Rate - consists of the cost of maintaining equipment and personnel if a work stoppage occurs at the well, which is not due to any fault of the DRILLER or SUBCONTRACTORS. Payment for

any standby time is subject to prior approval by the DESIGN PROFESSIONAL and OWNER. Payment will be made on an hourly basis.

13. Bid Item No. 13 – Demolition – Consists of demolition/removal and abandonment of well#3 (per ADWR requirements) including all civil work, fence, concrete, wood structures, tanks, pumps, piping well header, 20' of well casing and electrical. Measurement shall be based on completion of work. Payment will be made on lump sum basis.
14. Bid Item No. 14 – Installation of well #4, Site work – Consists of furnishing and installation of Well#4, access road construction, grading of site, concrete pad installations, below ground piping and fencing. Measurement shall be based on completion of work. Payment will be made on lump sum basis.
15. Bid Item No. 15 – Installation of Well #4, Canopies over Electrical Equipment: Consists of furnishing and installation shade canopies for electrical equipment. Measurement shall be based on completion of installation. Payment will be made on lumpsum basis.
16. Bid Item No. 16 – Installation of Well #4, header and mechanical piping and equipment: Consists of furnishing and installation of well header and mechanical piping and equipment including valves, flanges, gages, switches, transmitters, flow meters, vertical turbine pump and motor, sand separator and related equipment. Measurement shall be based on completion of installation. Payment shall be made on lump sum basis.
17. Bid Item No. 17 – Well #4, Generator – Consists of furnishing and installation of generator per plans and specifications including auto transfer switch. Measurement shall be based on completion of installation. Payment shall be made on lumpsum basis.
18. Bid Item No. 18 – Well #4, Electrical and Instrumentation – Includes but not limited to furnishing and installation of all electrical and instrumentation related equipment per drawings and specifications. Measurement shall be based on completion of installation. Payment shall be based on lumpsum basis.
19. Bid Item No. 19 – Taxes, Bond and Insurance - This bid item includes all costs associated with applicable taxes, contract bonds, and required insurance necessary for the execution of the Work. These costs include, but are not limited to taxes, bonds and insurance. Payment shall be made on lump sum basis.

END OF SECTION

SECTION 01600

PRODUCT DELIVERY, STORAGE AND HANDLING

## PART 1 - GENERAL

### 1.01 SUMMARY

A. Section Includes:
   1. Scheduling of product delivery.
   2. Packaging of products for delivery.
   3. Protection of products against damage from:
      a. Handling.
      b. Exposure to elements or harsh environments.

B. Related Sections include but are not necessarily limited to:
   1. Division 1 - General Requirements.

C. Payment:
   1. No payment will be made to CONTRACTOR for equipment not properly stored and insured.
   2. Previous payments for items will be deducted from subsequent progress estimate(s) if proper storage procedures are not observed.

### 1.02 QUALITY ASSURANCE

A. Manufacturer’s written directions.

## PART 2 - PRODUCTS (NOT USED)

## PART 3 - EXECUTION

### 3.01 DELIVERY, STORAGE, AND HANDLING

A. Scheduling:
   1. Schedule delivery of products or equipment as required to allow timely installation and to avoid prolonged storage.

B. Packaging:
   1. Deliver products or equipment in manufacturer’s original unbroken cartons or other containers, clearly and fully marked and identified as to manufacturer, item, installation location and instructions for assembly, use and storage.

C. Protection:

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

## 3.02 FIELD QUALITY CONTROL

A. Inspect all products or equipment delivered to the site prior to unloading and reject all products or equipment that are damaged, used, or in any other way unsatisfactory for use on Project.

B. Continually monitor storage area to ensure suitable temperature and moisture controls are maintained.

END OF SECTION

SECTION 01610

REGULATORY REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

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

1.02 CODES AND ORDINANCES

A. Applicable Codes: Compliance with all laws, ordinances, and regulations of authorities having jurisdiction is an integral requirement of the Contract Documents, whether each code is mentioned or not in the Contract documents.

B. Compliance: Comply with all applicable codes, ordinances and regulations in effect at the time of bid opening, including but not necessarily limited to the following:
1. 2018 International Building Code with Local amendments.
2. 2017 National Electrical Code with Local amendments.
3. 2018 International Plumbing Code with Local amendments.
4. 2018 International Fire Code with Local amendments and supplemental rules and regulations.
5. National Fire Protection Association Standards.
6. Utility Company requirements (APS).
7. State and Federal Safety and Health Laws.
8. National Electrical Safety Code (NESC).
9. Amendments to Codes.
10. AZ NPDES compliance for storm water and potable water discharges.
11. NSF International Standards 60 and 61.

C. Detailed Requirements: Be familiar with and verify detailed requirements of applicable codes to verify that items and their installation provided under Work of this Contract meet or exceed legal requirements.
1. Discrepancies: If discrepancies occur between the Contract Documents, local codes, local utility requirements, etc., most stringent requirements shall apply.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01650

DEMONSTRATION OF SYSTEMS / COMMISSIONING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Pre-operational, Startup, and Commissioning.

B. Related Sections include but are not necessarily limited to:
   1. Division 1 - General Requirements.

1.02 DEFINITIONS

A. Pre-operational Period: The period of time after the initial installation/construction.

B. Startup Period: A period of time (anticipated one week) immediately following the completion of the pre-operational period during which the CONTRACTOR initiates flow through the facility, starts up process equipment, calibrates and adjusts systems, completes OWNER training, and confirms the equipment is working as a system. During this period, the CONTRACTOR, manufacturer's agents, and OWNER's equipment pre-purchase suppliers verify installation requirements.

C. Commissioning Period: A specified consecutive period of time (up to two weeks) immediately following the completion of the startup period during which the Owner operates the water treatment facility with support from the CONTRACTOR and Engineer.

D. Post Demonstration Period: The period of time after successful completion of the commissioning period but before final acceptance of Project during which the CONTRACTOR completes all punch list items and Project closeout procedures, and the OWNER has accepted ownership of the facility.

1.03 SUBMITTALS

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

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 EXECUTION

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

B. Pre-operational Period:
1. CONTRACTOR requirements:
a. Properly connect, align, calibrate, and adjust all system components. Check out procedures include but are not limited to:
1) Ring out all power, control and monitoring circuits prior to connection.
2) Voltage check of all circuits.
3) Phase sequence check.
4) Connecting piping system cleanliness check.
5) Alignment check of all connected machinery.
6) Pressure and vacuum testing of all closed systems.
7) Check of lubrication.
8) Calibration of all safety equipment.
9) Manual rotation/movement of moving parts to assure freedom of movement.
10) "Bump starting" of electrical motors to verify proper rotation.
11) Check of valving orientation and position status for manual operating mode.
12) Verify proper instrumentation and control signal generation, transmission, reception and response.
13) Check that all tagging/identification systems are in place.
14) Achieve successful bacteriological test for piping, equipment, and tanks.
b. OWNER shall witness CONTRACTOR operation of each system prior to training to verify functional integrity.
c. Provide all labor, supervision, utilities, equipment, vehicles, and required items necessary to perform work during this period.

d. Provide certificate signed by equipment manufacturer's representative and CONTRACTOR that equipment was correctly installed and is ready for operation (as shown in Exhibit A-1650).

C. Startup Period:

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

2. ENGINEER Responsibilities:
   a. Review start-up plan for well pump and on-site equipment.
3. OWNER Responsibilities:
   a. Provide well water.
   b. Provide power from new SES and power distribution system. If a generator is required, Contractor to provide and operate at their sole cost.
   c. Operates water distribution valves.
   d. Collect water quality samples.

D. Commissioning Period for Booster Pump:

1. CONTRACTOR Responsibilities:
   a. Complete punch list items.
   b. Assist OWNER with manpower as needed to operate the well site.
   c. Maintain the facilities.
   d. During this period, well water will be discharged to OWNER's distribution system.
   e. Prepare commissioning plan

2. ENGINEER Requirements:
   a. Review commissioning plan.

3. OWNER Responsibilities:
   a. Collect, and perform lab water quality tests at their cost.
   b. Provide system water.
   c. Operate the well pump and on-site equipment for duration of commissioning period.

END OF SECTION

SECTION 01651

# TRANSPORTATION AND HANDLING OF MATERIALS AND EQUIPMENT

## PART 1 - GENERAL

### 1.01 DESCRIPTION

A. CONTRACTOR shall make all arrangements for transportation, delivery and handling of equipment and materials required for prosecution and completion of the Work.

B. Shipments of materials to CONTRACTOR or subcontractors shall be delivered to the site only during regular working hours. Shipments shall be addressed and consigned to the proper party giving name of Project, street number and city. Shipments shall not be delivered to OWNER, except where otherwise directed.

C. If necessary to move stored materials and equipment during construction, CONTRACTOR shall move materials and equipment without any additional compensation.

### 1.02 PREPARATION FOR SHIPMENT

A. When practical, factory assemble products. Matchmark or tag separate parts and assemblies to facilitate field assembly. Cover machined and unpainted parts that may be damaged by the elements with a strippable protective coating.

B. Package products to facilitate handling and protect from damage during shipping, handling, and storage. Mark or tag outside of each package or crate to indicate its purchase order number, bill of lading number, contents by name, OWNER'S contract name and number, CONTRACTOR, equipment number, and approximate weight. Include complete packing lists and bills of materials with each shipment.

C. Protect products from exposure to the elements and keep thoroughly dry and dust free at all times. Protect painted surfaces against impact, abrasion, discoloration, or other damage. Grease or oil all bearings and similar items.

D. Do not have products shipped until:
   1. Related Shop Drawings have been approved by ENGINEER.
   2. Related factory test results, required in the individual Specification Sections, have been reviewed and accepted by ENGINEER.
   3. Required storage facilities have been provided.

1.03 DELIVERY

A. CONTRACTOR shall arrange, with the United States Postal Service, a special address for the Project, if needed. All deliveries shall be made to that address.

B. Arrange deliveries of products in accordance with construction schedules and in ample time to facilitate inspection prior to installation.

C. Coordinate deliveries to avoid conflict with Work and conditions on site and to accommodate the following:
   1. Work of other contractors, or OWNER.
   2. Limitations of storage space.
   3. Availability of equipment and personnel for handling products.
   4. OWNER'S use of premises.

D. Have products delivered to site in manufacturer's original, unopened, labeled containers. Keep ENGINEER informed of delivery of all equipment to be incorporated in the Work.

E. Partial deliveries of component parts of equipment shall be clearly marked to identify the equipment, to permit easy accumulation of parts and to facilitate assembly.

F. Immediately on delivery, inspect shipment to assure:
   1. Product complies with requirements of Contract Documents and reviewed submittal.
   2. Quantities are correct.
   3. Containers and packages are intact, and labels are legible.
   4. Products are properly protected and undamaged.
   5. Verify that the accelerometer recordings were made during shipment.

G. Promptly remove damaged products from the Project site and expedite delivery of new undamaged products, and remedy incomplete or lost products to provide that specified, so as not to delay progress of the Work.

1.04 PRODUCT HANDLING

A. Provide equipment and personnel necessary to handle products, including those provided by OWNER, by methods to prevent soiling or damage to products or packaging.

B. Provide additional protection during handling as necessary to prevent scraping, marring or otherwise damaging products or surrounding surfaces.

C. Handle products by methods to prevent bending or overstressing.

D. Lift heavy components only at designated lifting points.

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

SECTION 01715

EQUIPMENT OPERATION AND MAINTENANCE INSTRUCTIONS

## PART 1 - GENERAL

### 1.01 GENERAL REQUIREMENTS

A. This section of the specification describes the project requirements for equipment manufacturer representatives' instruction of the OWNER's operation and maintenance personnel in the proper operation and maintenance of the equipment furnished under the Contract.

B. The CONTRACTOR shall require the equipment manufacturer or supplier to include the costs for the on-site operation and maintenance equipment instructions specified herein in their price quotations for the equipment to be furnished under the Contract.

C. It is the goal and intent of the equipment operation and maintenance instruction specified herein to provide the OWNER's operation and maintenance personnel with technically accurate and current information on the theory, design, practical operation and maintenance, appropriate hands-on or field experience such that the equipment, systems and/or components can be efficiently operated and maintained by the OWNER's staff upon completion of the instruction program.

### 1.02 OPERATION AND MAINTENANCE INSTRUCTIONS

A. An experienced and authorized representative of the manufacturer or supplier of each item of equipment listed below shall conduct an instruction program on the proper operation and maintenance of the equipment. Instruction shall be given only by qualified persons who are familiar with the equipment and systems installed in the work. The required amount of continuous on-site instruction for each item of equipment is specified in Divisions 11, 15, 16, and 17.

B. Equipment manufacturer operation and maintenance manuals, conforming to the requirements of Section 01340 of these specifications shall be available for use in training.

C. The CONTRACTOR shall be solely responsible for scheduling the respective equipment operation and maintenance instruction sessions with the ENGINEER and OWNER. The instruction sessions shall be conducted with the installed equipment being fully tested, adjusted and operational. The equipment operation and maintenance instruction may be scheduled to immediately follow the manufacturer or suppliers' representative's field inspection and final adjustment of the equipment provided that the representative can certify that the equipment has

been installed in accordance with manufacturer's instructions and procedures and the equipment and controls operate properly.

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

## PART 2 - PRODUCTS (NOT USED)

## PART 3 - EXECUTION

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

A. Overview of the equipment and auxiliary or support systems covering nomenclature, function and theory of operation.

B. General safety requirements for operation of the equipment and auxiliary or support systems, including suggested safety equipment.

C. Pre-startup safety and equipment check.

D. Equipment and auxiliary or support systems startup procedures covering manual and automatic modes, if applicable.

E. Equipment or system operation and monitoring requirements; including specifics on normally expected ranges for items such as oil, water pressure and temperature, discharge pressures, sensory observations, and procedures to change operation parameters (such as air or flow rate).

F. Equipment and systems shut down procedures covering manual and automatic and modes (if available).

G. Operational troubleshooting of equipment and auxiliary or support systems.

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

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

A. If a session is specific to a discipline (electrical, mechanical, electrical/ instrumentation) include only appropriate maintenance items for that discipline; if sessions are to include multiple disciplines, include all items for all disciplines and indicate in submittal outline which discipline the material refers to.

B. All disciplines shall include, but not be limited to, the following:
   1. Overview of the equipment and auxiliary or support systems covering nomenclature, function and theory of operation.
   2. General safety requirements for maintenance of the equipment and auxiliary support systems appropriate to each discipline including suggested equipment and practices. Cover local and remote lockout procedures, safe procedure for handling alarms and built-in safety devices during preventive and corrective maintenance.
   3. Overview of pre-startup, routine operation monitoring, and shutdown procedures covering automatic and manual modes (if applicable).

C. Each specific discipline shall include, but not be limited to, the following:
   1. Provide preventive maintenance procedures to be followed; include parts, lubrication quantities, types, frequencies, application points, and time requirements to perform procedures.
   2. Specific procedures to cover adjustments required for alignment, wear, calibration for all preventive maintenance and corrective maintenance procedures including time required to perform.
   3. Special tools, techniques or procedures required for either preventive or corrective maintenance of equipment or its' auxiliary or support systems.
   4. Assembly and disassembly procedures required for preventive or corrective maintenance (the use of models, "exploded" views, part listed, hands-on field training or other audio visual materials are recommended for this area of training). Include time requirements for procedures performed.
   5. Maintenance troubleshooting of equipment and auxiliary systems.

3.03 CERTIFICATES OF INSPECTION

A. Provide Certificate signed by equipment manufacturer, CONTRACTOR and OWNER documenting that training was successfully completed.

END OF SECTION

SECTION 01770

CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

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

1.02 FINAL CLEANING

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

1.03 WASTE DISPOSAL

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

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

1.04 TOUCH-UP AND REPAIR

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

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

1.05 CLOSEOUT DOCUMENTS

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

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

3. Operation and Maintenance Manuals.
4. Warranties and Bonds.
5. Evidence of Payment and Release of Liens as outlined in Conditions of the Contract.
6. Release of claims as outlined in Conditions of the Contract.
7. Red-Line as-builts.

1.06 EVIDENCE OF COMPLIANCE WITH REQUIREMENTS OF GOVERNING AUTHORITIES

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

1.07 WARRANTIES AND BONDS

A. Provide executed Warranty or Guaranty Form if required by Contract Documents.

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

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION

# DIVISION 2

# SITEWORK

SECTION 02072

DEMOLITION, CUTTING AND PATCHING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. All demolition, cutting and patching.

B. Related Sections include but are not necessarily limited to:
   1. Division 1 - General Requirements.

1.02 QUALITY ASSURANCE

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

1.03 SUBMITTALS

A. Not Used.

1.04 DELIVERY, STORAGE, AND HANDLING

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

1.05 PROJECT/SITE CONDITIONS

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

1.06 SEQUENCING AND SCHEDULING

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

1.07 PERMITS

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

B. Obtain approval of authorities having jurisdiction for any work which affects access to or exit from such areas. Obtain approval of authorities for any temporary construction which affects such areas.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

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

2.02 MATERIALS

A. Nonshrink Grout:
   1. Nonmetallic, noncorrosive and nonstaining.
   2. Premixed with only water to be added in accordance with manufacturer's instructions at jobsite.
   3. Grout to produce a positive but controlled expansion. Mass expansion not to be created by gas liberation or by other means.
   4. Minimum compressive strength at 28 days to be 6500 psi.
   5. Coat exposed edges of grout with a cure/seal compound recommended by grout manufacturer.

B. Epoxy Bonding Adhesive:
   1. Two component, moisture insensitive adhesive manufactured for the purpose of bonding fresh concrete to hardened concrete.

PART 3 - EXECUTION

3.01 PREPARATION

A. Provide substantial barricades and safety lights as required.

B. Provide temporary weather protection as necessary.

3.02 INSTALLATION

A. Cutting and Removal:
   1. Remove existing work indicated to be removed, or as necessary for installation of new work.
   2. Neatly cut and remove materials, and prepare all openings to receive new work.
   3. Remove masonry or concrete in small sections.

B. Modification of Existing Concrete:
   1. Where indicated, remove existing concrete and finish remaining surfaces as specified:
      a. Protect remaining concrete from damage.
      b. Make openings by sawing through the existing concrete.
      c. Concrete may be broken out after initial saw cuts in the event concrete thickness prevents cutting through.
      d. Where sawing is not possible, make openings by drilling holes around perimeter of opening and then chipping out the concrete:
         1) Holes shall be sufficient in number to prevent damage to remaining concrete.
   2. Oversize required openings in existing concrete 1 IN on all sides and build back to required opening size by means of nonshrink grout epoxy bonded to the existing concrete.
   3. Where oversized openings cannot be made, remove the concrete to the required opening size and cut back exposed reinforcing 1 IN from face of concrete and fill resulting holes with nonshrink grout.

C. Matching and Patching:
   1. Methods and materials:
      a. Similar in appearance, and equal in quality to adjacent areas for areas or surfaces being repaired.
      b. Subject to review of ENGINEER.

D. Salvaged Items:
   1. Thoroughly dry and clean all metal surfaces.
   2. Prime all bare metal in accordance with Section 09800.
   3. Dispose of items or materials not designated for OWNER's salvage or reuse. Promptly remove from site.

4. Do not store or sell CONTRACTOR salvaged items or materials on site.

E. Clean up:
   1. Transport debris and legally dispose of offsite.

END OF SECTION

SECTION 02100

SITE PREPARATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: clearing, grubbing, and stripping project site.
B. Clear, grub, and strip the new well site within the perimeter of the new perimeter fence, and within 20 feet of new fence perimeter..

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 02235

AGGREGATE BASE COURSE

PART 1 - GENERAL

1.01 SUMMARY

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

1.02 REFERENCES

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

1.03 SUBMITTALS

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

B. Field Quality Control:
   1. Test Reports.
   2. Certificates of Compliance

1.04 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.01 MATERIALS

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

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

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

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

## PART 3 - EXECUTION

### 3.01 EXAMINATION

A. Verification of Conditions: Examine conditions upon which the work specified in this Section depends for defects that may influence installation and performance.

B. Do not proceed with installation unfit unsatisfactory conditions have been corrected

### 3.02 PREPARATION

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

## 3.03 INSTALLATION

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

## 3.04 FIELD QUALITY CONTROL

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

END OF SECTION

SECTION 02260

FINISHED GRADING

PART 1 - GENERAL

1.01 SUMMARY

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

B. Related Sections:
1. Section 02235 – Aggregate Base Course
2. Division 15 – Mechanical

C. Location of Work: All areas which are disturbed in the course of work.

1.02 REFERENCES

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

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

1.03 QUALITY ASSURANCE

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

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.01 PREPARATION

A. Identify required lines, levels, contours, and datum.

B. Notify utility company and ENGINEER to remove and relocate utilities.

C. Protect utilities indicated to remain from damage.

D. Protect plant life, lawns, rock outcropping and other features remaining as portion of final landscaping.

E. Protect bench marks, survey control point, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

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

3.02 FILLING

A. Fill areas to contours and elevations with unfrozen materials.

B. Maintain optimum moisture content of fill materials to attain required compaction density.

C. Make grade changes gradual. Blend slope into level areas.

D. Repair or replace items indicated to remain damaged by excavation or filling.

3.03 TOLERANCES

A. Top Surface of Subgrade: Plus or minus 1/10 (0.10) foot from required elevation.

B. Size of Surface Material: All material placed within three inches of the subgrade surface shall pass the ¾-inch sieve.

END OF SECTION

SECTION 02275

RIPRAP

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Riprap

1.02 RELATED SECTIONS

A. Section 02200—Earthwork

1.03 SUBMITTALS

A. Provide under provisions of Section 01340

B. Product Data: Provide sufficient data to verify compliance with these specifications

1.04 QUALITY ASSURANCE

A. Perform Work in accordance with FHWA FP-03, Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects or MAG Specification Section 220.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Riprap Materials: Provide in accordance with sizes shown on plans.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Do not place riprap over frozen or spongy subgrade surfaces

3.02 PLACEMENT

A. Place geotextile fabric over substrate, lap edges and ends. Fabric shall be Contech C-180 NW non-woven geotextile fabric or TenCate Mirafi 500 X or approved equal.

B. Place riprap as indicated on plans

END OF SECTION

SECTION 02445

CHAIN LINK FENCE AND GATES

## PART 1 - GENERAL

### 1.01 SUMMARY

A. This Section specifies chain link fence comprising fencing, gates, and appurtenances.

B. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

### 1.02 FACTORY TESTING

A. Wire fabric and barbed wire shall be tested for zinc coating weight by the method specified in ASTM A90. Ferrous metal, except the fabric, shall be tested for zinc coating uniformity by the method specified in ASTM A239; zinc coating shall withstand six 1-minute dips.

### 1.03 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. A90 - Standard Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
   2. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped Zinc-Coated, Welded and Seamless.
   3. A121 - Standard Specification for Zinc-Coated (Galvanized) Steel Barbed Wire.
   4. A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   5. A153 - Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
   6. A239 - Standard Practice for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles by the Preece Test (Copper Sulfate Dip).
   7. F567 - Standard Practice for Installation of Chain Link Fence.
   8. F900 – Standard Specifications for Industrial and Commercial Swing Gates.

### 1.04 SUBMITTAL

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

B. The layout of the chain link fence as it is to be provided illustrating fence height, post sizes, bracing configurations, and accessories.

C. Fence Appurtenances.

D. Operation and Maintenance Manual.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

A. Chain Link Fabric:
   1. Fabric to have 75,000 psi tensile strength. Chain link fabric shall be 2-inch mesh 9-gauge core wire. Height of fabric shall be 6 feet 0 inch (plus or minus 3/4 inch).
   2. Fabric shall conform with the requirements of ASTM F668, Class 2b and shall be hot dip galvanized after fabrication, and then covered with a thermally fused and bonded vinyl coating. The vinyl coated fabric shall be 8-gauge, finish.

B. Bottom Tension Wire:
   1. Bottom tension wire shall be at least 7-gage galvanized coil spring steel.

C. Barbed Wire:
   1. Barbed wire shall be double strand 12 1/2-gage galvanized steel with 14-gage barbs in 4-point pattern on 5-inch centers and shall have a Class 1 galvanized coating per ASTM A121.

D. Posts, Top Rail, and Braces:
   1. Pipe used shall be ASTM A53, Schedule 40 steel pipe. Posts, rails, braces and frames shall be hot-dip galvanized per ASTM A53, A123 or A153, whichever is applicable. Galvanizing shall apply at least 2.0 ounces of zinc per square foot of surface.
   2. Line posts shall be 1-7/8-inch outside diameter pipe weighing 3.65 pounds per foot. Corner and end posts shall be minimum 2-7/8-inch outside diameter pipe weighing a minimum of 5.79 pounds per foot. Braces and top rails where specified, shall be 1 5/8-inch outside diameter pipe weighing 2.27 pounds per foot.
   3. Provide galvanized rampart.
   4. End post at receiving end of gate leading edge shall have a catch bracket both near the bottom and top to receive and stabilize the gate.

E. Truss Rods and Miscellaneous Fittings:
   1. Truss rods shall be fabricated of 3/8-inch diameter steel rods and shall have turnbuckles or similar means of adjustment. Extension arms for barbed wire shall be steel or malleable iron. Fittings used shall be hot-dip galvanized iron or steel with a minimum coating of at least 2.0 ounces of zinc per square foot of surface in accordance with ASTM A123 or A153, whichever is applicable.

F. Concrete:
   1. Concrete for post foundations shall be Class C as specified in Section 03300.

G. Gates:
   1. Provide double swing gate as shown on the Drawings. Gate shall be manufactured of galvanized materials. Provide center post and hasp for a padlock. Gate shall be provided with x-bracing to prevent sagging.
   2. Double swing gate shall comply with ASTM F900.

## PART 3 - EXECUTION

### 3.01 FENCE

A. Line posts shall be equally spaced between corners and posts at a spacing not exceeding 10 feet. The base top shall be at least 1 inch above grade and sloped for drainage. Posts shall be set vertical, shall be accurately aligned, and shall have their tops level or at a constant slope between changes in grade. Tubular posts shall be fitted with extension arms for barbed wire, post top to permit passage of top rail or rainproof malleable iron caps as applicable.

B. Corner and end posts shall be braced to the nearest line post. Corner and end posts shall be diagonally braced. Line posts shall be braced horizontally and trussed in both directions with truss rods at 1000-foot minimum intervals. Top rails, where specified, shall be in lengths not less than 18 feet and shall be fitted with couplings for connecting lengths into continuous runs. Couplings shall be not less than 6 inches long and allow for expansion and contraction of the rail.

C. Chain link fabric shall be attached to posts, rails, and wires with galvanized fabric bands or tie wires at a maximum spacing of 12 inches on posts and 18 inches on the rails and tension wires. Stretcher bars shall be provided at ends of fabric. The bottom tension wire shall be stretched tight and shall be located 2 inches maximum above finished grade and on a straight grade between posts by excavating the high points of ground, and in no case shall depressions be filled.

D. Provide top rail.

E. CONTRACTOR shall provide additional fence posts as necessary to install gates.

F. Install chain link fence in accordance with ASTM F567.

END OF SECTION

# DIVISION 3

# CONCRETE

SECTION 03100

CONCRETE WORK

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Concrete formwork.

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

1.02 REFERENCES

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

1.03 SYSTEM DESCRIPTION

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

B. Performance Requirements:
1. Construct forms so that finished concrete conforms to shapes, lines, grades, and dimensions indicated on the Drawings.
2. It is intended that surface of concrete after stripping presents smooth, hard, and dense finish that requires minimum amount of finishing.
3. Provide 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 year experience, except as otherwise specified.

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

1.05 PROJECT CONDITIONS

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

PART 2 - PRODUCTS

2.01 MATERIALS

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

B. Built-Up Plywood Forms:
   1. Built-up plywood forms may be substituted for prefabricated forming system following minimum requirements:
      a. Size and Material:
         1) Full size 4 by 8 feet plywood sheets, except where smaller pieces are able to cover entire area.
         2) Sheet Construction: 5-ply plywood sheets, 3/4 inch nominal, made with 100 percent waterproof adhesive, and having finish surface that is coated or overlaid with surface which is impervious to water and alkaline calcium and sodium hydroxide of cement.

b. Wales: Minimum 2 by 4 inch lumber.
c. Studding and Wales: Contain no loose knots and be free of warps, cups, and bows.

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

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

## PART 3 - EXECUTION

### 3.01 EXAMINATION

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

### 3.02 INSTALLATION

A. Forms and Accessories:
1. Vertical Forms:
a. Remain in place minimum of 24 hours after concrete is placed.
b. If, after 24 hours, concrete has sufficient strength and hardness to resist surface or other damage, forms may be removed.

2. Other Forms Supporting Concrete and Shoring: Remain in place as follows:
   a. Sides of Footings: 24 hours minimum.
   b. Vertical Sides of Beams, Girders, And Similar Members: 48 hours minimum.
   c. Slabs, Beams, and Girders: Until concrete strength reaches specified strength or until shoring is installed.
   d. Shoring for Slabs, Beams, and Girders: Shore until concrete strength reaches specified strength.
   e. Wall Bracing: Until concrete strength of beams and slabs laterally supporting wall reaches specified strength.

B. Form Ties:
   1. Cone-Snap Rod and Bar Ties: Tie forms together at not more than 2 foot centers vertically and horizontally. After forms are removed from wall, fill tie-holes as follows:
      a. Remove form ties from surfaces.
      b. Roughen cone shaped tie holes by heavy sandblasting before repair.
      c. Dry pack cone shaped tie holes with drypack mortar as specified in Section 03600.
   2. Taper Ties:
      a. Neoprene Plug in Taper Tie Holes: After forms and taper ties are removed from wall, plug tie holes with neoprene plug as follows:
         1) Heavy sandblast and then clean tie holes.
         2) After cleaning, drive neoprene plug into each of taper tie holes with steel rod. Final location of neoprene plug shall be in center third of wall thickness. Bond neoprene plug to concrete with epoxy.
         3) Locate steel rod in cylindrical recess, made in plug, during driving:
            a) At no time are plugs to be driven on flat area outside cylindrical recess.
      b. Dry Pack of Taper Tie Holes: After installing plugs in tie holes:
         1) Coat tie hole surface with epoxy bonding agent and fill with drypack mortar as specified in Section 03600.
            a) Drypack Mortar: Place in holes in layers with thickness no exceeding tie hole diameter and heavily compact each layer.
            b) Drypack the outside of the hole no sooner than 7 days after the inside of the hole has been dry packed.
            c) Wall surfaces in area of drypacked tie holes: On the water side of water containing structures and the outside of below grade walls:
               i. Cover with minimum of 10 mils of epoxy gel.
               ii. Provide epoxy gel coating on wall surfaces that extend minimum of 2 inches past drypack mortar filled tie holes.
               iii. Provide finish surfaces that are free from sand streaks or other voids.
   3. For water retaining structures, use taper ties. No other type of tie will be allowed.

C. Built-Up Plywood Forms:
   1. Studding:
      a. Spaced at 16 inches or 24 inches on center.

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

C. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

### 1.02 REFERENCES

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

B. American Society for Testing and Materials (ASTM):
   1. A 143 - Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
   2. A 185 - Standard Specification for Steel Welded Wire Reinforcement, Plain for Concrete.
   3. A 615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   4. A 767 - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
   5. E 8 - Standard Test Methods for Tension Testing of Metallic Materials.
   6. A 706 - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.

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

### 1.03 SYSTEM DESCRIPTION

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

1.04 SUBMITTALS

A. Shop Drawings:
   1. Shop Drawings on Reinforcing Steel:
      a. Submit to the ENGINEER reinforcing steel detail drawings in accordance with Contract Documents.
      b. Changes to Reinforcing Steel Contract Drawing Requirements:
         1) Indicate in separate letter submitted with shop drawings any changes of requirements indicated on the drawings for reinforcing steel.
         2) Such changes will not be acceptable unless the ENGINEER has accepted such changes in writing.
         3) Shop Drawings shall include identification of materials subject to Build America, Buy America (BABA) requirements and shall be accompanied by manufacturer certification demonstrating compliance for all applicable materials.

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.

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 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 | 1/4 |
| Clay lumps and friable particles | ASTM C 142 | 1/4 |
| Materials finer than Number 200 sieve | ASTM C 117 | ½* |
| * Except when material finer than Number 200 sieve consists of crusher dust, maximum amount shall be 1 percent. | | |

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

D. Portland Cement:
1. General: Conform to specifications and tests for ASTM C 150, Types II or III, Low Alkali, except as specified otherwise.
2. Low Alkali Portland: Have total alkali containing not more than 0.60 percent.

3. Exposed Concrete in Any Individual Structure: Use only one brand of Portland cement.
4. Cement for Finishes: Provide cement from same source and of same type as concrete to be finished.

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

F. Admixtures:
1. General:
   a. Do not use admixtures of any type, except as specified, unless written authorization has been obtained from the ENGINEER.
   b. Compatible with concrete and other admixtures.
   c. Do not use admixtures containing chlorides calculated as chloride ion in excess of 5% by weight.
   d. Use in accordance with manufacturer's recommendations accordance with manufacture's recommendations and add each admixture to concrete mix separately.
   e. A single manufacturer shall provide all concrete admixtures.
2. Air Entraining Admixture:
   a. Provide all concrete with 5 percent, plus or minus 1 percent, entrained air of evenly dispersed air bubbles at time of placement.
   b. Conform to ASTM C 260.
3. Fly Ash Pozzolan Admixture:
   a. Pozzolan:
      1) 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, 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. Use Class A concrete except where indicated below or on 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 | 1. 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 manufacturer's instructions.
   5. Take special care to ensure that concrete is well consolidated around and against waterstops and that waterstops are secured in proper position.
   6. Cleaning of Construction Joints:
      a. Wash construction joints free of sawdust, chips, and other debris after forms and built and immediately before concrete or grout placement.
      b. Should formwork confine sawdust, chips, or other loose matter in such manner that it is impossible to remove them by flushing with water, use vacuum cleaner for their removal, after which flush cleaned surfaces with water.
      c. Provide cleanout hole at base of each wall and column for inspection and cleaning.
   7. Expansion, Contraction, and Construction Joints:
      a. Constructed where and as indicated on the Drawings.
      b. Expansion Joint Material, Synthetic Rubber Sealing Compound, and Other Similar Materials: As specified in 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:
    a. Test percent of entrained air in concrete at beginning of each placement, as often as necessary to keep entrained air within specified ranges, and when requested to do so by the ENGINEER.
    b. Provide test equipment.
    c. Do not use concrete that does not meet Specification requirements as to air entrainment and shall remove such concrete from project site.
    d. Test air entrainment in concrete in accordance with ASTM C 173.

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

## 3.04 ADJUSTING

A. Repair of Defective Concrete:
    1. Remove and replace or repair defective work.
    2. Correct defective work as specified in this Article.
    3. Do not patch, repair, or cover defective work without inspection by the ENGINEER.

4. Provide repairs having strength equal or greater than specified concrete for area involved:
    a. Chip out and key imperfections in the work and make them ready for repair.
5. Dry-Pack Method:
    a. Dry Pack Method: Use for holes having depth nearly equal to or greater than least surface dimension of hole, for cone-bolt, and narrow slots cut for repair.
    b. Smooth Holes: Clean and roughen by heavy sandblasting before repair.
6. Mortar Method of Replacement: Use for following:
    a. Holes too wide to dry pack and too shallow for concrete replacement.
    b. Comparatively shallow depressions, large or small, 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.

B. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

1.02 REFERENCES

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

1.03 SYSTEM DESCRIPTION

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

1.04 SUBMITTALS

A. Not Used.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Epoxy: Water-insensitive two-part type low viscosity epoxy adhesive material containing 100 percent solids and meeting or exceeding following characteristics when tested in accordance with standards specified: Manufacturers: One of the following or equal:
   1. Master Builders, Inc., 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 equal:
   1. Sika Chemical Corp.'s, Sikadur 31 Hi-Mod Gel.

C. Epoxy Bonding Agent: Manufacturers: One of the following or 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 03600

GROUT

PART 1 - GENERAL

1.01 SUMMARY

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

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

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. C 109 - Standard Test Method for Comprehensive Strength of Hydraulic Cement Mortars.
   2. C 157 - Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   3. C 191 - Standard Test Method for Time of Setting of Hydraulic Cement by Vicat Needle.
   4. C 827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.

B. U. S. Corps of Engineers (USCE):
   1. CRD C-621 - Corps of Engineers Specification for Non-Shrink Grout.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Concrete Mortar:
   1. General: Consist of concrete mixture with coarse aggregate removed and water quantity adjusted as required.
   2. At Exposed Concrete Surfaces not to be Painted or Submerged in Water: White cement.

B. Grout:
   1. Consist of mixture of Portland Cement and sand.

C. Dry-Pack Mortar:
   1. Consist of mixture of Portland cement and sand.

D. Non-Shrink Grout:
   1. Consist of hydraulic cement, which when mixed with water hardens rapidly to produce permanent high strength material suitable for exterior use.
   2. Nonmetallic and not contain calcium chloride or other chemicals which accelerate corrosion of embedded steel.
   3. Physical Characteristics:
      a. When Tested in Accordance with ASTM C 827: Show no shrinkage prior to initial setting.
      b. When Tested in Accordance with ASTM C 157 and Corps of Engineers CRD C-621: Show no shrinkage in hardened state.
   4. Manufacturers: One of the following or 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 items.
   2. Concrete Surfaces:
      a. Apply epoxy bonding agent to clean, roughened, and dry surface before placing mortar or grout.
   3. Placing:
      a. Exercise particular care in placing Portland Cement mortar or grout since they are required to furnish structural strength or impermeable water seal or both.
      b. Do not use cement mortar or grout that has not been placed within 30 minutes after mixing.

B. Epoxy Grout:
   1. Apply in accordance with manufacturer's installation instructions.
   2. Use where specified herein or where indicated on the Drawings.

3.03 FIELD QUALITY CONTROL

A. Tests:
   1. Non-Shrink Grout:
      a. A set of three specimens shall be made for testing. One at seven days, one at 25 days, and the third of a later date if needed.
      b. Compression test specimens shall be taken during construction from the first day of placement of grout.
      c. The costs of all laboratory tests shall be borne by the CONTRACTOR.
      d. Compressive Strength When Tested In Accordance With ASTM C 109:
         1) At One Day: Not less than 3,000 pounds per square inch. At 28 days: Not less than 6,000 pounds per square inch.
      e. Setting Time when Tested In Accordance with ASTM C 191: Not less than 30 minutes.

END OF SECTION

# DIVISION 5

# METALS

SECTION 05052

# ANCHOR BOLTS, TOGGLE BOLTS AND CONCRETE INSERTS

## PART 1 - GENERAL

### 1.01 DESCRIPTION

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

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

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

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

E. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

### 1.02 QUALITY ASSURANCE

A. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown and specified.
   1. ASTM A36M-14 - Standard Specification for Carbon Structural Steel.
   2. ASTM A123M-17 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   3. ASTM A153M-16a - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   4. ASTM A307-14e1 - Standard Specification for Carbon Steel Bolts, Studs and Threaded Rod 60,000 psi Tensile Strength.
   5. ASTM A484M-18a - Standard Specification for General Requirements for Stainless Bars, Billets and Forgings.
   6. ASTM A536-84(2019)e1 - Standard Specification for Ductile Iron Castings.

7. ASTM B633-19 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
8. ASTM F593-17 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
9. Federal Specification FF-S-325 - Shield Expansion; Nail Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry).
10. Federal Specifications WW-H-171E - Hangars and Support, Pipe.
11. ICBO, International Conference of Building Officials.
12. International Building Code.

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

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

1.03 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Copies of manufacturer's specifications, load tables, dimension diagrams and installation instructions for the devices per Section 01340.
2. Copies of ICBO, UL or FM Reports certifying load carrying capacities and installation requirements for the anchorage devices.

PART 2 - PRODUCTS

2.01 DESIGN CRITERIA

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

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

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

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

2.02 APPLICATION

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

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

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

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

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

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

2.03 MATERIALS

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

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

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

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

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

b. Haydon Bolts, Incorporated.
c. Or equal.

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

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

## PART 3 - EXECUTION

### 3.01 INSPECTION

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

### 3.02 INSTALLATION

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

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

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

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

### 3.03 CLEANING

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

END OF SECTION

# DIVISION 9

# FINISHES

SECTION 09800

SPECIAL COATINGS

PART 1 - GENERAL

1.01 SUMMARY

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

B. See Drawings.

C. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

1.02 REFERENCES

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

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

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

D. American Water Works Association (AWWA):
   1. D102 - Coating Steel Water-Storage Tanks

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

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

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

1.03 DEFINITIONS

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

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

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

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

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

F. Inaccessible Areas: Areas of the finished structure that, by virtue of the configuration of the completed structure, cannot be accessed to perform surface preparation or coating application (with or without the use of scaffolding, rigging, or staging). Inaccessible areas include such areas as the contact surfaces of roof plate lap joints, underside of roof plates where they cross supporting members, top surface of rafters directly supporting roof plates, contact surfaces of bolted connections, underside of column base plates, contact surfaces of mating parts not intended to be removed or disassembled during routine operation or maintenance of the tank, and underside of the tank bottom for ground-supported flat-bottom tanks.

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

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

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

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

K. Wet Film Thickness (WFT): Thickness of wet coating measured in mils.

1.04 PERFORMANCE REQUIREMENTS

A. Coating materials for metal surfaces shall be especially adapted for use in potable water purposes.

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

1.05 SUBMITTALS

A. Product Data: Submit in accordance with Section 01340. Include description of physical properties of coatings including solids content and ingredient analysis, VOC content, temperature resistance, typical exposures and limitations, and manufacturer's standard color chips.

B. Certificates: Submit in accordance with requirements for Product Data.

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

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

1.06 QUALITY ASSURANCE

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

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

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

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

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

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

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

D. No surface preparation or coating application work shall be done under unfavorable weather

conditions, unless the work is adequately protected, and then only with the specific approval of the ENGINEER and inspection.

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

F. Apply coatings to dust free surfaces. To test surfaces, apply strip of clear adhesive tape provided in OTB-SCATT test kit to surface and rub onto surface with finger or supplied roller. When removed, compare the tape to the supplied OTB-SCATT SC PERCENTAGES chart. Visual observations (without magnification) should show a rating of SC-1(1%) or less, i.e. little or no dust, blast abrasive, or other contaminant. Attach tape test strip to the middle rating sheet. Reject contaminated surfaces, clean by vacuum cleaning, and retest. Randomly test surfaces at rate of 8 tests for the first 1000 square feet. Afterwards conduct one test for each additional 1000 square feet. Provide two additional tests for each failed test or questionable test. Submit test tapes results with Daily Inspection Reports. OTB-SCATT can be obtained at OTB Technologies Inc. 5401 E. BeckLane Scottsdale, AZ 85254 or www.OTBTECH.NET, or approved equal.

G. Provide lighting for all work areas as prescribed in SSPC Guide 12.

1.08 MAINTENANCE

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

1.09 PRODUCTS DELIVERY, STORAGE, AND HANDLING

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

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

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

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

E. Take precautions to prevent fire and spontaneous combustion.

1.10 PROTECTION

A. During application of exterior coating of booster pump, the CONTRACTOR shall take any and all necessary precautions to avoid coating fallout on and the consequent damage to any works, improvements or properties either of the OWNER or of other parties, wherever located. The CONTRACTOR shall be responsible for all damage resulting from the coating.

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

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

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

PART 2 - PRODUCTS

2.01 MATERIALS

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

B. Acceptable Manufacturers
1. Following are acceptable coating manufacturers:
   a. AkzoNobel International Protective (Devoe) Coatings.
   b. Tnemec Coatings
   c. Carboline
   d. Or Approved Equal

C. Coating Systems:
1. System No. 1: Two coat Polyamide Epoxy and Acrylic Aliphatic Polyurethane coating system: For ferrous metals and metals exterior surface coating (except galvanized steel and pre-primed steel). Items include but are not limited to exterior surfaces of all exposed steel and ductile iron piping, equipment and pipe supports.

a. Surface Preparation: Per Section 3.01.E.

b. Following or approved equals are acceptable coating systems:

Devoe Epoxy/Urethane System

P1 = Bar-Rust 235 (Gray), 1 coat, 4-6 mils DFT.
I = Bar-Rust 235 (Off White), 1 coat, 4-6 mils DFT.
F1E = Devthane 378H (color choice by OWNER), 1 coat, 3-4 mils DFT.

Tnemec Epoxy/Urethane System

P1 = Series 66 (Gray), 1 coat, 4-6 mils DFT.
I = Series 66 (White), 1 coat, 4-6 mils DFT.
F1E = Series 1075U (color choice by OWNER) 1 coat, 3-4 mils DFT.

Carboline Epoxy/Urethane System

P1 = Carboguard 60 (Gray), 1 coat, 4-6 mils DFT.
I = Carboguard 60 (White), 1 coat, 4-6 mils DFT.
F1E = Carbothane 134 HB (color choice by OWNER) 1 coat, 3-4 mils DFT.

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

2. System No. 2 – 100% Solids Polyurethane (EPA/NSF) Coating System: Items included but are not limited to exterior surfaces of all exposed steel and ductile iron piping, equipment and pipe supports.
   a. Surface Preparation: Per Section 3.01.G.
   b. Coating system shall be NSF approved.
   c. Following or approved equals are acceptable coating systems:

Polibrid Polyurethane (Devoe) System

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

3. System No. 3: Polyamide Epoxy-Polyurethane: For exposed DI piping.
   a. Following or approved equals are acceptable coating systems:

Carboline

P1 = Carboguard 893 SG Epoxy, 1 coat, 4-6 mils DFT.
F1E = Carbothane 133HB (color choice by OWNER), 1 coat, 3- 4 mils DFT.

Devoe

P1 = Bar-Rust 233H, 1 coat, 4-6 mils DFT.
F1E = Devthane 378H (color choice by OWNER), 1 coat, 3- 4 mils DFT.

Tnemec

P1 = Series N69 Hi-Build Epoxoline II, 1 coat, 3-4 mils DFT.
F1E = Series 1075 Endura-Shield II (color choice by OWNER), 1 coat, 3-4 mils DFT.

4. System No. 4 - Two Coat Epoxy (EPA/NSF) - For interior roof surface and center column top plates. Items also include but are not limited to rafters, roof vents, and roof hatches.
   a. Surface Preparation: Per Section 3.01.G.

b. Following or approved equals are acceptable coating systems:

Carboline
P1 = Carboguard 61 (Gray), 1 coat, 6-8 mils DFT.
F1 = Carboguard 61 (White), 1 coat, 6-8 mils DFT.

Devoe
P1 = Bar-Rust 233H (Gray), 1 coat, 6-8 mils DFT.
F1 = Bar-Rust 233H (White), 1 coat, 6-8 mils DFT.

Tnemec
P1 = Series N140 (Gray), 1 coat, 6-8 mils DFT.
F1 = Series N140 (White) 1 coat, 6-8 mils DFT.

D. Blast Abrasive:

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

## PART 3 - EXECUTION

### 3.01 GENERAL PREPARATION

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

B. Protect following surfaces from abrasive blasting in accordance with Paragraph 1.10, by masking, or other means:

1. Surfaces to be assembled against gaskets.
2. Field instruments like pressure gauges, pressure sensors, flow meters, electrical panels, etc.

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

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

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

3.02 GENERAL PROTECTION

A. Protect adjacent surfaces not to be coated from weld spatter and droppings with drop cloths and other coverings.

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

3.03 GENERAL APPLICATION REQUIREMENTS

A. Apply coatings in accordance with manufacturer’s most current written instructions.

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

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

D. Spot prime exposed metal of shop primed surfaces before applying intermediate or finish coating over entire surface.

E. Apply minimum number of specified coats.

F. Apply coats to thicknesses specified.

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

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

I. Remove spatter and droppings after completion of coating.

J. When multiple coats of same material are specified, tint prime coat and intermediate coats with suitable pigment to distinguish each coat.

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

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

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

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

O. No coating work shall be performed on weekends.

## 3.04 FIELD QUALITY CONTROL

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

preparation.

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

C. Measure dry film thickness with calibrated thickness gauge.

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

3.05 SCHEDULE OF ITEMS NOT REQUIRING COATING

A. Nameplates.

B. Caution signs

C. Serial number tags.

D. Control panels and instruments.

E. Hardware (galvanized or stainless steel)

F. Shop painted items

3.06 CLEANING

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

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

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

D. Disinfection of systems as per specifications.

3.07 DISINFECTION

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

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

C. The OWNER shall take a taste and odor test of the water after disinfecting to detect the

presence of any volatile organic compounds (VOC's) imparted by the coating. If the water is not considered safe or acceptable after testing, further work shall be performed by the CONTRACTOR at his expense until the pipe is tested safe and acceptable for use as part of a potable water supply system.

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

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

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

END OF SECTION

SECTION 11005

EQUIPMENT: GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

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

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

C. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society for Testing and Materials (ASTM):
      a. A307 - Standard Specification for Carbon Steel Bolts, Studs and Threaded Rods 60,000 psi Tensile Strength.
      b. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   2. Institute of Electrical and Electronics Engineers (IEEE):
      a. 112 - Standard Test Procedure for Polyphase Induction Motors and Generators.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 6 - Enclosures - Industrial Control and System.
      c. MG1 - Motors and Generators.
   4. NSF International:
      a. 61 - Drinking Water System Components

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

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

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

1.03 DEFINITIONS

A. Product: Manufactured materials and equipment.

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

1.04 SUBMITTALS

A. Shop Drawings:
   1. General for all equipment:
      a. See Section 01340 - Shop Drawing Procedures.
      b. Acknowledgement that products submitted comply with the requirements of the standards referenced.
      c. Manufacturer's delivery, storage, and handling instructions.
      d. Equipment identification utilizing tagging system and name utilized in Drawings.
      e. Equipment installation details:
         1) Location of anchorage.
         2) Type, size, and materials of construction of anchorage.
         3) Anchorage setting templates.
         4) Manufacturer's installation instructions.
      f. Equipment area classification rating.
      g. Shipping and operating weight.
      h. Equipment physical characteristics:
         1) Dimensions (both horizontal and vertical).
         2) Materials of construction and construction details.
      i. Equipment factory primer and painting and coating data.
      j. Manufacturer's recommended spare parts list.

k. Piping and duct connection size, type and location.

2. Mechanical and Process Equipment
   a. Operating characteristics:
      1) Technical information including applicable performance curves showing specified equipment capacity, range-ability, and efficiencies.
      2) Brake horsepower requirements.
      3) Copies of equipment data plates.
   b. Piping and duct connection size, type, and location.
   c. Equipment bearing life certification.
   d. Field noise testing reports if such testing is specified in specific equipment sections.
   e. Equipment foundation data:
      1) Equipment center of gravity.
      2) Criteria for designing vibration, special or unbalanced forces resulting from equipment operation.
3. Electrical and control equipment:
   a. Electric motor information:
      1) Nameplate data.
      2) Service factor on motors ½ HP and above.
      3) Motor enclosure type.
      4) NEMA frame size, if applicable.
      5) NEMA design code, if applicable.
      6) Insulation type.
      7) Efficiency and power factor at full load, ¾ load, ½ load and ¼ load.
   b. Control panels:
      1) Panel construction.
      2) Point-to-point wiring diagrams.
      3) Scaled panel face and subpanel layout.
      4) Technical product data on panel components.
      5) Panel and subpanel dimensions and weights.
      6) Panel access openings.
      7) Nameplate test.
      8) Panel anchorage.
   c. Motor tests reports.
   d. Certification that equipment has been installed properly, has been initially started up and is ready for operation.
   e. Certification prior to Project closeout that electrical panel drawings for manufacturer-supplied control panels truly represent panel wiring including any field-make modifications.

B. Operations and Maintenance Manuals:
   1. Section 01340.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Motors:
      a. US Motors
      b. GE
      c. Emerson
      d. Baldor
      e. Approved equal.

2.02 MANUFACTURED UNITS

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

2.03 ACCESSORIES

A. Guards:
   1. Provide each piece of equipment having exposed moving parts with full length, easily removable guards, meeting OSHA requirements.

2. Interior Applications:
   a. Construct from expanded galvanized steel rolled to conform to shaft or coupling surface.
   b. Utilize non-flattened type 16 GA galvanized steel with nominal ½ IN spacing.
   c. Connect to equipment frame with hot-dip galvanized bolts and wing nuts.
3. External Applications:
   a. Construct from 16 GA stainless steel or aluminum.
   b. Construct to preclude entrance of rain, snow, or moisture.
   c. Roll to conform to shaft or coupling surface.
   d. Connect to equipment frame with stainless steel bolts and wing nuts.

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

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

## 2.04 FABRICATION

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

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

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

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

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

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

G. Machine the mounting feet of rotating equipment.

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

## PART 3 - EXECUTION

### 3.01 ERECTION/INSTALLATION/APPLICATION

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

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

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

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

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

F. Machine Base:
1. Mount machine bases of rotating equipment on subbases in manner that they are level in both directions according to machined surfaces on base. Use machinist level for this procedure.
2. Level machine bases on subbases and align couplings between driver and driven unit using steel blocks and shims.
    a. Size blocks and shims to provide solid support at each anchor bolt location. Area size of blocks and shims shall be approximately 1-1/2 times area support surface at each anchor bolt point.
    b. Provide blocks and shims at each anchor bolt. Blocks and shims shall be square shape with "U" cut out to allow blocks and shims to be centered on anchor bolts.
    c. After all leveling and alignment has been completed and before grouting, tighten anchor bolts to proper torque value.
    d. Do not use nuts below the machine base on anchor bolts for base leveling.

G. Grouting:
1. After machine base has been shimmed, leveled, couplings aligned and anchor bolts tightened to correct torque value, a dam or formwork shall be placed around base to contain grouting. Dam or formwork shall extend at least 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. 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 11214

VERTICAL TURBINE PUMPS

PART 1 – GENERAL

1.01 DESCRIPTION

A. Scope: CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install vertical turbine pumps(multi stage) complete and operational with motors, control equipment, and appurtenances. Anchor bolts are included in this Section.

B. Related Sections: CONTRACTOR shall coordinate the requirements of the Work in this Section along with the requirements of the Sections listed below which includes, but is not necessarily limited to, Work that is directly related to this Section.
   1. Section 01600 – Product Delivery, Storage, and Handling.
   2. Section 01340 – Technical Submittal.
   3. Section 03310 – Concrete Work.
   4. Section 05052 – Anchor Bolts, Toggle Bolts, and Concrete Inserts.
   5. Section 09800 – Special Coatings.
   6. Division 15, as applicable.
   7. Division 16, as applicable.

C. See Drawings

D. To centralize responsibility, it is required that all equipment and services provided under this Section be furnished by a single supplier or manufacturer who shall assume full responsibility for the completeness of the system. CONTRACTOR shall guarantee and be the source of information on all equipment furnished regardless of the manufacturing source of that equipment

E. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

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.

B. Component Supply and Compatibility:
   1. Obtain all equipment included in this section regardless of the component manufacturer from a single pump manufacturer or supplier. The pump shall arrive complete to the jobsite, including OEM discharge lead, column pipe and bowl assembly.

2. The pump manufacturer or supplier shall review and approve or shall prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. All components shall be specifically designed for pumping service and shall be integrated into the overall equipment design by the pump manufacturer or supplier.

C. Reference Standards: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. National Electrical Code.
2. Standards of National Electrical Manufacturers Association.
3. Institute of Electrical and Electronic Engineers.
4. American Gear Manufacturers Association.
5. American National Standards Institute.
6. Anti-Friction Bearing Manufacturer's Association.
7. Standards of the Hydraulic Institute.
8. Standards of the American Water Works Association.
9. National Sanitation Foundation.
10. ASTM A 48, Specification for Gray Iron Castings.
11. ASTM A 53, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
12. ASTM A 276, Specification for Stainless Steel Bars and Shapes.
13. ASTM B 584, Specification for Copper Alloy Sand Castings for General Applications.

D. Shop Tests:
1. All pumps shall be shop performance tested.
2. All tests shall be witnessed by a Registered Professional Engineer, who may be an employee of the manufacturer. The Registered Professional Engineer shall sign and seal all copies of curves and shall certify that hydrostatic tests were performed. The State of registration, registration number and the name on the seal shall be clearly legible. Tests shall be conducted in conformance with the methods described in Section A6 of AWWA E101.
3. Hydrostatic Test: All pump discharge heads, columns, and bowl assemblies shall be hydrostatically tested to twice the total head or one and half times the shutoff head, whichever is greater.
4. Performance Test Requirements:
    a. Pump bowl assembly shall be operated from zero to maximum capacity as shown on the approved curve. Results of the test shall be shown in a plot of test curves showing head, flow, horsepower, efficiency and current drawn. Readings shall be taken at a minimum of seven evenly spaced capacity points including shutoff, design point and 125 percent of flow at best efficiency point. Tests shall be conducted in conformance with applicable methods and standards of Section A6 of AWWA E101.
    b. Curves shall be corrected for column and discharge head losses, shaft friction loss, and operating speed to show the anticipated field performance of the complete pump assembly.

c. Performance of the pumping units shall be within the tolerances specified in the Hydraulics Institute Standard, latest revision, when operated at design speed and capacity.
d. Should the test results indicate that the pumping unit does not meet the above requirements, it shall be modified at no additional cost to the OWNER and retested until full compliance with specified performance can be demonstrated.

5. If manufacturer cannot run tests at full speed because of limitations in manufacturer's testing facilities, reduced speed tests, acceptable to ENGINEER, may be utilized and the results corrected to design conditions by means of accepted hydraulic computations.
6. All test measurements shall be taken with properly calibrated instruments and all procedures shall conform to the test code of the Hydraulics Institute, unless modified herein.
7. Pumps shall not be shipped until the ENGINEER has approved the test reports and test curves.

E. Witness Tests: OWNER and ENGINEER shall be permitted to witness the certified pump performance factory test. CONTRACTOR shall provide two weeks minimum written notice prior to scheduling shop tests to allow OWNER time to make travel arrangements. Cost of lodging, meals and travel shall not be CONTRACTOR'S responsibility. However, if the witness shop tests are not run on the date agreed upon because of CONTRACTOR'S or the supplier's fault, the cost of the excess travel, lodging, meals, and time for the OWNER may be deducted from the money due to the CONTRACTOR.

## 1.03 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
1. Manufacturer's literature, illustrations, paint certification, specifications and engineering data including: dimensions, materials, size, and weight.
2. Performance data and curves showing overall pump efficiencies, required net positive suction head, allowable suction lift, flow rate, head, brake horsepower, motor horsepower, speed, and shut off head. Supply data on pump head losses to include entrance, column, pump, discharge head and valve losses.
3. Shop Drawings showing fabrication methods, assembly, accessories, installation details and wiring diagrams.
4. Setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.
5. Three copies of certified pump performance test results and hydrostatic test.
6. Three copies of motor test results and data.
7. List of all deviations from the Contract Documents.

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 – Technical Submittals.

1.04 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices, which are to be embedded in cast in place concrete in ample time not to delay that Work.

B. All boxes, crates, and packages shall be inspected by CONTRACTOR upon delivery to the site. CONTRACTOR shall notify ENGINEER of any loss or damage to equipment or components. Replace losses and repair damage to new condition, in accordance with manufacturer's instructions.

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

D. Store all mechanical equipment in covered storage off the ground and prevent condensation.

PART 2 – PRODUCTS

2.01 PRODUCT MANUFACTURER

A. Provide pumps as manufactured by one of the following:
   1. Gorman Rupp / National Pump Company,
   2. FlowServe,
   3. Or approved equal.

B. Provide motors as manufactured by one of the following:
   1. U.S. Motors,
   2. General Electric,
   3. Baldor
   4. Or approved equal.

2.02 SERVICE CONDITIONS

A. Pumps shall be vertical turbine multi stage type pumps to be run to meet flow and pressure conditions.

B. The characteristic curve of the pump shall rise from minimum head condition to shutoff without dips. The complete pumping unit consisting of the pump and respective motor shall be suitable in all respects for continuous and stable performance without cavitation and in accordance with the vibration criteria specified in Hydraulic Institute Standards.

C. Each complete pumping unit, including the motor, shall be capable of safely operating at up to 125% of full load speed in reverse rotation without sustaining damage.

D. Materials in Contact with Potable Water:
   1. All surfaces, including coatings which will be in contact with water that will become potable following additional treatment, shall under both pump operating and non-operating (stagnant) conditions:
      a. Not impart taste or odor to water nor produce an organic or inorganic content in the water more than the maximum level established by applicable laws or regulations.
      b. Be listed by the National Sanitation Foundation as being suitable for contact with potable water, as applicable.

E. Pumps shall be specially designed, constructed, and installed for the service intended and shall comply with the following minimum conditions

| **Parameter** | **Well 4** |
|---|---|
| Flow Rate | 100 GPM |
| Assumed Motor/Pump Efficiency | 60.5% |
| Maximum Total Dynamic Head | 507 feet |
| Diameter | 4.59 inch |
| Shut off head | 779 ft |
| Maximum Operating Speed | 3600 rpm |
| NPSH | 13.4 ft |
| Water Temperature | 68 F |
| Drive Type | Constant Speed |
| Motor, Hp | 25 hp |
| Motor | 480 V/ 3 Ph / 60 Hz |

## 2.03 DETAILS OF CONSTRUCTION

A. Pump Materials and Construction:
   1. Inlet Bell and Bowl Assembly: The castings shall be of close grained cast iron, ASTM A 48, Class 30. The bowl assembly shall be fitted with a baffle basket strainer designed to reduce potential vortex formation. The inlet bell shall provide conservative entrance velocities and direct the flow to the impeller. The inner surfaces of the bell shall be smooth and free of sharp projections or cavities which might cause turbulence or cavitation. A streamlined housing, centered and held in the bell by means of rigid vanes, shall be provided to properly direct the flow to the impeller. The bowl shall be designed for a flanged, indexed fit to the inlet bell and discharge column to provide proper bearing alignment. The interior surfaces shall be smooth and free of sharp projections, transitions, and cavities which might incite turbulence and undesirable vibration. The contours of the bowl shall be designed to closely match the shape of the impeller's vanes and to provide a smooth conversion of kinetic to potential energy. A bearing housing, centered in the bowl by rigid vanes shall be positioned immediately above the impeller to ensure minimum shaft deflection at all conditions of service.

2. Impellers: Impellers shall be of bronze construction confirming to ASTM B 584. Impellers shall be cast in one piece. Impellers shall be securely keyed or colleted to the shaft. Split rings and thrust collars, or a tapered collet, shall be provided to prevent axial movement. They shall be adjustable vertically by means of an adjustable flanged spacer coupling. Provide bronze impeller and case wear rings of dissimilar harness. Impellers shall be mounted on their shafts and statically and dynamically balanced prior to final assembly and shall be free of sharp projections, cavities or abrupt transitions which could encourage or incite cavitation or excessive turbulence. The impeller thrust ring shall be stainless steel, ASTM A 276, Type 416. Impeller lock collet shall be stainless steel, ASTM A 276, Type 316 or Type 416.
3. Bowl shaft: The bowl shaft shall be ASTM A 276, Type 416 stainless steel, turned, ground, and polished. Shafts shall be sized as recommended by the manufacturer.
4. Strainer: The strainer shall be constructed of 18-8 stainless steel. Net inlet area shall be equal to four times the net impeller inlet area. Maximum inlet area shall be not more than 75 percent of the minimum opening of the water passage through the bowl or impeller.
5. Line shafts: The line shafts shall be 416 stainless steel, turned, ground, and polished. They shall be furnished in interchangeable sections not over ten feet in length. The shaft shall be sized in accordance with the maximum recommended horsepower for a given size of shaft, taking into account the affect of the hydraulic thrust on the pumping equipment and the weight of the shaft and suspended rotating parts. To ensure accurate alignment of the shafts, they shall be straight within 0.005 inches total indicator reading for a 10 ft section. The butting faces shall be machined with center relief and square to the axis of the shaft. The line shaft shall be coupled with 316 stainless steel couplings, and shall be held in place by bearing retainers with neoprene lineshaft bearings at each column joint. The shaft shall be provided with a non corrosive wearing surface of stainless steel at the location of each guide bearing. Provide a flanged adjustable spacer type head shaft coupling to facilitate impeller adjustment.
6. Column Pipes: The column pipes shall be flanged steel pipe conforming to ASTM A 53. The column pipe thickness shall be as recommended by the manufacturer. They shall be furnished not more than ten feet in length and shall be connected with Type 316 stainless steel nuts and bolts. Each section of column pipe shall be provided with two heavy-duty lifting lugs located approximately 12-inches below the top end. Column pipes shall be furnished with drilled steel flanges. The flanges shall be double-fillet welded at each end. They shall be machined and provided with a registered fit to ensure proper alignment. Friction pipe loss shall not exceed five feet per 100 feet based on the rated capacity of the pump.
7. Discharge Head Assembly: The discharge head assembly shall be fabricated steel, accurately machined with a rabbet fit for mounting the driver and supporting the pump column assembly and with above ground discharge flange machined and drilled to ANSI standards for 250 lb pressure rating and 8 inch diameter. The design shall allow for the lineshaft to be coupled to the motor shaft above the mechanical seal. Discharge head should include hinged coupling guards. Fabricated head to be manufactured by licensed welders with welding certificates to be submitted with final project documentation. A 1/4-inch tapped connection shall be provided on the pump discharge nozzle for installation of a pressure gage. Provide plug for tapped

connections. The discharge head assembly shall be provided with a cartridge type mechanical seal. The discharge head shall be designed so that the mechanical seal can be removed without disturbing the electric motor. The motor shall be provided with an adjustable flanged spacer coupling to connect the pump to shaft and motor drive shaft. The mechanical seal retainer shall be cast iron and rated for 250 psi discharge pressure. The seal bearing shall be bismuth bronze C89835. The top lineshaft shall be 416 SS and shall extend through the mechanical retainer. \

8. Mechanical Seal: It shall be ANSI cartridge type, John Crane, Chesterton, or equal self aligning mechanical single cartridge mechanical seal. This seal shall utilize a plan 13 flush with return port on the discharge head. The mechanical seal shall be capable of being removed without distributing the motor.
9. Provide removable, adjustable water slinger fitted to pump shaft to prevent pressurized leakage from the stuffing box from entering the motor enclosure. The stuffing box shall be bronze, ASTM B 584 or cast iron, ASTM A 48.
10. Type 316 stainless steel anchor bolts and inserts shall be furnished under this Section and shall be sized and installed in accordance with the manufacturer's recommendations
11. All bolts, nuts and cap screws shall have hexagon heads, and be Type 316 stainless steel.
12. Stainless steel nameplates giving the manufacturer's model and serial number, rated capacity, head, speed and all other pertinent data shall be attached to the pump.
13. A suitable gasket shall be provided to prevent leakage at the mounting flange.
14. As the motor shall be vertical solid shaft, impeller adjustment shall be made through the use of a space type rigid coupling offering a removable spacer for easy maintenance of the pump and an adjusting nut assembly, whereby the required vertical clearance in between the bowls and the impeller is attained. Coupling spacer shall be of sufficient length to remove both the seal cartridge and the seal retainer without disturbing the motor.
15. Pump base: Each pump motor, discharge assembly, and column pipe shall be mounted on the concrete base as shown on the Drawings. The pump manufacturer shall provide anchor bolts and installation instruction.

B. Motors:
1. Motors shall operate on 480 volts, 60 Hz, 3 phase electric power. It shall be 25 HP or smaller. It shall be run at constant speed. It shall be supplied with non reverse ratchet mechanism.
2. Motors shall be in accordance with all current applicable standards of NEMA, IEEE, AFBMA, NEC, HI, ASTM, ANSI, and AWWA.
3. Motors shall be Weather Protected Type-One with NEMA P-base. Motors shall be vertical solid shaft type.
4. Service Conditions:
   a. Suitable for serving indoor in a clean environment.
   b. Voltage variation of ± 10%.
   c. Frequency variation of ± 5%.
5. Enclosure shall be NEMA Weather Protected Type One.
6. Motors shall be TEFC type.

7. Motors shall be Division One explosion proof, as defined by UL, meeting the Class and Group as required by the hazard.
8. Motors shall be of the full voltage starting, squirrel cage induction type, of sufficient size so that there will be no overload on the motor above rated nameplate horsepower under any condition of operation from shut off to zero head, unless otherwise specifically permitted in this Section.
9. Insulation system shall be rated minimum Class F (155oC). Magnet wire shall be copper and rate Class H (180oC) or better. Magnet wire shall be classified Pulse Endurance, suitable for variable frequency applications. Varnish shall be 100% polyester. Water borne varnish is not acceptable.
10. Provide T-stat for motor over temperature protection built into windings. It shall protect against overload, high ambient temperature, too frequent starting, abnormal voltage, ventilation failure, and single phase condition.
11. Motors shall be capable of carrying full load current continuously without injurious temperature rise in an ambient temperature of 60°C.
12. Motors shall be provided with a service factor of 1.15.
13. Motors shall be premium efficiency in accordance with “NEMA PREMIUM” value for horsepower, speed, and enclosure.
14. Motors applied to variable frequency drives shall adhere to NEMA MG-1 Part 31 and shall be nameplated accordingly.
15. Provide each motor with air-cooled anti-friction guide and thrust bearings. Thrust bearings shall be oil lubricated; guide bearings shall be oil or grease lubricated. All bearings shall have a minimum L-10 or B-10 life of 100,000 hours as defined by the Anti-Friction Bearing Manufacturer's Association. Thrust bearings shall be angular contact ball or roller type rated for continuous operation and a total load consisting of the weight of the motor rotor, pump impellers and lineshafting plus the hydraulic thrust imposed by the pump at rated operating conditions. Thrust bearings shall have adequate capacity to carry the upthrust at starting and the combined downthrust at shutoff. The use of tandem or series bearings will not be acceptable. Thrust bearings for each motor shall be provided with a visual indicator for lubricant level and readily accessible connections for adding and draining lubricant. The lubricating system shall be designed to provide the correct amount of oil to the bearing with a minimum of foaming or aeration. Each motor shall be supplied with a stainless steel information plate indicating all essential information such as, type of lubricant, viscosity, and other pertinent data.
16. Lubrication of motor bearings shall be as recommended by the manufacturer.
17. Each motor shall have a stainless steel nameplate which shall provide the following: Type, frame, insulation, class, HP, full load current, RPM, centigrade degrees rise, manufacturers name and serial no., model, voltage, locked rotor KVA code, bearing numbers and a connection diagram. The motor terminal box shall be oversized to provide adequate space for connections. The motor terminal box shall be of cast iron or fabricated steel, neoprene gasketed and bolted, and oversized to provide adequate space for connections. The motor leads shall be permanently marked in agreement with the connection diagram.
18. Motors shall be high efficiency design type. Efficiencies shall be determined in accordance with NEMA Standard MGI-12.53a and IEEE Standard 112, Test

Method B. Nominal and guaranteed efficiencies shall be included on motor nameplates in compliance with NEMA Standard MGI-12 53b.

