

PART 3: SPECIFICATION FOR DESIGN OF SANITARY SEWERS
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CITY OF COLUMBIA REGULATIONS
PART 3
DESIGN OF SANITARY SEWERS

- 3.1 GENERAL – The City Engineer will approve plans for new systems, extensions, or replacement sewers only when designed according to the “separate plan”, in which rain water from roofs, streets, and other areas, and ground water from foundation drains are excluded. Sanitary sewers 15 inches and smaller shall be VCP or PVC with an approved joint. Sanitary sewers 18 inches and larger may be concrete with approved joints and an approved liner. Sewers shall not be constructed under street paving except for crossings. Variations must be approved, in writing, by the City Engineer.
- 3.1.1 Sewer systems should be designed for the estimated ultimate tributary population, except in considering parts of the system that can be readily increased in capacity. Similarly, consideration should be given to the maximum anticipated capacity of institutions, industrial parks, etc.
- 3.2 SYSTEM DESIGN CRITERIA – In determining the required capacities of sanitary sewers the following factors shall be considered:
- 3.2.1 General information, including
- 3.2.1.1 Maximum hourly sewage flow.
- 3.2.1.2 Additional maximum sewage or waste flow from industrial plants.
- 3.2.1.3 Ground water infiltration.
- 3.2.1.4 Topography of area.
- 3.2.1.5 Location of waste treatment plant.
- 3.2.1.6 Depth of excavation.
- 3.2.1.7 Pumping requirements.
- 3.2.1.8 The proposed sanitary sewers, above the point where there are 375 acres in the drainage basin or the pipe size is 15”, whichever is greater, must be adequately designed to handle the effluent at the ultimate land holding capability. Downstream from this point, design based on the Central Midlands Regional Planning Council’s 20 year projected population figures will be acceptable, provided easements 5 feet wide are furnished, to provide for future installation of parallel lines. Additionally, where at least 30 percent of a drainage area is already developed, a population density at least equal to that of the existing development must be used for the entire drainage area.
- 3.2.2 Per Capita Flow – New sewer systems shall be designed on the basis of an average daily per capita flow of sewage of not less than 100 gallons per day. This figure is assumed to cover normal infiltration, but an additional allowance should be made where conditions are unfavorable. Generally, the sewers should be

designed to carry, when running full, not less than the following daily per capita contributions of sewage, exclusive of sewage or other waste flow from industrial plants:

$$Q = (10 \times 104P) \left(I \div \frac{14}{4 \div \sqrt{P}} \right)$$

Where "P" is the population in thousands.

- 3.2.3 Alternate Method – When deviations from the foregoing per capita rates are demonstrated, a description of the procedure used for sewer design shall be included. Such design will be approved at the discretion of the City Engineer.
- 3.2.4 Minimum size – No sewer shall be less than eight inches in diameter. Wyes for services lines shall have a minimum branch size of six inches.
- 3.2.5 Depth – In general, sewers shall be sufficiently deep so as to receive sewage from basements and to prevent freezing. Sanitary sewers shall have a minimum cover of three feet between manholes except that they may be encased or constructed of cast iron if this depth cannot be achieved.
- 3.2.6 Slope
 - 3.2.6.1 All sewers shall be so designed and constructed to give mean velocities, when flooding full, of not less than 2.0 feet per second, based on Mannings' formula. The following are the minimum slopes which should be provided; however, slopes greater than these are desirable:

<u>Sewer Size</u>	<u>Minimum Slope in Feet per 100 Feet</u>
8"	0.40
10"	0.28
12"	0.22
14"	0.17
15"	0.15
16"	0.14
18"	0.12
21"	0.10
24"	0.08
27"	0.067
30"	0.058
36"	0.046

- 3.2.6.2 Under special conditions, if detailed justifiable reasons are given, slopes slightly less than those required for the 2.0 feet per second velocity when flowing full may be permitted. Such decreased slopes will only be considered where the depth of flow will be 0.3 of the diameter or greater for design average flow. Whenever such decreased slopes are selected, the design engineer must furnish with his report his computations of the depths of flow in such pipes at minimum, average, and daily or hourly rates of flow. It must be recognized that decreased slopes may cause additional sewer maintenance expense. Sewers shall be laid with uniform slope between manholes.

