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- D. Copper and Copper Alloy Pipe, Tubing, and Fittings:
1. Copper tubing shall be seamless, and conform to, ASTM B88 (Type K and L).
 2. Fittings shall be commercially pure wrought copper, socket joint, and conforming to ASTM B75 and ANSI B16.22.
 3. The solder used shall be 95-5 wire solder conforming to ASTM B32, Grade 95 TA. Do not use cored solder.
 4. Piping fabrication and installation shall conform to the requirements of Chapter V of ANSI B3 1.3.
 5. Bends in soft temper tubing shall be long sweep, wherever possible. Bends shall be shaped with bending tools and shall be made without appreciable flattening, buckling, or thinning of the tube wall at any point. Tubing shall be cut square and burrs removed. Inside of fittings and outside of tubing shall be cleaned with steel wool and muriatic acid before sweating. Take care to prevent annealing of fittings and hard-drawn tubing when making connections. The qualification of brazing procedures, brazers, and brazing operators shall be in accordance with the requirements of Articles XII and XIII, Section IX, ASME Boiler and Pressure Vessel Code.
 6. Buried service air type K copper piping shall be encased in concrete and concrete O.D. shall be 6-inches greater than pipe O.D.
- E. Cast Iron Soil Pipe and Fittings:
1. Above ground:
 - a. Pipe and fittings: Coated service weight cast iron no-hub soil pipe, CISPI 301.
 - b. Gasket (Sleeve): Neoprene rubber, CISPI 301.
 - c. Compression Band: Stainless steel, CISPI 301.
 2. Underground:
 - a. Pipe and fittings: Coated service weight cast iron hub and spigot soil pipe, ASTM A74, ANSI A112.5.1, Federal Spec. WW-P-401e.
 - b. Gasket: Neoprene rubber, CS-188.
- F. Insulating Flanges, Couplings and Unions: Materials and ratings shall be in accordance with the applicable piping system as listed by service in the Piping Schedule. Dielectric flanges and unions shall be as distributed by Epco Sales, Inc., of Cleveland, OH; Capitol Insulation Unions; or equal. Insulating couplings shall be Dresser STAB-39; R. H. Baker Series 216, or equal.
- G. Couplings:
1. Flexible couplings, flanged coupling adapters, or expansion joints shall be provided for piping systems at connections to equipment, and where shown. The Contractor may install additional flexible couplings to facilitate piping installation, provided that it submits complete details describing location, pipe supports, and hydraulic thrust protection.
 2. Acceptable types of couplings for ductile iron pipe are as follows:

- a. Flexible Couplings: Dresser Style 153 or equal, with zinc-plated bolts and nuts. Thrust ties shall be provided to sustain the force developed by 1-½ times the test pressure specified.
- b. Transition Couplings: Transition couplings used to connect pipes with small differences in outside diameter shall be Dresser Style 162, or equal.
- c. Flanged Adapters:
 1. Flanged coupling adapters shall be used for joining plain end cast iron or ductile iron pipe to flanged valves, pumps and fittings. Flanged adapters shall be suitable for working pressures to 150 psig.
 2. Flanged coupling adapters in sizes 12-inches and smaller shall consist of an ASTM 126, Class B cast iron flanged body drilled to mate with a 125 pound cast iron flange per ANSI B16.1, a cast iron follower ring, a rubber-compound, wedge section gasket, a sufficient number of track head and electroplated steel bolts to properly compress the gasket.
 3. Flanged coupling adapters in sizes 12-inches and larger shall consist of a high strength steel, flanged body drilled to mate with a 125 pound cast iron flange per ANSI B16.1, a high strength steel follower ring, a rubber-compound, wedge section gasket, a sufficient number of track head and electroplated steel bolts to properly compress the gasket.
 4. Rubber gasket shall be composed of a resilient synthetic rubber compound suitable for use in wastewater containing oil add grease.

1. Outdoor Piping Systems:

- a. Insulate all service watter piping, valves and fittings with 1" thick Insulation . . . Cover outdoor piping and insulation with 0.016-inch thick aluminum jacket. The jacket shall be held in place by a continuous friction type joint, providing a positive weatherproof seal over entire length of jacket. The circumferential joints shall be secured with preformed snap straps containing weatherproof sealant. Cover outdoor fittings with matching preformed aluminum jackets, two-piece elbows and flange covers, secured with stainless steel bands. Fitting covers shall be as manufactured by Childers, Papco, or equal.

L. Pipe Hangers and Supports:

1. General:

- a. Piping shall be supported, in general, as described hereinafter and as shown by the pipe support details on the Drawings. Manufacturers' catalog figure numbers are typical of the types and quality of standard pipe supports and hangers to be employed. Special support and hanger details are shown to cover typical locations where standard catalog supports are inapplicable.
- b. No attempt has been made to show all required pipe supports in all locations, either on the Drawings or in the details. The absence of pipe supports and details on any drawings shall not relieve the Contractor of the responsibility for providing supports for the piping shown on the Drawings at the spacing specified below.
- c. All submerged piping supports, guides, and fasteners shall be Type 316 stainless steel unless otherwise shown. Concrete anchors and anchor bolts shall also be Type 316 stainless steel.
- d. Where piping connects to equipment it shall be supported by a pipe support and not by the equipment.
- e. Pipe support system components shall withstand the dead loads imposed by the weight of the pipes filled with water, plus any insulation. Commercial pipe supports and hangers shall have a minimum safety factor of 5.

M. Slab, Floor, Wall, and Roof Penetrations and Closures:

1. All piping penetrations of slabs, floors, walls, and roofs shall be ductile iron wall pipes with integrally cast seep rings, unless otherwise noted on the Drawings. It shall be the Contractor's responsibility to verify the size and location of all building and structure penetrations prior to pouring concrete.
 - a. Ductile Iron Wall Pipes:
 1. Provide ductile iron wall pipes where ductile iron piping passes through concrete walls, floors, slabs and roofs, which are to be watertight and where shown on the Drawings. Wall pipe end connections shall be as shown on the Drawings and as specified herein. Wall pipes shall be of a thickness equal to or greater than the remainder of the piping in the line and shall comply with the requirements for fittings in the applicable Specifications. All wall pipes shall be provided with seep rings. Seep rings shall be of ductile iron and cast integral with the wall pipe where offered or catalogued by the manufacturer. All wall pipes that cannot be cast with integral seep rings shall be fabricated by welded attachment of the seep ring to the pipe. All welds shall be done in the manufacturer's shop by qualified welders and shall be electric arc welds of ductile iron to ductile iron with NI-55 or FC-55, nickel-iron-carbon weld rod. The seep ring shall be ductile iron, welded continuously around the pipe on both sides; alternatively, the seep ring shall be steel, as shown in the Standard Details.
 2. Flanges set flush with the face of concrete shall be tapped for stud bolts.
 3. Coat outside wall of pipes as specified in Section 09900, Painting. Support wall pipes by formwork to prevent contact with reinforcing steel.
 - b. Pipe Sleeves:
 1. Piping passing through concrete or masonry shall be installed through galvanized steel pipe sleeves where shown on the Drawings. Holes drilled with a suitable rotary drill will be considered in lieu of sleeves in existing walls.
 2. All sleeves in exterior or water-bearing walls shall have a center flange for water stoppage. The annular space between pipes and sleeves in exterior walls shall be watertight. The joint shall be caulked with rubber sealant, or sealed by a modular mechanical unit consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall sleeve. The interconnected rubber links shall be assembled with zinc phosphate-plated steel bolts and nuts and steel pressure plates under each bolt head and nut to prevent the nut from turning when the bolt is tightened. Tightening of the bolts shall cause the rubber sealing links to expand, resulting in a watertight seal between the pipe and wall sleeve opening. Closures shall be sized according to manufacturer's instructions for the size of pipes shown on the Drawings.
 3. Wall sleeves shall be coated with the appropriate system for the intended location as specified in Section 09900, Painting. When placing non-insulating type wall sleeves in concrete forms, support them by formwork to prevent contact with the reinforcing steel.

N. Polyvinyl Chloride Pipe and Fittings (PVC Gravity Pipe):

1. Polyvinyl chloride pipe shall be of unplasticized compounds suitable for use with wastewater facilities.

O. Flexibility:

1. Unless otherwise specified, piping 2 inches in diameter and larger passing from concrete to

earth or from below a structure to outside of the structure shall be provided with two pipe couplings or flexible joints. The first joint shall be within 2 feet of the face of the structure. The second joint shall be located 2 feet or one pipe diameter (whichever is greater) after the first joint. Where required for resistance to pressure, mechanical couplings shall be restrained as specified elsewhere.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General

1. All exposed piping shall be firmly anchored and supported by pipe supports or anchors as shown or required. Pipe supports shall be furnished as shown on the Drawings or in accordance with the requirements of Paragraph 2.01 M of this section. All pipe shall be carefully placed to the proper lines and grades as shown on the Drawings.
2. Full lengths of pipe shall be used wherever possible. Short lengths of pipe with couplings will not be permitted. Pipe shall be cut to exact measurement and shall be installed without forcing or springing.
3. Lines which slope shall have the right-of-way over lines whose elevations can be changed. Offsets, transitions, and changes in direction in pipes shall be made as required to maintain proper headroom, slope, etc.
4. Piping shall be installed in such manner and at such times as will require a minimum of cutting and repairing of building structures. In case any such cutting or repairing is necessary, it shall be done only with the permission of the Engineer. Cutting and repairing shall be performed by craftsmen of the trade, which originally executed the work, and repairs shall match the original condition.
5. All changes in direction in piping systems shall be made with suitable fittings.
6. When storing and installing pipe, care shall be taken to prevent damage to the pipe coatings. All damaged coatings shall be repaired to the satisfaction of the Engineer.
7. A liberal number of unions and/or flanged joints shall be used to permit the ready removal of any section. Unions shall be installed in all piping connections to equipment, to regulating valves, and wherever necessary to facilitate the dismantling of piping and removal of valves and other items requiring maintenance. Flanges on equipment may be considered as unions.
8. After installation, the interior of all piping shall be cleaned as necessary to remove flux, slag, scale, rust, dirt, oil, and other foreign material. As piping is installed, open ends shall be covered or plugged as necessary to prevent the entrance of foreign matter and to maintain the required cleanliness.
9. Changes in pipe size shall be made using reducing fittings, not bushings. If centerline elevation is not specified, use eccentric reducers in horizontal piping. On liquid lines, eccentricity shall be down with top of pipe level. On vapor and gas lines, eccentricity shall be up with bottom level.
10. Indicated locations and sizes of equipment connections are approximate; exact locations and sizes of piping, valves, etc., shall conform to approved shop drawings. Connection sizes shall not be smaller than scheduled size or equipment outlet size, whichever is larger.

11. Required straight runs of piping upstream and downstream of flow measuring devices shall be smooth.
12. Minimum pipe cover shall be 3 feet, as measured from the pipe barrel, unless otherwise indicated on the Drawings.

B. Installation of Steel Piping:

1. Pipe threads shall be concentric with the outside of the pipe and shall conform to ANSI B2.1. When threading stainless steel pipe, dies shall have 20 to 30 degree hook. Finished joints shall have no more than three threads exposed. Before assembly, pipe ends and threads shall be inspected and any defective pieces replaced. All joints shall be properly aligned before connection to prevent thread damage. Pipe dope shall be used on the male threads of all threaded connections. Teflon thread tape shall be applied two threads back from the end of the pipe or fitting to prevent shredding. Excess pipe dope shall be trimmed or cleaned off to provide adherence for paints or coatings. After joining, exposed threads in underground piping shall be given a heavy coat of bituminous paint or other suitable protective compound prior to backfilling.
2. All flanges shall be faced and drilled and shall be true and perpendicular to the axis of the pipe. Flanges shall be cleaned of all burrs, deformations or other imperfections before joining. Flanged joints shall be installed so as to ensure uniform gasket compression. All bolting shall be pulled up to the specified torque by crossover sequence. Where screwed flanges are used, the pipe edge shall not extend beyond the face of the flange, and the flange neck shall completely cover the threaded portion of the pipe. Where slip-on flanges are used, the distance from the end of the pipe to the gasket face of the flange shall not exceed "t" plus ¼-inch, where "t" is the pipe wall thickness. Unless otherwise required, bolt holes shall straddle the vertical and horizontal axes of the pipe. Connections to equipment shall be made in such a way that no strain is placed on the equipment flanges.
3. Flexible bellows-type connectors shall be installed in their undeformed configuration, in accordance with the joint manufacturer's instructions. Control rods shall be installed to permit fully rated expansion joint compression, and to limit expansion joint extension to 1/16-inch.
4. For flanged connections between steel piping and cast or ductile iron piping or valves, steel flanges shall be flat faced and furnished with full-face gaskets, insulating bushings, and, when buried, stainless steel bolts.
5. Where steel pipe is connected to copper tubing, insulating bushings or couplings shall be used to prevent galvanic corrosion.
6. Cut pipe with milling type cutter, rolling pipe cutter, or abrasive saw cutter. Do not flame cut.
7. Ends of pipe in accordance with the type of joint to be made. Dress cut ends of mechanical joint pipe to remove sharp edges or projections, which may damage the rubber gasket. Dress cut ends of pipe for flexible couplings and flanged coupling adapters, as recommended by the coupling or adapter manufacturer. Dress cut ends of push-on joint pipe by beveling, as recommended by the pipe manufacturer.
8. Prior to connecting flanged pipe, the faces of the flanges shall be thoroughly cleaned of all oil, grease, and foreign material. The rubber gaskets shall be checked for proper fit and thoroughly cleaned. Care shall be taken to assure proper seating of the flange gasket. Bolts shall be tightened so that the pressure on the gasket is uniform. Torque-limiting wrenches shall be used

to ensure uniform bearing insofar as possible. If joints leak when the hydrostatic test is applied, the gaskets shall be removed and reset and bolts retightened.

9. Mechanical joint push-on, and restrained joint pipe shall be joined in accordance with the manufacturer's recommendations. Provide all special tools and devices such as special jacks, chokers, and similar items required for proper installation. Lubricant for the pipe gaskets shall be furnished by the pipe manufacturer, and no substitutes shall be permitted under any circumstances.

C. Installation of Sanitary and Waste Drain and Vent Piping:

1. Set sanitary and waste drain and vent piping installed above floor slab true and plumb.
2. Set exposed risers as close to walls as possible.
3. Make roof penetrations watertight.
4. Extend vents at least 1 foot above roof.
5. Properly slope sanitary and waste drainage piping encased in concrete.
6. Coordinate routing of drains through steel reinforcement with affected trades.
7. Make changes of direction in waste piping with combination Y and  bend fittings.
8. Cleanout Fittings and Plugs:
 - a. Install where shown and where required by plumbing code.
 - b. T or Y branches or trap hubs shall be of the same material as the pipe in which they are installed.
 - c.

D. Buried Piping System Thrust Restraint:

1. General: Thrust restraint for all buried ductile iron pressure piping systems shall be accomplished by the use of restrained joints as specified hereinbefore.
2. Buried Pressure Pipelines:
 - a. Thrust restraint shall be capable of restraining the buried pressure pipelines for pressures up to 1-½ times the corresponding hydrostatic test pressures listed in the Piping Schedule.
 - b. Restrained joint type fittings for ductile iron pipe shall be as specified hereinbefore.

E. Pipe Dope:

1. All threaded connections shall be made up using Teflon pipe dope applied to the male threads only.
2. Virgin Teflon thread tape shall be Hercules Packing Company "Herculon", 3-M Company "Scotch No.48", Crane Packing Company "Teflon Thread tape", or equal.
3. Teflon thread paste may be used in place of tape on very large or very small joints.

F. Wall Pipes and Pipe Sleeves:

1. The Contractor shall provide restrained joints for all buried piping, except RCP, with test pressure higher than 20 psig.
2. Wall pipes and pipe sleeves embedded in concrete walls, floors, and slabs shall be embedded as specified in Section 03300, CONCRETE and as shown. Support all pipes embedded in concrete walls, floors, and slabs with formwork to prevent contact with the reinforcing steel.

G. Flexible Couplings, Flanged Coupling Adapters, and Service Saddles:

1. Prior to installation, thoroughly clean oil, scale, rust, and dirt from the pipe to provide a clean seat for the gasket. Care shall be taken that the gaskets are wiped clean before they are installed. If necessary, flexible couplings and flanged coupling adapter gaskets may be lubricated with soapy water or manufacturer's standard lubricant before installation on the pipe ends. Install in accordance with the manufacturer's recommendations. Bolts shall be tightened progressively, drawing up bolts on opposite sides a little at a time until all bolts have a uniform tightness. Workmen tightening bolts shall use torque-limiting wrenches.

H. Insulating Flanges, Couplings, and Unions:

1. Install insulating flanges, couplings, or unions wherever copper and ferrous metal piping are connected, wherever submerged metallic piping is connected to unsubmerged piping, and where shown on the Drawings. Insulated joints connecting submerged piping to exposed piping shall be installed above maximum water surface elevation and before the first pipe support not having coated anchor bolts or adhesive-bonded concrete anchors. All submerged metallic piping shall be isolated from the concrete reinforcement.

3.02 SURFACE PREPARATION AND SHOP PAINTING

- A. All ferrous piping not specified to be galvanized or otherwise coated shall be cleaned and shop primed or coated in accordance with the requirements of Section 09900, Painting.

3.03 FIELD PAINTING

- A. Following installation and testing, all exposed piping, including insulated piping, shall be field primed and painted in accordance with the requirements of Section 09900, Painting.

3.04 PIPING IDENTIFICATION

- A. Piping Systems: Identification of piping systems shall conform to ANSI A13.1, Scheme for the Identification of Piping Systems, unless otherwise specified herein.

3.05 NOT USED**3.06 TESTING**

- A. General: Conduct pressure and leakage tests on all newly installed pipelines. Furnish all necessary equipment and material and make all taps in the pipe, as required. The Engineer will monitor the tests.
- B. Testing New Pipe Which Connects to Existing Pipe: New pipelines, which are to be connected to existing pipe lines shall be tested by isolating the new pipe.

C. Preparation and Execution:

1. Buried Pressure Piping:

- a. Conduct final acceptance tests on buried pressure piping that is to be hydrostatically tested after the trench has been completely backfilled. The Contractor may, if field conditions permit, as determined by the Engineer, partially backfill the trench and leave the joints open for inspection and conduct an initial service leak test. The acceptance test shall not, however, be conducted until all backfilling has been completed.
- b. Buried pressure piping that is to be pneumatically tested or subjected only to an initial service leak test shall have all joints exposed for the acceptance test.

2. Exposed Pressure Piping: Conduct the tests on exposed piping after the piping has been completely installed, including all supports, hangers, and anchors, but prior to insulation.

3. Hydrostatic Leak Tests:

- a. Equipment: Furnish the following equipment for the hydrostatic tests:

Amount	Description
2	Graduated containers
2	Pressure gauges
1	Hydraulic force pump
	Suitable hose and suction pipe as required

- b. Procedure: Water shall be used as the hydrostatic test fluid unless otherwise specified. Test water shall be clean and shall be of such quality as to minimize corrosion of the materials in the piping system. Vents at all high points of the piping system shall be opened to purge air pockets while the piping system is filling. Venting during the filling of the system also may be provided by the loosening of flanges having a minimum of four bolts or by the use of equipment vents. All parts of the piping system shall be subjected to the test pressure specified in the Piping Schedule. The hydrostatic test pressure shall be continuously maintained for time duration specified in pipe schedule and for such additional time as may be necessary to conduct examinations for leakage. Examination for leakage shall be made at all joints and connections. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking. Any visible leakage shall be corrected at the Contractor's sole expense.

D. Buried Water and Wastewater Pressure Lines:

- 1. Some leakage is permissible from buried water and wastewater pressure lines. Consequently, the hydrostatic testing of these pipelines must be conducted in a different manner, as follows:
- 2. Where any section of pipe is provided with concrete thrust blocking, do not make the pressure test until at least 5 days have elapsed after the thrust blocking is installed. If high-early cement is used for thrust blocking, the time may be reduced to 2 days. When testing cement-mortar lined piping, slowly fill the section of pipe to be tested with water and allow to stand for 24 hours under slight pressure to allow the cement-mortar lining to absorb water.