19. Ratchets: Pumps shall be supplied with non-reverse mechanism in the motor.
20. Vibrations shall not exceed 0.08 inches per second, peak to peak.
21. Noise level shall not exceed 85 dbA at 1 meter.
22. Motors shall have permanent lifting lugs capable of a safety factor of 10.

C. Provide control panel and accessories as per Division 16.

## 2.04 CONTROLS

A. Provide pump controls as shown on the Drawings and specified herein.

B. Solid State Starter is a 480VAC, 3-Ph, NEMA 4, 10kA SCCR-rated panel equipped with protection, control, and starting components for the well pump PMP-101. The pump uses solid-state starter with bypass contactor. It includes a winding temperature sensor (TSH-101) and a high-pressure switch (PSH-101) on the discharge line, integrated into the control logic to prevent overheating and overpressure damage.

C. The panel includes a Hand-Off-Auto operation selector. In Auto mode, it will interface with the PLC. In Hand mode, the pump is started/stopped via door-mounted pushbuttons. The pump will have the following indicator lights:

1. Pump Running – Red
2. Pump Fault-Amber
3. Over Temperature - Amber
4. High Pressure – Amber

D. A manual Reset button will be installed to clear over-temperature and high-pressure alarms once the fault is resolved, allowing pump restart.

E. The control panel will include following coordination signals with the RTU:

1. YC-101 Run Command (DI)
2. YIR-101 Run Status (DO)
3. YIA-101 Auto Status (DO)
4. YA-101 SSS Fault Alarm (DO)
5. PAH-101 High Pressure Alarm (DO)
6. TAH-101 High Temperature Alarm (DO).

F. The Solid-State Starter shall be equipped with an Ethernet Communications module.

G. Pressure Gauge:

1. Provide indicating gauge on the discharge piping as shown on Drawings. Gauges shall be furnished with diaphragm seals (with flush connection) and gauge cocks. Range of the pressure gauge shall be 0 to 200 psi.

H. Well pump control panel will shut down the well immediately, if there is any critical alarm including motor overload, high temperature, and high-pressure alarm.

## 2.05 ANCHOR BOLTS

A. Furnish anchor bolts and nuts of ample size and strength for the purpose intended, sized by the equipment manufacturer. Anchor bolt materials shall be Type 316 stainless steel and shall conform to the requirements of Section 05052, Anchor Bolts, Toggle Bolts and Concrete Inserts.

## 2.06 TOOLS, SPARE PARTS AND MAINTENANCE MATERIALS

A. Each pump shall be furnished with a manufacturers repair kit which shall include as a minimum the following:
   1. Two sets of special tools required for maintenance and operation.
   2. One set of sleeve bearings for shafting.
   3. Wear rings, one for each impeller.
   4. A complete set of all fasteners, bolts, nuts, pins, keys, washers and the like which are not of standard manufacture.
   5. All bearing grease, and any other lubricants required for initial operation, properly labeled and boxed.
   6. One complete mechanical seal kit.
   7. Complete set of gaskets.

B. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the OWNER at the conclusion of the Project.

## 2.07 SURFACE PREPARATION AND SHOP PAINTING

A. Pumps, motors, and appurtenances shall receive shop primer and shop finish coating conforming to requirements of Section 09800 – Special Coatings. If any damage to the paint system occurs, the equipment shall be repainted as directed by the ENGINEER. The interior surfaces of the pump, suction bell and discharge column pipes, and the interior surfaces of the pump head and suction barrel shall be cleaned with a Near White Metal Sandblast (SSP-SP10), and coated with an NSF approved paint.

B. 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 INSPECTION

A. Inspection:
   1. Inspect and verify that structures or surfaces on which the equipment will be installed have no defects which will adversely affect installation.
   2. Inspect all equipment prior to installation.
   3. Promptly report defects which may effect the Work to the ENGINEER.

## 3.02 INSTALLATION

A. Install the pump equipment in a manner and to the tolerances recommended by the equipment manufacturer. CONTRACTOR shall arrange for a qualified service representative from each manufacturer of equipment to assist in the installation of the equipment, to check the equipment before it is placed into operation, and to provide start-up service.

B. Lubricants: Install products recommended by equipment manufacturer for initial operation.

C. Install pumping units on concrete bases and secure with anchor bolts in accordance with the manufacturer's recommendations and as shown on the Drawings. The concrete bases shall be poured up to 1-inch below the metal bases or soleplates. Concrete work and grout are specified in Division 3, Concrete. The base with the equipment mounted thereon, or the soleplate, shall then be accurately shimmed to grade and the spaces between filled with an approved nonshrink grout. After the grout has reached its initial set, exposed edges shall be cut back 1/2-inch and the edges neatly finished with one to two cement mortar.

D. Support piping independent of the pump.

E. Check and align all pump, motor, and flexible shafting.

## 3.03 START-UP AND FIELD TEST

A. CONTRACTOR shall verify that structures, pipes, and equipment are compatible.

B. Make adjustments required to place system in proper operating condition.

C. Field Vibration Tests (perform only if excessive vibration is noticed):
   1. A bump test shall be performed on pump in each of two orthogonal planes, one of which shall include the discharge elbow, to ensure that the pumps will not develop lateral and/or torsional critical speeds. These tests shall be performed after the pump has been installed on its foundation, and under both operating and non-operating conditions. Other suitable tests may be substituted subject to ENGINEER'S approval of CONTRACTOR'S written request and description of the tests proposed.
   2. Vibration measurements shall be made at the upper motor bearing of pump while operating over its speed range. Measurements shall be made in each of two orthogonal horizontal directions one of which shall be in the plane of the greatest vibration and in the vertical (pump axial) direction. Measured levels in the horizontal direction of the operating pump shall not exceed those in the Hydraulic Institute Standards latest edition.
   3. CONTRACTOR shall provide the services of an Engineer to conduct the vibration tests.

D. Testing, checkout, start-up and commissioning of the equipment shall be performed under the technical direction of the manufacturer's factory-trained representative. The pump system shall not be energized without authorization from the manufacturer's representative.

## 3.04 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 two visits (8 hours, each) 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. Manufacturer's representative shall test the system in the presence of the ENGINEER and verify that the pumps conform 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 11262

EMERGENCY SHOWER/EYEWASH

PART 1 - GENERAL

1.01 SUMMARY

A. This section includes safety stations, which are equipped with an eye wash and a plastic shower head. The safety stations shall be located near the chemical pump station, as shown in the Drawings.

B. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

1.02 RELATED SECTIONS

A. Division 1 - General Requirements.

B. Section 01340 - Technical Submittals.

C. Section 11005 - Equipment: General Requirements.

1.03 QUALITY ASSURANCE

A. Source Quality Control:
   1. Valve and spray head assemblies shall be factory assembled and water tested prior to shipment.
   2. The units shall be listed by Electrical Laboratories (ETL) and bear the ETL label.
   3. The manufacturer shall use only equipment which is compatible in function, arrangement, reliability, and accuracy and will perform in modes of operation outlined herein. The CONTRACTOR shall require all equipment listed in this Specification to be furnished or coordinated through a single eyewash equipment manufacturer.
   4. The manufacturer shall furnish equipment for which the controls shall meet the requirements as specified herein.

B. Reference Standards:
   1. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified:
      a. American National Standards Institute (ANSI) - American National Standard for Emergency Eyewash and Shower Equipment, Z358.1-2004.
      b. Occupational Safety and Health Act (OSHA).
      c. Joint Industrial Council.
      d. Instrumentation, Systems, and Automation Society.

1.04 SUBMITTALS

A. Shop Drawings.

PART 2 - PRODUCT

2.01 MANUFACTURER

A. GFR 1902 freeze-resistant unit as manufactured by Guardian Equipment for outdoor application.

B. G 1902 safety station as manufactured by Guardian Equipment for indoor application.

C. Or approved equal.

2.02 SPECIFICATIONS

A. Application:
   1. Outdoor Application: Freeze-resistant combination eyewash and shower safety station. Freeze-resistant valves and supply lines shall be buried below frost line to protect against freezing. The unit shall be designed to drain completely after use, so that no standing water remains in unit and possibility of freeze-up is eliminated.
   2. Indoor Application: Combination eyewash and shower safety station. Two spray-type outlet heads shall deliver flood of water for rinsing eyes.

B. Shower Head: 10" diameter shower head shall be orange ABS plastic.

C. Shower Valve:
   1. Outdoor Application: Provide 1-1/4" IPS freeze-resistant valve with push plate. Valve body and supply line are buried below frost line to prevent freezing. Valve has 1/4" IPS bleed outlet to permit water standing in unit to drain out after use. The bury depth shall be 5 ft below the ground.
   2. Indoor Application: Provide 1" IPS chrome plated brass stay-open ball valve. Valve shall be US-made with chrome plated brass ball and Teflon seals. The valve shall be furnished with stainless steel actuating arm and 29" stainless steel pull rod.

D. Spray Head Assembly: Provide two GS Plus spray heads, each one shall have a “flip top” dust cover and internal flow control.

E. Eye Wash Bowl: Provide 11-1/2" diameter stainless steel eye wash bowl.

F. Eye Wash Valve:
   1. Outdoor Application: 3/4" IPS freeze-resistant valve with push plate shall be provided. Valve has 1/4" IPS bleed outlet to permit water standing in unit to drain out after use. The bury depth shall be 4 ft below the ground.

2. Indoor Application: Provide 1/2" IPS chrome plated brass stay-open ball valve. Valve shall be US-made with chrome plated brass ball and Teflon seals.

G. Pipe and Fittings: Provide schedule 40 galvanized steel pipes furnished with orange polyethylene covers for vertical piping for high visibility and corrosion resistance.

H. Supply:
1. Outdoor Application: 3/4" NPT (eye wash valve) and 1-1/4" NPT(shower valve) male inlets shall be provided.
2. Indoor Application: 1-1/4" NPT female top or side inlet shall be provided.

I. Waste:
1. Outdoor Application: 1-1/4" NPT female outlet shall be provided.
2. Indoor Application: 1-1/4" NPT female outlet shall be provided. Outlet tee shall be positioned either 8" or 20" above finished floor by reversing pipe nipples above and below lower tee.

J. Sign: ANSI- compliant identification sign shall be furnished.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. The equipment shall be installed per the contract documents and manufacturer's recommendations.

B. A trained manufacturer's representative shall provide four (4) hours of training on the operation and maintenance of this product. The four hours may not be consecutive if more than one training session is necessary.

### 3.02 WARRANTY

A. The equipment/system warranty, unless otherwise stated, shall be one year from start-up.

END OF SECTION

# DIVISION 13

# SPECIAL CONSTRUCTION

SECTION 13334

MAGNETIC FLOW METERS

PART 1 – GENERAL

1.01 SUMMARY OF SECTION

A. Provide magnetic flowmeters as shown on the Drawings.

B. Related Sections include, but are not necessarily limited to:
1. Division 1 – General Requirements.
2. Section 01340 – Technical Submittals.
3. Section 01600 – Product Delivery, Storage, and Handling.
4. Section 01715 – Equipment Operation and Maintenance Instructions.
5. Section 11005 – Equipment: General.
6. Division 16 – Electrical.
7. Division 17 – Instrumentation and Controls.

C. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

1.02 REFERENCES

A. National Electrical Manufacturer's Association (NEMA).

B. ICS 6, Enclosures for Industrial Controls and Systems.

1.03 SUBMITTALS

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

B. Equipment Identification: Magnetic flow meters to be installed are identified in the Drawings.

| Meter Name | Location | Size (in) | Flow Range (gpm) |
|---|---|---|---|
| FM - 101 | Well header line | 4-inch | Min 50 gpm; Max 200 gpm |

C. Operations and Maintenance Manuals:
   1. See Section 11005 – Equipment, General Statement.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Krohne Enviromag 2000.

B. Endress + Hauser Promag W 400.

C. Or approved equal.

2.02 MATERIALS

A. Body: Carbon Steel.

B. Liner: Polyurethane.

C. Electrodes: Stainless steel.

2.03 DESIGN FABRICATION

A. Pulsed DC type sensor.

B. Provide integral flow transmitter mounted with flow meter on the well header line.

C. Solid state circuitry with adjustable span, zero and output signal damping.

D. Power Supply: Transmitter shall operate on 120 V ac, 60 Hz.

E. Flow Rate Ranges: Units shall operate under flow conditions specified in Meter Schedule on Drawings with an accuracy of ±0.5% under all conditions.

F. Outputs: Provide with amplifiers, noise suppression circuitry, signal converting circuitry to produce an isolated 4-20 mA signal and a totalizer pulse signal transmitted to the PLC.

G. Include local LCD display calibrated for instantaneous and totalized display.

H. Flanged end connections rated for 150 psi.

I. Accessories:
   1. Provide all ancillary devices required for a complete installation including grounding rings, signal isolators, cables, and hardware.
   2. Meter body and electrical connections shall be suitable for indoor use.

PART 3 – EXECUTION

A. Installation: As per drawings and manufacturer's installation instructions.

B. Project Conditions:
   1. Environmental Requirements: The instrument selected shall be suitable for the following conditions:
      a. Humidity: 0–50% relative humidity.
      b. Ambient temperature limit: 60 to 100 °F with local display.

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

END OF SECTION

# DIVISION 15

# MECHANICAL

SECTION 15050

BASIC PROCESS PIPING MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Basic piping materials and methods.

1.02 REFERENCES

A. American Society of Testing and Materials (ASTM):
   1. A106/A106M-19a - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   2. D2240-15e1 - Standard Test Method for Rubber Property - Durometer Hardness.
   3. A536-84(2019)e1 - Standard Specification for Ductile Iron Castings.

B. National Sanitation Foundation (NSF) 61 - Drinking Water System Components - Health Effects.

C. AWWA C111 - Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.

D. Refer to Section 09800 for coating requirements for exterior of exposed piping.

E. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

1.03 DEFINITIONS

A. Exposed Piping: Piping within buildings, vaults, tunnels, or other structures without regard to elevation of piping, or exposed piping outside buildings and structures.

B. Buried Piping: Piping actually buried in soil or cast in concrete.

C. Wet Wall: Wall with water on at least one side.

1.04 INTENT OF DRAWINGS AND SPECIFICATIONS

A. Except in details, piping is indicated diagrammatically. Sizes and locations are indicated on the Drawings. Not every offset and fitting, or structural difficulty that may be encountered has been indicated on the Drawings.

B. Perform minor modifications to piping alignment where necessary to avoid structural, mechanical, or other type of obstructions that cannot be removed or changed:
   1. Modifications are intended to be of minor scope, not involving a change to the design concept or a change to the Contract Price or Contract Time.

1.05 SYSTEM DESCRIPTION

A. Performance Requirements:
   1. Restraining Piping:
      a. Restrain piping as follows:
         1) When piping is underground, use mechanical restraints throughout. All buried piping shall be restrained.
         2) When piping is aboveground or under water, use mechanical or structural restraints.
      b. Provide restraints with ample size to withstand thrust forces resulting from test pressures.
   2. Connections to Existing Piping:
      a. Expose existing piping to which connections are to be made with sufficient time to permit, where necessary, field adjustments in line, grade, or fittings:
         1) Protect domestic water supplies from contamination:
            a) Make connections between domestic water supply and other water systems in accordance with requirements of public health authorities.
            b) Provide devices approved by owner of domestic water supply system to prevent flow from other sources into the domestic supply system.
      b. Make connections to existing piping and valves after sections of new piping to be connected have been tested and found satisfactory.
      c. Provide sleeves, flanges, nipples, couplings, adapters, and other fittings needed to install or attach new fittings to existing piping and to make connections to existing piping.
   3. Connections to In-Service Piping:
      a. Shutdown in-service piping in accordance with Section 01040:
         1) Establish procedures and timing in a conference attended by CONTRACTOR, ENGINEER, and OWNER of the in-service piping.
   4. Connections of Dissimilar Metals:
      a. Connect ferrous and nonferrous metal piping, tubing, and fittings with dielectric couplings especially designed for the prevention of chemical reactions between dissimilar metals.
      b. Nonferrous metals include aluminum, copper, and copper alloys.
      c. For flanged piping with dissimilar metals, use an insulated coupling or insulating gasket.
   5. All pipe tapping saddles are to be of bronze construction, unless noted otherwise on the Drawings.

PART 2 - PRODUCTS

2.01 ESCUTCHEONS (AS NEEDED)

A. Manufacturers: One of the following or approved equal:
   1. Dearborn Brass Company, Model Number 5358.
   2. Keeney Manufacturing Company, Model Number 102 or Number 105.
   3. Beaton and Corbin, Model Number 1 or Number 13.

B. Material: Chrome plated steel plate.

2.02 MODULAR SEAL

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

B. Characteristics:
   1. Modular mechanical type, consisting of interlocking neoprene or synthetic rubber links shapes to continuously fill the annular space between the pipe and wall opening.
   2. Assemble links solely with stainless steel bolts and nuts to form a continuous rubber belt around the pipe.
   3. Provide a stainless steel pressure plate under each bolt head and nut. Isolate pressure plate from contact with wall sleeve.

2.03 COUPLINGS

A. Ductile Iron Couplings:
   1. Provide ductile iron couplings for use in connection of smooth end joints of ductile iron, steel or other types of pipe.
   2. General Requirements.
      a. Sleeve or center rings shall be of nominal O.D. size, range and length specified. Sleeve shall be of Ductile Iron ASTM A 536. Ends shall have a smooth inside taper to provide uniform gasket seal. Sleeve shall be given a shop coat of oil-modified urethane, corrosion-resistant paint.
      b. Follower flanges or end rings shall be of the thickness determined by the coupling size, and shall be of ductile iron, ASTM A 536. Flanges shall be identified by a color coded shop coat finish as described in Item 2a.
      c. Gaskets shall be compression-type, formed with Virgin Styrene Butadiene Rubber (SBR), compounded with ingredients to produce permanence and resistance to set after installation. O.D. range shall be imprinted on the gasket in permanent ink (minimum).
      d. Bolts and nuts shall be of high-strength, low-alloy steel, with nominal coarse thread, and hex nuts with black finish. Dimensions and minimum stress values shall be in accordance with AWWA/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. Manufacturer: EBAA Iron Inc., Romac Industries Inc., or approved equal.

B. Expansion Joint (Flexible Bellows Coupling):
   1. Manufacturer: General Rubber or approved equal.

2. Performance and Design:
   a. Provide single and double arch expansion joints, as shown on the Drawings, complete with restraining rods to prevent over-expansion. Provide flanged spool with single or multiple arches, designed to provide motion capability as specified. Rubber expansion joints shall be rated for 250°F and 150 psi.
3. Materials:
   a. Tube - Provide single, seamless, leakproof tube made of Buna-N that extends through the bore to the outside edges of both flanges.
   b. Body - Fabric reinforcement shall be used as the flexible and supporting member between the tube and the cover. Fabrics of high strength synthetic fibers shall be used. All fabric plies shall be impregnated with rubber or synthetic compounds to permit flexibility between the fabric plies to reduce service strain.
   c. Cover - The exterior surface of the joint shall be formed from synthetic rubber to protect the body from outside damage. Utilize special polymers to resist sunlight.
   d. Integral Flanges - Constructed of resilient rubber, and smooth finish, the full-faced flanges form a tight seal against the pipe flange without the need of gaskets. Provide standard AWWA flanges as specified in Section 15062.
   e. Provide restraining rods attached to flanges for thrust protection.
4. Execution:
   a. Install expansion joint as shown on the Drawings and in accordance with the manufacturer's recommendations.

C. Flanged Coupling Adapter:
1. Description: One end of adapter shall be flanged and the other end shall have a sleeve type flexible coupling.
2. Pressure and Service: Same as connected piping.
3. Material: Cast iron or steel.
4. Bolts and Nuts: Type 316 stainless steel.
5. Harnessing:
   a. Harness adapters to restrain pressure piping. Test pressures for pressure pipelines shall conform to the requirements of Section 15050, Piping Systems.
   b. For adapters 12-inch diameter and less, provide 1/2-inch minimum stainless steel anchor studs installed in a pressure tight anchor boss. Provide number of studs required to restrain test pressure and service conditions. Harness shall be as designed and recommended by manufacturer; however, the following minimum anchor studs shall be provided, unless otherwise approved by ENGINEER:
      1) 6-inch diameter and less: Two.
      2) 8-inch diameter and less: Four.
      3) 10-inch diameter and less: Six.
      4) 12-inch diameter and less: Eight.
   c. For adapters larger than 12-inch diameter, provide split-ring harness clamps with a minimum of four Type 316 stainless steel bolts. Harness assembly shall be as designed and recommended by manufacturer. Dimensions, size spacing and materials shall be suitable for service and conditions encountered and shall be approved by ENGINEER.

6. Product and Manufacturer: Provide one of the following or approved equal:
   a. Smith-Blair, Model 912.
   b. Romac Industries Inc., FC400/FCA501/RFCA.
   c. Ford FFCA.

2.04 CONTROLLED LOW STRENGTH MATERIAL

A. Controlled low strength material shall consist of Portland cement coarse and fine aggregate, and water.

B. Cement content shall be 0.5 sack of cement per yard.

C. The material shall have slump of 7 inches ± dye inch.

D. Compressive strength at 28 days shall be 70 psi ± 30 psi.

2.05 BURIED PIPING

A. All buried plastic piping shall have tracer wire placed 1 foot above the crown of the pipe. The magnetic tracer wire shall be 12 gauge insulated solid copper wire.

B. All buried piping shall also be provided with an identification tape (non detectible) placed 3 feet above the crown of the pipe. The tape shall be an inert polyethylene-plastic impervious to alkalis, acids, chemical reagents, and solvents likely to be encountered in the soil. The tape shall be a minimum of 4.0 mils thick and not less than 3" wide. The color of the tape and the text will be selected by OWNER. Lettering shall be minimum 1 ½" high. OWNER will select text for each pipe run using manufacturer's normally available stock.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verification of Existing Conditions:
   1. Locate and expose existing structures, piping, conduits, and other facilities and obstructions which may affect construction of underground piping before starting excavation for new underground piping and appurtenances.
   2. Verify sizes, elevations, locations, and other relevant features of existing facilities and obstructions. Determine conflicts for the construction of the new underground piping and appurtenances.
   3. Make piping location and grade adjustments to resolve conflicts between new piping and existing facilities and obstructions.

3.02 WALL AND SLAB PENETRATIONS

A. Provide sleeves for piping penetrations through masonry and concrete walls, floors, ceilings, roofs, pilasters, columns, piers, and beams unless specified or otherwise indicated on the Drawings.

B. For piping 1 inch in nominal diameter and larger, provide sleeves with minimum inside diameters of 1 inch plus outside diameter of piping. For piping smaller than 1 inch in nominal diameter, provide sleeve of minimum twice the outside diameter of piping:
   1. Arrange sleeves and adjacent joints so piping can be pulled out of sleeves and replaced without disturbing the structure.
   2. Cut ends of sleeves flush with surfaces of concrete, masonry, or plaster.
   3. Conceal ends of sleeves with escutcheons where piping runs through floors, walls, or ceilings of finished spaces within buildings.
   4. Seal spaces between pipes and sleeves.

C. Cast couplings or wall pieces in walls for penetrations of buried rigid piping including cast iron, ductile iron, reinforced concrete, and vitrified clay through structures:
   1. Provide couplings or wall pieces with mechanical push-ons, or similar flexible joints at outside of walls.
   2. Provide additional similar joints in piping at transition points between trenches and structure excavations.
   3. For steel piping, single joints may be used in lieu of two joints. Locate single joints outside within 2 feet from outside faces of walls.

D. Modular Seal for Pipe Penetration: Provide Link-Seal or approved equal. Provide two modular seals to seal at wet wall sleeves or penetrations. Mount one seal on the inside face of the wall and the other on the outside face of the wall. Coordinate the inside diameter of the wall sleeve with the size of the seal to provide watertight sealing. For dry wall penetrations, provide 1 modular seal.

3.03 EXPOSED PIPING

A. Install exposed piping in straight runs parallel to the axes of structures, unless indicated otherwise:
   1. Install piping runs plumb and level, unless otherwise indicated on the Drawings.

B. Install exposed piping after installing equipment and after piping and fitting locations have been determined.

C. Support piping in accordance with Section 15141 and as shown on Drawings:
   1. Do not transfer pipe loads and strain to equipment.

D. In addition to the joints indicated on the Drawings, provide unions, flexible couplings, flanged joints, and other types of joints or means which are compatible with and suitable for the piping system, and necessary to allow ready assembly and disassembly of the piping.

E. Assemble piping without distortion or stresses caused by misalignment:
   1. Match and properly orient flanges, unions, flexible couplings, and other connections.
   2. Do not subject piping to bending or other undue stresses when fitting piping. Do not correct defective orientation or alignment by distorting flanged joints or subjecting flange bolts to bending or other undue stresses.

3. Flange bolts, union halves, flexible connectors, and other connection elements shall slip freely into place.
4. After piping assembly to fit when proper fit is not obtained.
5. Install eccentric reducers or increasers with the top horizontal for pump suction piping.

3.04 BURIED PIPING

A. Bury piping with minimum 4 foot cover without air traps, unless otherwise indicated on the Drawings.

B. Where 2 similar services run parallel to each other, piping for such services may be laid in the same trench. Lay piping with sufficient room for assembly and disassembly of joints, for thrust blocks, for other structures, and to meet separation requirements of public health authorities having jurisdiction.

C. Laying Piping:
1. Lay piping in finished trenches free from water or debris. Begin at the lowest point with bell ends up slope.
2. Place piping with top or bottom markings with markings in proper position.
3. Lay piping on an unyielding foundation with uniform bearing under the full length of barrels.
4. Where joints require external grouting, banding, or pointing, provide space under and immediately in front of the bell end of each section under and immediately in front of the bell end of each section laid with sufficient shape and size for grouting, banding, or pointing of joints.
5. At the end of each day's construction, plug open ends of piping temporarily to prevent entrance of debris or animals.

3.05 CLEANING

A. Piping Cleaning:
1. Upon completion of installation, clean piping interior of foreign matter and debris. Perform special cleaning when required by the Contract Documents.
2. Maintain pipe in clean condition during installation.
3. Before joint 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 hours prior to each test.
   5. Unless otherwise specified, completely assemble and test new piping systems prior to connection to existing pipe systems.
   6. Acknowledge satisfactory performance of tests and inspections in writing to OWNER prior to final acceptance.
   7. Provide all necessary equipment and perform all work required in connection with the tests and inspections.
   8. Bear the cost of all testing and inspecting, locating and remedying of leaks and any necessary retesting and re-examination.
   9. CONTRACTOR to dispose of testing water.

B. Pressure Testing Methods and Criteria:
   1. Types of pressure testing and inspection to be employed include hydrostatic pressure testing, and hydrostatic infiltration/exfiltration testing.
   2. Liquid systems:
      a. The following liquid piping systems shall have zero leakages at the specified test pressure throughout the specified duration:
         1) Exposed piping.
         2) Buried insulated piping and buried or exposed pressure piping.
   3. Hydrostatic pressure testing:
      a. All joints, including welds, are to be left exposed for examination during the test.
      b. Provide temporary restraints for expansion joints for additional pressure load under test. Equipment in piping system with rated pressure lower than pipe test pressure shall be isolated by valves or blind flanges.
      c. Do not paint or insulate exposed piping until successful performance of pressure test.
      d. Test soil, waste and drain piping at completion of installation of each stack or section of piping by filling system with water to highest point and checking joints and fittings for leaks. Leaks must be eliminated before proceeding with work or concealing piping. Minimum test heights shall be 10 ft.

3.07 PIPING SCHEDULE

A. See Drawings.

END OF SECTION

SECTION 15062

DUCTILE IRON PIPING

PART 1 - GENERAL

1.01 SUMMARY

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

1.02 REFERENCES

A. American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME):
   1. B 16.1 - Grey Iron Pipe Flanges and Flanged Fittings - Classes 25, 125, and 250.

B. American Society for Testing and Materials (ASTM):
   1. A 47 - Standard Specification for Ferritic Malleable Iron Castings.
   2. A 183 - Standard Specification for Carbon Steel Track Bolts and Nuts.
   3. A 536 - Standard Specification for Ductile Iron Castings.
   4. A 674 - Standard Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids.
   5. D 792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
   6. D 4976 - Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.

C. American Water Works Association (AWWA):
   1. C 104 - Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
   2. C 105 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
   3. C 110 - Ductile-Iron and Gray-Iron Fittings.
   4. C 111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   5. C 115 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
   6. C 150 - Thickness Design of Ductile-Iron Pipe.
   7. C 151 - Ductile-Iron Pipe, Centrifugally Cast.
   8. C 600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
   9. C 900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. Through 60 in.

D. National Sanitation Foundation (NSF) 61 - Drinking Water Components - Health Effects.

E. Build America, Buy America (BABA Requirements – comply with requirements of Build America, Buy America l Act (2 CFR Part 184).

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.

D. Submit manufacturer certifications demonstrating compliance with Build America, Buy America (BABA) requirements for all applicable materials prior to approval.

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.

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 approved equal.
4. Gaskets for Flanged Ductile Iron:
   a. Suitable for pressures equal to and less than 150 psi, temperatures equal to and less than 100 degrees Fahrenheit.
   b. Neoprene with minimum durometer hardness value of 70 when tested in accordance with ASTM D 2240, Type A; minimum 3/32 inch thick for less than 10 inch pipe; minimum 1/8 inch thick for 10 inch and larger pipe. Provide gaskets with inserted 13 ounce nylon fabric cloth for pipes 20 inch or larger.
   c. Manufacturers: One of the following or equal:
      1) Garlock, Style 8798.
      2) John Crane.
      3) Or 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.

# PART 3 - EXECUTION

## 3.01 INSTALLATION

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

B. Special Techniques:

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

3.02 JOINTS

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

3.03 FIELD QUALITY CONTROL

A. Clean and test ductile iron piping as specified in Section 15050.

END OF SECTION

SECTION 15110

VALVES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Basic requirement for valves:
   1. Requirements indicated on the Drawings and specified elsewhere in these Specifications take precedence over the requirements specified under this Section.
   2. Furnish and install valves required for proper piping and equipment operation and maintenance, in addition to the valves indicated on the Drawings, and specified.

B. Build America, Buy America (BABA Requirements – comply with requirements of Build America, Buy America l Act (2 CFR Part 184).

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. A126 - Standard Specification for Gray Icon Casting for Valves, Flanges, and Pipe Fittings.
   2. A48 - Standard Specification for Gray Iron Castings.
   3. A536 - Standard Specification for Ductile Iron Castings.

B. American Water Works Association (AWWA):
   1. C111 - Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
   2. C504 - Rubber Seated Butterfly Valves, 3 In. Through 72 In.
   3. C508 - Swing Check Valves for Waterworks Service, 2-In. through 24-In. NPS.
   4. C110 - Ductile-Iron and Grey-Iron Fittings.
   5. C207 - Steel Pipe Flanges for Waterworks Service, Sizes 4 In. Through 144 In.

C. Steel Structures Painting Council (SSPC):
   1. SP-2 - Hand Tool Cleaning.
   2. SP-10 - Near-White Blast Cleaning.

D. American National Standards Institute (ANSI):
   1. B1.20.1 - Pipe Threads, General Purpose.

E. NSF 61 - Drinking Water System Components - Health Effects.

1.03 DESIGN REQUIREMENTS

A. Pressure Rating: As per drawings.

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. Per specifications section 01340.

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 approved 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 approved equal.
b. High Solids Polyamine Cured Epoxy:
1) Manufacturers: One of the following or approved equal:
a) Tnemec: Series 140N Pota Pox
b) Ameron: Amercoat 395
c) Carboline: Carboguard 891
d) Devoe: Bar Rust 223H
e) Or approved equal
3. Clean surfaces to meet SSPC-SP-10, near-white metal blast cleaning, with grit of size recommended by epoxy manufacturer.

4. Apply in accordance with manufacturer's published instructions:
    a. High Solids Polyamine Cured Epoxy:
        1) Not less than 2 coats to the specified thickness.
5. Coating Thickness: 12 mils except that:
    a. Coating thickness in grooves for gaskets: 5 mils.
    b. Do not coat seat grooves in valves with bonded seat.
6. Quality Control:
    a. Coating Thickness: Measured with a nondestructive magnetic type thickness gauge.
    b. Verify coating integrity with a holiday detector set at 1,800 volts.
    c. Consider tests successful when coating thickness meets specified requirements and when no pin holes are found:
        1) Correct defective coating disclosed by unsuccessful tests, and repeat test.
        2) Repair pinholes in accordance with manufacturer's published recommendations.

D. Underground Valves:
1. Provide underground valves with flanged, mechanical, or other type of joint required for the type of pipe to which the valve is to be connected.
2. Coating and Wrapping:
    a. Paint buried valves with 3 coats of asphalt varnish in accordance with AWWA C 504:
        1) Protect coating from damage during handling and installation; repair coating where damaged.
    b. After installation, wrap valves in polyethylene as specified for ductile iron piping in Section 15062:
        1) Ascertain that polyethylene wrapping does not affect operation of valve.

E. Valve Operators:
1. Open counterclockwise.
2. Provide valves located below operating level or deck with extensions for key operation or floor stands and handwheels.
3. Provide manually operated valves and gates located not more than 6 feet above the operating level with levers, tee handles, wrenches, or handwheels, as shown on Drawings.
    a. Make the valve operator more conveniently accessible by rolling valves, located more than 5 feet but less than 6 feet above the operating level, toward the operating side.
    b. Secure tee handles and wrenches to the valve head or stem, except where a handle or wrench so secured constitutes a hazard to personnel; in which case, stow handle or wrench immediately adjacent to the valve on or in a suitable hanger, bracket, or receptacle.
4. Fit valves located more than 6 feet above operating level with chain operated handles or valve wheels:
    a. Chains: Sufficient length to reach approximately 4 feet above the operating level.
    b. Where chains constitute a nuisance or hazard to operating personnel, provide hold-backs or other means for keeping the chains out of the way.

F. Air Release Valve:
   1. Manufacturer: Vent-O-Mat, Series RBXb, APCO, or approved equal.
   2. Orifice: 5/16".
   3. Size: See Drawings.
   4. Body: stainless steel.
   5. Float: HDPE.
   6. Seat: Buna-N (soft seat).
   7. Float Guide: stainless steel.
   8. O Ring Seat: EPDM rubber.
   9. Other internal parts: stainless steel.
   10. Pressure rating: 150 psi.
   11. Provide isolation valve upstream of air release valve.

G. Valves equal to and larger than 6-inches and/or throttling service valves shall include handcrank and wormgear actuators. Valves located 60-inches or higher above finished floor level shall include chainwheel actuators. Chains shall hang down within 36-inches of the finished floor level.

## 2.02 FABRICATION

A. Valves:
   1. End connections:
      a. Provide end connections for valves as required in Piping Schedule.
      b. Assure end connections meet the following standards:
         1) Threaded: ANSI B1.20.1
         2) Flanged: AWWA C207.
         3) Bell and spigot or mechanical (gland) type: AWWA C111.

# PART 3 - EXECUTION

## 3.01 PREPARATION

A. Once flanged valves and flanged check valves are selected, determine face-to-face dimensions of valves.

B. Fabricate piping to lengths taking into account the dimensions of flanged valves and flanged check valves.

## 3.02 INSTALLATION

A. Prior to installation, valves that will be electrically actuated shall have actuators mounted and tested by the valve manufacturer. Actuators will be shipped by the actuator manufacturer to the valve manufacturer for mounting and testing.