- 3.2.6.3 Sewers on 20 percent slope or greater shall be anchored securely with concrete anchors or equal, spaced as follows:
- 3.2.6.3.1 Not over 36 feet center to center on grades 20 percent and up to 35 percent.
 - 3.2.6.3.2 Not over 24 feet center to center on grades 35 percent and up to 50 percent.
 - 3.2.6.3.3 Not over 16 feet center to center on grades 50 percent and over.
- 3.2.7 Alignments – Sewers 24 inches or less shall be laid with straight alignment between manholes.
- 3.2.8 Increasing Size – When a smaller sewer joins a larger one, the invert of the larger sewer shall be lowered sufficiently to maintain the same energy gradient. An approximate method for securing these results is to place the 0.8 depth point of both sewers at the same elevation.
- 3.2.9 High Velocity Protection – Where velocities greater than 15 feet per second are attained, special provisions shall be made to protect against displacement by erosion and shock.
- 3.2.10 Materials – The material selected for construction shall be adapted to local conditions, such as character of industrial wastes, possibility of septicity, soil characteristics, exceptionally heavy external loadings, abrasion and similar problems. Cement asbestos pipe is not approved for sanitary sewer construction. Where the proposed material is not covered in Columbia specifications, installation specifications shall contain appropriate requirements based on the criteria, standards and requirements established by industry in its technical publications. Requirements shall be set forth in the specifications for the pipe and method of bedding and backfilling thereof so as not to damage the pipe nor its joints, impede cleaning operations and future tapping, nor create excessive side fill pressures nor ovalation of the pipe, nor seriously impair flow capacity. All sewers shall be designed to prevent damage from superimposed loads. Proper allowance for loads on the sewer shall be made because of the width and depth of trench. When standard strength sewer pipe is not sufficient, the additional strength needed may be obtained by using extra strength pipe or by special construction.
- 3.2.11 Joints and Infiltration – In general, DIP or PVC joints are required although other materials will be considered for approval. The method of making joints and materials used should be included in the specifications. Sewer joints shall be designed to minimize infiltration and to prevent the entrance of roots. Leakage tests shall be specified. This may include appropriate water or low pressure air testing. The leakage outward or inward (exfiltration or infiltration) shall not exceed 200 gallons per inch of pipe diameter per mile per day for any section of the system. The use of television camera or other visual methods for inspection prior to placing the sewer in service is required. Results of such tests shall be certified to the City Engineer in writing by a registered engineer.
- 3.2.12 Sanitary sewers shall be constructed of ductile iron at stream crossings.

- 3.2.13 Calculations – Computations should be presented, in a tabular form, to indicate depths and velocities at minimum, average and maximum daily waste flow for the different sizes of sewers proposed.
- 3.2.14 Manholes
- 3.2.14.1 Location – Manholes shall be installed at the end of each line; at all changes in grade, size, or alignment; at all intersections; and at distances not greater than 400 feet for sewers 15 inches or less, and 500 feet for sewers 18 inches to 30 inches, except that distances up to 600 feet may be approved in cases where adequate modern cleaning equipment for such spacing is provided. Greater spacing may be permitted in larger sewers and in those carrying a settled effluent. Lampholes may not be used.
- 3.2.14.2 Drop Type – A drop pipe should be provided for a sewer entering a manhole at an elevation of 24 inches or more above the manhole invert. Where the difference in elevation between the incoming sewer and the manhole invert is less than 24 inches, the invert should be filleted to prevent solid deposition.
- 3.2.14.3 Diameter – The minimum diameter of manholes shall be 48 inches; larger diameters are preferable. For sewer pipes in sizes eight inches up to 15 inches, manholes are to be a minimum of four feet in diameter. For sewer pipes 18 inches and larger, manholes are to be a minimum of five feet in diameter.
- 3.2.14.4 Manhole Depth – The four foot diameter manhole shall have a minimum depth of four feet and a maximum depth of less than 12 feet measured from the top of pipe to the top of the ring. Manholes of larger diameter shall be proportionately deeper. This provides for proper corbel construction.
- 3.2.14.5 Flow Channel – The flow channel through manholes should be made to conform in shape and slope to that of the sewers.
- 3.2.14.6 Watertightness – Watertight manhole covers are to be used wherever the manhole tops may be flooded by street runoff or high water and where the manhole covers are below the base flood elevation (BFE). Manholes or brick shall be waterproofed on the exterior with plaster coatings; supplemented by a bituminous waterproof coating where ground water conditions are unfavorable.
- 3.2.14.7 Electrical – Electrical equipment installed or used in manholes shall conform to paragraph 3.1.18.3.10.
- 3.2.15 Inverted Siphons – Only if approved by the City Engineer, inverted siphons should have not less than two barrels, with a minimum pipe size of six inches and shall be provided with necessary appurtenances for convenient flushing and maintenance; the manholes shall have adequate clearances for rodding; and in general, sufficient head shall be provided and pipe sizes selected to secure velocities of at least 3.0 feet per second for average flows. The inlet and outlet details shall be arranged so that either barrel may be taken out of service for cleaning.