3. Expel all air from the piping system prior to testing and apply and maintain the specified test pressure by means of the hydraulic force pump. Valve off the piping system when the test pressure is reached and conduct the pressure test for 2 hours, reopening the isolation valve only as necessary to restore the test pressure. The pump suction shall be in a barrel or similar device, or metered so that the amount of water required to maintain the test pressure may be measured accurately. This measurement represents the leakage, which is defined as the quantity of water necessary to maintain the specified test pressure for the duration of the test period. No pipe installation will be accepted if the leakage is greater than the number of gallons per hour as determined by the following formula:

$$L = \frac{ND(P)^{1/2}}{7400}$$

In the above formula:

- L = Allowable leakage, in gallons per hour
- N = Number of joints in the length of pipe tested
- D = Nominal diameter of pipe, in inches
- P = Test pressure during the leakage test, in pounds per square inch

- a. The Contractor shall correct any leakage greater than the allowance determined under this formula at the Contractor's sole expense.
4. Pneumatic Leak Tests:
 - a. Equipment: Furnish the following equipment for the pneumatic tests:

Amount	Description
1	Pneumatic compressor separator-dryer system capable of providing oil-free dry air and equipped with one or more full capacity safety relief valves set at a pressure of not more than 105 percent of the required primary test pressure
1	Calibrated test gauge

- b. Procedure:
5. Pneumatic testing shall be performed using accurately calibrated instruments and oil-free, dry air. Tests shall be performed only on exposed piping, but only after the piping has been completely installed, including all supports, hangers and anchors, and inspected for proper installation. All parts of the piping system shall be subjected to the test pressure specified in the Piping Schedule. The Contractor shall recognize the hazards associated with air testing and shall take all necessary precautions to protect test personnel and County's operating personnel. All piping to be tested shall be secured to prevent damage to adjacent piping and equipment in the event of a joint failure. Any appurtenant instruments or devices that could be damaged by the test shall be removed from the piping or suitably isolated prior to applying the test. Prior to starting the test, the Contractor shall notify the Engineer.
 6. A preliminary pneumatic test not to exceed 25 psig shall be applied to the piping system prior to final leak testing, as a means of locating major leaks. Examination for leakage, detected by soap bubbles, shall be made at all joints and connections. After all visible leaks have been corrected, the pressure in the system shall gradually be increased to not more than 1/2 of the test pressure, after which the pressure shall be increased in steps of approximately 1/10 of the test

pressure until the required test pressure has been reached. The pneumatic test pressure shall be continuously maintained for a minimum time of 10 minutes and for such additional time as may be necessary to conduct a soap bubble examination for leakage. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no evidence of leakage. Any visible leakage shall be corrected at the Contractor's sole expense.

- c. Following pneumatic testing, lines which are to carry flammable gases shall be thoroughly purged with nitrogen to assure that no explosive mixtures will be present in the system during the filling process.
5. Initial Service Leak Tests:
 - a. Equipment: Equipment used for initial service leak testing may be the same as that specified under Paragraphs Hydrostatic Leak Tests and Pneumatic Leak Tests hereinbefore.
 - b. Procedure: The initial service leak test shall be performed by gradually bringing the piping system up to normal operating pressure and holding it there continuously for a minimum time of 10 minutes. Examination for leakage shall be made at all joints and connections. Soap bubbles shall be used to detect leaks in pneumatically-tested systems. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking. Any visible leakage shall be corrected at the Contractor's sole expense.
 6. Test Records: Records shall be made of each piping system installation during the test. These records shall include:
 - a. Date of test.
 - b. Description and identification of piping tested.
 - c. Test fluid.
 - d. Test pressure.
 7. Remarks, to include such items as:
 - a. Leaks (type, location).
 - b. Repairs made on leaks.

3.06 INTERIM CLEANING

- A. Care shall be exercised during fabrication to prevent the accumulation of debris within piping sections. All piping shall be examined to assure removal of foreign objects prior to assembly. Shop cleaning may employ any conventional commercial cleaning method if it does not corrode, deform, swell, or otherwise alter the physical properties of the material being cleaned.

3.07 FINAL CLEANING

- A. Following assembly and testing and prior to final acceptance, all pipelines installed under this section, except plant process air lines and instrument air lines, shall be flushed with water and all accumulated construction debris and other foreign matter removed. Flushing velocities shall be a minimum of 2.5 feet per second. Cone strainers shall be inserted in the connections to attached equipment and left there until cleaning has been accomplished to the satisfaction of the Engineer. Accumulated debris shall be removed through drains 2-inch and larger or by dropping spools and valves. Immediately following drainage of flushed lines, the piping shall be air dried with compressed air.

- B. Plant process air and instrument air piping shall be blown clean of loose debris with compressed air.

3.08 CORROSION PROTECTION OF PIPING SYSTEMS

- A. All atmospheric exposed piping and piping components including, but not limited to, pipe hangers, supports, expansion joints, pipe guides, flexible couplings, vent and drain valves and fasteners shall be painted in accordance with Section 09900, Painting, as applicable to the base metal material.
- B. Pipe support systems shall be painted No. 70, light gray, as specified in ANSI Z55.1; Tnemec Co., Inc. No. 2050; or equal.
- C. Corrosion protection for buried piping systems, other than copper piping, is not required.

3.09 CORROSION PROTECTION FOR COPPER PIPING

- A. For Atmospheric Exposed Copper Pipe: Copper piping shall be painted in accordance with Section 09900, Painting System No. 5.
- B. Exterior Coating for Buried Copper Pipe: All buried copper pipe shall be coated by hand taping with pipe tape. The pipe surface shall be solvent cleaned, SSPC-SP 1, and wire brushed, SSPC-SP 3, to remove all dirt and loose rust and mill scale, and immediately primed with the tape manufacturer's recommended primer in accordance with the manufacturer's recommendations. The tape shall be spirally applied to the pipe with a 50 percent overlap minimum after the primer has thoroughly dried. Joints shall be tape wrapped or heat shrink wrapped above grade to permit joint wrapping without contamination. Tape wrapping and heat shrink wrapped are specified under Paragraph MATERIALS.

3.10 DISINFECTION

- A. Pipelines intended to carry potable water shall be disinfected before placing in service. Disinfecting procedures shall conform to AWWA C651-86, as hereinafter modified or expanded.
- B. Flushing: Before disinfecting, flush all foreign matter from the pipeline. Provide hoses, temporary pipes, ditches, etc. as required to dispose of flushing water without damage to adjacent properties. Flushing velocities shall be at least 2.5 fps. For large diameter pipe where it is impractical or impossible to flush the pipe at 2.5 fps velocity, clean the pipeline in place from the inside by brushing and sweeping, then flush the line at the higher velocity.
- C. Disinfecting Mixture:
 - 1. Disinfecting mixture shall be a chlorine-water solution having a free chlorine residual of 50 ppm, minimum. The disinfecting mixture shall be prepared by injecting: (1) A liquid chlorine gas-water mixture; (2) dry chlorine gas; or (3) a calcium or sodium hypochlorite and water mixture into the pipeline at a measured rate while fresh water is allowed to flow through the pipeline at a measured rate so that the combined mixture of fresh water and chlorine solution or gas is of the specified strength.
 - 2. The liquid chlorine gas-water mixture shall be applied by means of a standard commercial solution feed chlorinating device. Dry chlorine gas shall be fed through proper devices for regulating the rate of flow and providing effective diffusion of the gas into the water within the pipe being treated. Chlorinating devices for feeding solutions of the chlorine gas or the gas itself must provide means for preventing the backflow of water into the chlorine cylinder.
 - 3. If the calcium hypochlorite procedure is used, first mix the dry powder with water to make a thick

paste, then thin to approximately a 1 percent solution (10,000 ppm chlorine). If the sodium hypochlorite procedure is used, dilute the liquid with water to obtain a 1 percent solution. The following proportions of hypochlorite to water will be required:

Product	Quantity	Water
Calcium Hypochlorite ⁽¹⁾ (65-70 percent Cl)	1 lb	7.5 gal.
Sodium Hypochlorite ⁽²⁾ (5.25 percent Cl)	1 gal.	4.25 gal.
⁽¹⁾ Comparable to commercial products known as HTH, Perchloron, and Pittchlor.		
⁽²⁾ Known as liquid laundry bleach Clorox and Purex etc.		

4. Point of Application: Inject the chlorine mixture into the pipeline to be treated at the beginning of the line through a corporation stop or suitable tap in the top of the pipeline. Clean water from the existing system or another source shall be controlled so as to flow slowly into the newly installed piping during the application of chlorine. The rate of chlorine mixture flow shall be in such proportion to the rate of water entering the pipe that the combined mixture shall contain 50 ppm of free available chlorine. Valves shall be manipulated so that the strong chlorine solution in the line being treated will not flow back into the line supplying the water. Use check valves if necessary.
5. Retention Period:
 - a. Treated water shall be retained in the pipeline long enough to destroy all nonspore-forming bacteria. With proper flushing and the specified solution strength, 24 hours is adequate. At the end of the retention period, the disinfecting mixture shall have a strength of at least 10 ppm of chlorine.
 - b. Operate all valves, hydrants, and other appurtenances during disinfection to assure that the disinfecting mixture is dispersed into all parts of the line, including dead ends, new services, and similar areas that otherwise may not receive the disinfecting solution.
 - c. Do not place concentrated quantities of commercial disinfectants in the line before it is filled with water.
 - d. After chlorination, flush the water from the permanent source of supply until the water through the line is equal chemically and bacteriologically to the permanent source of supply.
 - e. Disposal of Disinfecting Water: Dispose of disinfecting water in an acceptable manner that will protect the public and publicly used receiving waters from harmful or toxic concentrations of chlorine. Do not allow disinfecting water to flow into a waterway without adequate dilution or other satisfactory method of reducing chlorine concentrations to a safe level.
6. Collect two samples or sets of samples from each pipe or facility at least 24 hours apart. Submit samples to a state-approved laboratory for bacteriological (coliform and non-coliform) analysis. Continue disinfecting and testing until bacteriological clearance is achieved.

+++ END OF SECTION 15060 +++

**SECTION 15100
VALVES****PART 1 - GENERAL****1.01 SCOPE**

- A. Work Included in This Section. The work of this Section shall include the furnishing, installation and testing of all valves and required appurtenances as specified herein, shown on the Drawings and as required to make the entire facility operable except for those valves and appurtenances required to be provided in other Sections of these specifications. Items to be provided include but shall not be limited to the following:
1. Valves.
 2. Check Valves.
 3. Manual Operators, floor stands, and valve boxes.
- B. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the Work shown and specified.
- C. Related Work specified elsewhere:
1. Section 15060 - Piping and Appurtenances.
 2. Section 09900 - Painting.
 3. Division 13 - Instrumentation and Control.

1.02 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:
- B. For each type and model of valve, provide:
1. Assembly instructions and spare parts list.
 2. Preventative/corrective maintenance instructions.
 3. Certificate of seat compatibility with entailed fluid exposure.
- C. Erection Drawings. Erection drawings shall include the procedures to be used in setting, supporting, and/or anchoring the valves, the fitting of line pipe to the valves for proper coupling, and for adjusting and testing all valve assemblies.

1.03 VALVE SCHEDULE

- A. Valves shall be of the type shown on the Drawings or of the rating and construction as specified in Tables I and II comprising Valve Schedule. All valves of the same type shall be of the same make unless otherwise approved and shall be in accordance with Table II or as specified herein.

PART 2 - PRODUCTS**2.01 OPERATORS**

- A. General. All valves shall be equipped with operators. The operators shall be sized based on the maximum expected torque as per valve manufacturer's recommendations. The responsibility for proper operation shall reside with valve supplier. When the maximum force required to operate a valve under full operating head exceeds 40 pounds, gear reduction operators shall be provided. Gear operators shall be totally enclosed and lubricated. All valves shall open by turning counterclockwise.
1. Gate Valves. All gate, globe and angle valves shall be fitted with handwheels of suitable size or gear operators in accordance with the manufacturer's recommendation.
 2. Wrench Nut Operation. An AWWA nut or shaft key, as applicable shall be provided in lieu of handwheel where required for connection to extension stem and floor stand or as indicated on the Drawings. Nut shall be constructed of cast iron. No submerged or buried operator shall require maintenance following installation. Suitable gaskets, O-rings, and other features shall insure permanent watertightness.
 - a. Buried service operators on valves larger than 2-½ inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have cross handle for operation by forked key. All moving parts of the valve and operators shall be enclosed in a housing to prevent contact with the soil.
 - b. Buried service operators for quarter-turn valves shall be designed to withstand 450 foot-pounds of input torque at the fully open or fully closed positions without damage to the valve or operator and shall be grease packed and gasketed to withstand a submersion in water to 10 psi.
 - c. Valves shall be installed with extension stems, as required, and valve boxes.
- B. On quarter-turn valves, the valve operators shall be of the self-locking type to prevent the disc or plug from creeping and shall be provided with position indicators to show the position of the valve disc or plug. Operators of the worm and gear type shall have self-locking worm gears, one-piece design, of gear bronze material, accurately machine cut. The worm shall be hardened alloy steel, with thread ground and polished. Operators of the geared traveling nut type shall have threaded steel reach rods with an internally threaded bronze or ductile iron nut.

2.02 NOT USED**2.03 NOT USED**

2.04 MANUALLY OPERATED VALVES

A. Plug Valves:

1. PV-1, PV-2, PV-3, PV-4, PV-5, PV-6, PV-7: Eccentric plug valves 4 inches through 24 inches shall be suitable for buried, submerged and exposed service with ends matching those shown on the Drawings. Valves in buried or submerged service shall have extension stems and shall be suitable for installation in a valve box, with tee-handle wrench operation. Buried or submerged valves shall be of the nonlubricated type with manual nut operators for valves 6 inches and smaller, and totally enclosed, geared, manual operators for valves 8 inches and larger. Exposed valves shall be the nonlubricated type with wrench lever manual operators for valves 6 inches and smaller and totally enclosed, manual handwheel operators for valves 8 inches and larger. Valves shall be rated 150-pound WOG minimum, and shall have a cast iron body with joint ends to match adjoining piping, balanced plug coated with Hycar or EPT elastomer, Buna-Vee packing or O-ring seals, stainless steel bearings, and nickel or epoxy-coated seats. Ends shall meet 125-pound ANSI Standards. Valves shall be Homestead Figure 1100 and 1500, Keystone Ballcentric, DeZurik Series 100, or equal.

B. Check Valves:

1. CV-1, CV-2: Swing check valves 2 inches through 36 inches shall be in accordance with AWWA C508 and shall be flanged end, faced and drilled in accordance with ANSI B16.1 Class 125, cast iron body, bronze-mounted valves, with solid bronze hinges and stainless steel hinge shaft. Valves 2 inches through 12 inches shall be rated 175-pound and 14 inches through 36 inches rated 150-pound cold water, nonshock. Valves shall be fitted with adjustable outside lever and heavy-duty spring. Increasing-pattern body valves may be used where the outlet piping size is shown increased on the Drawings. Valves shall be M & H Valve Style 59, 159, or 3259; American Darling No. 50 Line; or equal.

C. Gate valves

1. 2-½ inches and larger for buried water service shall be iron body, bronze-mounted valves with push-on or mechanical joint ends, double-disc gate, nonrising bronze stem, O-ring sealed stuffing box, and 2-inch square wrench nut conforming to AWWA C500. Valves shall be rated 150-pound WOG minimum, and shall be American-Darling No. 55, or equal.

2.05 BACKFLOW PREVENTORS

- A. Backflow preventors shall be the reduced pressure type, providing protection during the emergency conditions of either back-siphonage or backpressure or a combination of both. Backflow preventors shall be certified by a nationally recognized testing laboratory as conforming to current requirements of ASSE 1013, AWWA C 506, or USC-FCCC. The installation shall meet all applicable state and local codes.
- B. Sizes ¾-inch through 2-inches shall have bronze bodies with threaded connections, a bronze union on either side and a strainer installed upstream of the device. Gate valves shall be installed upstream and downstream of the device.
- C. Sizes 2-1/2-inches and larger shall be bronze or iron bodied with corrosion resisting moving parts and trim and flange connections. Gate valves shall be installed upstream and downstream of the device.

- D. The device shall be equipped with three (3) leak-proof test cocks. A fixed air gap, or funnel, shall be installed at the relief port. A drain line shall be piped from the discharge side of the air gap as shown on the Drawings and shall be supported independently from the device.
- E. Backflow preventers shall be manufactured by Watts, Wilkins, Hersey or equal.

2.06 Air Release Valves (ARV-1, ARV-2)

- A. Wastewater Air Release Valves shall be suitable for pressures unto 25 psig
- B. Valves shall be provided at locations shown on the drawings
- C. Sizes 2-inch through 4-inches shall be automatic float operated valves designed to release accumulated air from piping system while the system is in operation and under pressure.
- D. The valve shall have a full size flanged or NPT inlets and outlets equal to the nominal valve size. The body inlet connection shall be hexagonal for wrench connection. The body shall have a 2" NPT cleanout and a suitable drain connection. The cover shall be bolted to the valve body and sealed with a flat gasket
- E. Valve body shall be constructed of ASTM A126 class B cast iron. The orifice, float and linkage mechanism shall be constructed of type 316 stainless steel. Non metallic floats or linkages are not acceptable.
- F. Wastewater Air Release Valves shall be as manufactured by Valmatic Manufacturing Corporation of equal.

2.07 NOT USED

2.08 PROTECTIVE COATINGS FOR VALVES

- A. Interior. Two coats of factory-applied asphaltic varnish suitable for potable water applications, or Factory applied heat-cured epoxy coating conforming to AWWA C550.
- B. Exterior. One coat of factory applied epoxy primer conforming to Section 09900, Painting for exposed valves (System No. 5); one coat of epoxy for buried valves (System No. 2). Field coat valves in conformance with referenced Systems detailed in Section 09900, Painting.

2.09 PRESSURE SENSORS

- A. Line pressure shall be sensed by a flexible cylinder lining and transmitted via a captive sensing liquid to the gauging mechanisms.
- B. The sensor body shall be full line size, constructed of carbon steel and mounted in-line as shown on the Drawings. The sensor body shall be constructed with ANSI 125 pound flange connections, or in a wafer body design to fit between ANSI 125 pound flanges.
- C. The manufacturer shall provide the sensor complete with gauges, pressure switches, or other accessories as shown on the Drawings and herein specified.
- D. Captive liquid chamber shall be factory-filled; provide fill and bleed valves for field filling.

2.10 PRESSURES GAUGES

- A. Pressure gages shall have bronze or stainless steel bourdon tube elements. Lens shall be heavy glass, with oil-resistant gasket seal. The dial shall be a minimum of 4.5-inches in diameter, with white coated metal lithographed with black metal graduations and numerals. The mounting as required. Connection shall be ¼-inch NPT with square wrench surface. Provide cartridge snubber and polished brass gauge cock. Range shall be as shown on the Drawings. Accuracy shall be plus or minus 0.5 percent.

2.11 TAPPING SLEEVES AND VALVES

- A. Tapping Sleeves: Provide caulked type sleeves, suitable for use on both ductile iron and steel pipe, in the sizes shown on the Drawings.
- B. Tapping Valves: Provide valves of the mechanical joint type with "O" ring seals, in the sizes shown on the Drawings.

2.12 VALVE BOXES (VB)

- A. Valve boxes shall be adjustable cast iron.

PART 3 - EXECUTION**3.01 INSTALLATION**

- A. Installation shall be in conformance with the following requirements.
 - 1. Above ground Valves shall be rigidly held in place using supports and hangers as shown on the drawings and as specified. The stem orientation of valves in elevated piping shall be as approved by the Owner for accessibility, but no valve shall have stem in the downward direction. Saddle type valve supports shall be provided for all valves in vaults. Supports shall be of rugged construction providing at least 120 degrees under-support for the valve body, shall be constructed of steel as specified in Division 5, and shall be anchored to the foundations using galvanized anchor bolts.