B. Provide incidental work and materials necessary for installation of valves including flange gaskets, flange bolts and nuts, valve boxes and covers, concrete bases, blocking, and protective coating.

C. Where needed, furnish and install additional valves for proper operation and maintenance of equipment and plant facilities under the following circumstances:
   1. Where such additional valves are required for operation and maintenance of the particular equipment furnished by CONTRACTOR.
   2. Where such additional valves are required as a result of a substitution or change initiated by CONTRACTOR.
   3. Install valves with their stems in vertical position above the pipe, except as follows:
      a. Butterfly valves, gate valves aboveground, globe valves, and angle valves may be installed with their stems in the horizontal position.

D. Install valves so that 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.

B. Build America, Buy America (BABA Requirements – comply with requirements of Build America, Buy America l Act (2 CFR Part 184).

1.02 REFERENCES

A. American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME):
   1. B16.5 – Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch.

B. American Petroleum Institute (API).

C. American Society for Testing and Materials (ASTM):
   1. A 351 – Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.

D. American Water Works Association (AWWA):
   1. C 507 – Ball Valves, 6 In. Through 60 In.

E. National Sanitation Foundation (NSF) 61 - Drinking Water Components - Health Effects.

1.03 SYSTEM DESCRIPTION

A. General: Unless otherwise indicated on the Drawings use:
   1. Plastic body ball valves on plastic pipelines.
   2. Where valves are connected to electric actuators, the valve and actuator assembly shall be supplied by the same Supplier/Manufacturer.

1.04 SUBMITTALS

A. Product Data: Submit detailed technical information relating to the ball valves including description of component parts, materials of construction, performance, dimensions, and weights. Per specifications section 01340.

PART 2 - PRODUCTS

2.01 BALL VALVE TYPES

A. Full Port Ductile Iron (DI) Ball Valves:
   1. Manufacturers: One of the following or approved equal.
      a. Conbraco.
      b. Dezurik.

B. Plastic Ball Valves:
   1. Manufacturers: One of the following or approved equal.
      a. Asahi America, Type 21.
      b. Spears.
      c. Hayward

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.

D. Build America, Buy America (BABA Requirements – comply with requirements of Build America, Buy America l Act (2 CFR Part 184).

1.02 REFERENCES

A. American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME):
1. ANSI/ASME B16.1 – Gray Iron Pipe Flanges and Flanged Fittings, Classes 25, 125 and 250.
2. ANSI/ASME B16.5 – Pipe Flanges and Flanged Fittings, NPS ½ through NPS 24 Metric/Inch Standard.

B. American Society for Testing and Materials (ASTM):
1. A 126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
2. D 429 - Standard Test Methods for Rubber Property - Adhesion to Rigid Substrates.

C. American Water Works Association (AWWA):
1. C 110 – Ductile-Iron and Gray-Iron Fittings.
2. C 504 – Rubber-Seated Butterfly Valves.

D. National Sanitation Foundation (NSF) 61 - Drinking Water Components - Health Effects.

1.03 SYSTEM DESCRIPTION

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

b. Class: AWWA Class 150B, when not otherwise specified or indicated 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.
3. Electric Actuated Butterfly Valves:
   a. Tight shut off at the AWWA rated class with flow in either direction.
   b. Shall use power to close and open the valve.
   c. Motor controlling the valve shall turn in opposite direction to reverse the valve position.
   d. This electrically actuated valve can operate in manual or automatic mode, selected via a hand switch on the RTU door.
      - In manual mode, the valve is operated using pushbuttons on the RTU door.
      - In automatic mode, the valve is controlled by the PLC

## 1.04 SUBMITTALS

A. Shop Drawings: Include certified drawings and material specifications in accordance with AWWA C504, Sections 1.4 and 1.5.
1. Include description of the method of attachment of the edge to the valve disc.
2. Provide size and dimensions of operator/actuators.

B. Product Data: Include manufacturer's published recommendations for seating and

unseating torque coefficient, dynamic torque, and bearing friction for calculation of maximum operating torque.

C. Provide valve tags for the butterfly valves included in the shop drawing.

D. Test Reports: Records of tests performed in accordance with AWWA C504.

E. Certificates: Affidavit of compliance specified in AWWA C504, Section 1.7.

PART 2 - PRODUCTS

2.01 GENERAL PURPOSE BUTTERFLY VALVES

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

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

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

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

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

F. Seats:
   1. For valves less than 24 inches Nominal size, bond or vulcanize seats into the valve body.
   2. For valves 24 inches Nominal size and larger, mechanically retain seats in the valve body:
      a. Achieve retaining effect by an epoxy injection method that expands the seat into the body, or by segmented clamping tee lock ring with adjusting screws.
      b. Provide means to prevent nuts and screws used to retain rubber seats from loosening due to vibration or cavitation.
      c. Seat Retainers: Type 316 stainless steel.
   3. Do not provide 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 water tightness.

D. Manual Operators on Aboveground Butterfly Valves Larger than 8 Inches in Nominal Size: Worm geared; valves 10 inches in nominal size and smaller on low pressure air service may be lever operated.

E. Fit exposed butterfly valves not specified to have geared operators with ell or tee wrenches, or speed handles for operation.

F. Where handwheels are specified in Valve Schedule in Drawings, provide speed crank.

G. Motorized operation valves shall be operated in both automatic and manual modes.
- In manual mode, the valve is operated using pushbuttons on the RTU door.
- In automatic mode, the valve is controlled by the PLC

## 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 equal:
      1) Houghton, Rust Veto 344.
      2) Rust-Oleum, R-9.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install valves with valve shafts horizontal, unless a vertical shaft is required to suit a particular installation, and unless a vertical shaft is indicated on the Drawings.

B. Install pipe spools or valve spacers in locations where butterfly valve disc travel may be impaired by adjacent pipe lining, pipe fittings, valves, or other equipment.

3.02 SCHEDULE

A. See Drawings.

END OF SECTION

SECTION 15114

CHECK VALVES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Silent check valves.

B. Build America, Buy America (BABA Requirements – comply with requirements of Build America, Buy America l Act (2 CFR Part 184).

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM):
1. A 48 – Standard Specification for Gray Iron Castings.
2. A 126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
3. A 276 – Standard Specification for Stainless Steel Bars and Shapes.
4. B 582 – Standard Specification for Nickel-Chromium-Iron-Molybdenum-Copper Alloy Plate, Sheet and Strip.
5. B 584 – Standard for Copper Alloy Sand Castings for General Applications.

B. American Water Works Association (AWWA):
1. C 508 – Swing-Check Valves for Waterworks Service, 2 - 48 Inch NPS.

C. American Petroleum Institute (API).

D. National Sanitation Foundation (NSF) 61 - Drinking Water Components - Health Effects.

1.03 SYSTEM DESCRIPTION

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

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. Per specifications section 01340.

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

PART 3 - EXECUTION

3.01 INSTALLATION

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

3.02 ADJUSTING

A. Adjust cushioned check valves in the field by means of external adjustment devices to minimize pressure surges.

B. Adjust weight on check valves to affect proper closing action on equipment shutdown.

END OF SECTION

SECTION 15115

GATE VALVES AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals required to furnish and install all gate valves and appurtenances complete and operational as shown on the Drawings and as specified.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate with the Work which is related to this Section.

C. Related Sections: CONTRACTOR shall coordinate the requirements of the Work in this Section along with the requirements of the Sections listed below which includes, but is not necessarily limited to:
   1. Division 1 - General Requirements
   2. Section 09800 - Special Coatings.
   3. Section 01340 - Submittals.

D. See Drawings.

E. Build America, Buy America (BABA Requirements – comply with requirements of Build America, Buy America l Act (2 CFR Part 184).

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. Submit manufacturer's certification stating that materials comply with Build America, Buy America (BABA) (2 CFR Part 184).

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 or approved equal:
      1) Mueller Company.
      2) American Flow Control, American-Darling, Series 2500.

3) VSI
4) M&H
5) Clow.

2.02 APPURTENANCES FOR BURIED VALVES

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

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

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

2.03 TOOLS AND SPARE PARTS

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

2.04 SURFACE PREPARATION AND PAINTING

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

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

C. All gears, bearing surfaces, machined surfaces and other surfaces which are to remain

unpainted shall receive a heavy application of grease or other rust-resistant coating. This coating shall be maintained during storage and until the equipment is placed into operation.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. Install all valves and appurtenances in accordance with the manufacturer's instructions and recommendations, and MAG Standard Specification 610.7 and Avondale Supplemental MAG Detail A1310.

B. Conform to appendices of AWWA Standards, where applicable.

C. For buried valve installations, set valve boxes plumb and centered, with soil carefully tamped to a lateral distance of four feet on all sides of the box, or to the undisturbed trench face if less than four feet.

### 3.02 FIELD TESTS AND ADJUSTMENTS

A. Adjust all parts and components as required to provide correct operation of the valves.

B. Conduct a functional field test on each valve in the presence of the ENGINEER to demonstrate that each valve operates correctly.

C. Test ten percent valves of each type by applying 200 pounds effort on the manual operators. There shall be no damage to the gear actuator or the valve.

### 3.03 MANUFACTURER'S SERVICE

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

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

END OF SECTION

SECTION 15141

MECHANICAL - PROCESS PIPE SUPPORTS

## PART 1 - GENERAL

### 1.01 SUMMARY

A. Section Includes: Supports for pipe, fittings, valves, and appurtenances.

B. Build America, Buy America (BABA Requirements – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

### 1.02 REFERENCES

A. American National Standard Institute or Manufacturer's Standardization Society (ANSI/MSS):
   1. SP 58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application and Installation.
   2. SP 69 - Pipe Hangers and Supports - Selection and Applications.

### 1.03 SUBMITTALS

A. Shop Drawings: Include schedule, indicating where supports will be installed, and drawings of pipe support system components per Section 01340.

## 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 POTABLE 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 a temporary holding tank (as needed) supplied by the Contractor, to be disposed at an off-site location with appropriate permits or approvals.

3.06 MICROBIOLOGICAL TEST

A. Advise OWNER to take water samples no sooner than 24 hours after flushing system.

B. At the end of 24 hours and before the water main is placed in service, collect microbiological samples in accordance with the submitted disinfection test plan at each piping run.

C. When microbiological test proves water quality to be unacceptable, repeat disinfection treatment.

END OF SECTION

# 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. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

C. Related Sections

| | | |
|---|---|---|
| 1. | Division 1 | General Requirements |
| 2. | Division 2 | Site Construction |
| 3. | Division 3 | Concrete |
| 4. | Division 5 | Metals |
| 5. | Division 9 | Finishes |
| 6. | Division 11 | Equipment |
| 7. | Division 13 | Special Construction |
| 8. | Division 15 | Mechanical |
| 9. | Division 17 | Instrumentation |

1.02 DEFINITIONS

A. The term “Provide” means “Furnish and Install”.

1.03 SYSTEM DESCRIPTION

A. Design Requirements
   1. If any contradictions, contrasts, or inconsistency appears, the most strict criteria noted and the collective requirements in any and all of the project documents shall apply.

1.04 SUBMITTALS

A. Intent
   1. Organize work so that a complete electrical, instrumentation, and control system for the facility will be provided and will be supported by accurate shop drawings, record drawings, and O&M manuals.

2. Submit detailed shop drawings and data prepared and organized by the suppliers. Provide quantity of submittal sets in accordance with the requirements of Division 1.
3. Submittals shall be neatly grouped and organized by specification section number, and sub-section. Related information shall be highlighted, and the specific product shall be marked. All submittals shall be complete, and presented in one package. Incomplete submittals will be returned without review. If a portion of the project requires a fast track schedule, that portion only may be submitted earlier under a separate cover letter.
4. Work performed or equipment provided without engineer approved submittals is done at contractor's risk. Cost to re-work or re-supply will be born solely by the contractor.

B. Product Data
1. A complete list of the equipment and materials, including the manufacturer's name, product specification, descriptive data, technical literature, performance charts, catalog cuts, installation instructions, and spare part recommendations for each different item of the equipment specified. The above shall clearly show all the specified requirements as described in the Specifications including but not limited to specific UL and NEMA rating, technical capabilities, test result verifications, and acceptance letters.
2. Submittals not in compliance with the specifications must include the following information:
   a. Reason for non-compliance or variance
   b. Calculations and drawings for redesign of related components including detail drawings showing internal and assembly details, with installation instructions.
   c. Proposed layout showing any modifications or exceptions to related work made necessary by this work, with calculations and drawings showing such modifications or exceptions.

C. Shop Drawings
1. Drawings containing complete wiring and schematic diagrams, control diagrams, and any other details required to demonstrate that the system has been coordinated and will operate as intended. Drawings shall show proposed layout, anchoring, support, and appurtenances of equipment, and equipment relationship to other parts of the work including clearances for maintenance and operations.

D. Utility Coordination
1. Submit copies of service entrance shop drawings to the utility, per utility submittal requirements, prior to submittal to the Engineer. Obtain written approval from the power utility company that the service entrance equipment is acceptable prior to release the order to the supplier for

fabrication. Provide a copy of the approval letter from the utility with the submittal.

E. Closeout Submittals

1. Provide "Record Drawings" of the electrical, control, and instrumentation work to include:
   a. Step-by-step procedure manuals for the installation, operation start-up, and maintenance of the equipment.
   b. Installation, operating, troubleshooting, and maintenance and overhaul instructions in complete detail.
   c. Possible breakdowns and repairs, and troubleshooting guides, as well as simplified wiring and control diagrams of the system installed. This shall provide the Owner with comprehensive information on all systems and components to enable operation, service, maintenance and repair.
   d. Exploded or other detailed views of all equipment, devices, assemblies, and accessory components shall be included, together with complete parts lists and ordering instructions.
2. Provide an "As Built" set of Plans to Owner. Maintain at all times a marked up set of Plans showing the following information:
   a. Actual installed circuit numbers, conduit sizes, cable tray routing, number of conductors, conductor sizes larger than #12 AWG, and all other deviations from the design Plans.
   b. Underground conduit, duct banks, and concealed items dimensioned on the Plans from permanent, visible, building features.
   c. Actual motor size, starter size, and overload heater size, along with all other protective equipment for all 480 V and 4160 V motor circuits.
   d. Conductor identification and panel schedules.

## 1.05 QUALITY ASSURANCE

A. Regulatory Requirements

1. Electrical work, including connection to electrical equipment integral with mechanical equipment, shall be performed in accordance with the latest published regulations, codes, and standards, of the following:
   a. National Electrical Code (NEC)
   b. State and local codes
   c. Institute of Electrical and Electronic Engineers (IEEE)
   d. American National Standards Institute (ANSI)
   e. American Society for Testing and Materials (ASTM)
   f. Insulated Cable Engineers Association (ICEA)
   g. National Electrical Manufacturers Association (NEMA) Standards
   h. Federal Occupational Safety and Health Act (OSHA)
   i. National Fire Protection Association (NFPA)
   j. National Electrical Testing Association (NETA)

1.06 DELIVERY, STORAGE, AND HANDLING

A. Electrical panels, switchgear, motor control centers, and other electrical equipment, shall be shipped in sealed dust and moisture proof plastic sheet enclosures, and the seal maintained until units are installed. Said units shall be new and free of any dirt, dust, water, grease, rust, damaged parts or components.

1.07 PROJECT/SITE CONDITIONS

A. Verify site conditions before bidding or performing work.

1.08 SCHEDULING

A. Maintain a work schedule showing work to be performed, sequence of work, major milestones, and manpower loading. Coordinate schedule requirements with other trades. Provide adequate staff to perform the work in the time required by the schedule.

1.09 SYSTEM STARTUP

A. After installation and testing of all electrical and instrumentation equipment and systems, energize all equipment and leave ready for continuous operation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers and model numbers shown on Plans or listed in the specifications are intended to establish a minimum standard of quality and acceptability.

2.02 MATERIALS

A. Materials, equipment, and parts comprising any unit, or part thereof, specified or indicated on the Plans, shall be new and unused, of current manufacture, and of highest grade consistent with the state of the art. Damaged materials, equipment, and parts, are not considered to be new and unused, and will not be accepted.

2.03 MANUFACTURED UNITS

A. The fabricator of major components and manufactured units, such as distribution panel boards, switchgear, and motor control centers, shall also be the manufacturer of the major devices therein.

B. Electrical equipment provided with mechanical equipment assemblies shall be in

compliance with this specification.

2.04 EQUIPMENT

A. Minimum sizes of equipment, and electrical devices, are indicated but it is not intended to show every offset and fitting, nor every structural or mechanical difficulty that will be encountered during the installation of the work.

B. Electrical equipment shall be capable of operating successfully at full rated load, without failure, at listed site altitude and at highest anticipated ambient temperature in which equipment will be expected to operate. Provide air conditioning to meet the manufacturers' operating temperature for electrical equipment not rated for operation at that temperature.

C. When applicable, the material used in the performance of the electrical work shall be listed by the Underwriters' Laboratories, Inc. (UL) for the class of service for which they are intended.

D. Provide nameplates where indicated elsewhere in these specifications or on the Plans. Nameplates shall be black laminate with white letters and fastened to the various devices with round head stainless steel screws. Provide nameplates for each disconnecting means for service, feeder, branch, or equipment conductors, indicating its purpose.

2.05 FABRICATION

A. Shop Assembly
   1. Equipment assemblies, such as Service Entrance Sections, Switchgear, Switchboards, Control and Distribution Panels, and other custom fabricated electrical enclosures shall bear a UL label as a complete assembly. The UL label on the individual components making up the assembly will not be considered sufficient to meet the present requirement. Whenever a generic UL label does not apply for the assembly, a serialized UL label shall be affixed to the assembly, and the serial number shall be submitted with the assembly record shop drawings.
   2. Custom fabricated electrical control panels, and enclosures, shall be built by a certified UL508A shop and shall bear a serialized and recorded UL label.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Site Verification of Conditions
   1. Verify site conditions before bidding or performing work.

3.02 INSTALLATION

A. Coordinate work with other trades and with certified vendor shop drawing submittals.

B. Provide equipment in accordance with the manufacturers' requirements.

C. Identify each conductor as required by the Contract Documents.

D. Equipment Access:
   1. Install equipment so it is readily accessible for operation and maintenance.
   2. Equipment shall not be blocked or concealed.
   3. Do not install electrical equipment such that it interferes with normal maintenance requirements of other equipment.

E. Equipment shall be installed plumb, square and true with the building construction, and shall be securely fastened.

F. Outdoor wall-mounted equipment, and indoor equipment mounted on earth, or water bearing walls, shall be provided with corrosion-resistant spacers to maintain ¼-inch separation between the equipment and the wall.

G. Arrange for the building in of equipment during structure construction. Where equipment cannot be built-in during construction, arrange for sleeves, box-outs, and other openings, as required to allow installation of equipment after structure construction is complete.

H. Verify that equipment will fit support layouts indicated.

I. Screen or seal all openings into outdoor equipment to prevent the entrance of rodents and insects.

J. Equipment fabricated from aluminum shall not be imbedded in earth or concrete.

K. Provide all necessary anchoring devices and supports.
   1. Use supports as detailed on the Plans and as specified.
   2. Supports and anchoring devices shall be rated and sized based on dimensions and weights verified from approved equipment submittals.
   3. Hardware shall be stainless steel.
   4. Do not cut, or weld to, building structural members.
   5. Do not mount safety switches and external equipment to other equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.

L. Verify exact rough-in location and dimensions for connection to electrical items

furnished by others.

1. Obtain shop drawings from those furnishing the equipment.
2. Proceeding without proper information may require the Contractor to remove and replace work that does not meet the conditions imposed by the equipment supplied.
3. Provide sleeves wherever openings are required through new concrete or masonry members. Place sleeves accurately and coordinate locations with the Engineer.
4. Do not endanger the stability of any structural member by cutting, digging, chasing, or drilling and shall not, at any time, cut or alter the work without the Engineer's written consent.
    a. Provide additional reinforcing if required.
    b. Use proper tools and methods to cut, core drill, or make other penetrations.
    c. Restore walls, ceilings, or floors to their original condition.

M. Provide concrete foundations or pads required for electrical equipment as indicated or specified.

    a. Provide a 4-inch concrete housekeeping pad for floor mounted electrical equipment. Pour on top of the finished floor or slab. Drill existing slab and epoxy rebar to anchor housekeeping pad in place.

N. Do not use equipment that exceeds the indicated dimensions except as approved in writing by the Engineer.

O. Do not use equipment or arrangements of equipment that reduce required clearances or exceed the space allocation.

P. Work indicated on the Plans is approximately to scale, but actual dimensions and detailed Plans should be followed as closely as field conditions permit. Field verification of scale dimensions on Plans is governed by field conditions. Installation of systems and equipment is subject to clarification as indicated in reviewed shop drawings and field coordination.

Q. Discrepancies indicated on different Plans, between Plans and actual field conditions, or between Plans and Contract Documents shall be promptly brought to the attention of the Engineer for clarification, prior to purchasing and installing equipment.

R. Adjust the alignment of equipment and conduit to accommodate architectural changes or to avoid work of other trades.

S. Provide parts and pieces necessary to the installation of equipment, in accordance with the best practice of the trade, and in conformance with the requirements of these Contract Documents.

T. Items not specifically mentioned in these Contract Documents, or noted on the Plans, or indicated on reviewed shop drawings, but which are obviously necessary to make a complete working installation, shall be deemed to be included herein.

U. Lay out and install electrical work prior to placing floors and walls. Provide sleeves and openings through floors and walls, required for installation of conduits. Sleeves shall be rigidly supported and suitably packed, or sealed, to prevent ingress of wet concrete. Spacers shall be installed in order to prevent conduit movement. Dimensions indicated for electrical equipment and their installation are restrictive dimensions.

V. Provide inserts and hangers required to support conduits and other electrical equipment. Coordinate inserts and hangers with other trades. Replace inserts, hangers, sleeves, or other mounting hardware which are improperly placed.

W. Perform necessary saw cutting, core drilling, excavating, removal, shoring, backfilling, and other work required for the proper installation of conduits, whether inside, or outside of the buildings and structures. Use core drills to make circular holes.

X. ELECTRICAL UTILITY

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

Y. TELEPHONE SERVICE

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

Z. TEMPORARY POWER

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

AA. CORROSION PROTECTION

1. Wherever dissimilar metals, except conduit and conduit fittings, come in contact, the Contractor shall isolate these metals, as required, with neoprene washers, 9 mil polyethylene tape, or gaskets. Where fastening conduit, electro plated, or equivalent fasteners and stainless steel bolts shall be used.

## 3.03 REPAIR/RESTORATION

A. Repair damage caused by construction or demolition work to restore damaged areas to original condition.

B. Factory finishes damaged during shipping, or construction, shall be restored to original new condition. Rust shall be removed, and bare metal surfaces shall be primed and painted to match the original surrounding finish.

## 3.04 FIELD QUALITY CONTROL

A. Site Tests

1. The electrical work shall be free from improper grounds and from short circuits. Visually compare the conductor connections with connection diagrams. Perform individual circuit continuity checks using electrical circuit testers. Demonstrate proper operation of the energized electrical and mechanical devices. Correct any wiring deficiencies.

## 3.05 COORDINATION STUDY

A. A coordination study shall be provided for power distribution system protective devices unless specified otherwise elsewhere in contract documents. Provide the Power System Coordination Study after the electrical equipment submittals have been reviewed and approved. The Coordination Study to be performed using ETAP, SKM or other approved power system analysis software.

B. The final deliverable shall be a certified report summarizing the coordination study.

C. As a minimum, the coordination study for the power distribution system shall include the following:
   1. Time-current curves for each protective relay or fuse showing graphically that the settings will provide protection and selectivity within industry standards. Each curve shall be identified, and the protective device settings shall be specified.
   2. Time-current curves for each device shall be positioned to provide maximum selectivity to minimize system disturbances during fault clearing. Where selectivity cannot be achieved, the ENGINEER shall be notified as to the cause.
   3. Time-current curves and points for cable and equipment damage.
   4. Circuit interrupting device operating and interrupting times.
   5. Indicate maximum fault values on the graph.
   6. Sketch of bus and breaker arrangement.

D. Contractor to field-adjust and set trip settings associated with protective devices per coordination study results.

E. Coordination Study to comply with the provisions and recommendations of IEEE 242-2001, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.

## 3.06 ADJUSTING

A. Calibrate and set all adjustable electrical equipment including circuit breakers, motor circuit protectors, overload relays. Align photo cells and lights to achieve desired effects.

## 3.07 CLEANING

A. Relays, starters, circuit breakers, switches, contacts, insulators, mechanisms, and buses shall be free of dust, dirt, oil, moisture, metal shavings, and other debris before testing and energizing equipment. Vacuum and wipe down inside and outside of electrical enclosures and control panels.

## 3.08 PROTECTION

A. Once equipment is installed, it shall be protected at all times with plastic sheet covers until the area is free of dirt, dust, paint spray, water, and other trades. Provide heat to eliminate condensation.

END OF SECTION

SECTION 16010

ELECTRICAL: BASIC REQUIREMENTS

## PART 1 - GENERAL

### 1.01 SUMMARY

A. Section Includes:
   1. Basic requirements for electrical work.

B. Install and wire all equipment, including prepurchased equipment, and perform all tests necessary to assure conformance to the Drawings and Specifications and ensure that equipment is ready and safe before energizing.

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

F. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

### 1.02 AREA CLASSIFICATIONS

A. Outdoor locations may contain corrosive and hazardous areas:
   1. Corrosive and hazardous areas are identified on the Drawings.
      a. Areas not identified as such shall be considered wet.

B. Indoor locations may contain damp, wet corrosive and hazardous areas:
   1. Damp, wet, corrosive and hazardous areas are identified on the Drawings.
      a. Areas not identified as such shall be considered unclassified.

### 1.03 DEFINITIONS

A. Outdoor Areas:
   1. Those locations on the Project site where the equipment is normally exposed to wind, dust, rain, snow, etc.

B. Indoor Areas:
   1. Those locations on the Project site where the equipment is normally protected from wind, dust, rain, snow, etc.

C. Shop Fabricated:
   1. Manufactured or assembled equipment for which a UL test procedure has not been established.

1.04 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Iron and Steel Institute (AISI):
      a. Steel Products Manual Stainless and Heat Resisting Steel.
   2. American National Standards Institute (ANSI):
      a. C2, National Electrical Safety Code.
   3. American Society for Testing and Materials (ASTM):
      a. A36, Specification for Structural Steel.
      b. A153, Zinc Coating (Hot Dip) on Iron and Steel Hardware.
   4. Factory Mutual System (FM):
      a. A Guide to Equipment, Materials and Services.
   5. Institute of Electrical and Electronics Engineers (IEEE):
      a. 141, Recommended Practice for Electrical Power Distribution for Industrial Plants.
      b. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
   6. National Electrical Manufacturers Association (NEMA):
      a. ICS 6, Enclosures for Industrial Controls and Systems.
   7. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   8. Underwriters Laboratories, Inc (UL):
      a. 508, Safety Industrial Control Equipment.
      b. 698, Industrial Control Equipment for Use in Hazardous Locations.

B. When a specific code or standard has not been cited, the applicable codes and standards of the following code making authorities and standards organizations shall apply:
   1. American Association of State Highway and Transportation Officials (AASHTO).
   2. American Iron and Steel Institute (AISI).
   3. American National Standard Institute (ANSI).
   4. American Society for Testing and Materials (ASTM).
   5. ETL Testing Laboratories, Inc (ETL).

6. Insulated Cable Engineers Association (ICEA).
7. Institute of Electrical and Electronic Engineers (IEEE).
8. Illuminating Engineering Society of North America (IES).
9. Instrument Society of America (ISA).
10. Lightning Protection Institute (LPI).
11. National Electrical Manufacturers Association (NEMA).
12. National Fire Protection Association (NFPA).
13. Occupational, Health and Safety Administration (OSHA).
14. Underwriters Laboratories Inc (UL).

C. In case of conflict or disagreement between codes, standards, laws, ordinances, rules, regulations, drawings and specifications, or within either document itself, the more stringent condition shall govern.

1.05 SYSTEM DESCRIPTION

A. Provide functional systems in compliance with manufacturer's instructions, performance requirements specified or shown on the Drawings, and modifications resulting from reviewed shop drawings and field coordinated drawings.

1.06 SUBMITTALS

A. Shop Drawings:
1. See Contract Documents for other requirements.
2. Submit shop drawings prior to purchase or fabrication of equipment. See individual Division 16 sections for specific requirements.
3. Prior to submittals of shop drawings, coordinate electrical equipment, particularly motor control equipment, control panels, and instrumentation, with all applicable equipment and systems interfacing with that equipment.
4. For each product, clearly identify manufacturer by name.
5. Provide manufacturer's technical information on products to be used, including:
   a. Product descriptive bulletin.
   b. Electrical data pertinent to the Project and necessary to assure compliance with Specifications and Drawings.
   c. Equipment dimensions, where applicable.
   d. Evidence that the products submitted meet the requirements of the standards referenced.
6. When general data sheets are provided as part of the submittal, specifically identify the products to be used on this Project.
7. Ensure that all submittals clearly indicate the equipment is UL or ETL listed or is constructed utilizing UL or ETL listed or UL recognized components. Where an UL standard has not been established clearly identify that no UL standard exists for that equipment.
8. For all equipment, provide manufacturer's installation instructions.

B. Operation and Maintenance Manuals:
   1. See Contract Documents for requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

A. See Section 01600.

B. Ensure that equipment is not used as steps, ladders, scaffolds, platforms, or for storage either inside or on top of enclosures.

C. Protect nameplates on electrical equipment to prevent defacing.

D. Repair, restore or replace damaged, corroded and rejected items at no additional cost to the Owner.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Refer to related Division 16 sections.
   1. All equipment of a similar type shall be by one manufacturer unless otherwise noted in the Specifications.

2.02 MATERIALS

A. Trade names and catalog numbers may be used in the Drawings or Specifications to establish quality standards and basics of design.
   1. Other listed manufacturers in the applicable specification sections with equal equipment may be acceptable.
   2. If no other manufacturer is listed, then manufacturers of equal equipment may be acceptable.

B. Listed:
   1. Where UL test procedures have been established for the product type, electrical equipment shall be approved by UL or ETL and shall be provided with the UL or ETL label.

C. Structural Steel Supports:
   1. Galvanized steel: ASTM A36.
      a. PVC coated in Class I and in corrosive areas.
   2. Stainless steel: AISI Type 316.

2.03 FABRICATION

A. When equipment is shop fabricated for the Project, the electrical devices and

enclosures utilized shall be UL or ETL listed and labeled or shall be UL recognized.

B. Shop or Factory Finishes:
   1. Interiors of other painted equipment shall be either white or light gray.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment shall be installed in accordance with the requirements of the NEC.

B. Enclosures for Use with Electrical Equipment:
   1. NEMA 12: Use in unclassified indoor locations.
   2. NEMA 3R: Use with HVAC equipment in wet outdoor locations.
   3. NEMA 4:
      a. Use in wet indoor locations.
      b. Use in wet outdoor locations except with HVAC equipment.
   4. NEMA 4X: Use in all corrosive locations.
   5. Exceptions:
      a. As modified in other Division 16 sections.
      b. As otherwise indicated on the Drawings.
   6. Standards:
      a. NEMA ICS 6, Enclosures for Industrial Controls and Systems.
      b. UL 508, Safety Industrial Control Equipment.
      c. UL 698, Industrial Control Equipment for Use in Hazardous Locations.

C. Coordinate the installation of electrical equipment with other trades.
   1. Arrange for the building in of equipment during structure construction.
   2. Where equipment cannot be built in during construction, arrange for sleeves, box outs, openings, etc., as required to allow installation of equipment after structure construction is complete.

D. Verify that equipment will fit support layouts indicated.

E. Equipment Dimensions and Clearances:
   1. Do not use equipment that exceeds the indicated dimensions.
      a. Except as approved in writing by the Engineer.
   2. Do not use equipment or arrangements of equipment that reduce required clearances or exceed the space allocation.

F. Install equipment in accordance with the manufacturer's instructions.

G. Equipment Access:
   1. Install equipment so it is readily accessible for operation and maintenance.
   2. Equipment shall not be blocked or concealed.

3. Do not install electrical equipment such that it interferes with normal maintenance requirements of other equipment.

H. Equipment shall be installed plumbed, square and true with the building construction and shall be securely fastened.

I. Outdoor wall mounted equipment and indoor equipment mounted on earth or water bearing walls shall be provided with corrosion resistant spacers to maintain 1/4 IN separation between the equipment and the wall.

J. Screen or seal all openings into outdoor equipment to prevent the entrance of rodents and insects.

K. Equipment fabricated from aluminum shall not be placed in direct contact with earth or concrete.

L. Provide all necessary anchoring devices and supports.
1. Use supports as detailed on the Drawings and as specified.
   a. Where not detailed on the Drawings or specified, use supports and anchoring devices rated for the equipment load and as recommended by the manufacturer.
2. Supports and anchoring devices shall be rated and sized based on dimensions and weights verified from approved equipment submittals.
3. Hardware shall be malleable type, corrosion resistant and shall be supported by heavily plated machine screws or brass, bronze or stainless steel bolts.
4. Do not cut, or weld to, building structural members.
5. Do not mount safety switches and external equipment to other equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.

M. Provide concrete foundations or pads required for electrical equipment as indicated or specified.
1. Floor mounted equipment shall be mounted on a 4 IN high concrete housekeeping pad. Pad shall be poured on top of the finished floor or slab.

N. Material that may cause rusting or streaking on a building surface shall not be used.

O. To avoid interference with structural members and equipment of other trades, it may be necessary to adjust the intended location of electrical equipment. Unless specifically dimensioned or detailed, the Contractor may, at his discretion, make minor adjustments in equipment location without obtaining the Engineer's approval.

P. Provide tagging of electrical equipment, conduits, and conductors in accordance

with the Contract Documents.

1. Each equipment item shall be provided with a nameplate identifying the equipment by the tag number shown on the Drawings.
2. Each branch circuit and feeder shall be provided with a nameplate identifying, by name and tag number as shown on the Drawings, the load served.
    a. Do not abbreviate.
3. Each control device shall be provided with an escutcheon defining the device function and a nameplate identifying the controlled equipment.

Q. Provide electrical danger, caution, warning or safety instruction signs in accordance with applicable safety standards.

R. Conduit and wire between temperature control thermostats and the associated HVAC equipment shall be furnished and installed with the equipment (see Division 15 of the Specifications).

1. Conduit and wire between alarm or shutdown thermostats and air flow switches and the associated alarm devices or panels shall be furnished and installed as part of Division 16.
2. Thermostats included as part of a heat trace system shall be installed as part of Division 16.

## 3.02 FIELD QUALITY CONTROL

A. Do not remove or damage fireproofing materials.

1. Install hangers, inserts, supports, and anchors prior to installation of fireproofing.
2. Repair or replace fireproofing removed or damaged.

B. Make all penetrations through roofs prior to installation of roofing.

1. For penetrations required after installation of roofing:
    a. In built up roofing (BUR), provide all curbs, cants and base flashings.
    b. In elastic sheet roofing (ESR), arrange and pay for base flashing work by authorized roofer.

C. Make all penetrations of electrical work through walls and roofs water and weather tight.

D. Equipment furnished under this Contract for use on future work and all concealed equipment, including conduits, shall be dimensioned, on the record drawings, from visible and permanent building features.

E. After installation, test all electrical equipment and systems as recommended by the manufacturer and in accordance with Specification 16920 – ELECTRICAL ACCEPTANCE TESTING.