- 3.2.16 Sewer Extensions – In general, sewer extensions shall be allowed only if the receiving sewage treatment plant is either;
 - 3.2.16.1 Capable of adequately processing the added hydraulic and organic load; or,
 - 3.2.16.2 Provision of adequate treatment facilities on a time schedule acceptable to the approving agency is assured.
- 3.2.17 Protection of Water Supplies
 - 3.2.17.1 Water Supply Interconnections – There shall be no physical connection between a public or private potable water supply system and a sewer, or appurtenance thereto which would permit the passage of any sewage or polluted water into the potable supply.
 - 3.2.17.2 Relation to Water Works Structures – While no general statement can be made to cover all conditions, it is generally recognized that sewers shall meet the requirements of the approving agency with respect of minimum distances from public water supply wells or other water supply sources and structures.
 - 3.2.17.3 Relation to Water Mains
 - 3.2.17.3.1 Horizontal Separation – Whenever possible, sewers should be laid at least ten feet, horizontally, from any existing or proposed water main. Should local conditions prevent a lateral separation of ten feet, a sewer may be laid closer than ten feet to a water main if:
 - 3.2.17.3.1.1 It is laid in a separate trench.
 - 3.2.17.3.1.2 It is laid in the same trench with the water mains located at one side on a bench of undisturbed earth.
 - 3.2.17.3.1.3 In either case the elevation of the crown of the sewer is at least 18 inches below the invert of the water main.
 - 3.2.17.3.2 Vertical Separation – Whenever sewers must cross under water mains, the sewer shall be laid at such an elevation that the top of the sewer is at least 18 inches below the bottom of the water main. When the elevation of the sewer cannot be buried to meet the above requirements, the water main shall be relocated to provide this separation or reconstructed with slip-on or mechanical-joint cast-iron pipe or prestressed concrete cylinder pipe for a distance of ten feet on each side of the sewer. One full length of water main should be centered over the sewer so that both joints will be as far from the sewer as possible.
 - 3.2.17.3.3 Special Conditions – When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the water main shall be constructed of slip-on or mechanical-joint cast-iron pipe or prestressed concrete cylinder pipe and the sewer constructed of mechanical-joint cast-iron pipe, and both services should be pressure tested to assure water tightness.
 - 3.2.17.4 Relation to Storm Drain Systems

- 3.2.17.4.1 Horizontal Separation – Whenever possible, sewers should be laid at least five feet, horizontally, from any existing or proposed storm drain pipes or structures. Should local conditions prevent a lateral separation of five feet, a sewer main may be laid closer than five feet to a storm drain pipe main if:
 - 3.2.17.4.1.1 It is laid in the same trench with the storm drain pipe main located at one side on a bench of undisturbed earth.
- 3.2.17.4.2 Vertical Separation – Whenever sewers must cross storm drains, the sewer shall be laid at such an elevation that the top of the sewer is at least 18 inches below the bottom of the water main. When the elevation of the sewer cannot be buried to meet the above requirements, the water main shall be relocated to provide this separation or reconstructed with slip-on or mechanical-joint cast-iron pipe or prestressed concrete cylinder pipe for a distance of ten feet on each side of the sewer. One full length of water main should be centered over the sewer so that both joints will be as far from the sewer as possible.
- 3.2.17.4.3 Special Conditions – When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the water main shall be constructed of slip-on or mechanical-joint cast-iron pipe or prestressed concrete cylinder pipe and the sewer constructed of mechanical-joint cast-iron pipe, and both services should be pressure tested to assure water tightness.

3.3 SPECIFICATION FOR DESIGN OF PUMP STATIONS – The standards in this section are applicable to all pump stations that the City will own and maintain. This section is intended for pump stations with reliable design capacities of less than 1000 gpm serving domestic wastewater. For pump stations with larger reliable design capacities, or stations serving wastewater other than domestic, please contact the City for additional requirements and design standards.

All sewage pumping stations that will be turned over to the City for ownership and maintenance shall be reviewed during design before being bid for construction, and after completion of construction to ensure compliance with these standards. Failure to meet these requirements may result in denial of taking ownership of the pump station, force main, and appurtenances until the requirements are met.