3.02 TESTS

- A. Shop and Laboratory Tests. Perform shop and laboratory tests on valves and appurtenances as follows:
 - a. Performance Tests. Manufacturer shall shop test each butterfly valve for performance, leakage, and hydrostatic pressure in accordance with Section 5 of AWWA C504-80. Manufacturer shall submit valve size and class. If no recent test data is available for valve size and class to be furnished under these Specifications, manufacturer shall perform hydrostatic and cycle tests of said Section 5.4 and 5.5.
- B. Field Tests. Test all valves and appurtenances for proper operating adjustments and settings and for freedom from vibration, binding, scraping, and other defects. The testing of the hydraulically and electrically controlled valves shall be supervised by a representative of the manufacturer who shall verify proper installation, adjustments, and performance. The adequacy of all pipe hangers and supports and valve supports to meet specified

requirements shall be verified. All defects found shall be corrected as approved.

3.03 COORDINATION WITH INSTRUMENTATION

- A. It shall be the responsibility of the Contractor to coordinate with Division 11, Division 13, Division 16, and the Distributed Control System regarding the requirements of control valves.

3.04 COORDINATION WITH OTHER MECHANICAL SUPPLIERS

- A. The installation and operation of the valve and motorized actuators shall be the unit responsibility of the valve supplier.

3.05 CLEANING

- A. All valves and appurtenances shall be flushed clean of all foreign matter together with the piping as specified in other sections.

3.06 ISOLATION VALVES

- A. A line size ball valve and union shall be installed upstream of each solenoid valve for isolation during maintenance.

3.07 ANCHOR BOLTS

- A. Anchor bolts for floor stands, stem guides, etc. shall be in accordance with Sections 01600..

TAG NO.: PV-1, PV-2, PV-3, PV-4

Valve Type	Plug
Valve Size	12
Valve Travel	90 Degrees
Valve Speed(Open/Close time)	N/A - Manual
Actuator Type	Manual Lever
Actuator Power	No
Local-Remote Selector Switch	No
Open-Stop-Close Switch	No
Position Indicator Contacts	Normal OPEN/CLOSE Form C Contacts (25) in NEMA 4 Housing
Brake	No
Position Transmitter	No
Explosion-Proof Housing	No
Maximum Differential Pressure	Line Test Pressure
Failure Mode	No

TAG NO.: PV-5, PV-6, PV-7

Valve Type	Plug
Valve Size	16
Valve Travel	90 Degrees
Valve Speed(Open/Close time)	N/A - Manual
Actuator Type	Manual Lever
Actuator Power	No
Local-Remote Selector Switch	No
Open-Stop-Close Switch	No
Position Indicator Contacts	Normal OPEN/CLOSE Form C Contacts (25) in NEMA 4 Housing
Brake	No
Position Transmitter	No
Explosion-Proof Housing	No
Maximum Differential Pressure	Line Test Pressure
Failure Mode	No

TAG NO.: CV-1,CV-2

Valve Type	CHECK VALVE
Valve Size	12
Valve Travel	90 Degrees
Valve Speed(Open/Close time)	N/A - Manual
Actuator Type	Manual Lever
Actuator Power	No
Local-Remote Selector Switch	No
Open-Stop-Close Switch	No
Position Indicator Contacts	Normal OPEN/CLOSE Form C Contacts (25) in NEMA 4 Housing

+++ END OF SECTION 15100 +++

**SECTION 15857
ODOR CONTROL SYSTEMS****PART 1 - GENERAL****1.01 DESCRIPTION**

- A. Work described in this Section includes furnishing all labor, materials, equipment, tools and incidentals required for a complete and operable installation of odor control systems with accessories complete. All equipment shall be installed, adjusted, tested and placed in operation in accordance with these Specifications, the manufacturer's recommendations and as shown on the Drawings. The general requirements herein, together with the detailed requirements of the specific equipment specifications, establish the work necessary to furnish and install The activated carbon adsorption unit complete with all appurtenances as indicated and specified.
- B. Major constituents of each system include, but are not limited to, all materials, equipment, and work required implementing a complete odor control system. Equipment purpose is to handle gases from submersible pump pit.
- C. Contract drawings show only functional features and some of the required external connections. They do not show all components required for a complete installation nor exact dimensions particular to any manufacturer's equipment. Contractor shall supply all parts, devices and equipment necessary to meet the requirements of the Contract Documents and shall make all dimensional adjustments particular to the equipment being furnished. All costs associated with such changes and adjustments shall be considered as being included in the price bid for the work shown and specified.
- D. Related Work specified elsewhere:
 - 1. Section 09900 - Painting.
 - 2. Division 13 - Instrumentation and Controls.
 - 3. Division 15 - Mechanical.
 - 4. Division 16 - Electrical.

1.02 EQUIPMENT SPECIFICATIONS

- A. Equipment specifications contain detailed descriptions of the individual package control systems, which shall conform to the requirements specified herein.

1.03 DEFINITION OF TERMS

- A. Package Control System: Package control systems include all instrumentation and controls (including but not limited to circuit breakers, motor starters, gauges, transmitters, panels, process and manual switches, indicators, and controllers) furnished under sections other than Division 13, Instrumentation and Controls. Each package control system includes all instrumentation and controls furnished under a single section.

1.04 RESPONSIBILITY FOR COMPLETE SYSTEM

- A. The Contractor shall be ultimately responsible and shall provide for the supply, installation, (including all interconnecting conduit and wire), certification, adjustment, and startup of complete, coordinated systems, which shall reliably perform the specified functions.

1.05 SUBMITTALS

- A. Submittals shall be made in accordance with the requirements of the General Conditions of the Contract Documents. In addition, the following specific information shall be provided:
1. Bill-of-Material catalog information, descriptive literature, wiring diagrams, and shop drawings for all components of the control system including spares, expendables and test equipment. Include all scale ranges, set points, etc.
 2. Catalog information on all I devices furnished with the system.
 3. Shop drawings and catalog material for all control panels and enclosures.
 4. Panel elementary diagrams of rewired panels. Diagrams shall include all control devices and all auxiliary devices such as relays, alarms, fuses, lights, fans, heaters, etc.
 5. Plumbing diagrams of pre-plumbed panels and interconnecting plumbing diagrams.
 6. Interconnection wiring diagrams, which include numbered terminal designations which show external interfaces.
 7. Manufacturer's certification.
 8. Manufacturer's data.
 9. Operation and maintenance manuals.
 10. Complete wiring and control diagrams.

1.06 QUALITY ASSURANCE

- A. Reference Standards: Comply with all Federal and State laws or ordinances, as well as all applicable codes, standards, regulations and/or regulatory agency requirements .
- B. Experience: Equipment furnished under this Section shall be of a design and manufacturer that has been successfully used in similar applications. The manufacturer shall have furnished equipment for a minimum of five similar applications that have a demonstrated record of successful operation for a minimum period of 5 years. Provide a list of such installations with installation description, contact names, addresses and telephone numbers.

1.07 QUALITY STANDARDS

- A. The package control system shall be furnished by a single manufacturer who shall assume full responsibility for providing a complete, operating system designed for long life with a minimum of required maintenance meeting the requirements specified herein and as shown on the drawings.

1.08 WARRANTY

- A. Provide a warranty against defective equipment and workmanship in accordance with the requirements of the General Conditions of the Contract Documents.

PART 2 - PRODUCTS

2.01 COMPONENT COORDINATION

A. General:

1. Furnish major components of system from one supplier. Minor components of system including piping and accessories, need not be supplied with major components. However, coordinate all components to insure proper matching of sizes, capacities, and equipment to provide a complete operating system.

2.01 ACCEPTABLE MANUFACTURERS

- A. Calgon Corporation, Pittsburgh, PA
- B. Carbitrol Corporation, Bridgeport, CT
- C. Pure Air Filtration, Norcross, GA

2.02 DESIGN REQUIREMENTS:

- A. EQUIPMENT: Manufacturers latest and proven design making it a complete system compatible with functions required.
- B. Specifications and drawings indicate energy resources which will be available for operation of the equipment. Furnish with equipment all devices necessary to achieve satisfactory operation from these sources.
- C. Design components of the odor control system to be rated for continuous duty, 24 hours per day. Choose fans for maximum efficiency ratings.

2.03 ACTIVATED CARBON ADSORPTION UNIT:

- A. Adsorber vessel shall be full shop fabricated vessel suitable for continuous exposure to hydrogen sulphide gas. Ultraviolet adsorbents shall be added for weather protection. The vessel shall be suitable for operating at ambient temperatures.
- B. Each adsorption system shall have a sampling probe at suitable location.
- C. Provisions shall be included to adequately ground the carbon bed.
- D. Minimum carbon: 34 cubic feet (approximately 884 lbs).
- E. Carbon shall have a minimum H₂S capacity of 0.20 g/cc.

2.04 EXHAUST FANS DISCHARGING TO ADSORBER VESSELS:

- A. Exhaust fans shall be centrifugal type, with backward curved non overloading wheels.
- B. Fans shall be constructed of fiberglass reinforced plastic, or Aluminum. Plastic resins shall be suitable to withstand continuous exposure to saturated hydrogen sulphide gas.
- C. All steel parts of the fans and fan bases shall be either type 316 stainless steel, or shall be coated with protective coating suitable for continuous exposure to hydrogen sulphide.
- D. Fan housing and wheels shall be grounded to the fan steel bases with flexible woven copper wire.
- E. Furnish and install the following exhaust blower.

LOCATION	ADSORBER VESSEL	BLOWER CAPACITY	MAX STATIC PRESSURE W.C.	NUMBER REQUIRED
Pump Station	1	1000 cfm	6.0	1

2.05 MOTORS:

- A. In accordance with division 16 and as specified herein.
- B. All motors suitable for operation in Class 1, Division 1, Group D hazardous areas..
- C. Horsepower rating of motors, not less than maximum brake horsepower requirements of fan under any condition of operation from shutoff to free delivery.
- D. Make motors with sufficient capacity to operate fan throughout operating range without exceeding nameplate rating for current and power.

2.06 DUCTWORK:

- A. Designed to withstand internal static pressure of 8-inch water column. Integrally reinforced where required.
- B. Ductwork shall be square, rectangular, or round, as indicated on the drawings or recommended by the odor control equipment manufacturer. Ductwork material delivered to jobsite and not installed immediately shall be stored in a dry location and protected from damage.
- C. All ductwork shall be fiberglass or PVC. And shall be manufactured in accordance with applicable SMACNA standards. The wall and corner thickness shall be in accordance with manufacturer's recommendations. Fiberglass ductwork shall include fiberglass angle bracing on entire duct. All fittings shall be factory constructed and delivered to the job site for installation.
- D. Ductwork shall be installed in accordance with the recommendations of SMACNA HVAC Duct Construction standards manual.
- E. All duct joints and duct penetrations shall be sealed using methods outlined in SMACNA HVAC air duct leak test manual.
- F. Flexible duct connections shall be provided at odor control equipment. The flexible connections shall be non combustible glass fabric double coated with neoprene 30 ounces per square yard as manufactured by Vent Fabrics or Duro Dyne.
- G. Dampers shall be provided to balance the system, dampers shall be of stainless steel construction

2.07 Dampers:

- A. Manual type, opposed multiblade, butterfly or splitter type for balancing t suitable for operating at ambient temperatures of the system. Dampers shall be constructed of FRP or stainless steel, with lever type accessible locking quadrant identified with open and closed positions.

PART 3 – EXECUTION

3.01 EQUIPMENT INSTALLATION

- A. Necessary supports shall be provided for equipment, appurtenances, ductwork, and pipe as required not shown on the drawings; these include frames or supports for tanks, fans or other similar items requiring support. All equipment shall be set on concrete doweled pads. All equipment shall be carefully leveled and anchored in place.

EQUIPMENT: Manufacturers latest and proven design making it a complete

+++ END OF SECTION 15857 +++

**SECTION 16010
GENERAL ELECTRICAL PROVISIONS****PART 1 GENERAL****1.1 DESCRIPTION**

- A. Furnish and install all materials, equipment, labor, supervision and services necessary to complete all electrical work specified herein, and shown on the Drawings.
- B. Principal Features
 - 1. Complete system of conduits, cables and conductors to supply electrical energy throughout the facility.
 - 2. Coordination with the electric utility company for:
 - a. Incoming electrical service for the facility.
 - 3. Packaged power distribution system.
 - 4. Standby generator.
 - 5. Lighting fixtures, ballasts, and lamps.

1.2 APPLICABLE STANDARDS AND CODES

- A. Local, State, and National Electrical Codes.
- B. National Electrical Code, 2005.
- C. Rules of the Electrical Utility and the 2003 edition of the National Electrical Safety Code.
- D. Life Safety Code 101.
- E. NECA Standard of Installation.
- F. NFPA (National Fire Protection Association).

1.3 FEES AND TESTS

- A. Contractor shall be responsible for all fees for permits, inspections, and tests necessary to complete this work. Contractor shall demonstrate to the Owner and the Engineer that all items of equipment installed are completely operational and free of defects in all modes.

1.4 COORDINATION WITH OTHER TRADES

- A. Furnish and locate all anchor bolts, inserts and supports for installation by the other trades as required. Coordinate the location of all fixtures, outlets, equipment, and devices with other trades to avoid conflicts.

1.5 LIST OF PROPOSED MANUFACTURERS

- A. List of Proposed Materials: The Contractor shall submit a complete list of the proposed manufacturers for each of the items listed in the following electrical specifications. Additional submittal data, sufficient to determine equality, shall be required if the Contractor proposes to substitute another manufacturer's equipment.
 - 1. Intent of Drawings

- a. Electrical plan drawings show only general locations of equipment, devices and raceways, unless specifically dimensioned. The Contractor shall be responsible for the proper routing of raceway, subject to the review of the Engineer.
2. Departures from Contract Documents
 - a. Submit to the Engineer in writing details of any necessary, proposed departures from these Contract Documents, and the reasons therefore. Submit such requests as soon as practicable and within 30 days after award of the Contract. Make no such departures without written approval of the Engineer.

PART 2 PRODUCTS

2.1 REFERENCE TO DRAWINGS

- A. Reference shall be made to Drawing Schedules, Details, Notes, and Specifications for: Manufacturer, model, catalog number, size, capacity, performance, ratings and installation of equipment and material.

2.2 CHOICE OF MATERIALS AND EQUIPMENT

- A. In submitting substitutions, bidders should note the following minimum considerations: (1) capacities shown are absolute minimal and must be equaled, (2) physical size limitations for space allotted, (3) structural properties, (4) noise level, (5) interchangeability, (6) compatibility with other materials and assemblies, (7) similar items shall be same manufacture and style wherever possible.
- B. All material and equipment, for which a UL, ANSI, or a NEMA Standard is established, shall be so approved and labeled or stamped.
- C. Adhesives are not acceptable as a mounting, supporting, or assembling technique, unless noted otherwise.

2.3 ELECTRICAL EQUIPMENT

- A. NEMA Standards shall be taken as minimum requirements for electrical equipment.
- B. Equipment shall operate properly under a plus or minus 10 percent voltage variation.

2.4 SUBMITTALS DURING CONSTRUCTION

- A. Provide complete manufacturers' descriptive information and shop drawings for all equipment, material and devices furnished under Division 16, Electrical, including certified outline drawings, arrangement drawings, elementary (schematic) diagrams, interconnection and connection diagrams, in accordance with provisions elsewhere in these Contract Documents. Provide the number of copies specified herein for the Engineer, Contractor and Operation and Maintenance Manuals.
- B. Provide certified shop drawings, literature and requested samples showing items proposed for use, size, dimensions, capacity, special features required, schematic (elementary) control diagrams, equipment schedules, rough-in, etc., as required by the Engineer for complete review and for use during installation. Use NEMA device designations and symbols for all electric circuit diagrams submitted. Make content of the schematic (elementary) connection or interconnection diagrams in accordance with the latest edition of NEMA ICS 1.

- C. Manufacturer's standardized elementary diagrams will not be acceptable unless applicable portions of the diagram have been clearly identified and non-applicable portions deleted or crossed out.
- D. The following submittals shall be made in accordance with Division 1, General Requirements.
- E. Certified arrangement drawings, outline dimensions, and weights for all major (engineered) equipment including, but not limited to:
 - 1. Standby Generator and ATS.
 - 2. Main Breaker and Power Distribution Panel.
- F. Functional description or logic diagrams for all control systems furnished under Division 16, Electrical.
- G. Characteristic curves for all protective devices.
- H. Certified drawings and descriptive literature for all equipment and devices furnished under Division 16, Electrical, and not listed above.
- I. Schematic (elementary drawings for any electrical control and bills of material for equipment including, but not limited to:
 - 1. Standby Generator and ATS.
 - 2. Main Breaker and Power Distribution Panel.
- J. In addition to submittals for specific items mentioned above, furnish shop drawing information on the following items:
 - 1. Panelboards.
 - 2. Separately mounted circuit breakers, fused switches, and non-fused disconnect switches.
 - 3. Conduit, tubing, and fittings.
 - 4. Power conductors.
 - 5. Outlet and device boxes.
 - 6. Pull boxes and junction boxes.
 - 7. Terminal junction boxes.
 - 8. Manholes and handholes.
 - 9. 600-volt conductors.
 - 10. Control cable.
 - 11. Lighting fixtures.
 - 12. Ballasts: fluorescent, high-pressure sodium, metal halide.
 - 13. Light poles and luminaires.
 - 14. Receptacles.
 - 15. Light switches.
 - 16. Device plates.
 - 17. Push-button indicating lights, selector switches: devices and station.
 - 18. Control relays and timers.
 - 19. Dry type small power transformers, 0-600V primary.
 - 20. Surge suppressors.

PART 3 EXECUTION

3.1 WIRING ELECTRICALLY OPERATED EQUIPMENT

- A. The Contractor shall be responsible for electrical connections to all equipment requiring electrical power. This responsibility applies to equipment furnished under this and other Divisions and by the Owner.

3.2 RECORD AND AS-BUILT DOCUMENTS

- A. Maintain at the job site a set of Contract Documents kept current by indicating thereon all changes, revisions and substitutions, between work as specified and as installed. Refer to Section 01720, Project Record Documents for additional information.
- B. Furnish Owner with complete set of Operation and Maintenance Manuals in accordance with Section 01730, Operating and Maintenance Data.

3.3 EQUIPMENT OPERATION

- A. This Division is responsible for: (1) proper rotation, (2) observing that lubrication has been properly performed, (3) that motors operate within nameplate limits, and (4) adjustment of circuit breaker and MCP trip settings.

3.4 CLEANING AND PAINTING

- A. Fixtures, panels and equipment shall be thoroughly cleaned. All equipment shall be touched up or repainted as required to present a clean professional appearance. Paint all ferrous metal that is not otherwise protected against corrosion. Paint exposed pipe threads with Bitumastic No. 50.

3.5 IDENTIFICATION

- A. Identify all major items of equipment including controls, panels, switches, contactors, motor starters, junction boxes and metering by permanent nameplates, with wording approved by Engineer. Secure metal nameplate frame with screws or brads. Adhesives are acceptable on components within NEMA 1 enclosures.
- B. Nameplates after installation shall be easily visible and shall bear notations corresponding to those shown on record drawings.
- C. All conduits shall be identified with a stamped stainless steel tag system (Brady or approved equal). Conduit tags shall be permanently attached to each exposed end of conduit runs such as in manholes, pull boxes, panels, MCCs, junction boxes, etc. and at each point of entry into a structure or building. Each tag shall be stamped with the appropriate conduit number per the conduit and cable schedules.
- D. Each instrument shall be identified with a stamped stainless steel tag system (Brady or approved equal). Instrument tags shall be permanently attached to each individual instrument and stamped with the appropriate number per instrument specification section.
- E. Each cable shall be identified with a permanent labeling system (Brady Catalog Number B-292 with printed legends or approved equal). Instrumentation cables shall be labeled with the appropriate instrument number of the originating signal (Ex. FT-2020-1). Multiplex cables, power and control cables shall be labeled with the appropriate cable number per the conduit and cable schedules.
- F. All power panels, lighting panels, control panels, control cabinets, etc. shall be identified with permanently mounted phenolic labels.
- G. All power and lighting panels shall have typed schedules mounted on panel doors.
- H. All terminals and associated wires shall be numbered and labeled respectively, and wiring diagrams shall be installed in the electrical panel doors.

3.6 TEST PERIOD

- A. Each piece of equipment shall continue to meet performance specifications throughout the first year of actual operation. Contractor shall replace or repair any defect due to faulty workmanship or material which shall develop within 1 year from date of acceptance. This guaranty shall cover both material and labor.
- B. For first year after final acceptance, Contractor shall provide, at no cost to Owner, any required maintenance and service necessary to assure the proper operation of the system. Date of acceptance shall be certified by Engineer as that date on which the contract has been satisfactorily completed in accordance with the Contract Documents.