F. Test Equipment Interface:
   1. Verify systems coordination and operation.

3.03 CLEANING

A. Clean dirt and debris from all surfaces.

B. Apply touch up paint as required to repair scratches, etc.

C. Replace nameplates damaged during installation.

D. Thoroughly vacuum the interior of all enclosures to remove dirt and debris.

3.04 DEMONSTRATION

A. Demonstrate equipment in accordance with the Contract Documents.

END OF SECTION

SECTION 16011

# SHORT CIRCUIT, ARC FLASH ANALYSIS AND PROTECTIVE DEVICE COORDINATION STUDY

## PART 1 - GENERAL

### 1.01 SUMMARY

A. Section includes short circuit analysis, protective device coordination, and arc flash studies for the entire electrical distribution system.

### 1.02 REFERENCES

A. Institute of Electrical and Electronics Engineers:
   1. IEEE 141 – Recommended Practice for Electric Power Distribution in Industrial Plants
   2. IEEE 242 - Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (Buff Book).
   3. IEEE 1584-2018 - IEEE Guide for Performing Arc-Flash Hazard Calculations.

B. National Fire Protection Association:
   1. NFPA 70 - National Electrical Code.
   2. NFPA 70E – Standard for Electrical Safety in the Workplace.

### 1.03 MANUFACTURERS

A. Power system analysis software shall be used to perform the studies required in this specification. Software used to perform the studies shall be the latest version produced by the following manufacturers:
   1. ETAP by Operation Technology, Inc.
   2. PowerTools by SKM Systems Analysis, Inc.
   3. Or approved equal.

B. The signs or labels shall be self-adhesive, UV and fade resistant, and rated for outdoor use. Labels shall be vinyl, 4mil (0.004”) thick with adhesive, shall be 3M Controltac Print Film, type 40C-10R, or equal.

### 1.04 DESIGN REQUIREMENTS

A. Complete Short Circuit and Protective Device Coordination Study to meet requirements of NFPA 70.

B. Report Preparation:
   1. Prepare study prior to ordering distribution equipment to verify equipment ratings required.

2. Perform study with aid of computer software program.
3. Obtain actual settings for Blower motor characteristics and for equipment incorporated into Work.
4. Calculate short circuit interrupting and, when applicable, momentary duties for assumed 3-phase bolted fault short circuit current and phase to ground fault short circuit current at each of the following:
    a. Switchboards.
    b. Motor control centers.
    c. Distribution panelboards.
    d. Branch circuit panelboards.
    e. Each other significant equipment location throughout system.

C. Report Contents:
1. Include the following:
    a. Calculation methods and assumptions.
    b. Base per unit value selected.
    c. One-line diagram.
    d. Source impedance data including power company system available power and characteristics.
    e. Typical calculations.
        1) Fault impedance.
        2) X to R ratios.
        3) Asymmetry factors.
        4) Motor fault contribution.
        5) Short circuit kVA.
        6) Symmetrical and asymmetrical phase-to-phase and phase-to-ground fault currents.
        7) Tabulations of calculation quantities and results.
    f. One-line diagram revised by adding actual instantaneous short circuits available.
    g. State conclusions and recommendations.
2. Prepare time-current device coordination curves graphically indicating coordination proposed for system, centered on conventional, full-size, log-log forms.
3. Prepare with each time-curve sheet complete title and one-line diagram with legend identifying specific portion of system covered by that particular curve sheet.
4. Prepare detailed description of each protective device identifying its type, function, manufacturer, and time-current characteristics. Tabulate recommended device tap, time dial, pickup, instantaneous, and time delay settings.
5. Plot device characteristic curves at point reflecting maximum symmetrical fault current to which device is exposed. Include on curve sheets the following:
    a. Low voltage equipment circuit breaker trip device characteristics.
    b. Low voltage equipment fuse characteristics.
    c. Cable damage point characteristics.
    d. Pertinent motor characteristics.
    e. Other system load protective device characteristics.

D. Obtain and verify all data needed to perform the arc flash study. The arc flash analysis

study shall include the following IEEE Standard 1584 nine step analysis process:

1. Collect system and installation data.
2. Determine modes of operation.
3. Determine bolted fault current.
4. Determine arc fault current.
5. Determine protective device characteristic and arc fault duration.
6. Document system voltages and equipment class.
7. Select working distances.
8. Calculate incident energy.
9. Calculate the arc flash protection boundary.

## 1.05 SUBMITTALS

A. Qualifications Data: Submit the following for review prior to starting study.
   1. Qualifications and background of Preparer.
   2. Qualifications of Professional Engineer performing study.
   3. Provide reference names and current phone numbers of the Owner, Contractor, Engineer, or Construction Manager that has knowledge of the Preparer's work:
      a. Three projects for Owner completed within the past four years, or
      b. Three projects for the Engineer completed within the past four years, or
      c. Provide references for five recent projects that were completed within the last four years. Provide a description of the scope of the referenced project.

B. Software: Submit for review information on software proposed to be used in performing study.

C. Product Data: Submit the following:
   1. Report: Summarize results of study in report format including the following:
      a. Descriptions, purpose, basis, and scope of study.
      b. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short-circuit duties, and commentary regarding same.
      c. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.
      d. Fault current calculations including definition of terms and guide for interpretation of computer printout.
      e. Results of the arc flash hazard analysis.

D. Submit two searchable and indexed Adobe PDF copies of final report signed by professional engineer. Make additions or changes required by review comments.

E. Submit reports and electronic copy of the software files used for the coordination study on two USB Flash Drives to the Engineer and Owner for review.

## 1.06 QUALITY ASSURANCE

A. Maintain one copy of each document on site.

B. Use commercially available software, designed specifically for short circuit and protective

device coordination studies.

C. Perform study in accordance with IEEE 242.

D. Base study on final reviewed equipment submittals, not just contract documents. Preparer shall request copies of submittals from the Contractor. Contractor shall advise Preparer of changes or modifications to electrical equipment affecting the study.

1.07 QUALIFICATIONS

A. Study Preparer: Company specializing in performing work of this section with minimum 5 years documented experience. The Company shall be independent, providing unbiased study authority, professionally independent of the manufacturer, suppliers, and installers of equipment or systems to be evaluated by the Study Preparer.

B. Perform study under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Arizona with minimum of five years experience in power system analysis.

C. Demonstrate company performing study has capability and experience to provide assistance during system start up.

1.08 PRE-INSTALLATION MEETINGS

A. Convene minimum one week prior to commencing work of this section.

1.09 SEQUENCING

A. Complete study within 10 weeks after pre-installation meeting.

B. Allow 4 weeks for review of completed study by Owner/Engineer.

C. Submit short circuit and protective device coordination study to owner prior to receiving final approval of distribution equipment shop drawings and prior to releasing equipment for manufacturing.

D. When formal completion of study will cause delay in equipment manufacturing, obtain approval from Owner for preliminary submittal of study data sufficient in scope to ensure selection of device ratings and characteristics will be satisfactory.

1.10 SCHEDULING

A. Schedule work to expedite collection of data to ensure completion of study for final approval of distribution equipment shop drawings prior to release of equipment for manufacturing.

PART 2 - PRODUCTS --- NOT USED

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

A. Provide assistance to electrical distribution system equipment manufacturer during start up of electrical system and equipment.

B. Select each primary protective device for delta-wye connected transformer so device's characteristic or operating band is within transformer characteristics; including point equal to 58 percent of ANSI withstand point to provide secondary line-to-ground fault protection.

C. Separate transformer primary protective device characteristic curves from associated secondary device characteristics by 16 percent current margin to provide proper coordination and protection in event of secondary line-to-line faults.

D. Separate medium-voltage relay characteristic curves from curves for other devices by at least 0.4 second time margin.

3.02 ADJUSTING

A. Perform field adjustments of protective devices and modifications to equipment to place equipment in final operating condition. Adjust settings in accordance with approved short circuit and protective device coordination study.

3.03 ARC FLASH SIGNAGE

A. Study Preparer shall fabricate signs or labels with the arc flash hazard study results in accordance with the latest edition of NFPA 70E and shall display the following information:
   1. DANGER in white letters on red background
   2. Arc flash boundary
   3. Incident energy available
   4. Working distance
   5. Shock hazard
   6. Limited approach boundary
   7. Restricted approach boundary
   8. Insulating gloves class and v-rating
   9. Fed from – location of source protective device
   10. Source protective device
   11. Equipment tag or name
   12. Date installed.

B. The Study Preparer shall work with the Contractor for implementing the Arc Flash Hazard sign or label installation requirements for electrical equipment as specified in NEC Article 110.16 Flash Protection and NFPA 70E.

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.

B. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

### 1.02 SUBMITTALS

A. Submit product data in accordance with Section 16000, and the Contract Documents.

B. Submit manufacturer's literature for raceways and fittings, boxes, wires and cables, wiring devices, nameplates, legend plates, labels, panelboards, and safety switches, service entrance equipment, control panels and any other electrical component utilized in this project.

### 1.03 QUALITY ASSURANCE

A. Refer to Section 16000.

### 1.04 SPARE PARTS

A. Provide spare components as indicated on drawings and elsewhere herein.

## PART 2 - PRODUCTS

### 2.01 BASIC MATERIALS

A. Electrical safety switches, distribution and control equipment shall be rated for heavy duty service.

B. Wiring devices shall be specifications grade.

## 2.02 MISCELLANEOUS METAL AND MOUNTING CHANNELS

A. Metal Framing:
   1. Unless otherwise shown, mounting channels shall be cold rolled from mild strip steel, 12-gauge, 1-5/8 inches by 1-5/8 inches, with a galvanized finish by Unistrut, Unistrut P-1000, as manufactured by Unistrut, or equal.
   2. Screws, bolts, washers and nuts shall be stainless steel. Parts and brackets for assembly of channels shall be hot dipped galvanized.

B. Miscellaneous Metal: Galvanized steel, unless otherwise shown.

## 2.03 NAMEPLATES, LEGEND PLATES, AND LABELS

A. Nameplates: Laminated sheet plastic, approximately 1/16 inch-thick, with engraved white letters on a black background, with adhesive backing and mounting screw holes. Stainless steel or brass screws, minimum height of letters, 5/16 inch. Card holders are not acceptable.

B. Legend Plates: Type KN-3 standard legend plates, Square D, or equal.

C. Control Wire Markers: Heat shrink sleeve types, manufactured by W.H. Brady Company, or equal.

# PART 3 - EXECUTION

## 3.01 BASIC MATERIALS

A. The completed installation shall conform to all applicable federal, state, and local code ordinances and regulations. Contractor shall obtain necessary permits and inspections required by the governing authorities. Work shall be done in a neat, workmanlike, finished and safe manner, according to the latest published N.E.C.A. standards of installation, under competent supervision. Install grounding as required by the National Electrical Code.

## 3.02 MISCELLANEOUS METAL AND MOUNTING CHANNELS

A. Install where electrical equipment is to be surface mounted to walls and where indicated on Drawings. Where two or more devices are to be installed side by side, support on metal framing, bolt together, and brace as required to form a rigid structure.

B. Clean cuts and welds. Coat unpainted surfaces with cold application zinc galvanizing. Coat cuts and welds on painted surfaces with zinc chromate primer and finish to match existing paint.

## 3.03 NAMEPLATES, LEGEND PLATES, AND LABELS

A. Nameplates: Identify panels, switchgear, regulators, load-break junction boxes, disconnect switches, and component enclosures. Fasten nameplates with stainless steel, self-tapping screws or rivets.
   1. Panels: Identify panel number, voltage and amperage of panel bus.
   2. Switchgear: Identify equipment, voltage, amperage and phase and number of wires.
   3. Safety Switches and Relays: Identify equipment controlled and circuits from which they are fed.

B. Legend Plates: Install on selector switches, pushbuttons, pilot lights, starters, and other components.

C. Control Wire Markers: Install at both ends of each control wire interconnecting between such items as control panels, sensors, and control devices, and each end of control wires within control panels, and other such enclosures. Wiring markers shall correspond to control wire numbers on approved wiring diagrams.

END OF SECTION

SECTION 16060

ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Demolition of existing electrical shall be as indicated on the Drawings or as indicated elsewhere herein.

B. Demolition information shown on the Drawings is based on visual field examination and existing record drawings. The Contractor is responsible for verification of all items indicated or not. All items affected that are not indicated on the Drawings shall be brought to the Engineer's attention before demolition for direction.

C. The Contractor shall confine demolition work to the item specifically identified on the drawings. The Contractor shall be liable for any other damage he may inflict to the existing installations.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Care shall be taken in demolition or removal of items as indicated on drawings as being returned to the Owner. The Contractor shall notify the Owner prior to removing existing equipment.

B. Whether indicated on the drawings or not, the Contractor shall provide patching material to fill voids where demolition has taken place. Patching materials shall match, as nearly as practical, the existing original structure material for each surface being patched.

PART 3 - EXECUTION

3.01 COORDINATION

A. The Contractor shall verify existing field conditions, measurement, circuitry etc. as indicated on Drawings prior to performing any demolition.

B. The Contractor shall verify that abandoned or demolished wiring and electrical equipment serve only abandoned facilities. If demolished or abandoned electrical

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

C. Demolition shall not be performed without coordinating with new construction to limit down time and ease of switchover. The Contractor must coordinate with the Engineer and the Owner prior to any demolition.

D. Prior to performing any demolition work, the Contractor shall provide temporary wiring and connections to maintain existing systems in service during construction. Temporary wiring shall conform to the National Electrical Code.

3.02 PERFORMANCE

A. General: The means and methods of performing electrical demolition and removal operations are the sole responsibility of the Contractor. However, equipment used, and methods of demolition and removal will be subject to approval of the Engineer.
   1. Remove exposed abandoned conduit systems, including abandoned conduit systems in false ceilings.
   2. Remove wiring in abandoned conduit systems to source of power supply, where indicated.
   3. In exposed through-structure conduit or foundation locations, cut conduits and foundation below the finished structure surfaces in order to perform adequate surface patching.
   4. Maintain electrical continuity of existing electrical installations which remain active. Modify installations as necessary to maintain continuity and provide adequate access as required by the National Electrical Code.
   5. Extend existing installations using materials and methods compatible with existing electrical installations, and as specified elsewhere herein.
   6. Disconnect and leave in place electrical devices and equipment serving utilization equipment that has been removed or demolished.

B. Cutting: Perform cutting work of existing structure materials by such methods as will prevent extensive damage beyond the immediate area of cutting.

C. Unless otherwise indicated existing, electrical equipment, conduit, wire, etc. indicated for demolition shall be removed and disposed of in a lawful manner, off Site.

D. The Contractor shall move existing electrical equipment required to be returned to the Owner, to locations as directed by the Owner. Care shall be taken to ensure existing electrical equipment being returned to the Owner does not become damaged. The Contractor shall provide a means for storing and or stacking of the returned equipment prior to moving to final location, if necessary.

E. Items Abandoned in Place:
   1. All items to be abandoned in place shall be de-energized.

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

END OF SECTION

SECTION 16111

CONDUITS

PART 1 - GENERAL

1.01 SCOPE OF WORK

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

B. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

1.02 SUBMITTALS

A. Submit product data in accordance with Section 16000, and the Contract Documents.

B. Submit product literature including manufacturer part number, model number, material, size, and specifications. Material shall not be installed until the Engineer has reviewed the submittal data.

C. Shop Drawings shall be submitted for review and acceptance showing routing, conduit size, and number and size of wires in each conduit before installation of conduit and any related work.

D. Proposed routing of conduits buried under floor slabs-on-grade.

E. Identify conduit by tag number of equipment served or by circuit schedule number.

F. Proposed routing and details of construction including conduit and rebar embedded in floor slabs, columns, etc. Identify conduit by tag number of equipment served or by circuit schedule number.

G. Proposed location and details of construction for openings in slabs and walls for raceway runs.

1.03 REFERENCES

A. American National Standards Institute (ANSI): C80.1-2015, Electric Rigid Steel.

B. National Electric Manufacturers Association (NEMA): RN 1-2018, Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and

Intermediate Metal Conduit.

C. Underwriters Laboratories Inc. (UL):
   1. 1, Standard for Flexible Metal Conduit.
   2. 6, Electrical Rigid Metal Conduit - Steel.
   3. 360, Standard for Liquid-Tight Flexible Metal Conduit.
   4. 467, Grounding and Bonding Equipment.
   5. 514C, Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
   6. 651, Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
   7. 870, Standard for Wireways, Auxiliary Gutters, and Associated Fittings.
   8. 884, Standard for Underfloor Raceways and Fittings.

## PART 2 - PRODUCTS

### 2.01 RACEWAYS

A. Exposed conduit in an unclassified or hazardous area shall be galvanized rigid steel (GRS) unless specifically indicated otherwise on the Drawings. Conduits in the corrosive areas shall be PVC coated GRS unless otherwise indicated. Underground and/or concrete encased conduits shall be PVC, unless otherwise indicated. All wiring, except as otherwise noted, shall be in conduit. Conduit size shall not be less than the National Electrical Code (NEC) size required for the conductors therein and shall not be smaller than 3/4 inch. No underground conduit shall be less than one inch.

B. Condulet type fittings shall be Crouse–Hinds Series by Eaton, Appleton (Emerson), or equal with wedge nut covers. All condulets located outdoors or in wet locations shall be weathertight.

C. In unclassified areas, flexible conduit shall be grounding type, weatherproof, corrosion resistant, and watertight.

D. Couplings, connectors, and fittings shall be standard types specifically designed and manufactured for the purpose. They shall be installed to provide a firm mechanical assembly and electrical conductivity throughout.

E. Expansion fittings shall be Emerson O-Z/Gedney type AX with jumper for exposed locations and type DX at structural expansion joints, or equal. Conduits shall have expansion fittings in accordance with NEC.

F. The conduits and fittings shall be supported per NEC requirements as a minimum.

2.02 GALVANIZED RIGID STEEL (GRS)

A. Conduit and couplings shall be hot dipped galvanized with zinc coated threads and outer coating of zinc bichromate, in accordance with ANSI C80.1-2015 standards, as manufactured by Nucor, Allied Tube & Conduit, Triangle PWC Inc., or equal.

B. Steel conduit shall not be buried in earth without concrete encasement and additional corrosion protection. A half lapped rapping of 20 mil PVC based corrosion protection tape shall be used.

2.03 RIGID NONMETALLIC – PVC

A. Where specifically indicated on the Drawings, or elsewhere specified, conduit may be high density Schedule 40, 90 degrees C, heavy-duty PVC. The conduit shall be manufactured from virgin polyvinyl chloride compound which meets ASTM D1784-11, NEMA TC 2:2003, and UL 651 standards. Smoke emissions shall be limited to less than 6 grams per 100 grams of material tested.

B. Where conduit concrete encasement is indicated on the Drawings, conduit supports shall be installed at five foot intervals. PVC conduit shall be manufactured by Carlon (ABB), Cantex, Allied Tube & Conduit, or equal.

2.04 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

A. Liquidtight flexible metal conduit shall be liquid and vapor tight, oil and ultraviolet ray resistant and manufactured in accordance with UL 360 standards. Liquidtight flexible metal conduit shall be formed of a continuous, spiral wound, galvanized steel core with an extruded PVC jacket. The PVC jacket shall be rated for high ambient heat applications, 90 degrees Celsius.

B. For corrosive locations, liquidtight flexible metal conduit shall be formed of a continuous, spiral wound, aluminum core with an extruded PVC jacket. The PVC jacket shall be impervious to corrosive liquids and vapors.

C. An external bonding conductor shall be required for flexible conduit connections containing circuits rated at 60 amps or greater and for sizes 1 1/2 " or larger. Flexible conduit and connectors for 1 1/4" and smaller shall be listed for grounding.

D. Connectors for liquidtight flexible conduit shall be galvanized, furnished with a sealing ring and locknut, and suitable for wet locations.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Conduit runs are schematic only, and shall be modified as required to suit field conditions, subject to review and acceptance by the Engineer.

B. Conduit shall run continuously between outlets and shall be provided with junction boxes where connections are made. Couplings, connectors, and fittings shall be acceptable types designed and manufactured for the purpose, and shall provide a firm mechanical assembly, and electrical conductivity throughout.

C. Conduit runs shall be straight and true. Elbows, offsets, and bends shall be uniform and symmetrical. Changes in direction shall be made with long radius bends, or with fittings of the 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. GRS shall be reamed during the threading process, and Rigid Nonmetallic PVC shall be reamed before applying fittings. A zinc rich cold galvanizing shall be used to restore corrosion protection on field cut threads. Bushings and lock nuts or hubs shall be used at conduit terminations. The total number of bends in any run between pull points shall not exceed 360 degrees. Junction boxes and pull boxes shall be installed at points acceptable to the Engineer. Conduit ends shall be plugged to prevent the entrance of moisture or debris during construction. All spare conduits shall be adequately capped and shall contain a suitable pull string.

I. Joints shall be set up tight. Hangers and fastenings shall be secure, and of a type appropriate in design, and dimensions, for the particular application.

J. Conduit runs shall be cleaned and internally sized (obstruction tested) so that no

foreign objects, or obstructions remain in the conduit prior to pulling in conductors.

K. After installation of complete conduit runs 2 inches and larger, conduits shall be snaked with a conduit cleaner equipped with a cylindrical mandrel of a diameter not less than 85 percent of the nominal diameter of the conduit. Conduits through which the mandrel will not pass shall not be used.

L. Expansion fittings shall be installed across all expansion joints and at other locations where necessary to compensate for thermal expansion and contraction.

M. Provide trenching, backfill, and compaction for conduits installed underground.

N. Unless approved in advance by the Engineer, all conduits which transition from underground to aboveground will utilize galvanized rigid steel conduit for the bend from horizontal to vertical and for the extension above the ground. Factory 90 degree GRS bends shall be used. GRS bends and conduits shall be half lapped with 20 mil PVC tape in non-corrosive areas and shall be PVC coated rigid steel in corrosive areas. Tape wrapping shall extend a minimum 6 inches above top of slab or above finished grade.

O. Liquid tight flexible metallic conduit 1-1/2 inch and larger shall be provided with grounding style bushings and shall have an external ground wire sized and installed in accordance with the NEC.

END OF SECTION

SECTION 16123

600 VOLT CLASS CABLE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers the furnishing and installation of 600 Volt Class cables and conductors, terminations and splicing, and pulling lubricants.

B. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

1.02 SUBMITTALS

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

1.03 REFERENCES

A. Underwriters Laboratory, Inc.
   1. 44, Thermoset-Insulated Wires and Cables.
   2. 83, Thermoplastic-Insulated Wires and Cables.
   3. 486A-486B, Wire Connectors.
   4. 510, Standard for Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.

B. NFPA 70 National Electric Code

PART 2 - PRODUCTS

2.01 ACCEPTED MANUFACTURERS

A. Conductors and Multi Conductor Cables (MCC), subject to compliance with Contract Documents, the following manufacturers are acceptable: General Cable Corporation Group, Okonite Company, Southwire Company, or equal.

2.02 CONDUCTORS

A. Wire sizes shall be American Wire Gauge (AWG) sizes with Class B stranded construction. Number 2 AWG and smaller shall be factory color coded with a separate color for each phase and neutral, which shall be used consistently

throughout the system. Larger cables may be coded by the use of colored tape. All circuit conductors, #6 or smaller shall be "THWN" stranded copper. Conductors #4 through #2 AWG shall be "XHHW" stranded copper. Conductors #1 or larger shall be "XHHW-2" stranded copper rated for 90 degrees C.

B. Individual or multiple conductor cables for power, control, and alarm circuits of 480 volts or less shall be insulated for not less than 600 volts and shall have insulation type as indicated on the Drawings. "THHW" shall conform to UL 83 and "XHHW" shall conform to UL 44. Where wire size is not indicated, they shall be of the size required by the NEC, except that no wire external to panels and motor control centers shall be less than No. 12 AWG, unless specifically noted on the Drawings. Panel control wiring shall not be less than No. 14 AWG.

C. All wiring shall be as indicated on the Drawings. Wires shall be new and shall be soft drawn copper with not less than 97 percent conductivity. The wire and cable shall have size, grade of insulation, voltage, and manufacturer's name permanently marked on the outer covering at not more than 2-foot intervals. All wires shall conform to the latest Standards of the ASTM, and shall be tested for their full length by these Standards.

2.03 TERMINATIONS AND SPLICES

A. Cable shall be rated 600 volts. Other parts of cable systems such as splices and terminations shall be rated at not less than 600 volts. Splicing shall join conductors mechanically and electrically to provide a complete circuit prior to installation of insulation.

B. Splices in wires No. 10 AWG and smaller shall be made with an insulated, solderless, pressure type connector, Type I, Class 1, Grade B, Style G, or Type II, Class 1 of FS W-S-610 and conforming to the applicable requirements of UL 486A-486B.

C. Splices in wires No. 8 AWG and larger shall be made with non-insulated, solderless, pressure type connector, Type II, Class 2 of FS W-S-610, conforming to the applicable requirements of UL 486A and UL 486B. They shall then be covered with an insulation and jacket material equivalent to the conductor insulation and jacket.

D. Insulated conductor splices below grade or in wet locations shall be sealed type conforming to ANSI C119.4 or shall be waterproofed by a sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring a thermosetting resin into a mold that surrounds the joined conductors.

E. Bare conductor splices in wet locations or below grade shall be of the exothermic type.

2.04 PULLING LUBRICANT

A. All cables shall be properly coated with pulling compound such as ClearGlide, Aqua Gel, Polywater, or equal before being pulled into conduits so as to prevent mechanical damage to the cables during installation. "Yellow 77" is not acceptable.

B. Other lubricants to be substituted must be accompanied by a statement from the cable manufacturer as to its acceptable use with the cable being installed.

2.05 IDENTIFICATION

A. All conductors shall be numbered with "tube sleeve" type tags with heat impressed letters and numbers.

B. Color code all wiring as follows:
1. Lighting and power wiring:

| CONDUCTOR | 120/208 VAC | 480VAC | 24V DC | 120 VAC Control/ Power |
|---|---|---|---|---|
| Phase 1 | Black | Brown | Blue | Red |
| Phase 2 | Red | Orange | (-) Blue w/ white stripe | |
| Phase 3 | Blue | Yellow | | |
| Neutrals | White | White or Grey | | White |

2. Color code ends of feeder phase conductors only.

PART 3 - EXECUTION

3.01 INSTALLATION

A. The pulling tension and side wall pressures, as recommended by the cable manufacturer, shall not be exceeded.

B. As far as practical, all circuits shall be continuous from origin to termination without splices in intermediate pull boxes. Sufficient slack shall be left at the termination to make proper connections. In no case shall a splice be pulled into the conduit. Conductor splicing shall not be permitted without the Engineer's approval.

C. Install all cables in conduit unless otherwise indicated on the Drawings.

D. Each feeder and branch circuit shall be installed in its own individual conduit unless

combining feeder and branch circuits is permitted as defined in the following:

1. As specifically indicated on the Drawings.
2. For lighting, multiple branch circuits may be installed in a conduit as allowed by the NEC and with the wire ampacity derated in accordance with the requirements of the NEC. Conduit fill shall not exceed the limits established by the NEC.
3. When field conditions dictate and written permission is obtained from the Engineer.

E. Feeder and branch circuits shall be isolated from each other and from all instrumentation and control circuits.

F. Control circuits shall be isolated from all other feeder, branch and instrumentation circuits, except as noted below.

1. 12 V DC, 24 V DC and 48 V DC control circuits may be combined in common conduit.
2. 125 V DC control circuits shall be isolated from all other DC and AC control circuits.
3. 120 V AC control circuits shall be isolated from all DC control circuits.

G. Make splices only at pull or junction boxes.

1. Crimp or indented-type connectors are not allowed, except for control circuits landed on terminal strips.

3.02 TESTING

A. In accordance with Specification 16920 – ELECTRICAL ACCEPTANCE TESTING.

END OF SECTION

SECTION 16124

INSTRUMENTATION CLASS CABLE

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers cable use for process signal and controls.

B. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

1.02 SUBMITTALS

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

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with Contract Documents, the instrumentation cable shall be as manufactured by Belden, Okonite Company, or equal.

2.02 INSTRUMENTATION CABLE

A. Instrument cable shall be Type TC, and have the number of individually shielded twisted pairs indicated on the Drawings and shall be insulated for not less than 600 volts. Unless otherwise indicated, conductor size shall be No. 18 AWG minimum. Shielded, grounded instrumentation cable shall be used for all analog signals.

B. The jacket shall be flame retardant with 90 degrees C temperature rating. The cable shield shall be a minimum of 2.3 mil aluminum or copper tape overlapped to provide 100 percent coverage and a tinned copper drain wire.

C. The conductors shall be bare soft annealed copper, Class B, 7-strand minimum concentric lay, nylon jacket, 90 degrees C temperature rating. One conductor within each pair shall be numerically identified.

D. Pairs shall be assembled with a nominal 2 inch lay and shall then be group shielded, overlapped to provide 100 percent coverage. All group shields shall be completely

isolated from each other.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. Feeder and branch circuits shall be isolated from each other, and from instrumentation and control circuits. Instrumentation cables shall be installed in separate raceways from other cables and wiring. This includes portions running through manholes. Instrumentation cable shall be continuous between instruments or between field devices and instrument enclosures. There shall be no intermediate splices or terminal boards, unless otherwise shown on the Drawings.

B. Maintain electrical continuity of the shield when splicing twisted shielded pair conductors. Drain wires shall be terminated inside enclosures at grounded terminal blocks. Only one end of each instrument loop cable drain wire shall be grounded. Ground drain wire of shielded conductors at one end only.

C. Terminate instrumentation and control wiring, including spare wires, at control panels and motor control centers on terminal boards mounted inside the equipment.
   1. Contractor shall supply terminal boards as required.
   2. Do not field wire directly to devices.

END OF SECTION

SECTION 16130

OUTLET, PULL, AND JUNCTION BOXES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Outlet, pull and junction boxes.

B. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

C. Related Sections include but are not necessarily limited to:
   1. Division 1 - General Requirements.
   2. Section 16000 General Electrical Requirements.
   3. Section 16111 Conduits.
   4. Section 16141 Wiring Devices.
   5. Section 16170 Grounding.

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. Refer to Section 16000.

1.03 SUBMITTALS

A. Shop Drawings:
   1. Refer to the Contract Documents and Section 16000.

1.04 DELIVERY, STORAGE, AND HANDLING

A. See Section 01600.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers or approved equal are acceptable:
   1. Galvanized steel boxes:
      a. Emerson
      b. ABB Steel City.

c. Hubbell Raco.

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

B. Submit requests for substitution in accordance with Specification Section 01630.

2.02 MATERIALS

A. Pull and Junction Boxes for Offices and other Dry Architecturally Finished Areas:
   1. Material: 14 GA, galvanized steel.
   2. Concentric knockouts on all four sides.
   3. Flat cover fastened with screws.
   4. NEMA 1 classification.
   5. UL listed.

B. Pull and Junction Boxes for General Use Unclassified Areas Suitable for NEMA 12 Enclosures:
   1. Material: 14 GA galvanized steel with seams continuously welded, ground smooth and no knockouts.
   2. Zinc rich coating on all seams.
   3. Stainless steel captivated cover screws threaded into sealed wells.
   4. Flat door with oil resistant gasket.
   5. NEMA 12 classification.
   6. UL listed.

C. Pull and Junction Boxes for Wet Areas:
   1. Material: 14 GA steel with polyester powder coating inside and out over phosphatized surfaces.
   2. Seams continuously welded, ground smooth, no knockouts.
   3. Stainless steel clamps on four sides.
   4. Flat cover with oil resistant gasket.
   5. NEMA 4 classification.
   6. UL listed.

D. Pull and Junction Boxes for Corrosive Areas:
   1. Material: 304L or 316L stainless steel or fiberglass reinforced polyester material.
   2. Stainless steel boxes:
      a. Seams continuously welded, ground smooth, no knockouts.
      b. Rolled lip around all sides.
      c. Hinged door.
      d. Captivated stainless steel door screws.
      e. Flat door with oil resistant gasket.
   3. Fiberglass reinforced polyester boxes:
      a. Hinged door with latch and lockout.
      b. Neoprene door gasket.
      c. Grounding bushing(s).
   4. NEMA 4X classification.
   5. UL listed.

E. Pull and Junction Boxes for Hazardous Areas:
   1. Material: Cast gray iron alloy or copper free cast aluminum.
   2. Drilled and tapped openings or tapered threaded hub equipped.
   3. Flat bolted down or threaded cover with neoprene gasket.
   4. Stainless steel hex head screws.
   5. Explosion proof, UL listed for Class 1 Groups C and D.

F. Pull and Junction Boxes for Sidewalks:
   1. Cast iron box and cover, hot dip galvanized.
   2. Flange for flush mounting.
   3. Checkered cover with neoprene gasket, pry bar slots and stainless steel screws.
   4. UL listed.
   5. Drilled and tapped holes.
   6. Watertight NEMA 4 classification.

G. Large Pull and Junction Boxes (100 CU IN and larger):
   1. Located in offices and other dry architecturally finished areas where EMT is utilized:
      a. NEMA 1 gasketed without knockouts.
   2. Located in general use areas:

a. NEMA 12 construction:
   1) Welded steel.
   2) Furnished with gray enamel inside and out over phosphatized surfaces.

3. Located in wet and corrosive areas:
   a. NEMA 4X with stainless steel screws.
   b. Type 304 L welded stainless steel:
4. Constructed of 14 GA steel with seams continuously welded, ground smooth, no knockouts.
5. Rolled lip around all sides.
6. Rigid handles for covers larger than 9 SF or heavier than 25 LBS.
7. Split covers when heavier than 25 LBS.

H. Terminal Boxes:
1. Galvanized 16 GA steel box provided with plain blank screw cover, subpanel, and terminal points.
2. Refer to Drawing for dimensions and number of terminals.

I. Fiberglass Cable Pulling Enclosure:
1. Use: Access points to facilitate pulling of electrical cables in buried conduit runs.
2. Size and quantity: As shown on Drawings.
3. Type: Rectangular fiberglass composite, suitable for direct burial pedestrian traffic rated, 50 DegF, chemical, sunlight, and weather resistant.
4. Provide matching top with "ELECTRIC" logo.

J. Outlet Boxes:
1. Use: Installation of wiring devices.
2. Boxes for exposed wiring:
   a. Cadmium plated, cast, ferrous metal, with threaded hubs.
3. Boxes for concealed wiring:
   a. Code gage, hot dip galvanized steel.
   b. Include bar hangers for metal stud partitions.
   c. Provide barriers between switches in boxes with 277 V switches on opposite phases.
   d. Use extension and plaster rings where required.
   e. Provide grounding screw.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. Use locknut and bushing for boxes in non-classified areas.

B. Use cast metal boxes with threaded conduit hubs in hazardous areas.

C. Use Type FS and FD boxes in wet areas and where exposed rigid steel conduit is required.

D. Fill unused punched out, tapped, or threaded hub openings with insert plugs.

E. Use outlet boxes sized to accommodate quantity of conductors enclosed.

F. Use boxes sized to accommodate conduit tying into box.

G. Install pull boxes or junction boxes in conduit runs where indicated or required to facilitate pulling of wires or making connections.

1. Make covers of boxes accessible.

H. Install pull boxes or junction boxes rated for the area classification.

I. Install rigid conduit squarely into boxes which do not have hubs or are drilled and tapped.

1. Install with locknut on the outside and bushing on inside.

J. Install conduit into boxes with hubs, or that are tapped, using thread lubricant.

K. Do not use back to back boxes on this Project.

L. Seal all points of conduit entry into fiberglass cable pulling enclosures for a waterproof installation.

M. Support outlet boxes for incandescent fixtures and other ceiling mounted devices in lay in acoustical tile ceilings by bar hangers anchored to ceiling construction members which do not interfere with tile removal.