The standards listed below are minimum City of Columbia design standards. The written standards in combination with the standard details and referenced documents are all included as a part of the standard. These should be adhered to, with good Engineering practice. If a variation or exception is needed to maintain good Engineering practices, please provide an explanation supporting the type of variation, and the reason for the variation for review by the City for acceptance. A submittal of a variance request does not guarantee approval.

The developer is responsible for securing and paying all application and permit fees and costs associated with and incurred for the pump station before final acceptance. The City will take ownership of the pump station upon final acceptance, at which time billing for utilities will be transferred to the City of Columbia.

- 3.3.1 GENERAL - In general pumping stations will only be approved where gravity service is not possible.
- 3.3.1.1 Pump stations shall not be subject to flooding. Pump stations should remain fully operational and accessible during the 25 year flood. Temporary facilities expected to be in service from five to ten years shall be protected from the 25 year frequency storm in accordance with the Columbia Drainage Ordinance. Pump station structures, electrical and mechanical equipment shall be protected from physical damage by flooding to the 100 year flood elevation. Permanent structures which have a life expectancy of more than ten years shall be 2 feet above the 100 year flood plain or one foot above the base flood elevation, whichever is more stringent. It is important that the station be readily accessible.
- 3.3.1.2 All pump stations and force mains shall meet the requirements of SCDHEC Standards for Wastewater Facility Construction R.61-67 and Ten States Standards, latest edition.
- 3.3.1.3 Pump Station sites, collection system, force main, access road, and any other appurtenances that are to be owned and maintained by the City are to be deeded over to the City per the City property requirements for pump stations.
- 3.3.1.4 All paints and coatings to be applied must meet or exceed manufacturer's recommendations for the specific application.
- 3.3.1.5 Provide flood elevation, and base flood elevation (where applicable) on drawings and record drawings. List surveyor information including company, date, and datum.
- 3.3.2 PUMP STATION SITE AND EQUIPMENT - The size of the site provided for the pumping station must be a minimum of 60 feet by 60 feet. The pumping station site must be fenced with an access gate. The fence shall be a 6 foot tall standard galvanized fence with eight gauge wire (not coated) with 3 strand barbed wire. Wooden fences or other decorative fences are not allowed as a substitution. However, a wooden or decorative fence is allowed outside of the galvanized fence for screening and aesthetic purposes, but must be located outside of the City's pump station property and be maintained by the property owner.
- 3.3.2.1 A double swing gate shall be provided at the pump station site access. The gate shall consist of two eight-foot gates with self-holding latches and a recessed center latch point.
- 3.3.2.2 The fence shall have a City standard weather durable emergency contact sign attached at a location visible from the access road.
- 3.3.2.3 An all weather access road a minimum of 12 feet wide shall be provided for access to the pump station site. The road shall consist of a minimum of 6-inches of crusher run stone, AND must be capable of supporting 36,000 pound vehicles. A permanent easement, a minimum of 20 feet wide, must be furnished centered along the access road.

- 3.3.2.4 The entire pump station site within the limits of the fencing shall be crusher run stone that meets the same minimum requirements as specified for the all weather access road unless specified otherwise.
- 3.3.2.5 Pump stations shall be designed to be submersible type stations.
- 3.3.2.6 Pump station wet wells shall be round. Wet wells shall be sized for sewershed basin build-out condition utilizing sound Engineering practice and standards and shall include design information such as Metcalf and Eddy land use flow projections, topographic maps, land use maps, zoning, population projections, the study of available land for development, and other available City or County planning studies which may include the sewershed area. Coordination with the City's hydraulic engineer may be required to collaborate on design flow for build-out conditions.
- 3.3.2.7 The wet well shall be positioned inside the fence so as to allow easy access with a vacuum or boom truck.
- 3.3.2.8 A by-pass pumping connection utilizing Bauer fittings shall be provided close to the entrance and easily accessible with a truck.
- 3.3.2.9 Pump station wet well and valve vaults to be sized for build-out conditions and shall be large enough to accommodate future pump sizes.
- 3.3.2.10 Valve vaults shall be of sufficient inside depth to house valves and appurtenances with enough clearance, but shall be shallow enough to not be defined as a confined space.
- 3.3.2.11 Wet well access hatch to be aluminum double door by Halliday, Bilco or approved equal with spring assist. Access hatch to be sized to provide the ability to remove pumps and future pumps sized for build-out conditions, as well as provide easy access to guide rails and float hangars. Access hatch to be a minimum 4-foot by 4-foot.
- 3.3.2.12 Wet well shall be provided with a ductile iron vent with a 90-degree elbow on the end with a 24 mesh stainless steel screen. The entire vent shall be coated with Light Grey 32GR Tnemec paint or approved equal.
- 3.3.2.13 Pumps to be submersible Flygt pumps. A minimum of two identical pumps are to be installed. In addition to the pumps installed, an additional identical spare pump shall be provided and delivered to the City Metro Wastewater Treatment Plant. Pumps are to be designed with a design capacity that will be able to handle maximum anticipated peak flows with any one pump out of service.
- 3.3.2.14 The design of the pumping station shall include the submission of the proposed flows to the City for review in accordance with the City's Capacity Assurance Program for approval of the downstream receiving collection system to ensure that there is adequate capacity to handle the proposed flows and pumping rates. The extent of the downstream collection system requiring evaluation, as well as the criteria for evaluation, shall be determined by the City.