3.7 GROUNDING

- A. See section entitled "Grounding" of these Specifications.

3.8 ELECTRICAL TESTING AND START-UP

- A. General
 - 1. Prior to energizing any equipment, the electrical contractor shall thoroughly vacuum clean the equipment with an industrial type vacuum cleaner. The outside of all electrical equipment shall be cleaned and paint touched up as required leaving equipment in an "as purchased" condition.
 - 2. During start-up of new equipment, the electrical contractor shall provide sufficient personnel to aid with start-up of the electrical equipment to remove any faults, and to make the necessary adjustment for proper operation of electrical equipment and installation. This includes sufficient personnel to aid equipment service personnel in their check-out of the electrical equipment and service.
 - 3. All testing equipment shall be furnished by the Contractor.
 - 4. All failures under tests due to defective material or poor workmanship shall be corrected by the Contractor at no expense to the Owner.
 - 5. The electrical contractor shall not, under any circumstances, energize any electrical equipment covered by these Specifications without first obtaining permission from the Engineer.
- B. Grounding
 - 1. After all connections have been made to the ground, ground tests shall be made to verify its adequacy.
- C. Typewritten directories shall be inserted in all panels showing the designation of each circuit. All power and replacement fuses necessary for testing shall be furnished and paid for under this item.
- D. Testing, Circuit Continuity and Insulation Resistance

Complete installation shall be free of short circuits, open circuits, and other defects. Insulation Resistance and Continuity Tests shall be performed as follows:

Perform visual and mechanical inspection of each individual exposed power cable #6 AWG and larger for physical damage, correct terminations in accordance with the Drawings, cable bends in accordance with bending radius requirements, proper circuit identification, proper lug type, tightness of bolted connections with proper torque level per NETA ATS, Table 10.12 or manufacturer's specifications, and proper grounding.

Perform Insulation Resistance Testing of all conductors #6 AWG and larger with respect to ground and each adjacent conductor. Apply 1,000 volts dc for one minute on 600 volts insulated conductors in accordance with NETA. Minimum insulation resistance values shall not be less than 50 meg-ohms. Investigate all deviations between adjacent phases.

Perform Continuity test by ohmmeter method to ensure proper cable connections of all conductors #6 AWG and larger.

- E. Infrared (Hot Spot) Thermal Imaging Testing
 - 1. The contractor shall perform an infrared thermal imaging inspection on the main breaker, ATS, and all 480 volts electrical connections.
 - 2. The infrared testing shall conform to NETA standards.

3.9 INSTALLATION OF EQUIPMENT

- A. The electrical contractor shall coordinate with the Contractor and Owner in order to have electric power available when required.

3.10 TEMPORARY ELECTRIC POWER

- A. Refer to General Conditions in these Contract Documents for necessary provisions for electric power used during construction.

+ + + END OF SECTION 16010 + + +

**SECTION 16050
BASIC ELECTRICAL MATERIALS AND METHODS****PART 1 GENERAL****1.1 DESCRIPTION**

- A. Provide all labor, equipment and material required to complete the installation specified herein, and shown or scheduled on the Drawings. Since the drawings are schematic, all fittings, connectors, etc., are not shown, but shall be furnished as required for a complete functional installation.

1.2 QUALITY ASSURANCE

- A. Where not otherwise specified, all material and methods shall be of the highest industrial quality suitable for the application. All electrical equipment that is stored prior to installation, or that is installed outdoors, shall be protected from corrosion and rust with a product equal to Zerust Vapor Capsules or Cutler-Hammer Oxidation Inhibitor Capsules.

1.3 SHOP DRAWINGS

- A. Shop drawings are required for the all electrical equipment and materials such as standby generator system, power distribution panel and mini-power center, circuit breakers, cables and conduit, lighting, switches, and junction boxes.

PART 2 PRODUCTS**2.1 MATERIALS**

- A. Conduits
 - 1. Types
 - a. PVC-coated Galvanized Rigid steel Conduit (GRC) shall be used for all exposed conduit and Polyvinyl Chloride Conduit (PVC), schedule 40 conduit shall be used for underground concrete-encased ductbank.
 - 2. Minimum size: ¾-inch.
 - 3. Reference Standards
 - a. GRC - Federal Specifications WW-C-581, UL labeled, UL Standard 6, ANSI C80.1, hot dip galvanized mild steel. PVC-coated rigid conduit shall meet the ASTM D870 boil test.
 - b. PVC - NEMA TC-2, UL 651, ANSI C33.91, NEC Article 347, UL listed, Schedule 40, Heavy wall, 90°C.
 - 4. Manufacturers
 - a. PVC-coated GRC shall be Plasti-Bond as manufactured by Robroy Industries and PVC conduit shall be by Carlon or equal.
 - 5. Restrictions
 - a. All exterior exposed conduits shall be PVC-coated GRC, unless noted otherwise.
 - b. EMT shall not be used on this project.
- B. Explosion-Proof Flexible Metal Couplings
 - 1. Manufacturers:
 - a. Appleton.

- b. Crouse-Hinds.
 - c. Or as approved.
2. Description: Liquid-tight, flexible, braided steel approved for NEC Class I, Division 1, Group D areas.

C. Wires and Cables

- 1. Power and control cables (600 volt and below).
 - a. No. 6 AWG - 500 MCM: Type XHHW, 90°C, 600 volt, insulation with Class B stranded copper conductors, UL Standard 44 & 854.
 - b. No. 14 - No. 8 AWG: Type THHN/THWN, 90°C, 600 volt, insulation with stranded copper conductors, UL Standard 83, ANSI c33.80.
- 2. Instrumentation Cables
 - a. Instrumentation and low level dc signal wiring shall be shielded twisted conductor-pair cables. Single twisted pairs shall consist of two, stranded, class B, Number 16 AWG annealed copper conductors, rated for 600 volts ac, 90 degrees C continuous temperature. The cable shall include a shield, a tinned copper drain wire, and an overall jacket.
 - b. Other types: as required by equipment supplier.
- 3. All conductors are to be identified. Branch circuits, motor feeders, and lightning wiring shall be identified by color coding as follows:

	277/480V	120/208/240V
Phase A	Brown	Black
Phase B	Orange	Red
Phase C	Yellow	Blue
Neutral	Grey	White
Ground	Green	Green

The color coding on No. 8 AWG and smaller conductors shall be continuous in length. No taping, painting, or other means of coding will be acceptable. Conductors No. 6 AWG and larger and conductors operating above 600 volts shall be black with color-coded tape visible at each point of access or view.

D. Wire Connections and Devices

- 1. All wire runs shall be splice-free.
- 2. Wire and cable splices
 - a. No. 14 - No. 10 AWG: Scotch "Scotchlok" Type R, Thomas & Betts (T&B) "Piggy," Ideal No. 452 (Red) Wingnuts, or equal.
 - b. No. 8 and larger: T&B Method Color-Keyed Compression Joints, Anderson, or equal.
- 3. Equipment Terminals: T&B Locktite Lugs, Ilisco, or equal.
- 4. Electrical Insulating Tape: Plymount "Slipknot Grey," Scotch 33+, or equal.

E. Outlet Boxes and Covers

- 1. Outlet Boxes: Raco, Steel City, or equal.
- 2. Outlet Box Covers:
 - a. Switch: Sierra Cat. No. S-1N, S-2N, etc.; Hubbell 93071, or equal.
 - b. Receptacle; Sierra Cat. No. S-8N, Hubbell 93101 or equal.
 - c. Weatherproof Covers: Sierra Cat. No. WPD-8, or equal.
- 3. Outlet Bodies: Crouse-Hinds Feraloy Type T, or TB; Appleton Form 35 Type T, or TB, Unilets; or equal.

F. Switches and Receptacles

- 1. Switches

- a. Heavy-duty, AC quiet, premium, specification grade, toggle type.
 - b. Federal Specification W-S-896E.
 - c. UL Test UL 20.
 - d. 120/277 volts AC, 20 amps; gray toggle.
 - e. General Electric, Hubbell, or equal. Switches shall be gasketed watertight, NEMA 4X.
2. Switches for Classified Areas
 - a. Manufacturers:
 - 1) Appleton.
 - 2) Crouse-Hinds.
 - 3) Or as approved.
 - b. Type: Corrosion-resistant, explosion-proof tumbler switches rated for Class I, Division 1, Group D areas. Use Type EDS (factory-sealed) or Type EFS (in conjunction with external sealing fittings).
 - c. Mounting: Surface mount.
 - d. Rating: NEMA 7.
 - e. Material: Malleable cast iron body and cover with front-operated handle. Include stainless steel cover screws.
 3. Receptacles
 - a. Two-pole, 3-wire, straight blade, heavy-duty, grounding.
 - b. Federal Specification W-S-596d.
 - c. UL Test U1 498.
 - d. 125 volts AC, 5-20R configuration, 20 amps, gray urea face.
 - e. General Electric, Hubbell, or equal. Receptacles shall be gasketed weatherproof with cover.
 4. Explosion-Proof Receptacle and Matching Plug
 - a. Manufacturers:
 - 1) Crouse-Hinds Cat. No. ENR 21201 with EDS backbox and ENP5201 plug.
 - 2) Or as approved.
 - b. Description:
 - 1) Explosion-proof receptacle and plug assembly.
 5. Device plates
 - a. Appleton, Crouse-Hinds, or equal, Type FS Weatherproof cast malleable covers.
- G. Supporting Devices
1. Expansion and/or Deflection Fittings: O.Z. Gedney, Appleton, or equal.
 2. Channel Support: Unistrut, Kindorf, Super Strut, or equal.
 3. Fastening Devices: Caddy, Appleton, or equal.
 4. Cable Ties: Panduit, Thomas & Betts, or equal.
- H. Lightning Arresters
1. 650 volt, 3 phase, 4 wire.
 2. Square D Cat. No. J9200-9A, General Electric, or equal.
- I. Safety Switches
1. Furnish and install fusible and non-fusible, 3-pole, safety switches where shown on the Drawings. All safety switches shall be heavy duty and Underwriters' Laboratories listed. All switches shall be of dead front construction with blades fully visible when in the "OFF" position with the door open. Mechanism shall be quick-make, quick-break with provisions for up to 3 padlocks in the OFF position. All exterior switches shall be of code gauge (UL98), stainless steel, NEMA 4, or foamed thermoplastic NEMA 4X. Enclosures shall be Carlon, Hoffman, or equal, or as furnished by the electrical equipment manufacturer. Safety switches shall be Square D, General Electric, Cutler-Hammer, or approved equal.

2.2 MATERIALS FOR HAZARDOUS AREAS

- A. Provide devices, materials, and equipment for installation in hazardous areas that are specifically approved for installation in hazardous areas of the Class and Division indicated, and are of construction that will ensure safe performance under conditions of proper use and maintenance. Provide devices, materials, and equipment meeting the requirements of the NEC [NFPA 70], applicable state and local codes, and the authority enforcing these codes. Acceptable manufacturers: Crouse Hinds, or Appleton.

PART 3 EXECUTION

3.1 CONDUIT INSTALLATION

- A. Minimum size conduit shall be $\frac{3}{4}$ inch above ground and 1 inch below ground except where noted otherwise.
- B. During construction, all installed conduits shall be temporarily plugged, capped, or otherwise protected from the entrance of dust, trash, moisture, etc., and any conduits which become clogged shall be replaced. No conductor shall be pulled in until all work that might cause damage to the conduit or conductors has been completed.
- C. Conduit connections to sheet metal enclosures shall be securely fastened by double lock nuts inside and outside and shall have grounding bushings.
- D. Conduit straps or brackets secured to concrete, brick, or masonry shall be by means of expansion bolts, toggle bolts, or approved drill anchors. No wood plugs will be permitted.
- E. Conduits supported from building walls shall be installed with at least $\frac{1}{4}$ -inch clearance from the wall using pipe spacers equal to Appleton Electric Company, T&B Company, Steel City, or equal.
- F. Unless otherwise shown or specified, exposed conduit shall be installed parallel or at right angles to structural members, surfaces, and building walls.
- G. Two or more conduits in the same general routing shall be parallel with symmetrical bends.
- H. Conduit installed horizontally shall allow headroom of at least 7 feet, except where it may be installed along structures, piping, equipment, or in other areas where headroom cannot be maintained because of other considerations.
- I. Wherever necessary and where shown on the Drawings, conduit boxes and pulling elbows shall be inserted in the lines. Gaskets shall be used to ensure a dust and watertight installation on all conduit boxes and fittings.
- J. All bends and turns in conduits shall have a bend radius of not less than 6 times the internal diameter of the conduit. Bends shall be made using an approved bender to provide smooth bends with no kinks, dents, or flattening.
- K. All concealed conduit shall be placed in walls, floors, ceilings, or slabs at the proper time in accordance with the progress of the work. The Contractor shall cooperate in every respect in meeting schedules and shall not delay the structural work unnecessarily. Conduits embedded in concrete shall be blocked and braced in place by use of adequate conduit separators to prevent displacement during pouring of the concrete. Where conduit interferes with structural steel, steel reinforcement, or in the opinion of the Engineer occupies too much space in the

slab, the conduits shall be rearranged or installed exposed as directed by the Engineer or required. No additional payment will be made for such rearrangement of conduit whether or not additional conduit or fittings might be required.

- L. Terminations and connections of rigid conduit shall be threaded. Conduits shall be reamed free of burrs and terminated with insulated metallic conduit bushings.
- M. Conduit threads shall be coated with a petroleum base corrosion-inhibitor with low electrical contact resistance before assembly equal to Burndy Engineering Company, Inc., Penetrax "A" or equal screw thread lubricant (zinc-petroleum or zinc-chromate compounds are permissible).
- N. All conduits shall be suitably grounded to the plant ground grid using grounded type insulated bushings, O.Z. Electrical Manufacturing Company, Type BLG or IGB, T&B Company, Appleton Electric Company, or equal.
- O. Conduit across structural joints where structural movement is allowed shall have bonded, weather-tight expansion and deflection fitting the same size as the conduit.
- P. Support spacing for conduits 1 inch and smaller shall not exceed 6 feet, and conduits 1¼ inches and larger shall not exceed 10 feet. Supports shall be cadmium-plated steel or galvanized iron. Conduits 1½-inch and smaller may be supported by 1-hole conduit straps and 2-inch and larger shall be supported by 2-hole conduit straps. Conduit racks shall be as manufactured by Unistrut, Kindorf, or equal.
- Q. Conduit joints shall be made up tight using a pipe wrench. Channel lock pliers will not be permitted, and unions shall be used as necessary to aid in the installation. Conduits shall be cut square and the ends reamed smooth after threading to prevent injury to conductors. Conduit joints in concrete or exposed to weather or damp locations shall be drawn up tight and coated with insulating paint before casting in concrete or painting exposed conduit system.

3.2 CUTTING AND PATCHING

- A. Provide all cutting and patching required to perform this work.
- B. Do not cut into any major structural element without approval of Engineer.
- C. Patching shall be of quality equal to, and of appearance matching, existing construction.

3.3 FLOOR AND WALL PENETRATIONS

- A. Where raceways, pipes, and conduits pass through walls or roof, flash in accordance with drawing details and the section entitled "Flashing and Sheet Metal" of these Specifications.
- B. Locate raceways, pipes, and conduits through roof to clear parapet walls or perimeter of building by at least 18 inches.
- C. Flashing shall provide water-tight seal with standing water on roof.

3.4 EQUIPMENT MOUNTING

- A. Wherever any electrical component, such as panels, raceways, pipes and conduits, will be in contact with surfaces which may become damp or wet, mount using spacers to hold electrical work $\frac{1}{4}$ " away from damp surfaces.

+++ END OF SECTION 16050 +++

**SECTION 16210
ELECTRIC UTILITY SERVICE AND ENTRANCE****PART 1 GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions, Supplementary Conditions (if included), and Division 1 Specifications Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Removal of existing electric utility service.
- B. Establishment of permanent electric utility service to the Site.

1.3 RESPONSIBILITIES

- A. The following shall be performed by the Electric Utility Company under the Allowance established in Section 01019:
 - 1. Demolition:
 - a. Removal of existing trailer utility services upon completion and acceptance of pump station.
 - b. Primary Electric Service:
 - c. Furnishing of meter cabinet, meter, and meter rack for mounting on primary meter pole by CONTRACTOR.
 - d. Provide final connections to the utility service.
 - 2. Secondary Electric Service:
 - a. Furnishing of secondary service meter for mounting by CONTRACTOR..
 - b. Provide lightning arrestors, and other appurtenances for protection and support of service wiring systems on the secondary side of the Utility Company's transformer.
 - c. Coordinate with local power company to provide new three-phase transformer bank for delivering rated secondary service ampacity and voltage requirements.
 - d. Provide secondary service conductors to meter.
 - e. Provide final connections for secondary service.
- B. The following are included in the scope and shall be performed by CONTRACTOR:
 - 1. Demolition:
 - a. Removal of existing trailer service at end of project.
 - 2. Secondary Electric Service:
 - a. Provide secondary conductors, raceway systems, and secondary terminations.
 - b. Provide terminations to transformer.
 - c. Install meter cabinet, meter rack, conduit, and other items necessary to complete installation of the Utility Company's metering equipment.
 - d. Obtain meter base from local power co. and install per local utility guidelines.
 - e. Provide lightning arrestors which are located within the service equipment after the Utility Company's meter.
 - f. Provide ground rods and grounding system for meter and main disconnects.
 - g. Coordination and scheduling of utility work.
 - 3. Secondary Electric Service:
 - a. When not provided by local power co., provide concrete pad for transformer.
 - b. Provide 4 inch PVC raceways and pull wire for underground medium voltage raceway to service transformer, including 10 foot high conduit riser on meter pole.
 - c. Provide secondary conductors and raceway systems.

- d. Provide meter cabinet or meter base for Utility Company's secondary service meter, as required by Utility Company.
- e. Install service meter furnished by Utility Company.
- f. Provide raceway systems as required to complete installation of the Utility Company's metering equipment.
- g. Provide structural supports and channel framing as required to support metering equipment.
- h. Provide ground rods and grounding system for meter, transformer, and main disconnects.
- i. Provide underground trenching and backfill for new underground conduits.
- j. Coordination and scheduling of utility work.

1.4 ALLOWANCES

- A. Cash Allowance: Include under provisions in Section 01019.
- B. Submit Utility Company invoices for services rendered by the Utility Company for processing of the cash allowance.

1.5 SYSTEM DESCRIPTION

- A. Electrical System Service Characteristics as indicated in drawings:
 1. 120/240 240 480 480Y/277 volts.
 2. Single & Three-phase.
 3. Two Three Four-wire.
 4. 60 Hz.

1.6 QUALITY ASSURANCE

- A. Electric Utility Company: The Southern Co.-Georgia Power Co.
 1. Address: Atlanta, GA
 2. Phone Number: Office: 770-216-1391; Mobile: 404-218-8978
 3. Contact Name: Pete Aufdemorte
- B. Perform Work in accordance with Utility Company's written requirements.

1.7 PRE-INSTALLATION MEETING

- A. Convene pre-installation meeting with Electric Utility Company 1 weeks prior to commencing Work of this Section. Review service entrance requirements and details with Utility Company representative.

PART 2 PRODUCTS

2.1 METERING CABINETS

- A. Manufacturers: Square D Company, or as approved per local utility co. standard.
- B. Sheet metal cabinet with hinged door and sized to conform to Utility Company's requirements, with provisions for locking and sealing.

2.2 METER BASES

- A. Furnished by Utility Company.

- B. Manufacturers: Square D Company, or as approved.
- C. Rated 320 Amperes Continuous Duty per utility co. standard.

2.3 SERVICE TRANSFORMER

- A. Existing- by Utility Company- coordinate with power company see section 1.6A above.

PART 3 EXECUTION

3.1 PREPARATION

- A. Arrange with Electric Utility Company to obtain permanent electrical service and temporary construction service to the Project. All installations shall meet utility co. and NEC requirements.
- B. Review proposed hardware and equipment with Utility Company representatives prior to Shop Drawing review.
- C. Verify that concrete pads for transformers are appropriately sized, including conduit entrance area locations, and that they are ready to receive products.