END OF SECTION

SECTION 16141

WIRING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Light switches, receptacles, device plates, dimmers, plug in strips and tele power poles.

B. Related Sections include but are not necessarily limited to:
   1. Division 1 General Requirements.
   2. Section 16000 Electrical: Basic Requirements.
   3. Section 16130 Outlet, Pull, and Junction Boxes.
   4. Section 16170 Grounding.

C. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

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 or approved equal are acceptable:
   1. Light switches (except explosion proof):
      a. Hubbell.
      b. Pass & Seymour.
      c. Arrow Hart (Eaton).
      d. General Electric.
      e. Leviton.
   2. Explosion proof light switches:

a. Eaton.
b. Emerson.
c. Hubbell Killark.

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

B. Submit requests for substitution in accordance with Specification Section 01631.

## 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.

D. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

### 1.02 DESCRIPTION

A. The safety outlet enclosure shall consist of a suitable style outlet/receptacle plate with a hinged safety cover.

B. The safety outlet enclosure shall have cord port(s) capable of allowing an appropriate size electrical cord(s) to pass through when safety cover is closed.

C. The safety outlet enclosure shall have a latching mechanism to allow the enclosure to maintain weatherproof integrity. The latch shall be a tamper resistant (locking/security) style in areas where security is needed.

D. The safety outlet enclosure shall be sufficient depth to allow full closure with attachment plug(s) in use.

### 1.03 SUBMITTALS

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

1.04 MANUFACTURER

A. Manufacturer shall be Hubbell Taymac, or equal.

PART 2 - PRODUCTS

2.01 WEATHERPROOF WHILE IN USE OUTLET ENCLOSURES

A. The enclosures shall be used in outdoor locations, where attachment plugs will be connected permanently, or for an indefinite period of time, in potentially wet or weather exposed environments, or as indicated on the Drawings.

B. They are also to be used where outlets are subject to contamination, corrosion or damage.

C. The enclosure shall consist of a suitable style outlet/receptacle plate with a hinged safety cover, and shall be of sufficient depth to allow full closure with attachment plugs in use.

D. The enclosure shall have cord ports capable of allowing an appropriate size electrical cords to pass through when safety cover is closed.

E. The enclosure shall have a latching mechanism to allow the enclosure to maintain weatherproof integrity. The latch shall be a tamper resistant, and locking style, in areas where security is needed, as shown on the Drawings.

F. The enclosure shall be Underwriters Laboratories (UL) listed per UL Standard 514C for non-metallic boxes, flush device boxes and enclosures, and conform to National Electric Code (NEC), Article 406.9 paragraphs A, B(1), and B(2), pertaining to damp, wet or possible corrosive installations.

G. Body materials shall be of a flame resistant, self-extinguishing, ultraviolet inhibiting, impact resistant, polycarbonate resin such as GE Lexan 943A, MobayMakrolon 6457 or equal. Material must meet UL Standard 94.

H. Gasket materials shall be of sufficient thickness to form a weatherproof seal under normal mounting conditions. Thicknesses; 3/16” for base plate and 1/8" for covers. Material is to be closed cell neoprene foam by Monarch Rubber A5032, or equivalent, self-extinguishing and flame retardant. Material must meet UL Standard 94 HF-1.

I. Mounting hardware shall be stainless steel, and of sufficient length to properly secure the device, and ensure seal to mounting surface.

J. The enclosures shall be installed over a weatherproof box and outlet in

conformance with the manufacturer's instruction. Cover shall be mounted to insure that access holes for the portable line cords will be located at the lower end of the cover.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

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

END OF SECTION

SECTION 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.

B. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

1.02 SUBMITTALS

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

1.03 MANUFACTURERS

A. Enclosures shall be manufactured by Hammond Manufacturing, Nvent Hoffman, Rittal, or equal.

PART 2 - PRODUCTS

2.01 STEEL

A. Enclosures shall be fabricated from 14 gauge steel with seams that are continuously welded. Doors shall have full length piano hinges with the door removable by pulling the hinge pin.

B. A rolled lip shall be provided around three sides of the door and around all sides of the enclosure opening. The gasket shall be attached with oil resistant adhesive and held in place with steel retaining strips. Exterior hardware, such as clamps, screws, and hinge pins, shall be of stainless steel for outdoor installations. A hasp and staple shall be provided for padlocking. Each enclosure shall have a print pocket. All wires entering or leaving the enclosure shall terminate on terminal strips. All wires and terminals shall be clearly identified as specified elsewhere in these specifications.

C. Finish shall be white enamel interior, light gray enamel, ANSI 61 exterior, over phosphatized surfaces. Special finishes and colors shall be furnished for wet

locations. Drawings should be checked for special conditions.

2.02 NEMA RATING

A. Unless otherwise indicated on the Drawings, enclosures shall be NEMA 12 for indoors, NEMA 4X for corrosive areas, and NEMA 4 for outdoor installations. NEMA 4X enclosures shall be stainless steel, unless noted otherwise. NEMA 4 enclosures shall also be used in wet, or wash down areas.

2.03 FIBERGLASS

A. Enclosures shall be heavy-duty, compression molded, fiberglass reinforced polyester, high impact, heat resistant, NEMA 4X.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Enclosures shall be installed as indicated on the Drawings, and according to manufacturer's instructions.

B. Enclosures shall be properly grounded, and shall include ground straps connected to hinged doors and accessories.

END OF SECTION

SECTION 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.

B. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

1.02 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society for Testing and Materials (ASTM):
      a. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
   2. Joint Industrial Council (JIC): 111
      a. EMP 1, Mass Production Equipment.
   3. National Electrical Manufacturers Association (NEMA):
      a. ICS 4, Terminal Blocks for Industrial Use.
      b. ICS 6, Enclosures for Industrial Controls and Systems.
      c. 250, Enclosures for Electrical Equipment (1000 V Maximum).
   4. National Fire Protection Association (NFPA):
      a. National Electric Code (NEC).
   5. Underwriters Laboratory (UL)
      a. UL 508A, Standard for Industrial Control Panels

B. Miscellaneous:
   1. Prior to placement of conduit feeds, assure approved control panel layouts available.
   2. Assure completely matching color tones for any individual color specified.
   3. Provide panel with the required NEMA rating per NEMA Publication No. 250 to meet classifications shown on drawings or specifications.
   4. Control panels shall be UL 508A listed and labeled by the panel shop or manufacturer.

1.03 SUBMITTALS

A. Shop Drawings:
   1. Scaled panel face and subpanel face instrument and nameplate layout drawings.
   2. Panel and subpanel materials of construction.
   3. Panel and subpanel dimensions and weights.
   4. Panel access openings.
   5. Conduit and wiring access locations.
   6. Internal wiring and terminal block drawings.
   7. Nameplate text.
   8. Scaled layouts of any graphic panels.

B. Operation and Maintenance Manuals.

## PART 2 - PRODUCTS

### 2.01 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Enclosures:
      a. 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.
2. Welded construction.
3. Completely enclosed, self-supporting, and gasketed dust tight.
4. Edges turned back minimum of 2 IN.

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

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

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

7. Finish all instrument cutouts smooth and true.

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

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

a. For intrinsically safe instruments, provide uniform and compatible additional color scheme.

16. Termination requirements:
    a. Terminal block markings, mechanical characteristics and electrical characteristics shall be in accordance with NEMA ICS 4.
    b. Terminals shall facilitate wire sizes as follows:
        1) 120 V AC applications: Wire size 12 AWG and smaller.
        2) Other: Wire size 14 AWG and smaller.
    c. Provide terminal blocks with continuous marking strip.
    d. Tag each I/O terminal to indicate tag number of the connected device.
    e. Provide terminals for individual termination of each signal shield.
    f. Provide 20 percent excess terminals for future expansion.
17. Pneumatic tubes and appurtenances:
    a. Provide 1/4 IN OD pneumatic control tubing.
    b. Main headers within panels shall be minimum 1 IN.
    c. Compression type pressure fittings.
    d. Equip panel instrument leads with globe type isolation valve.
    e. Connection to devices not in the panel shall be terminated on tubing terminal plate.
    f. Install tubing neatly and mount securely.
    g. Do not route tubing in front of or in wiring raceways.
    h. Code terminal plates.
    i. Supply and install dual function filter regulator to serve pneumatic devices.

F. Panel Lighting and Power:
1. Receptacles:
    a. Panels less than 4 FT long:
        1) One electrical outlet.
        2) One LED light fixture with switch(es) and separate circuit breakers.
    b. Panels or panel faces greater than 4 FT long:
        1) One electrical outlet per 6 FT of length.
        2) Continuous LED lighting strip with switches and separate circuit breakers.

G. Environmental Controls:
1. Furnish circulation fans near hot spots where required to prevent temperature from exceeding instrument rating.
2. Over temperature switches shall be utilized to provide special cooling if required to maintain operating temperatures within the manufacturer's specified range.
3. Air conditioning applications shall include means of preventing moisture condensation.
4. For panels or control cabinets located outside, or in area classification requiring a NEMA 4 or 4X rating:

a. Provide printed circuit boards with "Humiseal" conformal coating, covering entire components on both 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.

5. All environmental controls shall be based on a maximum ambient temperature of 122 degrees Fahrenheit (50 degrees Celsius).

2.05 MAINTENANCE MATERIALS

A. Extra Materials:

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

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install free standing panels on concrete pads as detailed on the Drawings.

B. Anchor panel fronts rigidly into wall system with approved anchorage devices.

END OF SECTION

SECTION 16170

GROUNDING

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. A grounding electrode system consisting of the indicated configuration of copper wires, and ground rods, or concrete encased grounding electrodes ("UFERs") shall be provided to minimize station potential gradient irregularities and drain leakage and fault currents to earth.

B. Whether indicated on the Drawings or not, neutral conductors, cable shields, metallic conduits, cable terminations, junction boxes, poles, surge arresters, and other noncurrent-carrying metallic parts of equipment shall be grounded.

C. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

1.02 SUBMITTALS

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

1.03 REFERENCES

A. National Electrical Code (NEC) Article 250.
B. Underwriters Laboratories (UL) Standard No. 467, Electrical Grounding and Bonding Equipment.
C. ANSI-J-STD-607-A, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications.

PART 2 - PRODUCTS

2.01 GROUND RODS

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

## 2.02 BARE GROUND WIRE

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

## 2.03 CONNECTIONS

A. Connections above grade shall be made with bolted solderless connectors, and those below grade shall be made by a fusion-welding process. In lieu of a fusion-welding process, a compression ground grid connector of a type which uses a hydraulic compression tool to provide the correct circumferential pressure may be used. Tools and dies shall be as recommended by the manufacturer. An embossing die code or other standard method shall provide visible indication that a connector has been adequately compressed on the ground wire.
   1. Manufacturer (Pressure Connectors):
      a. O.Z./Gedney, Division of General Signal Corporation
      b. Burndy Corporation
      c. Or approved equal.
   2. Manufacturer (Welded Connections):
      a. Cadweld by Erico Products, Inc.
      b. Therm-O-Weld by Burndy Corporation
      c. Or approved equal.

## 2.04 GROUNDING ELECTRODE CONDUCTOR

A. Service entrance ground wires shall be sized in accordance with NEC Table 250.66, unless otherwise indicated on the Drawings. After being located to provide maximum physical protection, exposed ground wires shall be securely attached to structural supports at not more than 2-foot intervals with suitable fasteners. Bends greater than 45 degrees in ground wires are not permitted. Routing of ground conductors through concrete should be avoided, except where specifically called for in these Documents. When concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit, to provide an opening for the ground wire. The opening shall be sealed with a suitable compound after installation of the ground wire.

## 2.05 EQUIPMENT GROUNDING CONDUCTOR

A. Neutral conductors shall be grounded where indicated. Equipment grounding conductors shall be sized in accordance with NEC Table 250.122, unless otherwise indicated. Ground wires shall be protected by conduit, where such wires run

exposed above grade in non-fenced enclosed areas or are run through concrete construction. Where concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit, to provide an opening for the ground wire. The opening shall be sealed with a suitable compound after installation of the ground wire. Bends greater than 45 degrees in ground wire connections to the ground rods, or counterpoises are not permitted.

2.06 EQUIPMENT GROUNDING

A. Equipment frames of motor housings, metallic tanks, metallic equipment enclosures, metal splicing boxes, chain-link fencing, and other metallic noncurrent-carrying metal items, shall be grounded. Connections to earth shall be made in the same manner as required for system grounding. Equipment or devices operating at less than 750 volts may be connected to secondary neutral grounding electrodes.

2.07 SURGE ARRESTER GROUNDING

A. Surge arresters shall be grounded. Resistance to ground for intermediate-class arresters shall be not more than 10 ohms and for distribution-class arresters shall be not more than 25 ohms. Ground wire connections shall be not less than No. 4 AWG for distribution arresters and No. 1/0 AWG for intermediate arresters. Connections to earth shall be made in the same manner as required for neutral conductors. Surge arrester grounds may use the same ground wires provided for equipment operating at more than 750 volts. Surge arrester and secondary neutral grounds shall be separate from and independent of each other but both grounds shall be bonded together below grade at the ground rods or may utilize a common counterpoise.

2.08 LIGHTING POLE GROUNDING

A. Base of lighting poles shall be connected to an adjacent ground rod as indicated on Drawings. A ground connection from poles back to neutral ground points shall also be provided utilizing equipment grounding conductor.

2.09 METALLIC STRUCTURES

A. Metallic structures and buildings shall be grounded per NEC.

2.10 GROUNDING RINGS

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

PART 3 - EXECUTION

3.01 INSTALLATION

A. It is the intent of these Contract Documents that all device and equipment grounds shall be run as a separate conductor in the conduit from the equipment to the distribution panels or system ground. Wireways and enclosures shall be properly bonded and grounded, and ground conductors shall be run for all circuits.

B. Equipment cases and devices shall be grounded. Ground rods shall be driven, and concrete encased conduits installed, before a building, or structure is built, and ground conductors brought through the concrete to accessible points for grounding equipment. These systems shall be installed at each structure, where transformers, switchboards, panelboards, and MCCs are installed.

C. Duct banks shall contain a concrete encased system bare copper ground conductor. The system ground conductors shall run continuously in duct banks, through handholes and other raceway boxes. The system ground shall be connected to the structure grounding systems to provide a continuous grounding system. Each metallic raceway, panel, switchboard, and other metallic devices associated with the electrical and control systems shall be bonded to this grounding system.

D. Ground rod shall be installed not less than 6 inches below grade. In counterpoise systems, tops of ground rods shall be approximately at elevations of counterpoises. Where the specified ground resistance cannot be met with the indicated number of ground rods, additional ground rods, longer ground rods, or deep-driven sectional rods shall be installed and connected until the specified resistance is obtained, except that not more than three additional ground rods shall be required at any one installation. Ground rods shall be spaced as evenly as possible at least 6 feet apart and connected below grade. Equipment, neutral, and surge arrester ground wires shall be connected to the ground grid as indicated.

E. A resistance of not greater than 25 ohms shall be provided, unless otherwise specified. Ground resistances shall be measured as herein described. Resistances of systems requiring separate ground rods, rather than a counterpoise, shall be measured separately before bonding below grade. The combined ground resistance of separate systems bonded together below grade may be used to meet the specified ground resistance, but the minimum number of rods indicated must still be provided.

3.02 TESTS

A. Test the grounding and bonding system in accordance with Specification 16920 – ELECTRICAL ACCEPTANCE TESTING.

B. No part of the electrical system shall be energized until all station grounding system components have been tested and demonstrated to comply with the requirements specified, and until associated test reports have been submitted and approved.

3.03 TEST RESULTS

A. Perform the above tests and submit a certified test report prior to energizing the equipment.

END OF SECTION

SECTION 16190

SUPPORTING DEVICES

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Supports, anchors, sleeves, and seals, are indicated on the Drawings, schedules, and specified in other sections of these Specifications.

B. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

C. Types of supports, anchors, sleeves and seals specified in this section include the following:
1. One-hole Conduit Straps
2. One-Hole Conduit Straps with Clamp Backs
3. Two-Hole Conduit Straps
4. Conduit Hangers
5. I-beam Clamps
6. Channel Clamps
7. Round Steel Rods
8. Drop-in Anchors
9. Wedge Type Anchor Bolts
10. Lead Expansion Anchors
11. Toggle Bolts
12. Wall and Floor Seals
13. Cable Supports
14. U-Channel Strut System
15. Sleeves

1.02 SUBMITTALS

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

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following: Abbeon Cal Inc., Ackerman Johnson Fastening

Systems Inc., Elcen Metal Products Co., Ideal Industries, Inc., MacLean Power Systems, Eaton B-Line, Rawlplug Inc., Allied Tube and Conduit, Greenfield Mfg Co., Inc., Emerson O-Z/Gedney; Power-Strut; Unistrut; and Robroy Industries.

2.02 GENERAL

A. Provide supporting devices that comply with manufacturers' standard materials, design, and construction, in accordance with published product information, and as required for complete installations, and as specified herein.

2.03 SUPPORTS

A. Provide supporting devices of types, sizes, and materials indicated, and having the following construction features:
   1. One-Hole Conduit Straps: For supporting electrical metallic tubing, and liquidtight flexible conduit; zinc plated steel, stainless steel or galvanized steel; snap-on, heavy duty.
   2. One-Hole Conduit Straps with Clamp Backs: For supporting rigid metal conduit, and intermediate metal conduit; cast galvanized steel.
   3. Two-Hole Conduit Straps: For supporting electrical metallic tubing, rigid metal conduit, and intermediate metal conduit; zinc plated steel, stainless steel or galvanized steel.
   4. Conduit Hangers: For supporting electrical metallic tubing, rigid metal conduit, and intermediate metal conduit; zinc plated steel, stainless steel or galvanized steel.
   5. I-Beam Clamps: Electroplated zinc or hot dipped galvanized malleable iron.
   6. Channel Clamps: Electroplated zinc or hot dipped galvanized steel.
   7. Round Steel Rod: National coarse thread, electroplated.

2.04 ANCHORS

A. Provide anchors of types, sizes, and materials indicated, with the following construction features:
   1. Lead Expansion Anchors: For CMU walls, 1/4"-20 threads, set tool required.
   2. Toggle Bolts: Electroplated steel, size as required.
   3. Drop-in Anchors: Stainless steel, size as required.
   4. Anchor Bolts: Stainless steel, size as required.
   5. Half-round head, non-removable anchor bolts shall not be used.

2.05 SEALS

A. Provide seals of types, sizes and materials indicated; with the following

construction features:

1. Wall and Floor Seals: Provide factory-assembled watertight wall and floor seals, of types and sized indicated; suitable for sealing around conduit, pipe, or tubing passing through concrete floors and walls. Construct seals with steel sleeves, malleable iron body, neoprene sealing grommets and rings, metal pressure rings, pressure clamps, and cap screws.
2. Conduit sealing bushings shall be manufactured by Emerson O-Z/Gedney, Model CSMI, or equal.
3. The conductor sealing bushings shall be manufactured by Emerson O-Z/Gedney, Model CSBG, or equal.

## 2.06 CONDUIT CABLE SUPPORTS

A. Provide cable supports with insulating wedging plug for non-armored type electrical cables in risers; construct 2" rigid metal conduit; 3-wires, type wire as indicated; construct body of malleable-iron casting with hot-dip galvanized finish.

## 2.07 U-CHANNEL STRUT SYSTEM

A. Provide U-channel strut system for supporting electrical equipment, 12-gage hot-dip galvanized steel, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with the following fittings that mate and match with U-Channel:

1. Fixture hangers
2. Channel hangers
3. End caps
4. Beam clamps
5. Wiring stud
6. Thinwall conduit clamps
7. Rigid conduit clamps
8. Post Bases
9. U-bolts

## 2.08 PIPE SLEEVES

A. Provide pipe sleeves from the following:

1. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.

## 2.09 PVC COATED U-CHANNEL STRUT SYSTEM

A. Provide PVC Coated U-channel strut system for supporting electrical equipment, 20 mil PVC coated steel, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with all Stainless Steel hardware, and the following fittings that mate and match with PVC Coated U-Channel:

1. PVC Coated Strut nut
2. PVC Coated Pipe straps

3. Touch up compound (Gray)

## 2.10 STAINLESS STEEL U-CHANNEL STRUT SYSTEM

A. Provide Stainless Steel U-channel strut system for supporting electrical equipment, of types and sizes indicated; construct with 9/16" dia. holes, 8" o.c. on top surface, with all stainless steel hardware, and the following stainless steel fittings that mate and match with Stainless Steel U-Channel:
   1. Fixture hangers
   2. Channel hangers
   3. End caps
   4. Beam clamps
   5. Wiring stud
   6. Post bases
   7. Rigid conduit clamps
   8. U-bolts

# PART 3 - EXECUTION

## 3.01 INSTALLATION

A. Install hangers, anchors, sleeves and seals as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NEC for installation of supporting devices.

B. Coordinate with other electrical work, including raceway and wiring work, as necessary to interface installation of supporting devices with other work.

C. Install hangers, supports, clamps and attachments to support piping properly from building structure. Arrange for grouping of 2 or more parallel runs of conduits to be supported together on channel type hangers where possible. Install supports with spacing indicated and in compliance with NEC requirements.

D. Torque sleeve seal nuts, complying with manufacturer's recommended values. Ensure that sealing grommets expand to form watertight seal.

E. Comply with manufacturer’s recommendations for touch up of field cut ends or damaged PVC coated U-channel and fittings.

F. Remove burrs and apply a cold zinc galvanizing paint to field cut galvanized U-channel strut.

END OF SECTION

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. Electrical identification work specified in this section covers the following:
   1. Buried cable warnings.
   2. Electrical power, control and communication conductors.
   3. Operational instructions and warnings.
   4. Danger signs.
   5. Equipment/system identification signs.

B. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

1.02 SUBMITTALS

A. Submittals to the engineer shall include the following:
   1. Manufacturers data on electrical identification materials and products.
   2. Samples of each color, lettering style and other graphic representation required for each identification material or system.

1.03 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering electrical identification products maybe incorporated in the work include, but not limited to, the following:
   1. Brady Corporation.
   2. Ideal Industries, Inc.
   3. Panduit.
   4. Or, equal.

B. Custom signs and labels applied to electrical gear and panels shall be self-adhesive, UV and fade resistant, and rated for outdoor use. Labels shall be vinyl, 4mil (0.004”) thick with adhesive, shall be 3M Controltac Print Film, type 40C-10R, or equal.

1.04 QUALITY COMPLIANCE

A. Comply with applicable requirements of UL 969, "Standard for Marking and Labeling Systems", pertaining to electrical identification systems.

B. Comply with applicable requirements of ICEA S-67-401 pertaining to

identification of power and control conductors.

## PART 2 - PRODUCTS

### 2.01 GENERAL

A. Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option, but provide single selection for each application.

### 2.02 CONDUIT MARKERS

A. Conduit tags shall be 1-1/2-inch diameter, round, aluminum tags, laser engraved or standard engraving with the conduit number. Punched or stamped lettering is not allowed. Font shall be 1/4-inch Arial or Helvetica. The conduit tags shall be manufactured by Brady, Catalog No. 49900 or equal.

B. Each tag shall be attached with 0.048 inch diameter stainless steel wire and fasteners, as manufactured by Brady, Catalog No. 38091, and zinc plated wire clamps, double ferrule design, as manufactured by Brady Catalog No. 38090 to secure the stainless steel wire or equal.

C. Unless otherwise indicated or required by governing regulations, provide white markers with black letters.

### 2.03 CABLE AND CONDUCTOR WIRE MARKERS

A. Cable and conductor wire markers shall be self-laminating vinyl on white background, printed using a Brady BMP61 printer, Seton printer, or equal. Handwritten wire markers are not acceptable.

### 2.04 SELF-ADHESIVE PLASTIC SIGNS

A. Provide manufacturer's standard, self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application, e.g., 208V, EXHAUST FAN, RECTIFIER.

B. Unless otherwise indicated or required by governing regulations, provide white signs with black lettering.

### 2.05 LETTERING AND GRAPHICS

A. Coordinate names, abbreviations and other designations used in electrical

identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of electrical systems and equipment. Comply with ASME A13.1-2015 pertaining to minimum sizes for letters and numbers.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. Install electrical identification products as indicated, in accordance with manufacturer's written instructions, and requirements of NEC.

B. Where identification is to be applied to surfaces that require finish, install identification after completion of painting.

C. Comply with governing regulations and requests of governing authorities for identification of electrical work.

### 3.02 CONDUIT IDENTIFICATION

A. Where electrical conduit is exposed in spaces with exposed mechanical piping that is identified by a color-coded method, apply color-coded identification on electrical conduit in manner similar to piping identification. Except as otherwise indicated, use white as coded color for conduit.

### 3.03 CABLE/CONDUCTOR IDENTIFICATION

A. Apply cable/conductor identification, including voltage, phase and feeder number, on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present, except where another form of identification (such as color-coded conductors) is provided. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work.

### 3.04 EQUIPMENT/SYSTEM IDENTIFICATION

A. Install engraved plastic-laminate sign on each major unit of electrical equipment in building; including central or master unit of each electrical system including communication-control-signal systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, 1/2” high lettering on 1-1/2” high sign (2” high where 2 lines are required), white lettering in black field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each

unit of the following categories of electrical work:

1. Panelboards, electrical cabinets and enclosures.
2. Access panel/doors to electrical facilities.
3. Major electrical switchgear.

B. Install signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with brass or stainless steel screws, except use adhesive where screws should not or cannot penetrate the substrate.

## 3.05 CIRCUIT IDENTIFICATION

A. The 3 phase wires shall be identified at the switchgear, panelboards and motor control centers as Phases A, B, and C. At 277/480V, Phase A shall be brown, Phase B shall be orange, and Phase C shall be yellow. The neutral shall be gray or white.

B. In addition to color coding all conductors, each conductor shall be identified in each pull box, manhole, panelboard, cable tray, or termination with circuit identification markers. This identification is applicable to all power, control, alarm, and instrumentation conductors and these markings shall be recorded on the Record Documents. Markers shall be slip on PVC sleeve type as manufactured by Brady, Seton, or equal.

C. Markers for other cabling shall be B 292 vinyl as manufactured by Brady, Seton, or equal.

D. Exposed medium voltage conduits shall be labeled at 50-foot intervals with 1-inch letters stating the voltage - example - “12,470 volts”. Labels shall be vinyl plastic as manufactured by Brady, Seton, or equal.

## 3.06 AUTOMATIC EQUIPMENT WARNING SIGNS

A. Permanent warning signs shall be mounted at all mechanical equipment that may be started automatically or from remote locations. Signs shall be in accordance with OSHA regulations and shall be suitable for exterior use. The warning signs shall be fastened with round head brass screws or bolts, located and mounted in a manner acceptable to the Engineer.

B. Warning signs shall be 7 inches high by 10 inches wide, colored yellow and black, on not less than 18-gauge vitreous enameling stock. Sign shall read:

CAUTION
THIS EQUIPMENT STARTS
AUTOMATICALLY
BY REMOTE CONTROL

## 3.07 HIGH VOLTAGE WARNING SIGNS

A. Permanent and conspicuous warning signs shall be mounted on all equipment, doorways to equipment rooms, pull boxes, manholes, where the voltage exceeds 600 volts.

B. Signs shall be in accordance with OSHA regulation and shall be suitable for exterior use. The warning signs shall be fastened with round head brass screws or bolts, located and mounted in a manner acceptable to the Engineer.

C. Signs shall be 7 inches high by 10 inches wide, colored red and white, on not less than 18-gauge vitreous enameling stock. Sign shall read:

WARNING
HIGH VOLTAGE
KEEP OUT

## 3.08 CONDUCTOR FASTENERS

A. Glue-on type conductor fasteners shall not be used in any panels, panelboards, switchboards, switchgear, motor control centers, or other enclosures containing electrical devices and/or conductors.

END OF SECTION

SECTION 16420

SERVICE ENTRANCE SECTION

## PART 1 - GENERAL

### 1.01 SCOPE OF WORK

A. This section covers the service entrance section and related service equipment.

B. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

### 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. Manufacturer shall submit their drawings to utility company for approval 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 metering, 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 switchboard designation, voltage, amperage and short circuit withstand rating, manufacturer's name, general order number, and item number mounted on the outside of the enclosure. Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background. Characters shall be 3/16-inch high, minimum. Nameplates shall give item designation and circuit number as well as frame ampere size and appropriate trip rating.

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, General Electric, Siemens, or 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.

END OF SECTION

SECTION 16470

PANELBOARDS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Panelboards furnished in accordance with the Plans and this specification.
   1. Service entrance rated main distribution panelboards.
   2. Distribution panelboards.
   3. Lighting and appliance branch circuit panelboards.
   4. Electronic Power Metering on panelboards per Section 2.05, when specified.

B. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

1.02 RELATED SECTIONS

A. Section 16000 – General Electrical Requirements

B. Section 16195 - Electrical Identification

C. Section 16505 – Surge Protective Devices

1.03 CODES, STANDARDS, AND REGULATORY REQUIREMENTS

A. All parts, materials, assembly, installation, testing and commissioning shall meet the requirements of the latest edition of the following Codes and Standards, and Regulatory agencies. In case of the conflict between the codes' requirement, the most stringent shall apply.
   1. Underwriters' Laboratories:
      a. Standard for Panelboards: UL 67.
      b. Enclosures for Electrical Equipment, Non-Environmental Considerations: UL 50.
      c. Molded Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures: UL 489.
   2. Federal Specification W-C-375 - Circuit Breakers, Molded Case, Branch Circuit and Service.
   3. Federal Specification W-P-115 - Power Distribution Panel.
   4. NEMA AB 1 - Molded Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   5. NEMA PB 1 - Panelboards.

6. NEMA PB 1.1 – General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 V or Less.
7. NFPA 70 - National Electrical Code.
8. UBC - Uniform Building Code.

1.04 SUBMITTALS

A. Submit product data in accordance with Section 16000, and the Contract Documents.

B. Shop drawings for equipment and component devices.

C. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker arrangement, sizes and numbering system.

D. Include information on all the accessories, locking hardware, shunt trip, under-voltage release mechanism, typical thermal magnetic curves for each size and type.

1.05 SPARE PARTS

A. Keys: Furnish two door keys for each panelboard.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Eaton

B. General Electric

C. Siemens

D. Square D/Schneider Electric

E. Approved Equal

2.02 BUS AND HARDWARE

A. Panelboards shall be completely factory assembled and equipped with the type, size and number of branch circuit breakers, arranged and numbered as shown on the Plans. Panelboards shall be fully rated. Series rated panelboards are not acceptable.

B. All multi-pole breakers shall be common trip. Branch circuits shall be arranged using double row construction. Bus sequence shall be ABC top to bottom, left to

right for both top and bottom fed panels. Provisions or space for future breakers shall be located at the bottom of the panel and be fully bussed, complete with all necessary mounting hardware. Use at least 100 ampere breaker-connecting bus straps and mounting hardware.

C. Where SPARE is indicated on the panel schedule(s), the specified circuit breaker and at least 100 ampere branch-circuit busing and mounting hardware shall be installed.

D. Where SPACE is indicated on the panel schedule(s), 100 ampere branch-circuit busing and mounting hardware shall be installed, ready for future installation of circuit breakers, furnished by others. At least 20% spare pole spaces, grouped in multiples of three, shall be provided in each panelboard, for future installation by the Owner. Provide single pole filler plates in the spaces, as required.

E. A nameplate shall be provided, and located near the top of the front trim on the exterior surface, listing panel type and ratings, as required by UL. Each circuit shall be permanently numbered to agree with the panel schedule, using plastic or metal buttons mounted adjacent to the breaker and secured by rivets or grommets with an engraved or depressed number. Adhesive numbering tape, painted numbers, or use of more than one number per breaker is not acceptable.

F. Main vertical bus bars shall be copper and silver or tin plated per UL requirements. Bus bars shall be supported by glass-filled polyester-type insulators. All bolts, used to connect current-carrying parts together, shall be accessible for tightening from the front of the panel. Bus bars shall be factory drilled and tapped with spacing arranged to permit breaker interchange, from the front, while the panel is energized.

G. Neutral bus shall be copper and insulated from the cabinet and all other parts. It shall be rigidly mounted in the panel and shall be provided with a solderless cable connector for each circuit breaker and each space in the panelboard and the main connecting lug(s).

H. A 1/4-inch (8mm) thick copper equipment ground bus, of sufficient width and length, shall be solidly bolted and grounded to the enclosure at the bottom and shall leave clear space for the bottom cable entries. The bus shall be drilled and tapped for 1/4" (8mm) - #20 machine screws in number to agree with branch circuits and spaces. A solderless connector, for No. 2 to No. 4/0 cable size, shall be bolted to the ground bus.

I. Copper bus bars shall be of sufficient size to provide a current density of not more than 1000 amperes per square inch of cross section, and not more than 200 amperes per square inch at bolted connections.

J. Minimum Short Circuit Rating for Bus Bracing: The bus shall be braced for the minimum symmetrical short circuit rating of the panel, as shown on the panel

schedule.

K. Provide main bus pressure connectors (main lugs) and separately supported sub-feed pressure connectors (lug landings) where noted. Provide additional bottom raceway space to accommodate pressure connectors and lug landings. In no instance shall the gutter space be less than required by NFPA 70.

L. Provide Surge Protective Devices where required on Plans.

M. Where required on Plans, provide re-installed locking devices for locking each circuit breaker in the OPEN position, by means of a padlock. Locking devices shall not be removable from the front of the panel with the trim in place. Attachment of the locking device to the panel with adhesives is not acceptable.

2.03 CIRCUIT BREAKERS

A. Molded Case Circuit Breakers: NEMA AB 1; provide bolt-on type circuit breakers with integral thermal and instantaneous magnetic trip in each pole and common trip handle for all poles. Provide circuit breakers, UL listed as Type HACR, for air conditioning equipment branch circuits. Provide circuit breakers, UL listed as Type SWD, for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where shown on Plans.

B. Instantaneous magnetic trips shall be accessible and adjustable from the front of the breaker on frame sizes above 250 amperes.

C. All breakers shall be rigidly mounted, separately removable and independent of trim plates for their support. Breakers shall be bolt on type.

D. The minimum width of one pole shall be 1 inch.

E. The minimum symmetrical interrupting rating for molded-case circuit breakers shall be as specified on the panel schedule(s). Series rated breakers are not acceptable.

2.04 CABINETS (BOXES)

A. All details of construction and methods of assembly shall meet the requirements of the "Enclosures for Electrical Equipment" of the Underwriters' Laboratories. The panel box shall not be less than 20” wide, 4.5” deep and of sufficient height to enclose the specified main and branch circuit breakers, buses, metering equipment and wire gutter. The panelboard enclosure shall be fabricated from code-gauge galvanized or galvanized-annealed steel without knockouts and with full front flange. The panel front shall be as shown on the plans and fabricated from cold rolled steel. Surface mounted panel boxes shall be finished with an ANSI-61 light grey baked enamel. There shall be no screws projecting into the wiring raceways.

The panelboard enclosure type shall be coordinated with the environment and location shown on the plans. Unless noted otherwise on the panel schedule, provide NEMA 3R for panelboards located outdoors and NEMA 12 elsewhere.