- 3.3.2.15 Pumps to be provided with Flygt standard guide rails with spacing that will also accommodate build-out condition pumps. Guide rails may be welded for wet wells up to 23 feet deep as long as the extension rail added to the 20 foot section is no longer than 3 feet in length. A smaller internal pipe which fits within the rails should extend at least 3 inches into each rail being welded together. The finished weld should be smooth with the exterior of the welded sections so as not to interfere with the pump guide rail bracket when removing or installing the pumps. Any wet well requiring more than three feet extension rail shall use an intermediate guide rail bracket attached to the discharge pipe.
- 3.3.2.16 All hardware shall be stainless steel including, but not limited to, lifting chains, bolts, nuts, guide rails, anchors, bolts, nuts, washers, screws, etc.
- 3.3.2.17 Each pump to include a 3/8-inch PC 316 stainless steel lifting chain.
- 3.3.2.18 Provide two Flygt or approved equal flat bolted stainless steel plates with 4 hooks minimum on each on opposite sides of the wet well access.
- 3.3.2.19 Level sensors shall be provided to be read using a submersible level transducer as defined in the Remote Telemetry Unit, Instrumentation, and SCADA System Interface Specification for wet wells over 20 feet deep (with a minimum 30 foot range capability if less than 30 feet is required, or greater if needed), and either a submersible level transducer as defined above or a ultrasonic level sensor Milltronics MultiRanger 200 with Echomax XPS-15 series transducer or approved equal for wet wells 20 feet deep or less (with a minimum 30 foot range capability). All pump stations shall have a float switch backup system with floats as defined in the Remote Telemetry Unit, Instrumentation, and SCADA System Interface Specification that is in place and operates in case of level sensor failure as further defined in the SCADA specifications. Pneumatic bubbler systems are not acceptable.
- 3.3.2.20 Wet well interior (excluding the bottom) and all exposed piping in the wet well shall be coated with Raven 405 coating with a minimum of 120 mils.
- 3.3.2.21 The wet well floor shall have a minimum slope of one to one to the hopper bottom. The horizontal area of the hopper bottom shall be no greater than necessary for proper installation and function of the pump inlet.
- 3.3.2.22 Valve vault shall be less than 4 feet deep and a minimum 4-foot by 4-foot size for a 4-inch discharge and 4-foot by 6-foot for a 6-inch discharge.
- 3.3.2.23 Valve vault to have an access hatch that opens to expose the entire vault, matching the size of the vault interior. The hatch shall be a traffic rated aluminum access hatch.
- 3.3.2.24 A drain from the valve vault to the wet well shall be provided with a minimum 4-inch drain at a minimum 1 percent slope. A Tideflex Series 35 Flanged Check Valve or approved equal shall be used on the interior of the wet well on the end of the drain line from the valve vault. The valve shall be installed in accordance with manufacturer recommendations and positioned as to not interfere with pump removal, and be visible and readily accessible from the wet well hatch opening

(i.e.-not behind guide rails, etc). A removable screen shall be installed on the intake side of the drain to prevent debris from entering the drain.