3.2 INSTALLATION

- A. Install electrical service and related metering equipment as required by Utility Company.
- B. Install pullwire in each empty conduit.

3.3 FIELD QUALITY CONTROL

- A. Test secondary voltages for line-to-line and line-to-ground potentials.
- B. Coordinate with Utility Company for adjustment of primary taps if secondary voltage is not within 2 percent of rated voltage under normal loading conditions.

+++ END OF SECTION 16210 +++

**SECTION 16220
MOTORS****PART 1 GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions, Supplementary Conditions (if included), and Division 1 Specifications Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Single and three-phase, horizontal and vertical electric motors.

1.3 SHOP DRAWINGS

- A. Provide wiring diagrams with electrical characteristics and connection requirements.
- B. Indicate test results verifying nominal efficiency and power factor for three-phase motors, 5 HP and larger.
- C. For single and three-phase motors, 1/2 HP and larger, submit "Motor Data Sheet" at the end of this Section.

1.4 OPERATION AND MAINTENANCE DATA

- A. Include instructions for safe operating procedures.
- B. Include assembly drawings bearing data including replacement sizes and lubrication instructions.

1.5 REGULATORY REQUIREMENTS

- A. Conform to applicable electrical code.
- B. Comply with applicable provisions of the Energy Policy Act of 1992.
- C. Comply with applicable provisions of NEMA MG-1-1993.
- D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories, Inc., as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored at the Site from weather and moisture by maintaining factory covers and suitable weather-proof covering.
- B. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 PRODUCTS**2.1 SINGLE AND THREE-PHASE HORIZONTAL AND VERTICAL ELECTRIC MOTORS**

- A. Manufacturers:
 - 1. General Electric.
 - 2. Reliance.
 - 3. U.S. Electrical Motors.
 - 4. Or as approved.
- B. Electrical Service:
 - 1. Motors Smaller than 1/2 HP: 115 volts, single-phase, 60 Hz, unless otherwise specified or noted.
 - 2. Motors 1/2 HP and Larger: 460 volts, three-phase, 60 Hz, unless otherwise specified or noted.
- C. Visible Nameplate: Indicate motor rated horsepower, rated voltage, number of phases, rated frequency, rated full load speed, full load amps, code letter, frame size, manufacturer's name, model number, and serial number or date code, service factor, rated temperature rise or the insulation system class, time rating, power factory, efficiency.
- D. Enclosure Type:
 - 1. Use open drip-proof, fully guarded in dry indoor locations.
 - 2. Use totally enclosed, non-ventilated (TENV) or totally enclosed, fan-cooled (TEFC) in outdoor locations, damp locations, and in spray-down areas.
 - 3. Use explosion-proof motors in Class I, Division 1 classified areas. Motors shall be UL approved and labeled for hazard classifications, with over-temperature protection.
 - 4. Use weather-protected, NEMA Type II only where specified.
- E. Service Factor: 1.15.
- F. Insulation:
 - 1. Motors With Open Drip-Proof Enclosures and Weather-Protected Enclosures Mounted Indoors: Type B.
 - 2. Totally Enclosed Motors, Motors Installed Outdoors, and Motors Driven by Non-Linear Voltage Sources such as Variable Frequency Drives: Type F. Designed to meet limits defined by MG-1, Part 31, 1993.
 - 3. Motors Driven by Non-Linear Voltage Sources: 1600 volt insulation. Motors shall be inverter-duty rated in accordance with NEMA MG-1, Part 31.
- G. Classification: NEMA Design B.
- H. Duty: Continuous duty operation in 40 degrees C environment.
- I. Efficiency: Provide energy efficient motors rated in accordance with NEMA MG-1-1993, Revision 1 guidelines for open and enclosed motors.
- J. Horsepower: As specified in other Sections.
- K. RPM: As specified in other Sections.
- L. Starting Codes:
 - 1. Motors Greater than 10 HP: Starting Code G or lower.
 - 2. 7.5 HP and 10 HP Motors: Starting Code H or lower.
 - 3. 3 HP and 5 HP Motors: Starting Code K or lower.

4. Motors Under 3 HP: Starting Code M or lower.
- M. Frame: NEMA standard T-frames.
- N. Bearings:
1. Type: Self-lubricating, anti-friction type bearings. Bearings shall be selected to meet the radial and axial forces of the application. Provide the following bearings unless otherwise specified:
 - a. Motors 50 HP and Under: Grease-lubricated ball bearings.
 - b. Motors Over 50 HP:
 - 1) Direct-Coupled Equipment: Grease-lubricated ball bearings.
 - 2) Belt Driven Equipment: Grease-lubricated roller type bearings on drive end.
 2. Bearing Life: L-10 life rating of 20,000 hours in accordance with AFBMA Standards.
 3. Vertical motors shall be provided with thrust bearings adequate for all thrusts to which they can be subjected in operation.
- O. Winding Overheat Contacts: Provide normally closed thermostat for winding overheat protection for:
1. Motors driven by non-linear voltage sources, such as variable frequency drives.
 2. Motors exceeding 100 HP. Wire multiple winding overheat contacts for larger motors in series to provide one common protective circuit.
- P. Motor Heaters: Provide 120 VAC motor heaters on all motors installed in damp or wet environments which are used to drive non-continuous loads.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install securely on firm foundation.
- C. Check line voltage and phase, and ensure agreement with nameplate.
- D. Install totally enclosed motors with weep holes at bottom.

+++ END OF SECTION 16220 ++

MOTOR DATA SHEET

MOTORS – DRIVEN EQUIPMENT _____

Manufacturer _____

Type _____

Enclosure _____

Frame Number _____

Horsepower Rating (HP) _____

Voltage, Phase, Frequency (V, Ph, Hz) _____

Speed – at Rated Full Load _____

Type of Bearings _____

Insulation Class _____

Starting Code Character _____

Full Load Efficiency _____

Full Load Power Factor _____

Service Factor _____

**SECTION 16250
AUTOMATIC TRANSFER SWITCH – UTILITY SELECTION****PART 1 GENERAL****1.1 SCOPE**

- A. Furnish and install automatic transfer switches (ATS) with number of poles, amperage, voltage, withstand and close-on ratings as shown on the plans. Each automatic transfer shall consist of an inherently double throw power transfer switch mechanism and a microprocessor controller to provide automatic operation. All transfer switches and controllers shall be the products of the same manufacturer.

1.2 CODES AND STANDARDS

- A. The automatic transfer switches and controls shall conform to the requirements of:
1. UL 1008 - Standard for Transfer Switch Equipment.
 2. IEC 947-6-1 Low-voltage Switchgear and Controlgear; Multifunction equipment; Automatic Transfer Switching Equipment.
 3. NFPA 70 – 2005 National Electrical Code.
 4. NFPA 110 - Emergency and Standby Power Systems.
 5. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
 6. NEMA Standard ICS10-1993 (formerly ICS2-447) - AC Automatic Transfer Switches.
 7. UL 508 Industrial Control Equipment.

1.3 ACCEPTABLE MANUFACTURERS

- A. Automatic transfer switches shall be ASCO 4000 Series or approved equal. Any alternate shall be submitted for approval to the consulting engineer at least 10 days prior to bid. Alternate bids must list any deviations from this specification.

PART 2**2.1 MECHANICALLY HELD TRANSFER SWITCH**

- A. The transfer switch shall be electrically operated and mechanically held. The electrical operator shall be a momentarily energized, single-solenoid mechanism. Main operators utilizing overcurrent disconnect devices, or linear motors shall not be acceptable. The switch shall be mechanically interlocked to ensure only two possible positions, normal or emergency.
- B. All transfer switch sizes shall use only one type of main operator for ease of maintenance and commonality of parts.
- C. The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.
- D. All main contacts shall be silver composition. Switches rated 800 amperes and above shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.

- E. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.
- F. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.
- G. Where neutral conductors are to be solidly connected as shown on the plans, a neutral conductor plate with fully rated AL-CU pressure connectors shall be provided.

2.2 MICROPROCESSOR CONTROLLER

- A. The controller's sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communication module or Ethernet connectivity module.
- B. A single controller shall provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to $\pm 1\%$ of nominal voltage. Frequency sensing shall be accurate to $\pm 0.2\%$. The panel shall be capable of operating over a temperature range of -20 to +60 degrees C and storage from -55 to +85 degrees C.
- C. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator's manuals.
- D. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:
 - 1. EN 55011:1991 Emission standard - Group 1, Class A
 - 2. EN 50082-2:1995 Generic immunity standard, from which:
 - EN 61000-4-2:1995 Electrostatic discharge (ESD) immunity
 - ENV 50140:1993 Radiated Electro-Magnetic field immunity
 - EN 61000-4-4:1995 Electrical fast transient (EFT) immunity
 - EN 61000-4-5:1995 Surge transient immunity
 - EN 61000-4-6:1996 Conducted Radio-Frequency field immunity
 - 3. IEEE472 (ANSI C37.90A) Ring Wave Test

2.3 ENCLOSURE

- A. The ATS shall be furnished in a Type 4X Stainless Steel enclosure unless otherwise shown on the plans. The enclosure shall be capable of being locked/secured with a key.
- B. All standard door mounted switches and indicating lights described in section 3 shall be integrated into a flush-mounted, interface membrane or equivalent in the enclosure door for easy viewing & replacement. The panel shall include a manual locking feature to allow the user to lockout all membrane mounted control switches to prevent unauthorized tampering.

The membrane panel shall be suitable for mounting by others when furnished on open type units.

PART 3 OPERATION

3.1 CONTROLLER DISPLAY AND KEYPAD

- A. A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the communications interface port. The following parameters shall only be adjustable via DIP switches on the controller:
1. Nominal line voltage and frequency
 2. Single or three phase sensing
 3. Operating parameter protection
 4. Transfer operating mode configuration (Open Transition)
- B. All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

3.2 VOLTAGE, FREQUENCY AND PHASE ROTATION SENSING

- A. Voltage and frequency on both the normal and alternate sources (as noted below) shall be continuously monitored, with the following pickup, dropout, and trip setting capabilities (values shown as % of nominal unless otherwise specified):

<u>Parameter</u>	<u>Sources</u>	<u>Dropout / Trip</u>	<u>Pickup / Reset</u>
Undervoltage	N&E, 3 ϕ	70 to 98%	85 to 100%
Overvoltage	N&E, 3 ϕ	102 to 115%	2% below trip
Underfrequency	N&E	85 to 98%	90 to 100%
Overfrequency	N&E	102 to 110%	2% below trip
Voltage unbalance	N&E	5 to 20%	1% below dropout

- B. Repetitive accuracy of all settings shall be within $\pm 0.5\%$ over an operating temperature range of -20°C to 60°C .
- C. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via the communications interface port.
- D. The controller shall be capable (when activated by the keypad or the communications interface port) of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).
- E. Source status screens shall be provided for both normal & emergency to provide digital readout of voltage on all 3 phases, frequency, and phase rotation.

3.3 TIME DELAYS

- A. An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 24 VDC power supply.

- B. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.
- C. Two time delay modes (which are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.
- D. A time delay shall be provided on loss of preferred source, adjustable from 0 to 60 minutes.
- E. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes:
 - 1. Prior to transfer only.
 - 2. Prior to and after transfer.
 - 3. Normal to alternate only.
 - 4. Alternate to normal only.
 - 5. Normal to alternate and alternate to normal.
 - 6. All transfer conditions or only when both sources are available.
- F. All time delays shall be adjustable in 1 second increments, except the extended parallel time, which shall be adjustable in .01 second increments.
- G. All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the communications interface port.

3.4 ADDITIONAL FEATURES

- A. Membrane-type switches shall be provided for the test and retransfer to normal functions. The test position will simulate a normal source failure. The retransfer to normal position shall bypass the time delays on retransfer to normal.
- B. A SPDT contact, rated 5 amps at 30 VDC, shall be provided for annunciation of load transfer. The transfer signal shall prevent nuisance transfer to the alternate source by requiring the ATS to sense normal source output, and run for the duration of the delay setting, regardless of whether the normal source restores before the load is transferred.
- C. Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of two contacts, closed when the ATS is connected to the normal source and two contacts closed, when the ATS is connected to the alternate source.
- D. LED indicating lights shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the Alternate source (red).
- E. LED indicating lights shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal and emergency sources, as determined by the voltage sensing trip and reset settings for each source.
- F. A membrane switch shall be provided on the membrane panel to test all indicating lights when pressed.

- G. Provide the ability to select "commit/no commit to transfer" to determine whether the load should be transferred to the second utility source if the normal source restores before the generator is ready to accept the load.
- H. Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or the communications interface port.
- I. An Inphase monitor shall be provided in the controller. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents, and shall not require external control of power sources. The inphase monitor shall be specifically designed for and be the product of the ATS manufacturer. The inphase monitor shall be equal to ASCO Feature 27.
- J. The controller shall be capable of accepting a normally open contact that will allow the transfer switch to function in a non-automatic mode when a non-automatic version of the user interface membrane is furnished.
- K. All transfer switch voltage and current sensing PT's and/or CT's shall be full three (3) phase sensing. Open phase delta sensing or relaying/control schemes will not be allowed.
- L. Key Locking Feature – The control switches on the interface membrane shall be capable of being locked via password protected screens on the controller LCD display to prevent unauthorized tampering. A red LED indicator shall be illuminated on the interface membrane when the membrane controls are locked.
- M. System Status – The controller LCD display shall include a "System Status" screen which shall be readily accessible from any point in the menu by depressing the "ESC" key a maximum of two times. This screen shall display a clear description of the active operating sequence and switch position. For example,

Normal Failed
Load on Normal
TD Normal to Alternate
2min15s

- N. Controllers that require multiple screens to determine system status or display "coded" system status messages, which must be explained by references in the operator's manual, are not permissible.
- O. Self Diagnostics – The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.
- P. Communications Interface – The controller shall be capable of interfacing, through an optional communications interface module, with a network of transfer switches. It shall be able to connect via an RS-485 Serial communication module (up to 4000 ft. direct connect or multi-drop configuration), an Ethernet connectivity module (over standard 10baseT Ethernet networks) or remotely through PSTN dial-up modem communications. This module shall allow for seamless integration of existing or new communication transfer devices. Standard software specific for transfer switch applications shall be available by the transfer switch manufacturer. This software shall allow for the monitoring, control and setup of parameters. The transfer switch shall also be able to interface to 3rd party applications using ModbusRTU

and ModbusTCP open standard protocols. The communication interface module shall be equal to ASCO Accessory 72A (RS-485 Serial), ASCO Accessory 72E (10BaseT Ethernet), or ASCO Accessory 92A (PSTN dial-up modem).

- Q. Data Logging – The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory:
1. Event Logging
 - a. Data and time and reason for transfer normal to alternate.
 - b. Data and time and reason for transfer alternate to normal.
 - c. Data and time and reason for transfer.
 - d. Data and time re-transfer occurred.
 - e. Data and time alternate source available.
 - f. Data and time alternate source not available.
 2. Statistical Data
 - a. Total number of transfers.
 - b. Total number of transfers due to source failure.
 - c. Total number of days controller is energized.
 - d. Total number of hours both normal and alternate sources are available.

PART 4 ADDITIONAL REQUIREMENTS

4.1 WITHSTAND AND CLOSING RATINGS

- A. The ATS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the ATS terminals with the type of overcurrent protection shown on the plans.
- B. The ATS shall be UL listed in accordance with UL 1008 and be labeled in accordance with that standard's 1½ and 3 cycle, long-time ratings. ATSs which are not tested and labeled with 1½ and 3 cycle (any breaker) ratings and have series, or specific breaker ratings only, are not acceptable.

4.2 TESTS AND CERTIFICATION

- A. The complete ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.
- B. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.
- C. The ATS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001.

4.3 SERVICE REPRESENTATION

- A. The ATS manufacturer shall maintain a national service organization of company-employed personnel located throughout the contiguous United States. The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.
- B. The manufacturer shall maintain records of each switch, by serial number, for a minimum of 20 years.

+ + + END OF SECTION 16250 + + +

**SECTION 16251
AUTOMATIC DELAYED –TRANSITION TRANSFER SWITCH****PART 1 GENERAL****1.1 SCOPE**

- A. Furnish and install closed transition transfer switches (DTTS) with number of poles, amperage, voltage, withstand and close-on ratings as shown on the plans. Each DTTS shall consist of a power transfer switch mechanism and a microprocessor controller to provide automatic operation. All transfer switches and controllers shall be the products of the same manufacturer.
- B. The DTTS shall transfer the load in delayed transition (break –before-make) mode. Transfer is accomplished with a user – defined interruption period in both directions adjustable from 1 second to 5 minutes in at least 15 increments.

1.2 CODES AND STANDARDS

- A. The delayed transition transfer switches and controls shall conform to the requirements of:
 - 1. UL 1008 - Standard for Transfer Switch Equipment.
 - 2. IEC 947-6-1 Low-voltage Switchgear and Controlgear; Multifunction equipment; Automatic Transfer Switching Equipment.
 - 3. NFPA 70 – 2005 National Electrical Code.
 - 4. NFPA 110 - Emergency and Standby Power Systems.
 - 5. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
 - 6. NEMA Standard ICS10-1993 (formerly ICS2-447) - AC Automatic Transfer Switches.
 - 7. UL 508 Industrial Control Equipment

1.3 ACCEPTABLE MANUFACTURERS

- A. Delayed transition transfer switches shall be ASCO 4000 Series or approved equal. Any alternate shall be submitted for approval to the consulting engineer at least 10 days prior to bid. Alternate bids must list any deviations from this specification.

PART 2 PRODUCTS**2.1 MECHANICALLY HELD TRANSFER SWITCH**

- A. The transfer switch unit shall be electrically operated and mechanically held. The electrical operator shall be a solenoid mechanism, momentarily energized. The transfer switch unit shall include both electrical and mechanical interlocks to prevent both sets of main contacts from being closed at the same time. Main operators which include overcurrent disconnect devices OR do not include electrical and mechanical interlocks will not be accepted.
- B. All transfer switch sizes shall use only one type of main operator for ease of maintenance and commonality of parts.

- C. The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.
- D. All main contacts shall be silver composition. Switches rated 800 amperes and above shall have segmented, blow-on construction for high withstand and close-on capability and be protected by separate arcing contacts.
- E. Inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. All stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.
- F. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.
- G. Where neutral conductors are to be solidly connected as shown on the plans, a neutral conductor plate with fully rated AL-CU pressure connectors shall be provided.

2.2 MICROPROCESSOR CONTROLLER

- A. The controller's sensing and logic shall be provided by a single built-in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communication module or Ethernet connectivity module.
- B. A single controller shall provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to $\pm 1\%$ of nominal voltage. Frequency sensing shall be accurate to $\pm 0.2\%$. The panel shall be capable of operating over a temperature range of -20 to +60 degrees C and storage from -55 to +85 degrees C.
- C. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multi-layer printed circuit boards. Interfacing relays shall be industrial grade plug-in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built-in pocket for storage of the operator's manuals.
- D. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:
 - 1. EN 55011:1991 Emission standard - Group 1, Class A
 - 2. EN 50082-2:1995 Generic immunity standard, from which:
 - EN 61000-4-2:1995 Electrostatic discharge (ESD) immunity
 - ENV 50140:1993 Radiated Electro-Magnetic field immunity
 - EN 61000-4-4:1995 Electrical fast transient (EFT) immunity
 - EN 61000-4-5:1995 Surge transient immunity
 - EN 61000-4-6:1996 Conducted Radio-Frequency field immunity
- 3. IEEE472 (ANSI C37.90A) Ring Wave Test

2.3 ENCLOSURE

- A. The DTTS shall be furnished in a NEMA Type 4X enclosure unless otherwise shown on the plans. The enclosure shall be capable of being locked/secured with a key.
- B. All standard door mounted switches and indicating lights described in section 3 shall be integrated into a flush-mounted, interface membrane or equivalent in the enclosure door for easy viewing & replacement. The panel shall include a manual locking feature to allow the user to lockout all membrane mounted control switches to prevent unauthorized tampering. The membrane panel shall be suitable for mounting by others when furnished on open type units.