B. The front trim shall have full-length hinged outer door designed to expose the wiring raceways and breakers, when open. Another, inner hinged door shall expose breakers only, when open, making this a door-in-door construction. Both doors shall open to the right.

C. Both doors shall be provided with concealed butt or piano hinges. A suitable latch, which can be operated without tools, shall be provided to properly hold the inner door closed. For doors 30 inches (765mm) high or less, a flush-type latch is satisfactory. For doors more than 30 inches (765) high, a vault-type handle shall be provided with a three-point latch that holds the door closed at the top and bottom. The outer door shall be secured with at least four (4) captured oval head machine screws.

D. A sturdy metal frame, with a clear plastic cover, for an 4-1/2 inch x 8 inch panel schedule, shall be attached inside of the panel door with the RTV adhesive.

E. Panel trim and doors, and surface mounted cabinets shall be thoroughly cleaned, given a rust-inhibiting treatment, and finished with an ANSI-61 light grey baked enamel.

F. All panelboards shall bear the Underwriters' Laboratories label.

## 2.05 ELECTRONIC POWER METERING

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

## 2.06 EXCEPTIONS

A. The bidders shall list all the exceptions taken from the specification with their

quote. If no exceptions are listed with the bid, it is understood that the bidder shall meet all the requirements of this specification and applicable Codes and Standards.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. Install panelboards plumb and flush with wall finishes, in conformance with NEMA PB 1.1. Where surface mounted, provide suitable supports and rack all branch circuit conduits. Where mounted on concrete wall, install with ½" (15mm) steel spacers behind the panel. All mounting attachments and connections shall be designed in conformance with the minimum lateral seismic force of 0.5g per the most current adopted version of the UBC.

B. Height: Install top of trim 78 inches above finished floor, unless otherwise noted on drawings.

C. Provide filler plates for unused spaces in panelboards.

D. Provide typed or neatly hand printed 4-1/2x8-inch circuit directory for each panelboard, in the format as shown on the drawings. Revise directory to reflect circuiting changes required to balance phase loads.

### 3.02 QUALITY CONTROL

A. Owner reserves the right to witness any of the following tests conducted by the contractor and shall be notified in advance of these tests. Test in accordance with Specification 16920 – ELECTRICAL ACCEPTANCE TESTING.

B. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Maintain proper phasing for multi-wire branch circuits.

### 3.03 FINAL SUBMITTALS

A. After completion of the installation, wiring and testing, submit the following information within two weeks of the equipment acceptance.
   1. As-Built Panel Schedules.
   2. Copy of the certified test report described in Section 3.02.

END OF SECTION

SECTION 16475

MINI POWER CENTERS

## PART 1 - GENERAL

### 1.01 SCOPE OF WORK

A. This section covers electrical Mini Power Centers.

B. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

### 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, 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.

## 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 two 5% full capacity primary taps below normal and shall be rated 115 degF temperature rise above 40 degF maximum ambient. All insulating materials are to be in accordance with current NEMA ST 20 standards for a 185 degF 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 Eaton, Square D/Schneider Electric, or equal.

## 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.

B. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

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 Eaton, Square D/Schneider Electric, Allen-Bradley, General Electric, or equal.

B. Circuit breaker frame, trip, short circuit, and interruption ratings shall be as indicated on the Drawings, except that they shall be coordinated with the ratings of the equipment actually furnished, and shall be modified where necessary to suit the equipment. Circuit breakers to be used in motor control centers shall be as indicated on the Drawings. Where no indication of type is given on the Drawings circuit breakers protecting motors shall be motor circuit protectors, and other circuit breakers shall be molded case type.

C. Circuit breaker for mounting in motor control centers, or for separate mounting shall be of the air break type, quick make and quick break, 600 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 UL 489.

H. Molded case circuit breakers shall be ambient temperature compensating that provides inverse time delay overload and instantaneous short circuit protection by means of a thermal magnetic element. Compensation shall be accomplished by a secondary bi-metal that will allow the breaker to carry rated current between 25 degrees C and 50 degrees C with tripping characteristics that are approximately the same throughout this temperature range.

I. On breakers with interchangeable, thermal, adjustable magnetic trip, the accessibility and position of the adjustment knob shall not be changed from those on the standard breaker.

J. Unless mounted in a switchboard, or panelboard, circuit breakers shall be housed in a NEMA rated enclosure as described elsewhere in these specifications.

K. Provide circuit breakers with shunt trip mechanisms where shown on the Drawings.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

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

END OF SECTION

SECTION 16482

SOLID STATE MOTOR CONTROLLERS

## PART 1 - GENERAL

### 1.01 SCOPE OF WORK

A. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

### 1.02 SUMMARY

A. Section Includes
   1. Solid state motor controllers (SSMC) for use with NEMA Design "B" 460 VAC motors to reduce the current inrush as well as mechanical shocks that can result from starting or stopping a motor across the line.
   2. This section pertains to stand-alone solid state motor controllers in addition to those provided as part of a Motor Control Center.
   3. Provide SSMC fully assembled as part of a Motor Control Center or as a standalone controller, ready for field installation, testing, and startup.

B. Related Sections include but are not necessarily limited to:
   1. Section 16000 Electrical: Basic Requirements.
   2. Section 16161 Control Panels.
   3. Section 16170 Grounding.
   4. Section 16902 Electrical Controls, Relays, and Alarms.

### 1.03 SUBMITTALS

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

### 1.04 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.

1.05 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.

1.06 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.

1.07 WARRANTY

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

PART 2 - PRODUCT

2.01 MANUFACTURERS

A. Eaton

B. Allen-Bradley

C. Square-D/Schneider Electric

D. Engineer and Owner approved equal.

2.02 GENERAL DESCRIPTION

A. Provided in a configuration suitable for panel mounting.

B. Uses a thyristor bridge consisting of at least two SCRs per phase to control the starting and stopping of industry standard motors. A soft start/current limit will be obtained by a timed voltage ramp of the thyristors. The thyristors will be controlled in such a manner that a smooth and stable acceleration ramp is ensured, independent of motor load.

C. Controlled by a microprocessor that continuously monitors the current and thyristor phasing of the starter.

D. All soft start power ratings shall use the same control module.

2.03 RATINGS

A. Designed to operate in an ambient temperature of 0º to 50 º C.

B. Storage temperature range shall be -25 º to 70 º C.

C. Maximum relative humidity shall be 93% at 40 º C, non-condensing.

D. Designed to operate in attitudes up to 3300 feet. For higher altitudes, derate by 1.2% for each additional 330 feet.

E. Capable of operation within -15% to +10% of nominal voltage rating and automatically adapt for 50 or 60 Hz.

F. Capable of supplying 300% of rated full load current for 60 seconds at maximum ambient temperature.

G. The SCRs shall have a minimum P.I.V. rating of 1400V. Lower rated SCRs with "protection" by MOVs will not be acceptable.

2.04 ADJUSTMENTS AND CONFIGURATIONS

A. All dialog functions, display units, remote functions, terminal blocks, configuration switches and adjustment potentiometers shall be accessible on the front of the control module. Exposure to control circuit boards or electrical power devices during routine adjustments shall be prohibited.

B. Dialog indication shall provide, as a minimum, the following conditions:
   1. Soft start ready for start.
   2. Soft start starting/stopping motor.
   3. Soft start running at full voltage.
   4. Thermal pre-alarm condition.
   5. Thermal fault.

6. Soft start internal fault.
7. Power supply fault.

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

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

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

## 2.05 PROTECTION

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

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

## 2.06 CONTROL OPTIONS

A. Provide lockable disconnecting means to isolate the SSMC from incoming power. 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, 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. SSMC shall be equipped for control via Ethernet/IP and/or Modbus TCP. At a minimum start and stop capabilities are required, as well as monitoring of all signals described in 2.04B.

## 2.07 SHORTING CONTACTOR

A. A microprocessor shall control the operation of the shorting contactor via an output relay.

B. The shorting contactor shall close, shorting the thyristors after the motor current is below 130% of motor FLA and voltage is below nominal voltage (indicating the acceleration ramp is complete), and open on a stop command to allow a deceleration ramp or DC injection stop.

C. Overload protection shall continue to protect the motor when shorting is used.

## 2.08 BRAKING CONTACTOR

A. If required by contract drawings, a microprocessor shall control the operation of the braking contactor via an output relay.

B. If an overload condition occurs during the injection brake period, braking shall

continue as set. When braking is complete, restart shall be prohibited until the motor has cooled.

2.09 ISOLATION AND BYPASS CONTACTORS

A. If required by contract drawings, provide NEMA rated three-pole isolation contactor to completely isolate the SSMC from the incoming power in the event of a shorted SCR or another defined fault condition.

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

PART 3 - EXECUTION

3.01 INSTALLATION

A. Mount the SSMC in accordance with manufacturer's recommendations.

B. Provide sufficient clearance for air circulation and operation of any vent fans or cooling equipment.

C. Install conduit, pull and terminate all power and control conductors.

3.02 TESTING

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

END OF SECTION

SECTION 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.

B. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

### 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.

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 and shall be supplied with the 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.

## 2.02 ACCESSORIES

A. The transfer switch shall be equipped with the following:
   1. Nominal 0 to 6 second time delay to override momentary normal source outages and delay all transfer and generator starting signals.
   2. An adjustable time delay from 0 to 60 minutes for controlled timing of transfer of loads to standby power source to allow for adequate motor shutdown.
   3. Two time delay modes, individually field adjustable from 0 to 60 minutes time delay to retransfer to normal source One delay shall be for normal power failures and the other for the test mode function.
   4. Differential protection on 3 phases. Dropout and pickup.
   5. Test switch.
   6. Auxiliary contacts which close in normal position. Two sets of contacts shall be provided.
   7. Auxiliary contacts which close in standby position. Two sets of 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.
B. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).
C. Interior and exterior lighting shall use LED technology unless otherwise shown on the drawings or in the specifications.

1.02 QUALITY ASSURANCE

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

B. Miscellaneous:
   1. Lamps are identified for each luminaire in the Lighting Fixture Schedule on the Drawings.
   2. Lighting fixtures and electrical components:
      a. UL labeled, complete with lamps.
      b. Rated for area classification as indicated.
   3. Location of lighting fixtures on Drawings are intended to be used as a guide.
      a. Field conditions may affect actual locations.
      b. Coordinate with other trades to avoid conflicts in mounting of fixtures and other equipment.

4. The quality standard is established by the fixture listed in the Lighting Fixture Schedule.
    a. This quality standard includes, but is not necessarily limited to construction features, materials of construction, finish, and photometrics.
5. LED lighting systems manufacturer shall have a minimum of 10 years' experience producing LED lighting systems.

1.03 SUBMITTALS

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

B. Contractor shall submit shop drawings, manufacturer's data sheets, and a complete wiring diagram detailing all connections to the electrical system in accordance with Section 16000, and other requirements of the Contract Documents.

C. Submit warranty: Products specified herein shall have a 5 years warranty on complete mechanical assembly, electrical components of LED lamps, drivers, and fixture body.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Luminaires, fixtures, and lamps shall be manufactured by Eaton, General Electric,

Lithonia, Phillips, or equal.

B. Lighting fixtures shall be provided as indicated on the Lighting Fixture Schedule on the Drawings.

C. Light poles shall be as indicated on the Drawings. Include base template, anchor bolts, cadmium-plated hardware and pole grounding lug, handhole, anchor base and bolt covers. Pole foundations shall be as indicated on the Drawings.

2.02 MATERIALS

A. General:
   1. Lamps:
      a. See lighting fixture schedule on Drawings for wattage, voltage and number required.
   2. All Fixtures:
      a. There shall be no live parts normally exposed to contact.
      b. LEDs shall be high efficiency with minimum output of 100 lumens per watt.
      c. LEDs and driver system lifespan shall be greater than 50,000 hours.
      d. LED color temperature shall be warm white in the range of 2700-3500 Kelvin. Mixing of color temperatures with different LEDs is not permitted.
      e. LED drivers or fixtures shall have inrush current limiting circuits or devices to prevent tripping of breakers on startup or switching of LED lighting loads.
      f. Outdoor LED systems shall be protected by UL 1449 listed surge-protection devices.
      g. LED drivers shall be electronic, labeled as compliant with radio frequency interference (RFI) requirements of FCC Title 47 Part 15, comply with NEMA SSL 1, have a sound rating of "A," and be rated for a THD of less than 20% at all input voltages with a minimum power factor of 0.90.
      h. When intended for use in wet area mark fixtures "suitable for wet locations."
      i. When intended for use in damp areas mark fixtures "suitable for damp locations" or "suitable for wet locations."
      j. In wet or damp area, install fixtures so that water cannot enter or accumulate in the wiring compartment, lamp holder or socket, or other electrical parts.
      k. Gasket seals: Urethane foam
      l. Diffusers: UV stabilized acrylic plastic
   3. Underground wiring:
      a. Provide all wiring runs with separate green grounding conductor.
      b. Ground all pole bases.

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

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. Install, test, and commission lighting contactor controls, motion sensors, photocell controls, astronomical time clock controls, and switches as shown on the Drawings.

B. Replace all failed lamps with new lamps prior to final acceptance by Owner.

C. Surface and flush mounted fixtures shall be solidly connected to a junction box. Suspended fixtures shall be hung utilizing pendant mounting or stainless steel chains and hooks. Each suspended fixtures, shall be electrically connected by a length of Type SO flexible cord. 3 conductor No. 14 AWG, minimum, with a twist-lock receptacle mounted in an individual junction box. Plugs and receptacles shall be as manufactured by Hubbell, General Electric Company, or equal.

D. Provide mounting brackets and/or structural mounting support for fixtures.
   1. Do not support fixture from conduit system.
   2. Do not support fixture from outlet boxes.

E. Install with approved mounting hardware following manufacturer's recommendations.

F. Pole mounted fixtures shall be mounted on steel or aluminum poles as indicated on the Drawings. All metal poles shall be bonded to the facility ground system. Poles shall have adequate handholes and weatherproof receptacles where indicated.

G. All anchor bolts and nuts shall be stainless steel and insulated to prevent galvanic corrosion between dissimilar metals.

H. Fixture mounting heights and locations indicated on the Drawings are approximate and are subject to revision in the field where necessary to avoid conflicts and obstructions.

### 3.02 ADJUSTING AND CLEANING

A. Wipe all lighting fixture reflectors, lenses, lamps, and trims clean after installation and prior to acceptance of Project by Owner.

END OF SECTION

SECTION 16505

SURGE PROTECTIVE DEVICES (SPD)

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section specifies Surge Protective Devices (SPD).

B. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

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. Electrical and mechanical drawings which show unit dimensions, weights, mounting provisions, connection details and layout diagram of the unit.
   3. Certification of the MCOV 1-hour burn-in.
   4. Certification from an independent laboratory of single-pulse surge current ratings.
   5. A copy the UL 1449 compliance document showing UL 1449 Suppression Ratings.
   6. Certification of life-expectancy testing.

1.03 QUALITY ASSURANCE

A. Comply to the latest applicable following codes and standards:
   1. IEEE (PC62.41.3 and C62.45);
   2. NFPA 70 (NEC), 75 and 78;
   3. NEC (240.21 and 110.9);
   4. 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 25 years.

1.04 WARRANTY

A. The manufacturer shall provide a limited ten (10) 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. Eaton
   2. Current Technology
   3. Liebert
   4. Advanced Protection Technologies
   5. Or equal.

### 2.02 ELECTRICAL REQUIREMENTS

A. Provide SPD 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. 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 IEEE PC62.41's 8 x 20 microsecond current waveform, 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-N + L-G) | L-N | L-G | N-G |
| MAIN SPD | 250,000 | 150,000 | 100,000 | 100,000 |

| SURGE CURRENT CAPACITY | | | | |
|---|---|---|---|---|
| PRODUCT | AMP CLASS (L-N + L-G) | L-N | L-G | N-G |
| PANELBOARD SPD | 160,000 | 80,000 | 80,000 | 80,000 |

E. ANSI/UL 1449 Latest Edition Voltage Protection Rating (VPR) – The maximum ANSI/UL 1449 VPR for the device shall not exceed the following:

| MODES | 208Y/120 | 480Y/277 | 600Y/347 |
|---|---|---|---|
| L-N; L-G; N-G | 700 | 1200 | 1500 |
| L-L | 1200 | 2000 | 3000 |

F. The system shall be tested and capable of protecting against and surviving at least 6,000 IEEE PC62.41 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.

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-E220B 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 SPD 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
   2. Line to ground
   3. Neutral to ground

G. Each SPD shall include a disturbance counter for both common mode (L-G) and normal mode (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 and Owner.

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.

C. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

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 (power factor). 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 per control circuit.

1.03 MANUFACTURERS

A. Generator set shall be manufactured by Caterpillar, Cummins, Kohler or approved equal.

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 (or as indicated on plans), 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 MG1-2016 - 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. The fuel storage tank shall be a subbase type, with integral secondary containment, gauges, piping, fittings, and valves shall be supplied as part of the generator set. The fuel storage tank shall be aboveground and an integral part of the generator. The fuel tank shall be U.L. listed.

I. The tank shall be provided with a level gauge and a level transmitter in the primary tank, and leak detection in the secondary tank capable of producing low level and leakage alarm.

J. The tank shall be of sufficient capacity to run the generator set at full load for a minimum of 24 hours.

K. The level gauges shall be Liquidometer industrial type as manufactured by Hersey Products Company, Petro Meter Company, or equal.

L. An engine mounted fuel filter, fuel pressure gauge, and engine fuel priming pump shall be provided.

M. A DC electric starting system with positive engagement drive shall be furnished.

N. 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.)

O. 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.

P. 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.

Q. 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 ensure 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. AC Voltmeter, (3-phase, line to line and line to neutral).
   2. AC Ammeter (3-phases).
   3. Voltmeter/Ammeter phase selector switch.
   4. AC Frequency meter.
   5. Emergency Stop Switch: Switch shall be a red “mushroom head” pushbutton device, complete with lock-out tag-out provisions. Depressing switch shall cause the generator set to immediately stop the generator set and prevent it from operating.
   6. DC voltmeter (alternator battery charging).
   7. Automatic starting controls.

8. Panel illumination lights and switch.
9. Voltage level adjustment rheostat.
10. Engine lubricating oil pressure gauge.
11. Engine coolant temperature gauge.
12. Dry contacts for remote alarms wired to terminal strips for the following:
    a. Run status.
    b. In Auto status.
    c. Common Fault alarm.
    d. Low Fuel Level alarm.
    e. Fuel Leak alarm.
13. Fault indicators for low oil pressure, high water temperature, overspeed, and overcrank.
14. Provide necessary communications adapters to facilitate communication for remote monitoring and control of the generator via RS-485, Ethernet, or cellular modem using Modbus RTU, Ethernet/IP, or ModbusTCP protocols as indicated on plans.
15. Four position function switch marked AUTO, MANUAL, OFF/RESET, and STOP.
16. Running time hour meter.

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 PANELBOARDS (FOR GENERATORS GREATER THAN 500KW)

A. The generator system shall be equipped with a 120/240 volt, single phase, 100 amp (min.) rated 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 amps minimum unless indicated otherwise on Drawings.

C. All devices requiring power inside the generator system including interior lighting package, 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.

E. Generators 500KW or less shall be provisioned with necessary electrical distribution provisions to allow all devices requiring power inside the generator to be powered from (1) 120V and (1) 208/240V power feed from site electrical distribution system. Provisions shall be in compliance with requirements defined in latest adopted version of NEC.

## 2.05 WEATHERPROOF SOUND ATTENUATING ENCLOSURE

A. Provide a sound attenuating weatherproof 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 bolt holes 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) as measured from center of generator, whichever is the most stringent.

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 fuel 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

B. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

1.02 RELATED SECTIONS

A. Section 16000 - General Electrical Requirements

B. Section 16160 – Enclosures

1.03 REFERENCES

A. NEMA ICS 1-2000 - Industrial Control and Systems: General Requirements.

B. NEMA ICS 2-2000 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.

C. NEMA ICS 6-1993 - Industrial Controls and Systems: Enclosures.

D. UL 506 – UL Standard for Specialty Transformers.

1.04 SUBMITTALS

A. Data - a complete list of equipment and material including manufacturer's descriptive data and technical literature, performance charts, catalog cuts and installation instructions, spare parts data for each different item of equipment specified. The data shall include a complete Bill of Materials.

B. Drawings - containing complete wiring and schematic diagrams, control diagrams,

and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Drawings shall show proposed layout, anchorage, support and appurtenances of equipment and equipment relationship to other parts of the work including clearances for maintenance and operations.

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

1.05 PROJECT RECORD DOCUMENTS

A. Submit record documents in accordance with the Contract Documents.

B. Accurately record actual locations of control equipment. Revise diagrams included in Drawings to reflect actual control device connections.

1.06 OPERATION AND MAINTENANCE DATA

A. Submit operation data in accordance with the Contract Documents.

B. Include instructions for adjusting and resetting time delay relays, timers, and counters.

C. Submit maintenance data in accordance with the Contract Documents.

D. Include recommended preventative maintenance procedures and materials.

PART 2 - PRODUCTS

2.01 PUSHBUTTONS AND SELECTOR SWITCHES

A. Pushbuttons, pilot lights and selector switches shall be of the full size (30mm), 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 Eaton, Square D/Schneider Electric, Allen Bradley, General Electric, or equal.

2.02 RELAYS

A. TIMING RELAYS shall be heavy duty, have 250V/5A rated contacts, solid state design, poles as required per application, -10°C to +60°C, have timing repeatability of ±2.0% of setting, and be UL listed. The range shall be determined from the control descriptions and or schematic drawings. Provide mounting accessories, as required. The timing relays shall be manufactured by Eaton, Allen Bradley, Square D/Schneider Electric, or equal.

B. CONTROL RELAYS shall be of the plug-in socket base type with dust-proof plastic enclosures, with silver-cadmium oxide contacts rated 250-volt, 10 amperes, with contact arrangement and operating coils of the proper voltage as required by the control circuit sequence. Relays shall have indicating 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 Eaton, Allen Bradley, Square D, or equal.

C. ALTERNATING RELAYS shall be UL listed, 120 VAC, with contacts rated for 10 amperes at 250 VAC, life expectancy of 100,000 operations, load indicating LEDs, and switch for load locking and load selecting options. Alternating relays shall be manufactured by TimeMark Corporation models 261, 271, and B471, ATC Diversified Electronics model ARA, or equal.

2.03 ALARMS

A. AUDIBLE ALARMS shall be UL listed, 120 VAC, with solid state circuitry, vibrating horn, non-metallic corrosion resistant housing, with required mounting hardware, suitable for outdoor use capable of producing 100 dB at 10 feet. The audible alarm shall be manufactured by Federal Signal model 350, Edwards model 870-EX, or equal.

B. ROTATING BEACONS for interior and/or exterior locations shall be UL listed, 120 VAC, rotating lights at 60 times per minute minimum with required mounting hardware. Lens color shall be verified at the time of construction. The rotating beacons shall be manufactured by Federal Signal model 371LED or equal.

C. ROTATING BEACONS for corrosive and/or hazardous locations shall be UL listed, 120 VAC, with solid state circuitry, rotating lights at 60 times per minute minimum, suitable for outdoor use with halogen bulb capable of producing 265 lumens with required mounting hardware. Lens color shall be verified at the time of construction. The rotating beacons shall be manufactured by Edwards model 52 or equal.

D. STROBE BEACONS shall be UL listed, NEMA 4X, 12-24VDC or 120 VAC as indicated on drawings, flashing at 80 times per minute minimum, producing peak candlepower of 520,000, effective candlepower of 165, with required mounting hardware. Lens color shall be verified at the time of construction. The rotating beacons shall be manufactured by Federal Signal model 151XST, or equal.

2.04 INTRINSIC SAFETY BARRIERS

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

2.05 WIREWAYS

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

2.06 WATTHOUR TRANSDUCERS

A. WATTHOUR TRANSDUCERS for active or reactive power shall be DIN rail and surface mount, single phase or three phase with balanced or unbalanced load,

electrically isolated input and output signals, 4 to 20 mA output signal, 1 to 6 A input current, 100 to 690 VAC input voltage. The watthour transducers shall be manufactured by Camille Bauer Sineax model P530/Q531, or equal.

2.07 ELAPSED TIME METERS AND TIME CLOCKS

A. ELAPSED TIME METERS shall be self-powered, non-reset, solid state counter which provides silent, accurate and noise immune operation. Elapsed time meters shall require no external power, five year minimum battery life, 120 VAC power, accessories for panel mounting, nameplate below LCD display reading "HOURS", liquid crystal display with 6 digits approximately 2 inches high with 99,999 hour minimum display life and indication of sufficient battery power. The elapsed time meters shall be manufactured by Eaton, or equal.

B. TIME CLOCKS shall be microprocessor based, have 24 hour time control, up to 24 operations per day, programmable from panel face keys, skip-a-day feature allowing schedule to be skipped for one to seven days, SPDT switch contact rated at 15 amps at 120 V AC, with battery carryover to maintain time and program during power outage for 275 hours. The time clocks shall be manufactured by Tork, or equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Fasteners shall be type 304 stainless steel.

B. Install devices in strict accordance with NEC requirements and per 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 16903

PROGRAMMABLE LOGIC PROCESS CONTROLLERS

## PART 1 - GENERAL

### 1.01 SCOPE OF WORK

A. This section covers the programmable logic controller (PLC) used for control and monitoring, as indicated on Drawings.

B. Provide software support and debugging time for a period of fifteen (15) days after start-up of the equipment under PLC control.

C. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

### 1.02 SUBMITTALS

A. Submit product data in accordance with Section 16000, and the Contract Documents.

B. Submittals shall include the following:
   1. Manufacturer's data on electrical characteristics, capabilities and physical properties.
   2. 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. PLC ladder logic program complete with I/O memory map and addressing, I/O module physical slot locations, and cross-referenced list of program elements such as contacts, coils, timers, and other devices. The PLC program shall be documented with symbol names for each program element or device, and comments shall clearly describe the logic for no more than 3 rungs of ladder logic. This submittal shall be provided for review prior to field start-up of the equipment under PLC control. The Contractor shall make corrections to the program logic as requested by the Owner, or the Engineer, and resubmit the document for review and approval.

### 1.03 MANUFACTURERS

A. The PLC shall be manufactured by Allen-Bradley, or approved equal.

PART 2 - PRODUCTS

2.01 PROGRAMMABLE LOGIC CONTROLLER

A. PLCs shall be furnished with hardware and software necessary to monitor and control equipment, as listed in the Specifications, and shown on the Drawings. Each field input and output shown as an I/O Point shall be connected as per manufacturer's recommendations. Additionally, the Contractor shall provide the hardware, software, and installation necessary for connecting additional future equipment as indicated on the Drawings. The type of field input and output shall be defined as follows:
   1. Analog inputs and outputs (4 20 mA DC).
   2. Discrete inputs (dry contact).
   3. Discrete outputs (24 VDC, form "C" relay)

B. The ladder logic control programs shall reside in the PLCs. The program shall consist of software relay and attendant logic control. Control narratives, loop or logic flow diagrams, or process control descriptions shown on the Drawings, provided in the specification, or Control Descriptions listed herein, shall be fully implemented.

C. The programmable controllers shall be supplied with extended functions communication interface. No programmable controller will be accepted unless the programmable controller supplier can document, to the satisfaction of the Owner and the Engineer, that the supplier has communication interfaces, along with the required software; all of which are standard, off the shelf products, that allow full communication between networks of programmable controllers, and personal computers.

2.02 CENTRAL PROCESSING UNIT (CPU)

A. The PLC CPU shall be a microprocessor based industrial controller with a minimum temperature rating of 0 to 60 degrees C, and a minimum humidity rating of 5 to 85 percent non-condensing. The CPU shall have non-volatile EEPROM or flash memory storage for user programmed instructions and program documentation. The memory capacity shall be large enough to store the ladder logic program, plus a minimum of 200% extra memory for program expansion.

B. The PLC shall have register memory which shall retain information on power failure. Each location shall be capable of storing 16 bits of data. This information shall represent process set points, timer and counter presets, accumulated values, positions, or other measured process variables. User program memory shall be a minimum of 2MB.

C. Program control and logic functions shall be solved sequentially during each CPU scan. The scanning tasks shall include, at a minimum:
   1. Update of time reference from a built in real-time clock.

2. Diagnostic self test of PLC to include input and output.
3. Reset watchdog timer which shall be used to verify correct functioning of the PLC and which shall be preset to 100 to 250 milliseconds.
4. Scan 1K of logic in less than 1 millisecond.

D. The CPU shall have an I/O capacity of 2048 points, 64 analog loops, and be capable of addressing a minimum of 15 local and remote I/O racks.

E. LED indicators shall display RUN, CPU FAULT, FORCED I/O, BATTERY LOW, and RS232 status information.

F. A network interface module, mounted in the PLC rack, or integral port within the CPU, shall be provided to communicate with other PLCs on a network, or a master SCADA computer running operator interface or programming software.

2.03 INPUT/OUTPUT MODULES

A. Analog inputs and outputs shall have a minimum of 12 bits resolution. Analog modules shall be configurable for 4 to 20 mA DC, or 1 to 5 Volt DC signals. Provide external, or user power, as needed.

B. Each discrete output shall be fused, with fuse blown indicators on each module. Indicator lights shall also be provided on each I/O point to indicate status of each signal. Each individual input or output point shall be optically isolated to protect the controller I/O circuitry from high voltage transients. External wiring shall terminate on removable terminal strips, or swing arms to allow quick installation, or extraction of I/O modules without disconnecting field wiring. Labels shall be provided on modules or wiring arms that indicate the I/O address of each termination.

C. The power supply shall provide power for the processor, and I/O modules. The power supply shall have built in overvoltage and under voltage detection circuitry, protection against overcurrent conditions, and automatic power up sequence that enables outputs only when proper operating tolerances are reached. Power requirements shall be 120 VAC, or 24 VDC.

D. Provide a minimum of 25% spare I/O of each type connected to terminals for future expansion.

E. The I/O rack system shall be field expandable to the maximum I/O capacity of the CPU, without modifications of the processor. Blank, or empty slots shall have covers, or filler plates installed.

F. The PLC system shall be provided with modular remote I/O, connected to the CPU via a dedicated remote I/O port, and be able to communicate over a shielded twisted

pair cable at rate of one million bits per second, or greater.

2.04 STORAGE AND DOWNLOADING OF PLC PROGRAMS

A. The PLC shall be programmable through an RS-232 port, or Ethernet port, connected to a personal computer through a standard cable. The latest version of the PLC programming software shall be provided with the user's manuals, original diskettes or external drive, and licensing agreement for registration by the Owner. Cables, adapters, connectors, or other hardware required to connect to the PLC shall be provided to the Owner.

B. The PLC programming software shall enable the user to write the PLC program on-line or off-line. The software shall include utilities to manage PLC program files, document and print the programs, configure the programming environment, monitor and force the PLC addresses while on-line, and configure the PLC memory and addressing structure.

C. The PLC programming software shall the provide the ability to create custom logic function blocks based on object oriented programming standards. Function blocks may be embedded in ladder logic, or programs may be written using only function blocks. Libraries of function blocks shall be available for use and modifiable to suit any application.

PART 3 - EXECUTION

3.01 INSTALLATION

A. PLC shall be installed as indicated on the drawings and according to the manufacturer's instructions.

3.02 START UP AND TESTING

A. 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.

B. The PLC program and I/O shall be thoroughly tested. Each input and output signal shall be tested for correct indication and control function. The Contractor shall demonstrate operation of the PLC control logic with simulated inputs, before the entire system is started, and run in automatic mode.

C. 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.

D. Proportional-Integral-Derivative (PID) loops shall be tested and tuned to provide stable control over the process variable.

3.03 TRAINING

A. Provide four (4) hours of training on the control system. Instruction shall include a description of the control system operation. Teach the Operators how to make control system parameter changes (set points, timer values, etc.), and show them how to enter passwords to make these changes.

3.04 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.

END OF SECTION

SECTION 16906

REMOTE TELEMETRY UNIT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes
   1. Remote Telemetry Unit (RTU) cabinet used for monitoring and control of process variables and for communicating process status to a remote Supervisory Control and Data Acquisition System (SCADA) via radio or other communication path.
   2. Programming of the Programmable Logic Controller (PLC) within the RTU.

B. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

1.02 REFERENCES

A. All RTU control panels shall be UL 508A listed.

1.03 DEFINITIONS

A. RTU Remote Telemetry Unit

B. PLC Programmable Logic Controller

C. OIT Operator Interface Terminal

D. SCADA Supervisory Control and Data Acquisition System

E. HMI Human Machine Interface

F. FAT Factory Acceptance Test

1.04 SYSTEM DESCRIPTION

A. Provide a fully functional system for monitoring and controlling the process including the RTU, all programming, 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” RTU 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 RTU layout.
   5. Cable and connector details for all communication cables including Ethernet, RS-232, RS-485, vendor proprietary (Ethernet/IP, ModbusTCP, etc.), and radio-to-antenna cabling.
   6. Comprehensive bill of materials complete with description, manufacturer, model, part number, 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 on USB Flash Drives in Adobe PDF searchable format including tabs, table of contents, index, manufacturers literature for all components provided, list of recommended spare parts, and factory acceptance test certification.
   2. Label documentation cover page with OWNER’s project name, number, the name, address, phone number, and shop order of the RTU fabricator.
   3. Manuals must be provided for each RTU panel, and be submitted, reviewed and approved by the Owner and Engineer prior to final acceptance of the RTU.

1.06 QUALITY ASSURANCE

A. Work to be performed by qualified contractor having a minimum of 10 years experience in the design, fabrication, installation, and programming of RTUs and control systems.

1.07 DELIVERY, STORAGE, HANDLING

A. Store RTU and all related hardware 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 themself 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 SCHEDULING

A. Coordinate supply, installation, and commissioning with other trades.

1.10 WARRANTY

A. All parts and components of the RTU for 24 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. All custom programming for the PLC, OIT, and SCADA system shall be supported during the warranty period. If the programming problem prevents the facility from operating in the 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.

C. If a new revision of any purchased software is released during the software support period provided by the software manufacturer, provide this new revision to OWNER at no additional cost to OWNER.

1.11 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.

1.12 COMMISSIONING

A. Provide personnel, tools, equipment, and accessories to fully test, debug, and commission the RTU and associated components. Specifically:
   1. Validate that each I/O point is properly terminated and wired to the correct card and channel within the PLC.
   2. Validate that all I/O is properly addressed and represented within the PLC and OIT.
   3. Validate that all PLC programming functions as intended.
   4. Validate that all OIT and SCADA programming functions as intended.
   5. Validate that all communication paths including radio, cellular, modem, and hard-wired network cables function as intended.
   6. Demonstrate to OWNER that these requirements have been met.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

A. PLC
   1. Allen-Bradley Model CompactLogix 5069-L320ER
   2. Approved equal.

B. OIT
   1. Allen-Bradley Model 9” PanelView Plus 7
   2. Approved equal.

C. Power Supplies - Enclosed
   1. IDEC
   2. Phoenix Contact
   3. Approved equal

D. Terminal Blocks
   1. Allen-Bradley
   2. Phoenix Contact
   3. Weidmuller
   4. Entrelec
   5. Approved equal

E. Relays
   1. Allen-Bradley
   2. Cutler-Hammer
   3. IDEC
   4. Approved equal

F. Signal Conditioners
   1. Moore Industries
   2. Phoenix Contact

3. Action Instruments
4. Approved equal

G. Surge Protectors
1. EATON MTL Surge Technologies
2. Phoenix Contact
3. Approved equal.

H. Enclosures
1. NVENT Hoffman
2. Rittal
3. Hammond Manufacturing
4. Approved equal.

I. Air Conditioners
1. Kooltronic
2. Hoffman Cooling (McLean)
3. Approved equal

J. Uninterruptible Power Supplies
1. EATON Powerware
2. Schneider Electric APC
3. Approved equal

2.02 EXISTING PRODUCTS

A. If the RTU will be installed as a node in an existing SCADA system, all hardware and software must match the OWNERS existing equipment.