- 3.3.2.25 Safety grating shall be provided in the wet well. Provide hinged aluminum grating panels in access hatch openings to provide protection against fall through accidents when the access hatch is open. Aluminum grating panels shall be constructed from aluminum "I" bar construction, be rated for a minimum load rating of 300 lbs. per sq. ft., include a positive latch to hold safety grate open when in the open position, include lockable safety grates, spring assisted lifting handle, have 316 stainless steel mounting hardware, and have an orange powder coating finish. Attach access hatch safety grate to concrete below access hatch frame. For openings greater than 53" wide, provide two panels.
- 3.3.2.26 All exposed piping, fittings, and valves shall be painted with 09SF Spearmint Green/Safety Tnemec paint or approved equal.
- 3.3.2.27 No check valves shall be installed inside of the wet well. Check valves shall be located within the valve vault between the pump and the shut-off valve.
- 3.3.2.28 A water supply with a minimum 4-inch service shall be installed to the site with a Mueller or approved equal post hydrant as well as a yard hydrant. The hydrants shall be frost and freeze proof, and shall be anti-siphon. All water related items shall be coordinated with the Water Division within the City of Columbia for fees, preferences, and standards.
- 3.3.2.29 A testable backflow preventer and meter shall be provided for the water service to the site. The meter and backflow preventer shall be located in separate meter boxes. All water related items shall be coordinated with the Water Division within the City of Columbia for fees, preferences, and standards.
- 3.3.2.30 Two hoses shall be provided at the site. A 25-foot industrial 2-inch hose with an adjustable brass spray nozzle and a 25-foot 3/4-inch hose with an adjustable brass spray nozzle shall be provided. A weatherproof hose rack shall be provided for each hose.
- 3.3.2.31 Check valves 12-inches and smaller shall be Mueller A-2606-6-01B1 flanged end with rubber disc facing swing type lever and weight.
- 3.3.2.32 Pressure gauges shall be 4-inch diameter quick disconnect Ashcroft or Wika that are glycerin filled and accurate within 0.5 percent of the total scale range. The gauges shall have type 316L stainless steel housing and components, and shall provide a top limit above the pump shutoff head. Provide optimal design point to be approximately at 50 percent of the total range of the gauge. Pressure gauges to be installed with a stainless steel shut-off ball valve with handle. Pressure gauge to face upward for optimal visibility from above without entry into the vault. Three pressure gauges shall be provided, 1 on the discharge end of each pump just before the check valve, and one on the force main on the discharge end after the tee where both pump discharges combine into one common force main. All three gauges shall be located within the valve vault.

- 3.3.2.33 Stainless steel shut-off ball valves 3-inches and smaller shall be full port with a lever handle operator, and a three piece body that is in-line serviceable without removing the valve from the line. Acceptable manufacturers include Series 60 as manufactured by Whitey or Apollo Series 86R-200 as manufactured by Conbraco, CF Ball Valve Series F12 as manufactured by CF Fluid Controls, or V3P-1000 as manufactured by Velan. Stainless steel ball valves 3 to 4 inches shall be regular port stainless steel ball valves with an oval handle operator, top entry design, fully serviceable without removing the valve body from the line, Seal body cover to body section with fully closed spiral wound graphite gasket, and adjustable two-piece packing gland and pre-compressed solid packing rings. Acceptable manufacturers include Series "TE-150/300/600" as manufactured by Velan.
- 3.3.2.34 Surge relief valves shall be provided if required in the valve vault. Valves shall have a cast iron body and shall be GA Industries 625-D or approved equal. Valve shall provide a full opening of the pipeline area in the open position. The requirement of a limit switch shall be determined by the City based on force main and pump conditions and should be verified before final design.
- 3.3.2.35 Plug valves shall be Dezurik. Provide worm gear and hand wheel operator on 4 inches and larger. On sizes less than 4-inches ball valves shall be used with quarter turn lever type operator.
- 3.3.2.36 Air release valves shall be ARI D-025 HDPE and shall be housed in a manhole with an open bedded bottom. Air release valves shall be located outside of the pump station site fence where possible.
- 3.3.2.37 Anchor bolts for the pump discharge stand must be J-type stainless steel cast in place in the wet well floor.
- 3.3.2.38 Two level indicators shall be marked on the inside of the wet well at a pre-measured distance for the use of draw-down tests. The markings should be clearly visible without entering the wet well, and shall be resistant to fading or reduced visibility over time due to debris or build-up. The pre-measured distance and diameter of the wet well shall be written clearly above the higher of the two levels and readable from outside of the wet well. The markings shall not be such to void the warranty of the coating on the interior of the wet well.
- 3.3.2.39 A canopy shall be provided on the pump station site that covers the panels. See the standard canopy detail. The canopy shall be painted Tnemec medium bronze 85BR, and shall be on a minimum 6-inch pad that spans the extents of the canopy. Engineer is responsible for reviewing the standard canopy detail and making modifications to ensure the canopy is structurally sound, and making adjustments as needed to increase the requirements. The standard detail shown is a minimum requirement and may not be sufficient for all sites. A light should be installed under the canopy with a switch with dual 48-inch fluorescent lights or similar.
- 3.3.2.40 A 20 foot creosoted southern pine service/light pole with all weather exterior light switches, and exterior LED flood lights shall be provided at the pump station site and shall be positioned to flood the wetwell access, valve vault access, and the front of the control panel and electrical equipment with light. Flood lights to be Philips Stonco GP Flood Series Floodlighting GP3 (Medium) LED. Heavy duty