PART 3 OPERATION**3.1 CONTROLLER DISPLAY AND KEYPAD**

- A. A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing all available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the communications interface port. The following parameters shall only be adjustable via DIP switches on the controller:
 - 1. Nominal line voltage and frequency
 - 2. Single or three phase sensing
 - 3. Operating parameter protection
 - 4. Transfer operating mode configuration (Delayed Transition)
- B. All instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals

3.2 VOLTAGE, FREQUENCY AND PHASE ROTATION SENSING

- A. Voltage and frequency on both the normal and alternate sources (as noted below) shall be continuously monitored, with the following pickup, dropout, and trip setting capabilities (values shown as % of nominal unless otherwise specified):

<u>Parameter</u>	<u>Sources</u>	<u>Dropout / Trip</u>	<u>Pickup / Reset</u>
Undervoltage	N&E, 3 ϕ	70 to 98%	85 to 100%
Overvoltage	N&E, 3 ϕ	102 to 115%	2% below trip
Underfrequency	N&E	85 to 98%	90 to 100%
Overfrequency	N&E	102 to 110%	2% below trip
Voltage unbalance	N&E	5 to 20%	1% below dropout

- B. Repetitive accuracy of all settings shall be within $\pm 0.5\%$ over an operating temperature range of -20°C to 60°C .
- C. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via the communications interface port.
- D. The controller shall be capable (when activated by the keypad or the communications interface port) of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).
- E. Source status screens shall be provided for both normal & emergency to provide digital readout of voltage on all 3 phases, frequency, and phase rotation

3.3 TIME DELAYS

- A. An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 24 VDC power supply.
- B. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.
- C. Two time delay modes (which are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails and the normal source is acceptable.
- D. A time delay shall be provided on loss of preferred source, adjustable from 0 to 60 minutes.
- E. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes:
 - 1. Prior to transfer only.
 - 2. Prior to and after transfer.
 - 3. Normal to alternate only.
 - 4. Alternate to normal only.
 - 5. Normal to alternate and alternate to normal.
 - 6. All transfer conditions or only when both sources are available
- F. The controller shall also include the following built-in time delay for Delayed Transition operation:
 - 1. 0 to 5 minute time delay for the load disconnect position for Delayed Transition operation.
- G. All time delays shall be adjustable in 1 second increments, except the extended parallel time, which shall be adjustable in .01 second increments.
- H. All time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the communications interface port.

3.4 ADDITIONAL FEATURES

- A. Membrane-type switches shall be provided for the test and retransfer to normal functions. The test position will simulate a normal source failure. The retransfer to normal position shall bypass the time delays on retransfer to normal.
- B. A SPDT contact, rated 5 amps at 30 VDC, shall be provided for annunciation of load transfer. The transfer signal shall prevent nuisance transfer to the alternate source by requiring the ATS to sense normal source output, and run for the duration of the delay setting, regardless of whether the normal source restores before the load is transferred.
- C. Auxiliary contacts, rated 10 amps, 250 VAC shall be provided consisting of two contacts, closed when the ATS is connected to the normal source and two contacts closed, when the ATS is connected to the alternate source.

- D. LED indicating lights shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the Alternate source (red).
- E. LED indicating lights shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal and emergency sources, as determined by the voltage sensing trip and reset settings for each source.
- F. A membrane switch shall be provided on the membrane panel to test all indicating lights when pressed.
- G. Provide the ability to select "commit/no commit to transfer" to determine whether the load should be transferred to the second utility source if the normal source restores before the generator is ready to accept the load.
- H. Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or the communications interface port.
- I. An Inphase monitor shall be provided in the controller. The monitor shall control transfer so that motor load inrush currents do not exceed normal starting currents, and shall not require external control of power sources. The inphase monitor shall be specifically designed for and be the product of the ATS manufacturer. The inphase monitor shall be equal to ASCO Feature 27.
- J. The controller shall be capable of accepting a normally open contact that will allow the transfer switch to function in a non-automatic mode when a non-automatic version of the user interface membrane is furnished.
- K. Engine Exerciser – The controller shall provide an internal engine exerciser. The engine exerciser shall allow the user to program up to seven different exercise routines. For each routine, the user shall be able to:
 - 1. Enable or disable the routine.
 - 2. Enable or disable transfer of the load during routine.
 - 3. Set the start time,
 - a. time of day
 - b. day of week
 - c. week of month (1st, 2nd, 3rd, 4th, alternate or every)
 - 4. Set the duration of the run.
At the end of the specified duration the switch shall transfer the load back to normal and run the generator for the specified cool down period. A 10-year life battery that supplies power to the real time clock in the event of a power loss will maintain all time and date information.
- L. Key Locking Feature – The control switches on the interface membrane shall be capable of being locked via password protected screens on the controller LCD display to prevent unauthorized tampering. A red LED indicator shall be illuminated on the interface membrane when the membrane controls are locked.
- M. System Status – The controller LCD display shall include a "System Status" screen which shall be readily accessible from any point in the menu by depressing the "ESC" key a maximum of two times. This screen shall display a clear description of the active operating sequence and switch position. For example,

Normal Failed
Load on Normal
TD Normal to Alternate
2min15s

- N. Controllers that require multiple screens to determine system status or display "coded" system status messages, which must be explained by references in the operator's manual, are not permissible.
- O. Self Diagnostics – The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.
- P. Communications Interface – The controller shall be capable of interfacing, through an optional communications interface module, with a network of transfer switches. It shall be able to connect via an RS-485 Serial communication module (up to 4000 ft. direct connect or multi-drop configuration), an Ethernet connectivity module (over standard 10baseT Ethernet networks) or remotely through PSTN dial-up modem communications. This module shall allow for seamless integration of existing or new communication transfer devices. Standard software specific for transfer switch applications shall be available by the transfer switch manufacturer. This software shall allow for the monitoring, control and setup of parameters. The transfer switch shall also be able to interface to 3rd party applications using ModbusRTU and ModbusTCP open standard protocols. The communication interface module shall be equal to ASCO Accessory 72A (RS-485 Serial), ASCO Accessory 72E (10BaseT Ethernet), or ASCO Accessory 92A (PSTN dial-up modem).
- Q. Data Logging – The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory:
1. Event Logging
 - a. Data and time and reason for transfer normal to alternate.
 - b. Data and time and reason for transfer alternate to normal.
 - c. Data and time and reason for transfer.
 - d. Data and time re-transfer occurred.
 - e. Data and time alternate source available.
 - f. Data and time alternate source not available.
 2. Statistical Data
 - a. Total number of transfers.
 - b. Total number of transfers due to source failure.
 - c. Total number of days controller is energized.
 - d. Total number of hours both normal and alternate sources are available.

PART 4 ADDITIONAL REQUIREMENTS

4.1 WITHSTAND AND CLOSING RATINGS

- A. The DTTS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the ATS terminals with the type of overcurrent protection shown on the plans.
- B. The DTTS shall be UL listed in accordance with UL 1008 and be labeled in accordance with that standard's 1½ and 3 cycle, long-time ratings. ATSS which are not tested and labeled with

1½ and 3 cycle (any breaker) ratings and have series, or specific breaker ratings only, are not acceptable

4.2 TESTS AND CERTIFICATION

- A. The complete DTTS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.
- B. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards, and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.
- C. The DTTS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, and installation and servicing in accordance with ISO 9001.

4.3 SERVICE REPRESENTATION

- A. The ATS manufacturer shall maintain a national service organization of company-employed personnel located throughout the contiguous United States. The service center's personnel must be factory trained and must be on call 24 hours a day, 365 days a year.
- B. The manufacturer shall maintain records of each switch, by serial number, for a minimum of 20 years.

+ + + END OF SECTION 16251 + + +

**SECTION 16450
GROUNDING****PART 1 GENERAL****1.1 STANDARDS**

- A. All electrical systems shall be grounded in accordance with the National Electrical Code, Local Codes, these Specifications and the contract drawings.

PART 2 PRODUCTS**2.1 CABLE AND EQUIPMENT**

- A. Use green colored and bare stranded copper conductors.
- B. Use approved ground clamp manufactured for such purpose.
- C. Use approved grounding electrodes and rod.
- D. Make permanent ground connection with thermoweld method.

PART 3 EXECUTION**3.1 GENERAL**

- A. In general, alternating current circuits of 600 volts and below, surge suppressors, conductor raceway systems, and platform steel framework shall be effectively and permanently connected to a grounding system by means of copper conductors having cross section as required by the National Electrical Code and of capacity sufficient to ensure continuity and continued effectiveness of the ground connections under conditions of excess current. If some of the equipment to be grounded is not covered herein by detailed instructions or is not shown completely and clearly on the Drawings, such provisions of the National Electrical Code as may apply are to be considered minimum requirements for the work.
- B. All metallic conduit systems, whether used for power or lighting wiring, shall be installed in such a manner as to produce electrical continuity and shall be bound together at one or more points and connected to the building system ground, except that isolated sections of conduit not exceeding 4 feet in length are not to be grounded or bonded unless specifically called for.
- C. Rigid metal conduit systems made up with fittings, boxes, and apparatus housings having fully-threaded hubs need no additional provisions for continuity of ground. If the conduit
- D. system contains cutouts, pull boxes, junction boxes, switchboxes, etc., to which the conduit is fastened by means of locknuts and bushings, such interruptions in the grounding continuity shall be eliminated by bonding the conduit to the housings or by separately grounding each box and conduit sections, etc., that are so isolated. Grounding wedge lugs shall be used between all bushing and metal boxes. Paint and other nonconducting material shall be removed from the surface of conduit, fittings, and metal housings prior to connecting grounding clamps, straps, or other devices.

- E. Equipment Grounding: Panel, starters, lighting fixtures, motor control center, etc., for power and lighting constitute the fundamental center of the associated distribution systems. As such, the metallic enclosures, frames, and other noncurrent carrying metal parts of this equipment shall be connected by one or more grounding conductors to the grounding system. Install a ground connection from the ground bus of switchgears, MCCs, and other electrical panels with ground bus to the ground grid.
- F. All motor frames shall be grounded. The ground conductor shall be run inside the conduit containing the power conductors. In the case of most 3-phase circuits, this means a fourth conductor in each branch circuit. The grounding conductor may be as large as the power conductor or as small as allowed by Section 250 of the NEC but shall not be smaller than No. 12 AWG. The grounding conductor shall be stranded, with green insulation through No. 4 AWG; larger sizes may be bare stranded. Ground connection at the motor shall be terminal lug or servit post inside motor conduit box and the other end connected to the ground bus in the motor control center.
- G. Transformer Grounding: Bond the neutrals of outdoor substation transformers and distribution transformers within buildings to system ground network, and any additional grounding electrodes shown near the transformers. Connect the case of the transformer to the grounding system as well.
- H. In making ground connections, the surfaces to all parts that will touch shall be thoroughly cleaned to ensure making good electrical contacts.
- I. All clamped joints shall be made up firmly. Thermal joints shall be equal to Caldwell Type TA. Where exposed to mechanical injury, the grounding conductor shall be suitably protected by pipe or other substantial guard. If guards are iron pipe or other magnetic material, the grounding conductor shall be electrically connected to both ends of the guard to reduce impedance of the circuit.
- J. Grounding conductors shall be without splice or joint if applicable and shall be straight and short except that when laid underground they shall be laid slack to prevent their being readily broken unless otherwise mechanically protected.
- K. No fuse, switch, circuit breaker, or similar disconnecting devices shall be inserted in the grounding conductor or connection throughout the entire installation.
- L. Grounding conductors shall be medium hard drawn, stranded bare copper wire sized as required by the National Electrical Code Article 250. Conductors Size No. 6 and smaller may
- M. be solid; Size No. 4 and larger shall be stranded. Ground wire shall be carried in conduit to the grounding point.
- N. Ground rods where required, shall be of copper-clad steel not less than ¾-inch in diameter, 10 feet long or as shown on the Contract Drawings, and driven full length into the earth. The maximum resistance of a single driven ground shall not exceed 5 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, a minimum of 2 additional rods shall be installed not less than 10 feet on center. Connections between grounding conductors and ground rods shall be mechanical if exposed, thermal if buried.
- O. Except where specifically indicated otherwise, all exposed noncurrent-carrying metallic parts of electrical equipment, raceway systems, and neutral conductor of the wiring system shall be grounded. The ground connection shall be made at the main service equipment and shall be extended to driven rods on the exterior of the building.

- P. All neutral conductor shall be continuous throughout the system and shall be grounded only at the point of origin of the service neutral.
- Q. All receptacles shall have provision for grounding conductor connection, and shall be grounded to the grounding conductor and outlet box.
- R. All exposed steel columns, tanks, ladders, towers, and elevated platform shall be effectively grounded using No. 2/0 or larger bare copper grounding conductors and driven ground rods. Where multiple columns or tanks must be grounded, ground points shall be interconnected by minimum No. 2/0 bare copper grounding conductors buried approximately 18 inches below finished grade.
- S. Anchor bolts securing exposed electrical equipment, structures, metal enclosures, and tanks located outdoors shall be electrically connected to the steel reinforcement in the concrete foundation or footing. Connection shall consist of minimum No. 2/0 bare copper conductors and mechanical grounding clamps.
- T. Surge arrestor ground terminals shall be connected to the equipment ground bus. Ground paths for lightning and surge arresters and capacitors shall be kept as short and direct as practical. If possible, arresters shall be connected in direct shunt relationship to the equipment terminals. Supporting brackets shall be connected directly to the equipment frame.
- U. Grounding resistors, where specified, shall have a resistance within the boundary limits specified in IEEE Standard 142 in order to minimize transient overvoltages during ground faults. Ground fault current shall not be less than that required to operate protective devices or 25 amps, whichever is greater.
- V. Lightning and surge arresters used with grounded-wye systems which do not have effectively grounded neutrals as defined by IEEE Standard 100 shall have a voltage rating not less than the maximum phase-to-phase voltage of the system.
- W. The grounding system equivalent resistance shall not exceed 5 ohms for the entire system under normally dry conditions unless otherwise specified. After the grounding system has been installed and all connections made, tests shall be made by the Electrical Contractor to determine the resistance to earth. If the resistance of the entire system exceeds the specified maximum, additional ground rods shall be driven to reduce the resistance to this value.
- X. Gas piping or piping conveying flammable liquids shall not be used as grounding electrodes.
- Y. The use of salts or electrolytes to reduce earth resistance shall not be permitted.
- Z. Permanently connect the green ground conductor to each receptacle junction box (self-tapping screw).
- AA. Install a ground rod inside each manhole. Connect any metallic raceway and all noncurrent-carrying metal parts to the ground rod with a No. 6 AWG (min.) copper conductor. Similarly, provide a ground rod for every pole-mounted site lighting and make grounding connections.
- BB. Bond the standby generator neutral to the grounding system with a properly sized grounding conductor. Ground the generator frame to the ground grid.
- CC. Ground metallic fences when used to enclose electrical equipment.

+++ END OF SECTION 16450 +++

**SECTION 16463
TRANSFORMER LOAD CENTERS****PART 1 GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions, Supplementary Conditions (if included), and Division 1 Specifications Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Combination panelboard/transformer.

PART 2 PRODUCTS**2.1 COMBINATION PANELBOARD/TRANSFORMER**

- A. Manufacturers:
 - 1. Cutler-Hammer.
 - 2. General Electric.
 - 3. Siemens.
 - 4. Square D Company.
 - 5. Or as approved.
- B. Ratings:
 - 1. KVA and voltage ratings as shown on Schedule.
 - 2. Designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96.
 - 3. Transformer Sound Levels: Follow ANSI and NEMA levels for self-cooled ratings.
 - a. Up to 9 kVA: 40 dB.
 - b. Up to 50 kVA: 45 dB.
- C. Construction:
 - 1. Include a main primary breaker, an encapsulated dry type transformer, and a secondary panelboard with main breaker.
 - 2. Main primary, secondary, and feeder breakers enclosed with a padlockable, hinged door.
 - 3. Insulation Systems:
 - a. Transformer insulation with a 185 degrees C insulation system.
 - b. Required performance obtained without exceeding the above indicated temperature rise in a 40 degree C maximum ambient, with a 30 degrees C average over 24 hours.
 - c. Insulation materials flame-retardant and not supporting combustion as defined in ASTM Standard Test Method D635.
- D. Wiring/Terminations:
 - 1. Factory-installed interconnecting wiring between the primary breaker and transformer, secondary main breaker and transformer, and distribution section.
 - 2. All transformers equipped with a wiring compartment suitable for conduit entry and large enough to allow convenient wiring.

- E. Main Devices: Include a main primary breaker with an interrupting rating of 25 kA at 480 volts; and a secondary panelboard with main breaker rated 10 kA interrupting rating at 240 volts.
- F. The secondary distribution section to accommodate 1 inch, plug-in breakers, each 10 kA interrupting capacity.
- G. Enclosure:
 - 1. Heavy gage steel with the maximum temperature of the enclosure not to exceed 90 degrees C.
 - 2. Totally enclosed, non-ventilated, NEMA 3, with lifting eyes.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install all equipment per manufacturer's instructions and as shown on Drawings.

+++ END OF SECTION 16463 +++

SECTION 16471
DISTRIBUTION PANELBOARDS AND INTEGRATED LOAD CENTERS

PART 1 GENERAL**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions, Supplementary Conditions (if included), and Division 1 Specifications Sections, apply to this Section.

1.2 SECTION INCLUDES

- A. Distribution panelboards and integrated load centers.

1.3 SHOP DRAWINGS

- A. Indicate voltage, bus ampacity, ampacity of main lugs or circuit breaker, integrated short circuit ampere rating, and circuit breaker arrangement and sizes.

1.4 MAINTENANCE MATERIALS

- A. Panelboard Keys: Two of each.

PART 2 PRODUCTS**2.1 MANUFACTURERS**

- A. Cutler-Hammer.
- B. General Electric.
- C. Siemens.
- D. Square D Company.
- E. Or as approved.

2.2 DISTRIBUTION INTEGRATED LOAD CENTER (IPC)

- A. Panelboard: Circuit breaker type equipped with a solid neutral.
- B. Service: 480 VAC, three-phase, three -wire.
- C. Panelboard Bus: Copper; ratings as indicated in Schedule. Provide copper ground bus in each panelboard.
- D. Minimum Integrated Short Circuit Rating: 25,000 AIC RMS symmetrical.
- E. Panelboard Busing Cross-Sectional Area: Sufficient to meet UL Standard 891 on temperature rise.

- F. Main Circuit Breaker: 225 ampere, bottom feed main circuit breaker for short circuit and over-current protection and as a means of disconnecting the main service, capable of accepting conductor sizes as shown on plans
- G. Neutral bus bar shall be capable of terminating two No. 250 KCMIL conductors; grounding bus bar capable of terminating four No. 1/0 copper ground wires and one bonding jumper from the neutral bus bar.
- H. Molded Case Branch Circuit Breakers: NEMA AB 1. Integral thermal and instantaneous magnetic trip in each pole; UL listed as Type HACR for air conditioning equipment branch circuits.
 - 1. Group-mounted, molded case circuit breakers shall be totally front accessible.
 - 2. Line Side Connections: Bolt-on.
 - 3. Include circuit breakers listed on Schedule, plus space to add a minimum of two 100 ampere frame circuit breakers for future use.
- I. Enclosure: Dead-front with front accessibility, wall-mounted in a NEMA 4x stainless steel gasketed enclosure.
- J. Wireway Front Covers: Hinged to permit easy access to the branch circuit breaker load side terminals.
- K. Cabinet Front: Surface type fastened with concealed trim clamps or screw cover. Provide hinged door with flush lock. Finish in manufacturer's standard gray enamel.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install integrated load center in accordance with NEMA PB 1.1.
- B. Install distribution equipment plumb. Provide supports as required for secure installation. Follow NECA Standards of Installation and Section 16050,2.1,I.
- C. Height: Do not exceed more than 6 feet to top of IPC.
- D. Provide filler plates for unused spaces.
- E. Provide typed circuit directory for each circuit breaker.
- F. Provide engraved plastic nameplates; see Section 16010,3.5. Attach plates with corrosion-resistant screws.

3.2 FIELD QUALITY CONTROL

- A. Correct deficiencies identified by tests and observations and provide retesting of panelboards. Verify by the system tests that the total assembly meets specified requirements.