2.03 MATERIALS

A. All materials shall be new and the manufacturers most current model unless contractor is matching older existing units as required by 2.02.A.

2.04 MANUFACTURED UNITS

A. The RTU shall be constructed with off-the-shelf components, available from local venders and Factory tested as a complete unit and UL listed.

B. Provide ventilation or air conditioning to maintain the internal temperature of the RTU enclosure below the maximum recommended operating temperature of any of its components.
1. If RTU is located indoors in an environmentally controlled room, flow through ventilation is acceptable.

2. Non ventilated enclosures are allowed if the interior of the RTU cannot exceed the manufacturers recommended operating temperature for any RTU component.
3. If RTU is located outside, provide an air conditioning unit with thermostat controls on the RTU. Air conditioner must be suitable for the environment. If RTU is located in a wet and/or corrosive environment, air conditioner must be weatherproof and corrosion resistant.
4. In all cases, provide a high temperature switch set at 90 degrees F within the RTU and wire it to a PLC digital input so that over temperature conditions may be remotely monitored.

## 2.05 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 non-volatile EEPROM or flash memory 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 OIT, radio, and other external devices.
5. Remote I/O communication modules if remote I/O is used.
6. Digital input cards shall be 24 volts DC, 16 or 32 channel, sinking style.
7. Digital outputs shall be 24 volts DC, 8 or 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 isolated channel.
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.
12. Provide one copy of the PLC programming software licensed to the Owner including one year of software support from the manufacturer.
13. The PLC programming software shall be provided with the user manuals, original disks or external USB drive, and licensing agreement for registration by the Owner. Cables, adapters, connectors, or other hardware required to connect to the PLC shall be provided to the Owner.

### B. 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.

### C. 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.

D. 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.

E. 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 RTU components due to failure or inadequacy of the surge protector to be remedied by contractor at no additional cost to OWNER.

F. Enclosures
1. Sized to adequately house all RTU 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 padlockable latch or handle.
4. NEMA rating in accordance with environment. Indoors shall be NEMA 12. Out of doors under weather shall be NEMA 4. 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.

G. 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.

H. 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.

I. Uninterruptible Power Supply (UPS)
1. UPS shall provide a pure sine wave output.
2. Capable of supporting complete RTU operation for a period of not less than 30 minutes after loss of normal 120 VAC power.
3. Provided with batteries and accessories to form a complete system.

2.06 ACCESSORIES

A. Internal LED light with door mounted switch.

B. Isolated ground bus.

C. Service receptacle rated 125 volts at 15 amps for connection of programming terminals.

D. Dedicated receptacle for air conditioner.

E. Surge arrestor on incoming power.

F. Circuit breakers and fuses rated for available fault current and sized per NEC for the supplied load.

2.07 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.

2.08 FABRICATION

A. The RTU enclosure, and all system components contained within, shall be UL listed

as an assembly at the Factory.

2.09 FINISHES

A. Unless specified otherwise in this document, standard factory finish is acceptable.

2.10 SOURCE QUALITY CONTROL

A. Contractor to have a documented Quality Assurance/Quality Control program and to validate that the RTU was 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 PREPARATION

A. Provide a radio path survey report, performed by a qualified technician, containing the following information:
   1. Path profile.
   2. Predicted fade margins in dBs.
   3. In-field radio check of pathway.
   4. Antenna height and gain necessary for dependable reception.

3.04 INSTALLATION

A. Provide housekeeping pad or other means of support.

B. Firmly anchor RTU to housekeeping pad or support structure in accordance with seismic and structural support requirements of local UBC.

C. Ground RTU in accordance with contract drawings and the NEC.

D. Pull and terminate all conductors.

E. Install antenna mast and antenna. Pull and terminate radio cable.

F. Energize, test, leave ready for operation.

3.05 CONSTRUCTION

A. All equipment, components, and accessories to be installed in accordance with manufacturers recommendations.

B. Mount all components to RTU sub-panel allowing sufficient room for wire terminations, labeling, and ventilation and in accordance with approved shop drawings.

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 RTU is located in or for all analog inputs if RTU is located out of doors.

G. Provide shelf or other means of support for the radio.

H. Provide shelf for UPS or install in bottom of the RTU.

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. Mount external components including OIT and air conditioner.

M. Ground all panel and sub-panel components in accordance with the NEC. Terminate all shield grounds to the isolated ground bus.

3.06 REPAIR/RESTORATION

A. Touch up any paint or damage to enclosure, sub-panel, or components.

3.07 CLEANING

A. Wipe down enclosure, sub-panel, and components.

B. Vacuum loose debris or blow out with low pressure air.

3.08 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 RTU and test for short circuits and incorrect wiring. Test every I/O point using a circuit simulator to demonstrate that wiring is correct. Download PLC and OIT programs and demonstrate successful communications between them. 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 RTU 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 startup 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 of the remote SCADA system and demonstrate successful operation to OWNER.

I. Turn over to OWNER all software licenses, documentation, shop manuals, and spare parts.

J. Provide document certifying successful startup testing to OWNER.

K. Provide four (4) hours of training on the control system. Instruction shall include a description of the control system operation. Teach the Operators how to make control system parameter changes (set points, timer values, etc.), and show them how to enter, and change passwords to make these changes.

3.09 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. Standby generator
c. Automatic transfer switch
d. Main distribution panel
e. Motor control centers
f. Switchgear, low and medium voltage
g. Panelboards, power and lighting/receptacle
h. Transformers, dry type and oil filled
i. Feeders
j. Cables rated 600 volts and higher
k. Transfer switches, manual and automatic
l. Transient voltage surge suppression systems
m. Grounding and bonding system
n. Lighting fixtures and associated controls
o. Other systems as listed under Part 3 of this specification

C. Related Documents
1. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 1 Specification sections, apply to the work of this section.

2. All work performed under this Section of the work is subject to all requirements contained under Section 16000 “General Electrical Requirements”.
3. All Division 16 specifications for electrical equipment provided for this project that requires electrical acceptance testing.

1.02 REFERENCES

A. NETA ATS – Acceptance Testing Specifications, 2017 Edition

B. NFPA 70 – National Electrical Code, 2017 Edition

C. Incorporated by reference all Codes, Standards, and Specifications referred to in the “APPLICABLE REFERENCES” section of NETA ATS-2017.

1.03 DEFINITIONS

A. NETA InterNational Electrical Testing Association Inc.

B. NEC National Electrical Code

1.04 SYSTEM DESCRIPTION

A. Conditions
1. Provide all items, articles, materials, operations or methods listed, mentioned or scheduled on drawings and/or herein including all labor, materials, equipment and incidentals necessary and required for Electrical Acceptance Testing.
2. Following established procedures, equipment shall be energized after certification by the testing organization that the installation is satisfactory.
3. Correct or replace any current-carrying circuit, electrical equipment, or system which is defective or grounded and correct all other troubles encountered by these tests. All defects, whether through faulty workmanship or materials furnished, shall be corrected under this Section at the Contractors expense.

1.05 SUBMITTALS

A. Test Report Forms
1. All test reports shall be submitted using NETA or approved similar format and, where appropriate, test forms. Reports shall be legible using permanent ink. Pencil is not acceptable.
2. Provide for engineers review and approval a copy of each test form to be used on the project. No testing shall be started prior to approval of all test forms.
3. All test reports shall include the following information:

a. Summary/Description of the Project
b. Description of equipment tested.
c. Description of the tests.
d. Test data and analysis of the data indicating whether the equipment passed or failed the test.

4. All test data records shall include the following minimum requirements:
   a. Equipment identification including tag numbers.
   b. Humidity, temperature, and other conditions that may affect the results of the tests and/or calibrations.
   c. Date of inspections, tests, maintenance, and/or calibrations.
   d. Identification of the testing technician and their employer.
   e. Indication of inspections, tests, maintenance, and/or calibrations to be performed and recorded.
   f. Indication of expected results when calibrations are to be performed.
   g. Indication of "as-found" and "as-left" results, as applicable.
   h. Sufficient spaces to allow all results and comments to be indicated.

B. Closeout Submittals

1. Provide one copy each to engineer and owner of all testing reports organized as follows:
   a. Bind report in 3-ring binder(s).
   b. Identify project name, description, testing organizations name, and submittal date on front face and back cover of binder.
   c. Provide all test reports, organized by equipment tag number.
   d. Separate different equipment numbers with colored or numbered tabs.
   e. Provide an index/table of contents.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

A. Any materials provided as part of the testing shall be new, unused, and in manufacturer's original packing.

### 2.02 TEST INSTRUMENT CALIBRATION

A. Contractor performing the testing shall have a calibration program which assures that all applicable test instruments are maintained within rated accuracy for each test instrument calibrated.

B. Contractor performing the testing shall maintain up-to-date instrument calibration instructions and procedures for each test instrument calibrated.

C. It is preferred that instrument calibration accuracy be directly traceable to the

national Institute of Standards and Technology (NIST).

D. Instruments shall be calibrated in accordance with the following frequency schedule:
   1. Field instruments: Analog, 12 months maximum. Digital, 12 months maximum
   2. Laboratory instruments: 12 months maximum
   3. Leased specialty equipment: 12 months maximum.

E. Dated calibration labels shall be visible on all test equipment.

F. Records, which show date and results of instruments calibrated or tested, must be kept up to date.

G. Calibrating standard shall be better accuracy than that of the instrument tested.

## PART 3 - EXECUTION

### 3.01 QUALIFICATIONS

A. It is preferred that the testing organization shall be an independent, third party entity which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems being evaluated. When such testing organization is used, it must meet the following requirements:
   1. The testing organization shall be regularly engaged in the testing of electrical equipment, devices, installations, and systems.
   2. The testing organization shall use technicians who are regularly employed for testing purposes.
   3. The testing organization shall be a member of NETA or be able to prove qualifications equal to or better than required for membership in NETA.
   4. Submit appropriate documentation demonstrating that the testing organization meets the requirements listed above.
   5. Technicians performing these electrical tests and inspections shall be trained and experienced concerning the apparatus and systems being evaluated. These individuals shall be capable of conducting the tests in a safe manner and with complete knowledge of the hazards involved. They must evaluate the test data and make a judgment on the serviceability of the specific equipment.
   6. Technicians shall be certified in accordance with ANSI/NETA ETT-2000, “Standard for Certification of Electrical Testing Personnel”. Each on-site crew leader shall hold a current certification, Level III or higher, in electrical testing.

B. Contractor may perform the electrical acceptance testing under the following

conditions:

1. Contractor's personnel performing the testing and their testing equipment meets all other requirements of this specification.
2. Written approval is received from engineer after review of testing personnel qualifications. At a minimum, contractor's testing personnel must have specific instruction on the testing instruments, accessories, and tests being performed and must be able to evaluate the test results.

3.02 NOTIFICATION

A. Notify engineer and construction manager at least ten (10) days prior to testing so that they may be present during testing.

3.03 SAFETY AND PRECAUTIONS

A. Safety practices shall include, but are not limited to, the following requirements:
   1. Occupational Safety and Health Act OSHA
   2. Accident Prevention Manual for Industrial Operations, National Safety Council, Chapter 4
   3. Applicable State and Local safety operating procedures
   4. NETA Safety/Accident Prevention Program
   5. National Fire Protection Association –NFPA 70E
   6. ANSI Z244.1 American National Standards for Personnel Protection

B. All tests shall be performed with apparatus de-energized except where otherwise specifically specified.

C. The testing firm shall have a designated safety representative on the project to supervise operations with respect to safety.

3.04 EQUIPMENT TESTING REQUIREMENTS

A. The intent of this specification is not to duplicate testing performed at the point of manufacture or to impose additional burden on the contractor which does not benefit the project. The intent is to verify that electrical equipment has been securely fastened down, supported, and installed in accordance with the manufacturer's requirements. The intent is also to verify that all electrical connections are correctly torqued, properly aligned, properly insulated, and properly supported and that equipment is clean and ready for operation.

B. Except as noted below or as approved by engineer, test the following equipment and assemblies in full accordance with NETA-ATS 2017.

C. Switchgear and Switchboard Assemblies

D. Transformers, Dry Type, Air-Cooled, Low-Voltage, Small

E. Transformers, Dry Type, Air-Cooled, Large

F. Transformers, Liquid-Filled

G. Cables, Low-Voltage, 600 Volt Maximum
   1. Perform tests only on cables size #4 AWG and larger.

H. Cables, Medium-Voltage and High-Voltage

I. Metal-Enclosed Busways

J. Switches, Air, Low-Voltage
   1. Perform tests only on switches rated 100 amps or higher.

K. Switches, Air, Medium-Voltage, Metal-Enclosed

L. Switches, Oil, Medium-Voltage

M. Switches, Vacuum, Medium-Voltage

N. Switches, Cutouts
   1. Perform tests only on equipment rated 100 amps or higher.

O. Circuit Breakers, Air, Insulated-Case, Molded-Case
   1. Perform visual and mechanical inspections in accordance with NETA for all circuit breakers.
   2. Perform electrical tests only on circuit breakers rated 100 amps or higher provided in power distribution and lighting/receptacle panelboards.
   3. No testing is required for circuit breakers provided as part of any of the following:
      a. A UL listed control panel.
      b. UL listed factory supplied motor control centers.
      c. Stand-alone combination motor starters.

P. Circuit Breakers, Air, Medium Voltage

Q. Circuit Breakers, Oil, Medium Voltage and High Voltage

R. Circuit Breakers, Vacuum, Medium Voltage

S. Circuit Switchers

T. Network Protectors, 600 Volt Class

U. Protective Relays

V. Metering Devices

W. Regulating Apparatus, Voltage, Step and Induction Voltage Regulators

X. Regulating Apparatus, Load Tap-Changers

Y. Grounding Systems

Z. Ground-Fault Protection Systems, Low-Voltage

AA. Rotating Machinery, AC Motors and Generators
1. Motors provided as part of valve actuators do not require testing.
2. Perform visual and mechanical inspections on all motors.
3. Perform rotation tests on all motors.
4. Perform electrical tests only on motors 50 horsepower and larger.

BB. Motor Control, Motor Starters, Low-Voltage

CC. Motor Control, Motor Starters, Medium-Voltage

DD. Adjustable Speed Drive Systems

EE. Direct-Current Systems, Batteries, Flooded and Valve-Regulated Lead-Acid

FF. Direct-Current Systems, Chargers

GG. Surge Arresters, Low-Voltage Surge Protection Devices

HH. Surge Arresters, Medium- and High-Voltage Surge Protection Devices

II. Capacitors and Reactors – All Types

JJ. Outdoor Bus Structure

KK. Emergency and Standby Power Systems, Engine Generator

LL. Emergency and Standby Power Systems, UPS

MM. Emergency and Standby Power Systems, Automatic Transfer Switches

NN. Fiber-Optic Cables

3.05 CONSTRUCTION

A. Interface with Other Work
   1. Coordinate all testing activities with other disciplines. Retest any equipment disturbed or damaged in any manner after initial testing.

3.06 CLOSEOUT REPORT

A. Provide comprehensive bound test report in accordance with Part 1 of this specification.

END OF SECTION

# DIVISION 17

# 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 the following as shown on the drawings:
   a. Provide all instruments.
   b. Provide all control panels, PLC panels, SCADA consoles.
   c. Provide all communication equipment required to make the control system fully operational including but not limited to radios, antennas, switches, routers, hubs, protocol converters, communication cables, and communication racks and power supplies.
   d. Provide all conduit, conductors, enclosures, materials, and labor to fully interconnect and make operational all control system components.
   e. Provide power at proper voltage and ampacity to all system components.
   f. Provide startup and commissioning assistance.
   g. Train Owner's personnel on proper use and maintenance of the control systems.
   h. Other equipment, materials, and work as necessary to achieve a fully tested and operational control system.

B. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

C. Products Supplied But Not Installed Under This Section
1. None

D. Products Installed But Not Supplied Under This Section
1. Instruments and controls provided loose for field installation by packaged equipment or skid-mounted equipment vendors.
2. Existing equipment to be relocated as shown on the drawings.

E. 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.

F. Allowances
   1. Not applicable this section.

G. Unit Prices
   1. Not applicable this section.

H. Measurement Procedures
   1. Not applicable this section.

I. Special Payment Procedures
   1. Not applicable this section.

J. Alternates/Alternatives
   1. ENGINEER must approve all alternates, alternatives, or proposed substitutions of materials or equipment.

1.02 REFERENCES

1.03 DEFINITIONS

A. The word “provide” means “furnish and install”.

B. PLC means Programmable Logic Controller.

C. SCADA means Supervisory Control and Data Acquisition System.

1.04 SYSTEM DESCRIPTION

A. Design Requirements
   1. Using sound engineering principals and current best design practices, provide engineering drawings and design documents specifying system components and detailing their interconnection and installation.

B. Performance Requirements
   1. The instrumentation and control systems shall be furnished and installed complete and ready to operate, including all necessary interconnections and connections to sources of electrical power, air, water, drains and vents, with all required valves, switches and accessories as specified or as recommended for best operation by the manufacturer of the equipment furnished.

1.05 SUBMITTALS

A. General
   1. Submittals for the equipment shall be provided in accordance with Section 16000, and as required elsewhere in the Contract Documents.

B. Product Data
   1. Detailed catalog information for all system components in sufficient detail so that ENGINEER has sufficient information to determine if the equipment is acceptable for the intended purpose. Minimum information shall be:
      a. Instrument or Equipment tag number
      b. Manufacturer
      c. Model number
      d. Materials of construction
      e. Materials in contact with process fluids
      f. Dimensional information
      g. Weight
      h. Power consumption with required voltage and ampacity
      i. Heat dissipation if greater than 200 watts
      j. Process connection information detailing connection size, type (threaded, flanged, socket weld, etc…)
      k. Recommended mounting details
      l. Recommended spare parts for one year of operation
   2. Instrument Data Sheets in ISA S20 format for all instruments.

C. Shop Drawings
   1. For complex control systems consisting of mechanical, electrical, and control components, provide the following:
      a. A Piping and Instrument Diagram in ISA format
      b. Electrical load calculations with conduit and conductor sizing
   2. For integrated control panels or control assemblies, provide the following:
      a. Dimensioned layout of the control enclosure and mounted equipment and instruments.
      b. Full bill of material for all components with detailed catalog information on all components.
      c. 11”x17” fully developed schematic diagram(s) showing power and control wiring, terminal block assignments, and identifying field and enclosure wiring. Provide a drawing index and symbols and legend sheet with all schematics. Show all I/O card details including rack, slot, channel numbers, field termination points, and control power wiring. Label all conductors and identify conductor size and color. Identify all field devices by tag number and by description. Provide over current protection in accordance with NEC requirements.
      d. 11”x17” instrument loop drawings in ISA format for all analog control loops. Alternatively, multiple loops may be combined on a single analog input or analog output I/O card schematic diagram.
      e. Nameplate legend
      f. Paint color and type for painted assemblies
   3. Any special installation details.

D. Samples
   1. Not applicable for this section

E. Quality Assurance/Control Submittals
   1. Design Data, Test Reports

a. Submit calibration sheets for all field instruments containing the following information:
    1) Instrument tag number.
    2) Instrument manufacturer and model number.
    3) Person who performed the calibration.
    4) Manufacturer, model, and serial number of the calibrating device.
    5) Date that calibrating device was last calibrated.
    6) For analog instruments, process range and associated analog signal in at least 5 increments (For example: 4.00 maDC/0 psig, 8.00 maDC/25 psig, 12.00 maDC/50 psig, 16.00 maDC/75 psig, 20.00 maDC/100 psig).
    7) For switches, process values at which the switch changes state and at which the switch resets.
    8) For instruments calibrated by manufacturer, manufacturer's calibration report is acceptable as proof of calibration.
b. Factory acceptance test reports on all fabricated control panels or assemblies containing the following information:
    1) Date of test.
    2) Test participants.
    3) Visual inspection of components.
    4) Successful application of power.
    5) Validation of all internal wiring.
    6) Validation of correct control operation.
    7) Validation of screen graphics or alarm operation (if applicable).
    8) Validation of program installation into PLC's and that I/O is functioning properly (if applicable).

2. Certificates, Manufacturer's
    a. UL 508 certification for all assembled control panels and assemblies
3. Instructions, Manufacturer's Field.
    a. Furnish a complete Operations and Maintenance Manual for all assembled control panels and assemblies.
4. Reports
    a. Not applicable to this section.

F. Closeout Submittals
1. Furnish Operations and Maintenance Manuals in 3-ring binders complete with the following:
    a. On front and spine of binders provide the project name, owners name and project number.
    b. Within the binder, identify the contractor and provide contact information
    c. Inside binders, provide a volume index and table of contents for each binder. Each instrument or control component tag number must be cross referenced to a specific binder tab.
    d. Furnish manufacturers complete operations and maintenance manuals for all discrete instruments and controls.
    e. Furnish custom Operations and Maintenance section for each custom control system, control panel, or fabricated assembly.

f. Furnish “As-Built” loop and wiring diagrams.
g. Furnish the written warranty.

2. Turn over all spare parts to owner with documentation showing which instrument or control system the spare parts are for.

G. Schedule

1. Submit a detailed work schedule showing start/finish dates, task duration, task sequencing, critical path, and available float. Identify task predecessors and identify coordination activities with other trades.

H. Startup and Commissioning Plan

1. Submit a detailed startup and commissioning plan for review by Owner and Engineer. Plan should include the following information:
   a. The order in which the various plant systems will be started up.
   b. What work must be performed prior to the startup.
   c. What documentation will be maintained by the contractor and provided to the owner validating that the startup was performed in a safe and efficient manner.

## 1.06 QUALITY ASSURANCE

A. Qualifications

1. Contractor performing the work shall have a minimum 5 years’ experience performing similar work in similar industries. All contractors’ personnel shall be trained and experienced in best current construction practices.

B. Regulatory Requirements

1. Perform all work in accordance with all applicable national and local codes.

C. Certifications

1. Not applicable this section.

D. Field Samples

1. Not applicable this section.

E. Mock-Ups

1. Not applicable this section.

F. Pre-Installation Meetings

1. Not applicable this section.

## 1.07 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading

1. Perform these activities in a manner which assures instruments and equipment will arrive undamaged and in proper working order. Replace any instrument or equipment damaged upon arrival at no additional cost to owner.

B. Acceptance at Site
   1. Maintain a comprehensive log by instrument or equipment tag number of all received instruments or equipment.

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

1.08 PROJECT/SITE CONDITIONS

A. Environmental Requirements
   1. Follow any and all environmental requirements pertaining to the site.
   2. Maintain a safe and clean job site.
   3. Dispose of all trash and construction debris in an approved manner.

B. Existing Conditions
   1. Contractor is to examine the site and be thoroughly familiar with any site requirements which may affect the work or storage of instruments or equipment.

1.09 SEQUENCING

A. Coordinate all work with other trades.

1.10 SCHEDULING

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

1.11 WARRANTY

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

g. Other system malfunctions which prevent or impair the plant from operating at design capacity, requires excessive operator intervention, or results in unsafe operating conditions.

## 1.12 SYSTEM STARTUP/COMMISSIONING

A. General

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

B. System Startup Sequence

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

7. Verify PID loop operating correctly (either direct or reverse) and adjust gain constants to achieve critically damped operation.
8. Configure the mechanical system for normal operation and leave system ready for normal operation.
9. Utilize colored tagging scheme to identify startup condition. Red is not ready for startup, yellow is mechanically and electrically ready but not yet tested or started up, and green is fully tested and ready for normal operation. Place these tags on all mechanical, electrical, instrumentation, and control components of each system.
10. As plant systems are started up, coordinate and remedy any coordination or interface issues between systems.

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

1.13 OWNER'S INSTRUCTIONS

A. Not applicable this section.

1.14 MAINTENANCE

A. Extra Materials
1. Not required this section.

B. Maintenance Service
1. Not required this section.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

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

2.02 EXISTING PRODUCTS

A. Not applicable this section.

2.03 MATERIALS

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

2.04 MANUFACTURED UNITS

A. Manufactured units are to be fully assembled and tested at the point of manufacture and delivered to the job site ready for installation and start-up.

B. Regulated dc power supplies for instrument loops shall be designed and arranged so that loss of one supply does not affect more than one instrument loop or system. Power supplies shall be suitable for an input voltage variation of plus or minus 10 percent, and the supply output shall be fused or short circuit protected. Output voltage regulation shall be as required by the instrumentation equipment being supplied. Multi-loop, or multi-system power supplies, will be acceptable if backup power supply units are provided which will automatically supply the load upon failure of the primary supply. The backup supply systems shall be designed so that either the primary or backup supply can be removed, repaired, and returned to service without disrupting the instrument system operation.

C. The power distribution from multi loop supplies shall be selectively fused such that a fault in one instrument loop will be isolated from the other loops being fed from the same supply. Fuses shall be clearly labeled and located for easy access. Multi loop supply systems shall be oversized for an additional 10 percent future load. Failure of a multi loop supply shall be indicated on the respective instrument panel or enclosure.

2.05 EQUIPMENT

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

2.06 COMPONENTS

A. Not applicable this section.

2.07 ACCESSORIES

A. Not applicable this section.

2.08 MIXES

A. Not applicable this section.

2.09 FABRICATION

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

2.10 FINISHES

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

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

2.11 SOURCE QUALITY CONTROL

A. Fabrication/Tolerances
1. In accordance with generally accepted manufacturing standards.

B. Tests, Inspections
1. In accordance with generally accepted manufacturing standards.

C. Verification of Performance
1. Not applicable this section.

PART 3 - EXECUTION

3.01 ACCEPTABLE INSTALLERS

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

3.02 EXAMINATION

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

3.03 PREPARATION

A. Protection
1. Not applicable this section.

B. Surface Preparation
1. Not applicable this section.

3.04 ERECTION

A. Provide 4-inch-tall reinforced concrete housekeeping pads for all control panels and floor mounted fabricated control assemblies and consoles. Dowel into concrete base and extend a minimum of 2” past edges of equipment.

B. Provide Unistrut or fabricated structural supports for heavy equipment or assemblies. Prime and paint supports so that they are unaffected by the environment in which they are installed.

C. Securely fasten all panels and assemblies to their housekeeping pads or structural supports.

D. All interconnecting wiring shall be run in conduit in accordance with the division 16 sections requirements.

3.05 INSTALLATION

A. Install all instruments and controls in accordance with manufacturer’s recommendations and all applicable electrical codes and standards. Connect all required utilities including electrical power, air, hydraulics, water, and communications as required.

B. Provide stainless steel tags for each instrument engraved with instrument tag number. Attach to instrument with stainless steel wire.

C. Provide engraved nameplates for all panel mounted instruments. Attach to panel with stainless steel screws.

3.06 APPLICATION

A. Not applicable this section

3.07 CONSTRUCTION

A. Special Techniques
   1. In accordance with manufacturers recommended installation procedure.

B. Interface with Other Work
   1. Coordinate with all other trades.

C. Sequences of Operation
   1. Not applicable this section.

D. Site Tolerances
   1. Not applicable this section.

3.08 REPAIR/RESTORATION

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

3.09 RE-INSTALLATION

A. Not applicable this section.

3.10 FIELD QUALITY CONTROL

A. Site Tests
   1. Test and calibrate instrumentation in accordance with other parts of this section.

B. Inspection
   1. Not required this section.

C. Manufacturer's Field Services
   1. If recommended by manufacturer, have equipment/control systems inspected, tested, and started up by manufacturer's representative.

3.11 ADJUSTING

A. Not required this section.

3.12 CLEANING

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

3.13 DEMONSTRATION/TRAINING

A. In accordance with the Startup part of this section.

B. Provide training of personnel in the operation and maintenance of the furnished control systems.

C. Training shall be provided as required elsewhere in the Contract Documents, but shall consist of at least eight hours, in a single, or multiple sessions, to accommodate the personnel schedules.

D. Coordinate with the Engineer, and the Owner, to schedule the training sessions at least 5 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 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.

C. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

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

## PART 2 - PRODUCTS

### 2.01 PRESSURE TRANSMITTER

A. Provide pressure transmitters with ½-inch NPT process connection, block and bleed valve,

and local LCD indicator scaled in engineering units.

B. Transmitters shall be of a two-wire type, 24 VDC powered, producing a 4 to 20 mA output proportional to the calibrated pressure range of the instrument. Transmitters shall be capable of driving a minimum of a 500-ohm loop load.

C. Instrument accuracy shall be within +/- 0.75 percent of calibrated span.

D. Transmitters shall have external zero and span adjustment for field calibration.

E. Instrument housing shall be NEMA 4 rated or NEMA 6P rated if any potential for instrument submersion exists. Instrument wetted parts shall be 316 stainless steel or hastiloy C based on process fluid being measured.

F. Diaphragm seals:
   1. Provide fill/bleed screw to permit filling of instrument and diaphragm seal.
   2. Process Connection: ½-inch NPT.
   3. Filling fluid: Silicone
   4. Provide a clean-out ring which holds the diaphragm captive in the upper housing to allow the upper housing assembly to be removed for recalibration or cleaning of the process side housing without the loss of filling liquid or change in calibration.
      a. ¼-inch NPT flushing connection.
   5. Top housing shall be type 316 stainless steel.
   6. Complete diaphragm seal assembly, including gage, transmitter, shall be factory assembled, filled and calibrated to the ranges specified prior to shipment.
   7. System supplier shall be responsible for assuring that fill volumes and sensitivities of the supplied seals and diaphragms are suitable to provide the required gage or transmitter accuracy over the specified measurement range.
   8. Diaphragm seals shall be as manufactured by Ashcroft or equal.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. Equipment and materials specified in this section shall be installed, connected, and tested in accordance with the manufacturers' recommendations, 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.

C. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

### 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:
   1. NEC
   2. NEMA

### 1.03 SUBMITTALS

A. Submit product information cut sheets containing manufacturer's specifications, Operations and Maintenance data, instrument enclosure type, installation location, and process pressure range to be supplied. Indicate product part number in full.

B. Provide submittals in accordance with Section 16000, and elsewhere in the Contract Documents.

## PART 2 - PRODUCTS

### 2.01 PRESSURE SWITCHES

A. Pressure switches shall be capable of dual control with independent set points and adjustable deadbands. Differential pressure switches shall be capable of single control with adjustable

set points and adjustable deadband. Switches shall be snap action, single-pole, double-throw switching elements with an electrical rating of at least 10 amperes at 120 VAC. Pressure switches shall be enclosed in a NEMA 4 or weatherproof housing.

B. Operating pressures and set points shall be determined in the field, unless otherwise indicated on the Drawings.

C. Set points shall be fully adjustable and shall be in the middle of the working range. Set point adjustments shall be made with adjustment screws or thumbwheels. Accuracy shall be plus or minus one percent of adjustable range.

D. For pressures up to 150 PSIG pressure sensing element shall be of the diaphragm or bourdon tube type, and shall have a proof pressure of at least twice the maximum working pressure. For pressures above 150 PSIG, sensing element shall be bourdon tube type. Diaphragms or bourdon tubes shall be stainless steel.

E. Pressure switches shall be installed with individual ball valves for isolation. Valve material shall be compatible with the process piping and process fluid. In addition, process piping up to the sensor shall be insulated to protect against freezing.

F. Setpoint accuracy: +/- one percent of span.

G. All wetted parts shall be rated for fluid being measured.

H. Pressure switches shall be as manufactured by Mercoid Controls Series DAW, Barksdale Control Products Series D2H, or equal.

I. Differential pressure switches shall be as manufactured by Mercoid Controls Series DPAW, Barksdale Control Products Series DPD1T, or equal.

J. Diaphragm seals:
   1. Provide fill/bleed screw to permit filling of instrument and diaphragm seal.
   2. Process Connection: ½-inch NPT.
   3. Filling fluid: Silicone
   4. Provide a clean-out ring which holds the diaphragm captive in the upper housing to allow the upper housing assembly to be removed for recalibration or cleaning of the process side housing without the loss of filling liquid or change in calibration.
      a. ¼-inch NPT flushing connection.
   5. Top housing shall be type 316 stainless steel.
   6. Complete diaphragm seal assembly, including gage, transmitter, shall be factory assembled, filled and calibrated to the ranges specified prior to shipment.
   7. System supplier shall be responsible for assuring that fill volumes and sensitivities of the supplied seals and diaphragms are suitable to provide the required gage or transmitter accuracy over the specified measurement range.
   8. Diaphragm seals shall be as 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 17137

MAGNETIC FLOWMETERS

PART 1 - GENERAL

1.01 SCOPE OF WORK

A. This section covers the Magnetic Flowmeters to be provided where indicated on the Drawings.

B. Related work specified elsewhere includes, but is not limited to section 16000 Electrical. Also, refer to requirements of Contract Documents for testing, adjusting and balancing of systems.

C. Build America, Buy America (BABA) Requirement – comply with requirements of Build America, Buy America Act (2 CFR Part 184).

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. Materials:
   1. All mounting hardware shall be 316 stainless steel, flow sensor liner shall be Polyurethane, and electrode material shall be 316 stainless steel.

B. Transmitter configuration whether remote mount style or integral mount, shall be as

indicated on drawings.

C. Design and fabrication
1. Utilize characterized field principle of electromagnetic induction to produce signal directly proportional to flow rate.
2. Provide flanged end connections per ANSI B16.5 - 2017 rated for piping system operating and test conditions.
3. Operating pressure: 100 psi (min.).
4. Transmitter/display ambient temperature range: -4 to 122 deg. F (min.).
5. Allowable process temperature range: -4 to 122 deg. F (min.).
6. Grounding requirements:
   a. Nonmetallic or lined pipe:
      1) Inlet and outlet grounding rings of same material as electrode.
   b. Conductive piping:
      1) Conductive path between the meter and the piping flanges.
7. Provide cable between magnetic flowmeter and transmitter (N/A for applications requiring integral mount transmitter).
8. Pulsed DC magnetic field excitation.
9. Adjustable low flow cutoff.
10. Transmitter: NEMA 4X rated.
11. Capable of being equipped with a communications module to facilitate communications via Ethernet/IP protocol.
12. 4-line backlit display with touch control and guided menus.
13. Empty pipe detection to prevent false measurement when tube is empty.
14. Accuracy:
    a. +/- 0.5 percent of reading.
15. Flow rate signal: isolated, 4-20 mA output capable of driving a 0-700-ohm load.
16. Scaled totalized flow pulse output.
17. Power supply: 100-240V AC 60 Hz, or 24V DC or AC 60 Hz, as required by application.
18. Fluid conductivity range: 5 to 10,000 µS/cm/cm.

D. Acceptable Manufacturers:
1. Endress + Hauser Promag W 400
2. Or Equal.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

A. Equipment and materials specified in this section shall be installed and connected as specified, and as shown on the Drawings. The Contractor shall coordinate the installation with the other trades, to insure proper installation of the flow element, transmitter, and

associated conduit and cables.

B. The Contractor shall calibrate the instruments to the proper ranges, as required by the Owner and the Engineer. Where analog signals are connected to local, or remote monitoring equipment, the Contractor shall verify that the calibrated ranges and scaling of the local and remote indicators are correct.

3.02 ACCEPTANCE

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

3.03 SPARE PARTS

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

END OF SECTION