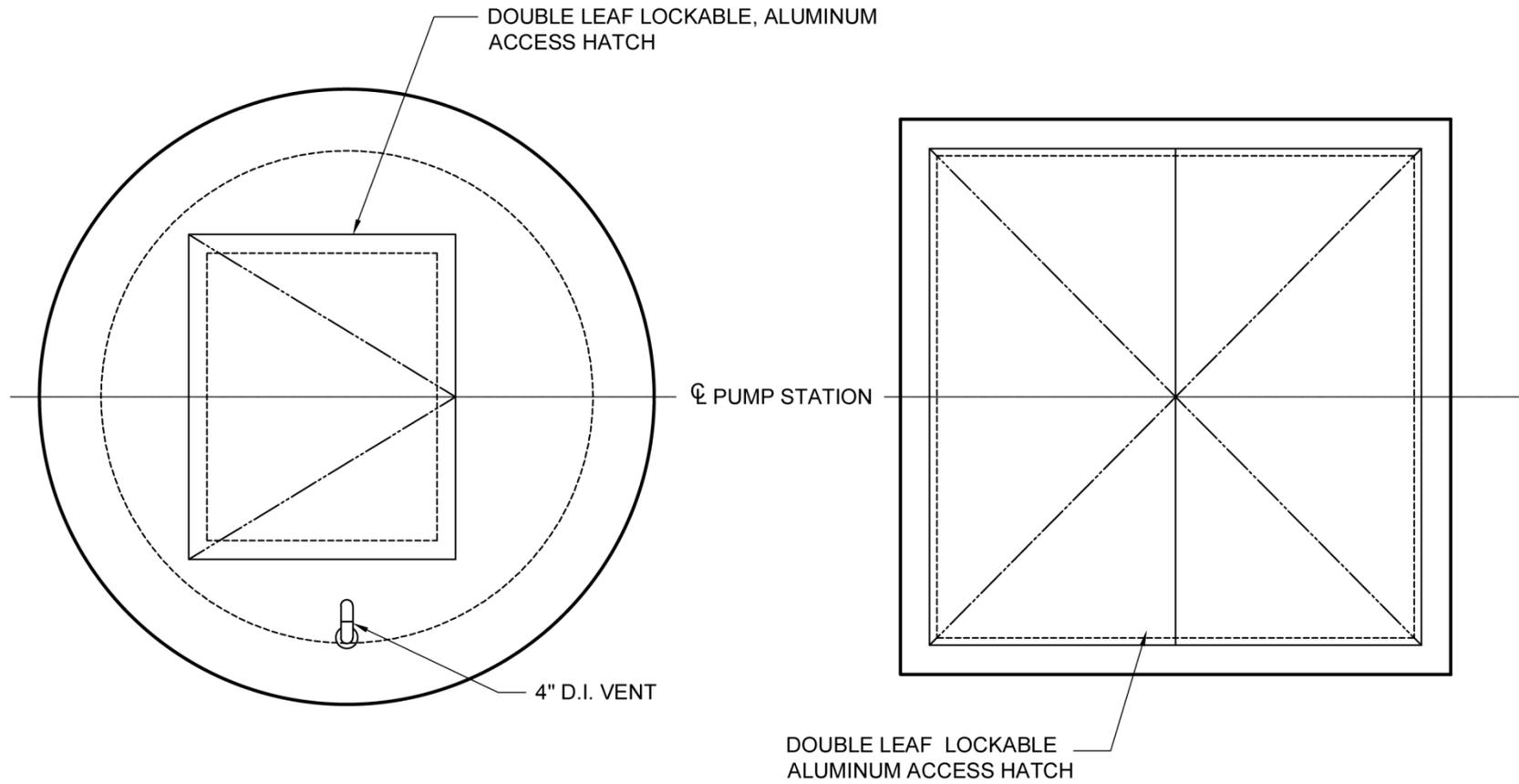
light switch and receptacle with gasketed cover and weatherproof plates shall be provided outside of the control panels at the site near or on the light pole.