3.3 SCHEDULES

As shown in drawing plans

+++ END OF SECTION 16471 +++

**SECTION 16484
INTEGRATED PUMP CONTROLS SYSTEM****1.0 GENERAL:**

- A. The pumps control system shall be designed to operate the required number of pumps specified on the drawing at the power characteristics shown on the plans. The control system shall be as manufactured by Sta-Con, Inc or equal.
- B. The control function shall provide for the operation of the pumps under normal conditions, and shall alternate the pumps on each pump down cycle to equalize the run time. In the event the incoming flow exceeds the pumping capacity of the lead pump, subsequent pumps shall automatically start to handle the increased flow. As the flow decreases, the pumps shall cut off at the elevations as shown on the plans.
- C. All operation control sequences shall be in accordance with and coordinated with the pump system sequence of operation as shown in the Mechanical documents.

2.0 MECHANICAL:

- A. The enclosure shall be a NEMA 3RX, stainless steel enclosure. The enclosure shall be a free standing type with legs for mounting to a concrete pad. The enclosure shall have a minimum depth of 12" and shall be 60"X60" minimum, no exceptions. The door gasket shall be rubber composition with a retainer to assure a positive weatherproof seal or be provided with foam in place gasket that does not create a memory in the material. The door shall open a minimum of 180 degrees and shall have a door stop to hold the door in the open position, while personnel are working in the enclosure. A three point stainless steel latching handle shall be supplied to latch the outer door closed.
- B. A three position safety switch sized according to motor horsepower, amperage, and voltage will be mounted to the back of the control enclosure. This switch will be Square D. A Crouse Hinds generator receptacle sized according to motor horsepower, amperage, and voltage will be mounted to the side of the control enclosure and wired to the safety switch, no exceptions.
- C. A fused knife switch disconnect will be mounted to the back of the control enclosure and wired as the main disconnect. The knife switch fuses will be sized per the motor data. The knife switch will be a Square D.
- D. A polished aluminum dead front shall be mounted on a continuous aircraft type hinge and shall contain cutouts for mounted equipment and provide protection of personnel from live internal wiring. Cutouts for breaker handles shall be provided to allow operation of breakers without entering the compartment. All control switches, indicator pilot lights, elapsed time meters, duplex receptacle and other operational devices shall be mounted on the external surface of the dead front. The dead front shall open a minimum of 150 degrees to allow access to equipment for maintenance. A 3/4" break shall be formed around the perimeter of the dead front to provide rigidity.
- E. The back plate shall be manufactured of 12-gauge sheet steel and be finished with a primer coat and two [2] coats of baked on white enamel. All hardware mounted to the subpanel shall be accomplished with machine thread tapped holes. Sheet metal screws are not

acceptable. All devices shall be permanently identified using engraved nameplates. Use of DYMO type labels is not acceptable.

- F. Cooling for the enclosure will be maintained through a set of vents in the upper left and lower right hand sides of the cabinet. A thermostatically controlled exhaust fan will be mounted behind the upper right hand vent.

3.0 ELECTRICAL:

- A. The panel power distribution shall include all necessary components and be completely wired with stranded copper conductors rated at 90 degrees c. All conductor terminations shall be as recommended by the device manufacturer. Single phasing and phase loss protection devices shall be provided.
- B. All circuit breakers shall be heavy-duty thermal magnetic or motor circuit protectors SQUARE D type FAL. Each motor breaker shall be adequately sized to meet the pump motor operating characteristics and shall have a minimum of 10,000 amps interrupting capacity for 230 vac and 14,000 amps at 480 vac. Heavy-duty breaker shall individually control the control circuit.
 - 1. Circuit breakers shall be indicating type, providing "on-off-trip" positions of the operating handle. When the breaker is tripped automatically, the handle shall assume a middle position indicating "trip".
 - 2. Thermal magnetic breakers shall be quick-make and quick-break on manual and automatic operation and have inverse time characteristic secured through the use of bimetallic tripping elements supplemented by a magnetic trip.
 - 3. Breakers shall be designed so that an overload on one pole automatically trips and opens all legs. Field installed handle ties shall not be acceptable.
 - 4. A Main breaker shall be provided with an interlocking operator located on the dead front door. The operator will only allow the dead front door to be opened when it is in the off position.
 - 5. A 6- pulse PWM Variable frequency drive (VFD) shall be provided equal to a Square D Altivar 61 for each pump motor. A door mounted key pad will be mounted on the inner door. Line side fuses will be provided in addition to the circuit breaker for added protection of the drive. A 5% line reactor will be supplied at each VFD to absorb power line spikes and motor current surges.
- C. Control transformers and power supplies shall be provided for the 120 vac and/or 24 VDC as necessary for control circuits. Transformers shall be fused on the primary and secondary circuits. The secondary shall be grounded. The transformers will be Square D.
- D. An integrally mounted lightning-transient protector meeting NEC article 280 and ANSI/IEEE C62.11, shall be provided. The device shall be solid state with a response time of less than 5 nanoseconds with withstanding surge capacity of 6500 amperes. Unit shall be instant recovery, long life and have no holdover currents. The lightning protector shall be Square D.
- E. A line voltage rated, adjustable 12 pin plug-in phase monitor shall be installed to sense low voltage, loss of power, reversed phasing and loss of a phase. Control circuit shall de-energize upon sensing any of the faults and shall automatically restore service upon return to normal power. The phase monitor shall be a Flygt phase monitor as manufactured by MPE in Apopka, FL.

- F. MINI- CAS 120
1. One plug in solid state Mini-Cas 120 unit shall be supplied for each pump to monitor the pump for over-temp and leakage. The unit shall have an 11pin, round base to mate with a standard 11 pin socket. The unit shall also be flanged in order to allow dead front door mounting.
 2. The unit shall be powered by 24VAC, 24VDC, or 120VAC. LED indication shall be provided for power on, over-temp, and leakage conditions. An over-temp reset push-button shall be provided to allow reset of the unit.
 3. The sensor input circuitry is to contain both hardware and software filters to provide noise immunity, as well as sensor input short circuit protection. The Mini-Cas 120 unit shall be model 14-407129, as supplied by Flygt Corporation.
- G. Remote terminals shall be supplied for all alarm signals to be remotely transmitted.
- H. Ground fault relays shall be provided for each pump.
- I. 1 additional power outlet shall be provided for the automatic dialer in the enclosure.

4.0 ALARM SYSTEM:

- A. The alarm light shall be a weatherproof, shatterproof, red light fixture with a 40-watt bulb to indicate alarm conditions. The alarm level shall turn on the alarm light.
- B. The alarm horn shall be mounted on the exterior of the cabinet. The alarm horn shall provide a signal of not less than 90db at 10 feet. An alarm silence switch shall deactivate the alarm horn; however, the alarm light will flash until the alarm condition ceases to exist. At that time the alarm-reset function will reset for normal operation.

5.0 PRIMARY CONTROL SYSTEM:

GENERAL:

The pump(s) controller shall consist of all the components, hardware and software to provide a trouble-free pumping station. The system shall be designed and specifically produced for the surveillance of the pump station. The system shall provide for interface to other RTU's and SCADA systems for remote control and data collection. The RTU shall control the pumps as a stand alone unit in the event of a communications loss. A UPS shall be supplied to back up the control voltage. The UPS shall be manufactured by PULSE. The controller shall be a APP 741 as manufactured by ITT Flygt or approved equal.

OPERATION:

A level sensor with continuous measurement of the wet well level shall be provided to interface with the controller and provide the necessary data to start and stop the pumps.

The RTU/Controller shall be simple to handle with information provided in English. The parameters shall be pass-word protected, recognized and available on the display. Communications shall be possible with a fixed line modem, a dialed modem, radio or GSM.

modem. The RTU shall be able to communicate with Aquaview protocol and send a SMS message to a mobile phone. Aquaview software shall be provided with the controller.

The system shall develop historical data based on 1-30 minute time period. The following data shall be provided:

- a. Wet well levels.
- b. Motor currents.
- c. Calculated capacity of wet well.
- d. Inflow.
- e. Pumped volume.
- f. Overflow.

In addition to the available historical data, the following daily reports shall be transferred to the central system on request.

- a. Pump run times
- b. Number of pump starts
- c. Average value of pump capacity.
- d. Pumped volume.
- e. Number of overflow events.
- f. The length of time of overflow.
- g. Overflow volume.
- h. The times and numbers of the station blocking from other RTUs.
- i. Energy consumption.

All components and operation of the system shall meet the following specifications:

1. Digital inputs and outputs shall be optically isolated.
2. Input signals shall be 11-30 Volts or 4-20 mA.
3. Relay outputs with maximum load shall be 2A, 250V AC/DC.
4. Solid state outputs shall be 100mA, 250V AC/DC.
5. Analog inputs shall be 4-20 with resolution of 12 bits and an inaccuracy of 0.1%.
6. The RTU shall be expandable up to 400 digital and analog inputs.

LED's on the front panel shall provide visual alarm and operation of the pumps.

- Cross section areas of the sump.
- Start-stop levels of the pumps.
- Alarm levels for high, low and overflow.
- Nominal capacities of the pumps.
- Current flow and accumulated inflow.
- Pumped volume for two days.
- Number of starts for the pumps.
- Running time for each pump.
- The last 1000 alarms.
- Amp draw for each pump.

Pump Station Operation:

Start and stop of the pumps and alarm acknowledgement of alarms shall be accomplished either locally or remote. A manually started pump shall shut down after a specified time delay. The pumps shall alternate to equalize run rime. The pump operation of multiple pumps shall be configured by

the operator. An alarm shall be generated if the motor current is below the adjustable alarm level. In addition to controlling the pumps, the controller shall provide the following:

1. Flow Calculation:

The RTU shall provide the calculation for the inflow and the pumped volume of the station. Levels and the cross sectional areas of the wet well shall be used to determine the inflow. The RTU shall determine the pump capacities based on discharge time and the calculated inflow.

2. Overflow Measurement:

A reliable level switch shall be provided to calculate the over flow measurement. The over flow shall be calculated based on time, flow and the accumulated volume.

3. Pump Protection Alarms:

The RTU shall monitor the pumps for leakage and temperature in the windings. Either noted condition shall shut the pumps down and activate and alarm.

4. Pump Cleaning Functions:

The controller shall provide for the automatic cleaning operation as noted below:

- a. The sump shall be cleaned by allowing the pump to "snore" When the amp draw of the pumps drops, the pump shall stop. Time delays shall be provided.
- b. If the pump is non operational for a specified time period, the pump shall automatically pump the station down to avoid stagnant water.
- c. A reverse cycle shall be instigated for a pump that has been running for a specified period.

5. Service Alarm:

An alarm shall be generated if the run time for the pumps has been exceeded over an adjustable pump maintenance interval.

6. Precipitation Measurement:

A rain gauge that registers in digital integers shall be provided. Exceeding the adjustable limits shall generate an alarm and the precipitation quantity shall be presented in the display status picture, periodical report and develop a historical trend.

7. Energy Measurement:

Energy consumption shall be calculated from the number of pulses from a digital input or calculated from the motor currents consumption.

8. Personnel Alarm:

An adjustable personnel working period alarm shall be activated if the working time has been exceeded. The alarm shall be sent to the central system if the alarm is not acknowledged locally. When the system is returned to automatic operation the alarm shall be disabled.

9. Test Alarm:

The RTU shall be configured to allow for alarm testing at least once a week.

6.0 ANCILLARY EQUIPMENT:

1. The controller shall incorporate Square D HOA switches, run lights and pump failure lights. All lights, switches and other control devices shall be rated NEMA 4X. A 100 watt condensation heater with adjustable thermostat shall be included in the control system.
2. A 20A single pole breaker shall be supplied for supplying 120V power to a GFI receptacle located in the valve vault to operate a sump pump.
3. In addition to the line side lightning arrester indicated in another section of this specification, provide an integrally mounted and installed within the control panel, a min. 240 KA per phase Transient Voltage Suppressor TVSS unit meeting UL 1449 and NEC 285.
4. ZERUST corrosion control anti-rust packages shall be installed at each cabinet enclosure.

9.0 MANUFACTURER:

- A. The manufacturer shall be listed as a certified National Recognized Testing Laboratory producing to UL 508 requirements for industrial control systems and shall provide evidence of such by attaching a serialized label on the cabinet door.
- B. The control shall be as manufactured by Sta-Con Inc.

MISCELLANEOUS

1. A final as built drawing encapsulated in mylar shall be attached to the inside of the front door. Schematics shall be done in ladder logic with wire numbers and line numbers. Real time cross referencing of relay contact to line numbers shall be given as well as written description of component function on each circuit of the drawings. From/ to wire and termination reports shall be shown on the as built drawings. Drawings shall be available in HTML format. Terminal strip layouts shall be provided for ease of connecting external devices. Electrical drawings and Bill of materials shall be provided in Auto Cad 2006 electrical.
2. All component parts in the control panel shall be permanently identified with engraved legend plates as designated on the drawings. A list of all legends shall be available in Excel format and attached with the schematics on the panel door.
3. All equipment shall be tested to the operational requirements.
4. All equipment shall be guaranteed for a period of three years from the date of installation. The guarantee is effective against all defects in workmanship and/or defective component. The warranty is limited to replacement of or repair of the defective equipment.
5. The system shall be as manufactured by ITT Flygt.

6. The control manufacturer will have a minimum installation history of 150 Flygt FMC controllers. In addition the control panel components shall interchange with the existing control panels at Marsh Creek, GA
7. The control manufacturer will be an Authorized Square D Panel Builder and Schneider Electric Systems Integrator.

+ + + END OF SECTION 16484 + + +

**SECTION 16510
INTERIOR LIGHTING****PART 1 GENERAL****1.1 SCOPE**

- A. Work covered by this section includes furnishing all labor, equipment, and materials required to install all lighting equipment, fixtures, lamps, outlet boxes, hangers, and all related work for a complete installation.

1.2 SHOP DRAWINGS AND ENGINEERING DATA

- A. Complete shop drawings and engineering data shall be submitted to the Engineer in accordance with requirements of the section entitled "Shop Drawings, Product Data and Samples" of these Specifications.
- B. The Contractor shall submit for review and approval, a complete list of fixtures he intends to furnish, including technical specifications, assembly details, and photometric data.

1.3 STORAGE AND PROTECTION

- A. Lighting equipment shall be stored and protected in accordance with requirements of the section entitled "General Equipment Stipulations" of these Specifications.

1.4 GUARANTEE

- A. Provide a guarantee against defective or deficient workmanship and products in accordance with requirements of the section entitled "Warranties and Bonds" of these Specifications.

PART 2 PRODUCTS**2.1 FIXTURES**

- A. Interior lighting fixtures of types and sizes as indicated on the fixture schedule shall be furnished and installed complete.
- B. All lighting fixtures, lampholders and accessories are to be Underwriters Laboratories approved.
- C. Unless called for otherwise, all pendant mounted fixtures shall be equipped with stem. Aligners shall be used on all pendant mounted fixtures hung from irregular or sloping ceilings.
- D. The fluorescent and high intensity discharge fixtures shall be complete with ETL-UL approved constant wattage ballasts and lamps as indicated on the schedule.
- E. Vapor-proof units shall have galvanized malleable iron or cast aluminum hood, glass globe and aluminum guards or as called for in the fixture schedule.
- F. All lighting fixtures which accommodate the use of gaskets shall be properly fitted with gaskets of an approved material.

2.2 LAMPS

- A. All lighting fixtures shall be provided with lamps of the proper type and wattage, as noted on the Drawings. Any lamps broken previous to the final acceptance of the work shall be replaced by the Contractor at his own expense.
- B. Incandescent lamps shall be wired with screw shell connected to neutral conductors. They shall be supplied with standard inside frosted lamps of wattage indicated, unless otherwise specified.
- C. Unless otherwise noted, fluorescent lamps shall be standard cool white.
- D. High intensity discharge lamps shall be sized as indicated on the schedule and suitable for the application indicated on the Drawings.

2.3 BALLASTS

- A. All fluorescent ballasts shall be electronic and shall bear the "CBM" and "ETL" labels. The ballasts shall be listed by Underwriters' Laboratories and shall meet all applicable ANSI lamp and ballast specifications as included in CBM requirements.
- B. The ballasts shall be sound rated and this sound group rating indicated on the ballast. The ballasts specified shall have the lowest sound rating consistent with the requirements of the application.
- C. All HID ballasts shall carry the "CBM" and "ETL" labels. The ballasts must be tested by the Underwriters' Laboratories.

2.4 CONTROLS

- A. Photoelectric control shall be provided where indicated on the Drawings.

2.5 SPARE PARTS

- A. The Contractor shall provide 2 spare lamps of each voltage and type required.
- B. Lamps shall be suitably protected against impact for long-term storage.

PART 3 EXECUTION

3.1 INSTALLATION

- A. The Contractor shall coordinate all work to assure a finished, neat appearance. Lamps, ballasts, mounting rings, fuses and other essentials shall be provided to entirely complete the lighting work in a workmanlike manner.
- B. The Contractor shall verify the final ceiling and finish schedules to insure the proper installation and mounting of fixtures; and shall coordinate with the Ceiling Contractor before making submittals.
- C. Suspended fixtures shall be supported at not more than 4-foot intervals.
- D. Pendant, chain or suspended fixtures shall be installed with a minimum clearance from bottom of fixture to floor as shown on Drawings.

- E. All fixtures shall be adequately supported in an approved manner whether or not the method or type of support is specified or detailed.
- F. The locations of lighting fixtures shall be shown in general on the Drawings. These locations shall be checked by the Engineer at the time of installation and shall be varied within reasonable limits so as to miss piping or other obstructions without extra cost to the Owner.
- G. Contractor shall specifically adhere to manufacturer's instructions and wiring diagrams where required.
- H. Install all lamps at the time fixtures are mounted. All burned-out lamps shall be replaced by the Contractor before the work is accepted by the Owner.

+++ END OF SECTION 16510 +++

**SECTION 16530
ELECTRICAL SITE LIGHTING****PART 1 GENERAL****1.1 WORK INCLUDED**

- A. Work covered by this specification consists of furnishing all labor, equipment, supplies and materials, and performing all operations including cutting, chasing, trenching and backfilling, etc. necessary for the installation of a complete site lighting system as shown on drawings and as hereinafter specified.
- B. Work shall include power, control, grounding and lightning protection for site, pump station floodlighting and sign lighting.

1.2 QUALITY ASSURANCE

- A. Installation shall comply with all laws applicable to electrical installations that are enforced by local authorities, with the regulations of National Electrical Code where such regulations do not conflict with local laws, and with regulations of the utility company that serves the facility. Contractor shall obtain all permits required by local authorities.
- B. All materials shall be new and shall bear a U.S. label and be listed by Underwriters' Laboratories, Inc. as conforming to its standards where such a standard has been established for the particular type of material in question.

1.3 REFERENCES

- A. All work shall conform to applicable standards of ANSI, IEEE, NEMA, UL, and NEC.

1.4 SUBMITTALS

- A. Materials and Equipment Lists
 - 1. As soon as practicable and before starting installation of any materials or equipment, the Contractor shall submit for approval complete lists, in triplicate, of materials and equipment to be incorporated in the work. These lists shall include catalog numbers, cuts, and other descriptive data required to assure compliance with the specification requirements and to permit ready and complete identification. Approval of the proposed materials and equipment based on manufacturer's published data will be tentative only, and will be subject to submission of complete shop drawings indicating compliance with the Contract Documents.
- B. Shop drawings shall be submitted for materials and equipment not readily identifiable from information submitted in materials and equipment lists. Departures from Contract Drawings will not be authorized without the written permission of the Engineer. If departures from the Contract Drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted as soon as practicable or with the shop drawings. Approved departures shall be made at no additional cost to the Owner.
- C. Shop drawings shall be submitted for the following list of items:
 - 1. Luminaires
 - 2. Ballasts
 - 3. Floodlights
 - 4. Poles, bases, anchor bolts

5. Photoelectric cells
 6. Time clocks
 7. Contactors
 8. Fuse holders
 9. Surge arresters
 10. Lamps
- D. Shop drawings and samples shall be thoroughly checked and coordinated by the Contractor for details and fulfillment of contract requirements prior to submittal. Approval of any item does not relieve Contractor of responsibility for coordinating dimensions and work required by other trades.
- E. Where materials or equipment are specified to conform to the standards and requirements of the Underwriters' Laboratories, Inc., 2005 National Electrical Code, or the National Electrical Manufacturers Association, the Contractor shall submit proof that the items furnished under this section of the Specifications conform to such requirements. The label of or listing in the Underwriters' Laboratories, Inc., or the manufacturer's certification that the items comply with applicable Specifications, with NEMA standards, and with the manufacturer's standards will be acceptable as evidence that the materials and equipment conform to the applicable standards.
- F. Materials and equipment shall be the standard catalog products of manufacturers regularly engaged in the manufacture of such products, and shall be of the latest standard designs that conform to the specification requirements.

1.5 DELIVERY, STORAGE AND HANDLING

- A. All material shall be unloaded and stored in a manner to avoid physical damage or detrimental effects of exposure to weather.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Catalog numbers of devices, fixtures, equipment, etc. are used for ease in describing standard of quality desired. Devices, fixtures, equipment, etc. by other manufacturers, performing the same functions and considered equal in quality by the Engineer, will be acceptable.

2.2 BOXES

- A. Boxes for exposed work shall be of cast alloy or cast steel type with threaded hubs.
- B. Pull or junction boxes shall be constructed of code gauge galvanized sheet sized per NEC or as noted, continuously welded along seams, and fitted with screw-on cover plate secured with stainless steel covers.
- C. All outlet or junction boxes of pressed or sheet steel type shall be galvanized, sheradized, bonderized or treated with a similar approved corrosion inhibitor.

2.3 GROUNDING

- A. Install a ground rod at each pole-mounted site light.
- B. Raceways, boxes, outlets, cabinets, etc. shall be bonded together to form a continuous metallic grounding circuit in accordance with NEC.

- C. Metal light poles shall be grounded to the continuous grounding conductor and also to the embedded anchor bolt and ground rod. The anchor bolt shall be bonded to the reinforcing steel cage using compression (bronze) connector and a minimum #8 soft drawn copper wire.

2.4 LIGHTNING PROTECTION

- A. Multi-pole lighting surge arresters shall be installed at selected pole locations to protect the exposed pole wiring and equipment and to reduce potential damage to indoor branch circuit devices.
- B. Where 3-phase branch circuits are used for lighting, the surge arrester should be connected at the first exposed pole supplied from the lighting panel. As an alternate, a single 3-pole surge arrester may be installed at the outdoor lighting contactor.

2.5 CIRCUIT PROTECTION

- A. Individual pole fixture circuits shall be equipped with weatherproof disconnecting fuse holders and fuses to provide reduced fixture tap wiring protection. The fuse holders shall be equal to Bussman KTK type HEB with boots connected per line/load side markings. Fuses shall be sized for 3 times ballast ampere rating.

2.6 FIXTURES

- A. Provide fixtures and poles as shown on the drawings.

2.7 CONTROLS

- A. Provide controls as shown on drawings.

PART 3 EXECUTION

3.1 VERIFICATION OF DIMENSIONS

- A. The Contractor shall be specifically responsible for the coordination and proper relation of his work to the site lighting layout and to the work of all trades. The Contractor shall thoroughly familiarize himself with all details of the work and working conditions, shall verify all dimensions in the field, and advise the Engineer of any discrepancy before performing any work.

3.2 PREPARATION

- A. Wiring layouts are schematics and are not intended to show the exact location or routing of conduits. The Contractor shall refer to civil site layouts and building plans for dimensions and shall fit his work to conform to the details of project construction. The right is reserved to shift any pole or conduit 10 feet from its location shown on the drawings before it is permanently installed, without incurring additional cost to the Owner.

3.3 INSTALLATION

- A. All materials and equipment shall be installed in accordance with approved recommendations of the manufacturer to conform to the contract documents. The installation shall be accomplished by workmen skilled in this type of work and shall conform to the 2005 National Electrical Code.

- B. Furnish all labor; and furnish, install, connect, test and adjust all lighting system equipment and materials to form a complete operating installation. The electrical work shall be installed in such a manner and at such times as will require a minimum of cutting and patching of the site surfacing, landscaping and/or building structure.
- C. All metallic raceways entering cabinets, panels and junction boxes shall be fitted with double locknuts and bushing. All raceway stubs shall be suitably capped or plugged during construction to prevent entry of water, debris, mortar, etc.
- D. Lightning protection shall be installed at each site. The surge arrester shall be grounded to pole foundation grounding system using a separate conductor for the purpose.
- E. All lighting fixtures shall receive new correctly sized lamps, wired in accordance with phasing system shown on the drawings.

3.4 ADJUSTING AND CLEANING

- A. Clean and lamp all lighting fixtures after installation and wiring. Install all fuses. All lighting fixtures and poles shall be clean at time of final acceptance.
- B. Provide all wiring for testing and trials, for all required corrections, changes, additions, completions and adjustments until final acceptance of the work.
- C. Coordinate numbers and label all field wiring between equipment of the various electrical suppliers.
- D. Any damage to work already in place as a result of electrical work shall be repaired and made good at no expense to the Owner.

3.5 TESTING AND ACCEPTANCE

- A. Prior to acceptance by the Owner, all lighting systems shall function as required, and control wiring shall be properly interconnected to all control devices for the proper functioning of the lighting equipment. Submit 1 blue-line print of the contract drawings marked to show as-built locations and description of all electrical work.

3.6 GUARANTEE

- A. The following equipment to be furnished under this section of the Specifications shall be guaranteed for a period of 1 year from the date of acceptance, either for beneficial use or final acceptance, whichever is earlier, against defective materials, design, and workmanship: luminaires, cable, floodlights, lamps, contactors, poles, time clocks, and photo controls. Upon receipt of notice from the Owner of failure of any part of the guaranteed equipment during the guaranty period, the affected part or parts shall be replaced promptly with new parts by and at the expense of the Contractor.

+++ END OF SECTION 16530 +++

**SECTION 16620
DIESEL ENGINE GENERATOR SET****PART 1 GENERAL****1.1 WORK INCLUDED**

- A. This section covers work necessary for one engine-generator sets as listed below:
 - 1. Engine-Generator at the pump station.
 - a. The engine-generators shall be the product of one company and that company and its authorized dealer shall have sole responsibility for the performance of the diesel engine-generator sets and its accessories.
 - b. Provide all labor, materials, and equipment to furnish, install, and place in operation the power generation system in accordance with the contract documents and manufacturer's drawings and installation instructions. These specifications also describe requirements for the design, fabrication, and testing of the power system.
- B. The generator manufacturer shall also furnish an Automatic Transfer Switch set.

1.2 SYSTEM DESCRIPTION

- A. The electric power generating systems shall be rated as shown on the drawings with a 0.8 power factor, 480 volts, Wye connected, three phase, and 60 hertz. This power shall be applied for standby operation to power electrical load as shown on the one-line diagrams. The generator shall be capable to start and run the pumps shown on the drawings. A maximum voltage drop of 25 percent at start-up is acceptable.

1.3 SYSTEM DESCRIPTION

- A. The generator sets will be used as stand-by power source.

1.4 GENERATOR SET

- A. The generator set start-stop sequence shall be initiated manually or automatically.
- B. The set shall immediately shut down in the event of over-speed, low oil pressure, high water temperature and over-crank. A light annunciator shall indicate cause of shutdown. System logic shall prevent restart until fault is cleared.

1.5 SITE CONDITIONS

- A. The operating environment of the power generating system shall be:
 - 1. Altitude 1000 ft
 - 2. Engine room temperature, max 104 F
 - 3. Outside temperature, min 32 F
 - 4. Engine jacket water, glycol 50%
 - 5. Installation Enclosure
 - 6. Fuel type Diesel
 - 7. Cooling System Type Radiator, Blower fan, engine mounted

1.6 SUBMITTALS

- A. Submittals shall include but not be limited to:
1. Component List - Breakdown of all components and options, including power distribution panel.
 2. Technical Data - Manufacturer produced generator set specification or data sheet identifying make and model of engine and generator, and including relevant component design and performance data.
 3. Auxiliary Equipment - Specification or data sheets, including transfer switch, power distribution panel, vibration isolators, and fuel tank.
 4. Drawings - General dimensions drawings showing overall generator set measurements, mounting location, and interconnect points for load leads, fuel, exhaust, cooling and drain lines.
 5. Wiring Diagrams - Wiring diagrams, schematics and control panel drawings published by the manufacturer in Joint Industrial Council (JIC) format for controls and power showing interconnected points and logic diagrams for use by contractor and owner.
 6. Warranty Statements - Warranty verification published by the manufacturer.
 7. Service - Location and description of supplier's parts and service facility including parts inventory and number of qualified generator set service personnel.
 8. Noise Attenuation exhaust system and enclosure.

1.7 SERVICE AND WARRANTY

- A. The Standby Power System electrical components, the complete electric plant, its controls, and automatic transfer switch shall be warranted against defective materials and workmanship for a period of two years. Warranty shall include corrective labor and transportation.
- B. The manufacturer shall have a local authorized dealer who can provide factory-trained servicemen, the required stock of replacement parts, technical assistance, and warranty administration.

1.8 PROXIMITY TO JOB SITE

- A. The manufacturer's authorized dealer shall have a parts and service facility within 50 miles of the job site.

1.9 SUPPLIER

- A. Subject to the specification requirements, the Standby Power System shall be by Caterpillar, Cummins-Onan, Generac or Kohler.

PART 2 EQUIPMENT

2.1 ENGINE

- A. The engine shall be a stationary, liquid cooled, 1800-rpm, four-stroke design, vertical in-line or V-type, with Dry exhaust manifolds. It shall be manufactured in the United States.

2.2 ENGINE EQUIPMENT

- A. The engine shall be equipped with air filters, fuel filters and pressure gauge, lubricating oil cooler, filters, and pressure gauge, water pump and temperature gauge, service hour meter, flywheel, and flywheel housing when applicable.

2.3 RADIATOR, ENGINE MOUNTED

- A. Heat rejected to the engine jacket water shall be discharged to the atmosphere through a close-coupled radiator. The generator set shall be installed in a drop-over enclosure and have a 50 % antifreeze/coolant mixture. The radiator shall cool the jacket water while the engine is operating at full site capability and 0.12 kPa external air restriction. Additional restriction affecting airflow shall not limit the radiator's capability to adequately cool at maximum site temperature.
1. Provide a jacket water heater suitable for operation on 240-volts, single-phase
 2. Provide isolation valves on the water lines.

2.4 EXHAUST SYSTEM

- A. The engine exhaust system shall be installed to discharge combustion gases quickly and silently with minimum restriction.

2.5 EXHAUST NOISE CONTROL

- A. The exhaust silencer shall be sized and supplied by the engine supplier.
- B. The silencer shall be mounted on the roof of the enclosure and include all mounting hardware, exhaust tailpipe cut to prevent rain entry, stainless steel exhaust flex and penetration thimble with rain collar. A provision for draining moisture shall be included.

2.6 WIRING AND CONDUIT

- A. Engine and generator control wiring shall be multi-strand annealed copper conductors encased by cross-linked polyethylene insulation resistant to heat, abrasion, oil, water, antifreeze, and diesel fuel. Wiring shall be suitable for continuous use at 120 degrees C (250 degrees F) with insulation not brittle at -50 degrees C (-60 degrees F). Each cable will be heat stamped throughout the entire length to identify the cable's origin and termination. Cables shall be enclosed in nylon flexible conduit that is slotted to allow easy access and moisture to escape. Reusable bulkhead fittings will attach the conduit to generator set mounted junction boxes.

2.7 GENERATOR

- A. The generator shall be rated for standby service as shown with 0.8 PF, 480 V, three-phase, wye-connected, 60 Hz, 1800 rpm. The generator shall be single bearing synchronous type, suitable for direct connection to the engine. It shall be designed, manufactured and tested in accordance with the latest issue of NEMA MG1, IEEE and ANSI standards that cover the equipment described herein.

2.8 CIRCUIT BREAKER-GENERATOR SET-MOUNTED

- A. Provide a generator main circuit breaker rated as shown on the drawings. The circuit breaker shall be a molded case type circuit breaker mounted in a guarded drip-proof enclosure and connected (wired) as required to the generator.

2.9 STRUCTURE

- A. The generator shall be close coupled, drip proof and guarded, constructed to NEMA standards, guarded, single bearing, salient pole, revolving field, and synchronous type with amortisseur windings in the pole faces of the rotating field.

2.10 WINDINGS

- A. Thermal Class 200 magnet wire as described by NEMA Magnet Wire Standard MW 1000, Section MW 35-C, shall be used for rotor and stator windings. The windings shall consist of copper magnet wire coated with an underlay of polyester (amide) resins and a superimposed heavy coat of polyamideimide resins. All winding insulation materials shall be Class H in accordance with BS and IEEE standards. No materials shall be used which support fungus growth, and shall be impervious to oil, dirt, and fumes encountered in diesel and natural gas engine operating environments.

2.11 WINDINGS-LOW VOLTAGE

- A. The revolving field coils shall be precision wet layer wound with epoxy-based material applied to each layer of magnet wire. Stator shall have at least two dips and bakes using Class H impregnating varnish. Basic lightning impulse insulation level (BIL) shall not be less than 3 kV. Windings shall be tested at 3000 volts AC.

2.12 EXCITATION

- A. The generator exciter shall be brushless with the circuit consisting of a three-phase armature and a three-phase full wave bridge rectifier mounted on the rotor shaft. Surge suppressors shall be included to protect the rotating diodes from voltage spikes.

2.13 VOLTAGE REGULATOR

- A. The automatic voltage regulator shall maintain generator output voltage by controlling the current applied to the exciter field of the generator.
- B. The regulator shall be a totally solid state design which includes electronic voltage buildup and over-current protection. It shall incorporate 1:1 volts per Hertz characteristics with the regulated voltage a linear function proportional to frequency over a 30 to 70 Hz range. The regulator shall have 3-phase sensing.
- C. The regulator shall be suitable for mounting within or external to the generator assembly, and have remote voltage level control in the control panel. As installed, the voltage regulator shall meet the applicable sections of the following standards:
 1. Institute of Electrical and Electronic Engineers (IEEE)
 2. National Electrical Manufacturers Association (NEMA)

2.14 MOUNTING

- A. The engine-generator manufacturer shall assemble the engine and generator to a common base. The generator set base shall be designed and built by the engine-generator manufacturer to resist deflection, maintain alignment, and minimize resonant linear vibration.

2.15 VIBRATION ISOLATORS

- A. Adjustable height spring type isolators sized to support the wet weight of the generator with 97% isolation efficiency shall support the generator set.

2.16 FUEL STORAGE TANK

- A. A double-walled fuel subbase tank shall be provided which complies with local codes and ordinances. The fuel tank capacity shall be sufficient for 24 hours at 100 percent load (minimum capacity of 190 gallons). The tank shall incorporate threaded pipe connections, low

level float switch, fuel gauge, and an integral rupture basin with leak detector float switch. Both float switches shall be wired to the control panel and light alarm lights. The tank shall be fabricated from structural steel shapes and sheet steel plates, minimum 3/16 thick, welded construction, capable of supporting the weight of the generator, isolators and enclosure. The tank shall have 4 lifting eyes capable of lifting the entire generator set package. Tanks fabricated from press broke sheet steel are not acceptable.

2.17 ENGINE-GENERATOR ENCLOSURE

- A. Provide a sound attenuated weather-proof enclosure to contain the generator and all accessories except the ATS. The enclosure shall attenuate the generator set, with the engine running at full load, to a maximum radiated sound level of 70 decibels at 7 meters from any point on the machine as measured on the A scale. Provide closed cell sound attenuating liner material and air inlet and outlet sound attenuating hoods. The enclosure shall be constructed of Aluminum metal, primed and painted with two coats of alkyd enamel, color as selected by the owner or engineer. Provide a minimum of four piano-hinged, gasketed, lockable doors and a radiator fill access cover.

2.18 STARTING SYSTEM

- A. The engine shall be equipped with automatic starting by 24-volt battery driven starter. Batteries minimum capacity shall be 190 Amp-Hour. The batteries shall be housed in an acid resistant frame or box mounted adjacent to the engine. The location of the battery container shall not interfere with the maintenance and inspection of the engine.
- B. An automatic battery charger shall be furnished for the batteries. The charger shall operate from 120-volt, single-phase supply. The charger shall be solid state, current-limiting with float equalize failure, timer, and battery charger failure contact wired to the control panel.
- C. Provide all cables and connectors necessary.

2.19 CONTROLS, PROTECTION, AND MONITORING

- A. The controls, protection, and monitoring systems of the generator set and its operation shall be the responsibility of the generator set manufacturer. All subsystem components, interfaces, and logic shall be compatible with engine-mounted devices.
- B. Furnish a generator local control and monitoring panel and an automatic transfer switch as specified below. The local generator control panel shall be mounted on the engine-generator set. It shall incorporate 100% solid state microprocessor based control circuitry, sealed dust tight, with watertight modular components, metal housings, and digital instrumentation.
- C. The generator protection shall include over-current and internal wiring fault protection as a minimum. Surge arrester and surge capacitor protection shall also be provided.
- D. Instrumentation and metering shall include but not be limited to the following:
 - 1. Voltmeter and Voltmeter Switch
 - 2. Ammeter and Ammeter Switch
 - 3. Frequency Meter
 - 4. Watt-hour Meter
 - 5. Power Factor Meter
 - 6. Elapsed Time Meter on the Engine
- E. The panel shall include the following equipment:
 - 1. Generator AC Output Metering Devices

2. Engine Monitoring Devices
 - a. Back-lit LCD to sequentially rotate display of operating hours, engine RPM, battery DC volts, oil pressure, and jacket water temperature.
3. Controls:
 - a. Generator voltage level rheostat and ammeter/voltmeter phase selector switch shall be mounted on the panel door. The engine start-stop switch shall be door mounted and include positions for off/reset, run/start, stop, and automatic mode. Start-stop logic shall have provisions for cycle cranking and cool down operation.
4. Shutdowns/Annunciation:
 - a. The generator set shall shut down and red flashing LEDs shall signal operational faults of high water temperature, low oil pressure, over-crank, and over-speed.
5. Alarms/Annunciation:
 - a. The panel shall include alarms for approach high water temperature, approach low oil pressure, low water temperature, battery charger failure, low fuel level and fuel in rupture basin.
6. Safety Devices:
 - a. ISO red emergency stop pushbutton shall be provided, and all controls, annunciation, and monitors labeled with ISO symbols.

2.20 AUTOMATIC TRANSFER SWITCH

- A. The generator manufacturer shall also furnish the automatic delayed- transition transfer switch (DTTS). See specification section 16251 for more information This transfer switch is to be supplied by the generator manufacturer as part of the generator package. This specification and the delayed transfer specification shall both be coordinated together to form part of a single source of supply generator package system.

PART 3 EXECUTION

- A. After installation, the system manufacturer's local dealer representative in the presence of the owner's engineer or designated appointee shall perform the following tests:
 1. Prestart Checks
 - a. Inspect equipment to ensure that nothing was damaged during shipment or installation.
 - b. Verify that the installation is in accordance with manufacturer's guidelines.
 - c. Check all fluid levels.
 - d. Verify all control and power wiring.

3.2 FUNCTIONAL TESTING

- A. Start engine, verify all operating parameters are within manufacturer's guidelines, verify phase rotation, and perform transfer to standby power.
- B. With unit in "automatic" simulate a power outage; verify proper operation and full operating sequence.
- C. Proper operation of controls, engine shutdown, and safety devices shall be demonstrated.
- D. Prior to acceptance of the installation, the equipment shall be subjected to a complete onsite acceptance test. The system shall be tested with full load and half load for a minimum of two hours each. Provide a resistive load bank for the test. The manufacturer's representative shall conduct the test, but shall coordinate the date with the Owner and Engineer in advance.

3.3 ORIENTATION

- A. The system manufacturer's authorized dealer shall provide a complete orientation for the owner's engineering and maintenance personnel. Orientation shall include both classroom and hands-on instruction. Topics covered shall include control operation, schematics, wiring diagrams, meters and indicators, warning lights, shutdown system and routine maintenance.

3.4 COMPLETION

- A. The Contractor shall fill generator fuel tanks to full capacity prior to turning them over to the Owner at substantial completion.

+ + + END OF SECTION 16620 + + +