- 3.3.2.41 Wet well shall be sized for build-out conditions. All conditions listed below shall be met for current design and future build-out design conditions by simple adjustments in level controls or changing of pumps.
- 3.3.2.42 When called to run the pumps shall not run less than the manufacturer's recommendations or 1 minute, whichever is longer.
- 3.3.2.43 The reliable pumping capacity (defined as one pump on in a duplex station) shall be higher than the peak inflow rate in gpm into the pump station.
- 3.3.2.44 The pump station shall be designed to run no more than 6 cumulative hours a day.
- 3.3.2.45 Pumps should be selected that have an operating point at or near peak efficiency.
- 3.3.2.46 Pumps shall be capable of passing spheres of at least three inches in diameter. Pump suction and discharge openings shall be at least four (4) inches in diameter.
- 3.3.2.47 Pump stations may be required to have screening mechanisms before the pumps if larger solids will be received by the station, or if wastewater received is determined to be more solids than typical domestic wastewater.
- 3.3.2.48 Force mains shall be adequately sized to handle the design peak flow of the contributing sewershed and within industry standards for velocity.
- 3.3.2.49 The force main should enter the gravity sewer system at a point not more than two feet above the flow line of the receiving manhole entering through either an inside or outside drop at the manhole. The receiving manhole shall be lined with Raven 405 120 mil coating for new manholes. If the receiving manhole is an existing manhole, see the City's standard Manhole Lining specification for approved Type 3 or Type 4 manhole linings for force main discharge manholes.
- 3.3.2.50 A combination air release valve for sewage application shall be placed at high points in the force main to prevent air locking. Air release valves shall be located outside of the pump station site fence where possible. Air release valves within the pump station site are preferred to be located within the valve vault if possible. A short body valve may be required.
- 3.3.2.51 At design flow, a cleaning velocity of at least two feet per second shall be maintained in the force main.
- 3.3.2.52 Pump Station Drawings Shall include a chart showing pump conditions and ranges such as the one below:

Condition	Flow Per Pump	TDH	Total Pump Station Flow
(Pumps On)	GPM	Feet	GPM
One Pump	XX	XX	XX
Two Pumps	XX	XX	XX

- 3.3.3 BACK-UP POWER - Natural gas generator shall be provided on all pump station sites and shall be capable of running all equipment as a secondary power source in case of a power failure. Generator shall meet a minimum of the standards in the City's Natural Gas Fueled Engine Driven Generator Specification as outlined in Attachment A.
- 3.3.3.1 All generator support structures, concrete pads, site layout, etc. shall be designed accordingly for a complete standby power system at each location.
- 3.3.4 SCADA - Provide equipment, services, and associated components to meet the City's standard Remote Telemetry Unit, Instrumentation and SCADA System Interface Specification Attachment C and associated Standard Construction Details.
- 3.3.5 ELECTRICAL - Provide equipment, services, and associated components to meet the City's Attachment D Pump Station Electrical Requirements Specification and associated Standard Construction Details.
- 3.3.6 OTHER REQUIREMENTS - Authorized supplier of check valves shall be present on site during installation to set valve weight and make adjustments as necessary to meet design conditions as intended by the design engineer.
- 3.3.6.1 Contractor responsible for the design, installation, and operation of by-pass pumping operations or pumping and hauling operations needed to complete the work for the construction of the pump station and its appurtenances, including the force main. Contractor to submit a plan to the Engineer for review of operations, which should include any requests and supporting reasoning for creating surcharge conditions within the sewer system that will need to be considered and reviewed by the City as well as the design engineer. The City's review of the proposed conditions does not relieve the Contractor of any responsibility and liability of these operations, including overflows, damage to property or the sewer system, and meeting the requirements of other regulatory agencies.
- 3.3.6.2 Contractor to submit to the design engineer written certification from the coating manufacturer demonstrating the persons applying the Raven 405 coating are certified in the application. The application shall have a standard manufacturer's warranty from defects.
- 3.3.6.3 A preconstruction conference of Metro WWTP personnel with the Contractor and design engineer will be held at the pump station site.
- 3.3.6.4 A full set up Operations and Maintenance Manuals shall be provided for the SCADA system, pumps, motors, control panel, generator, ATS, and any other appurtenances provided on the site. 2 hard copies and 1 electronic PDF copy shall be provided to the City before ownership transfer. The manuals shall include, but not be limited to, operational instructions, emergency procedures, maintenance schedules, pump curves, parts lists, tools, spare parts, etc. Contractor to coordinate with the City to determine what asset information is to be provided by the Contractor necessary for City Works before the completion of the project.

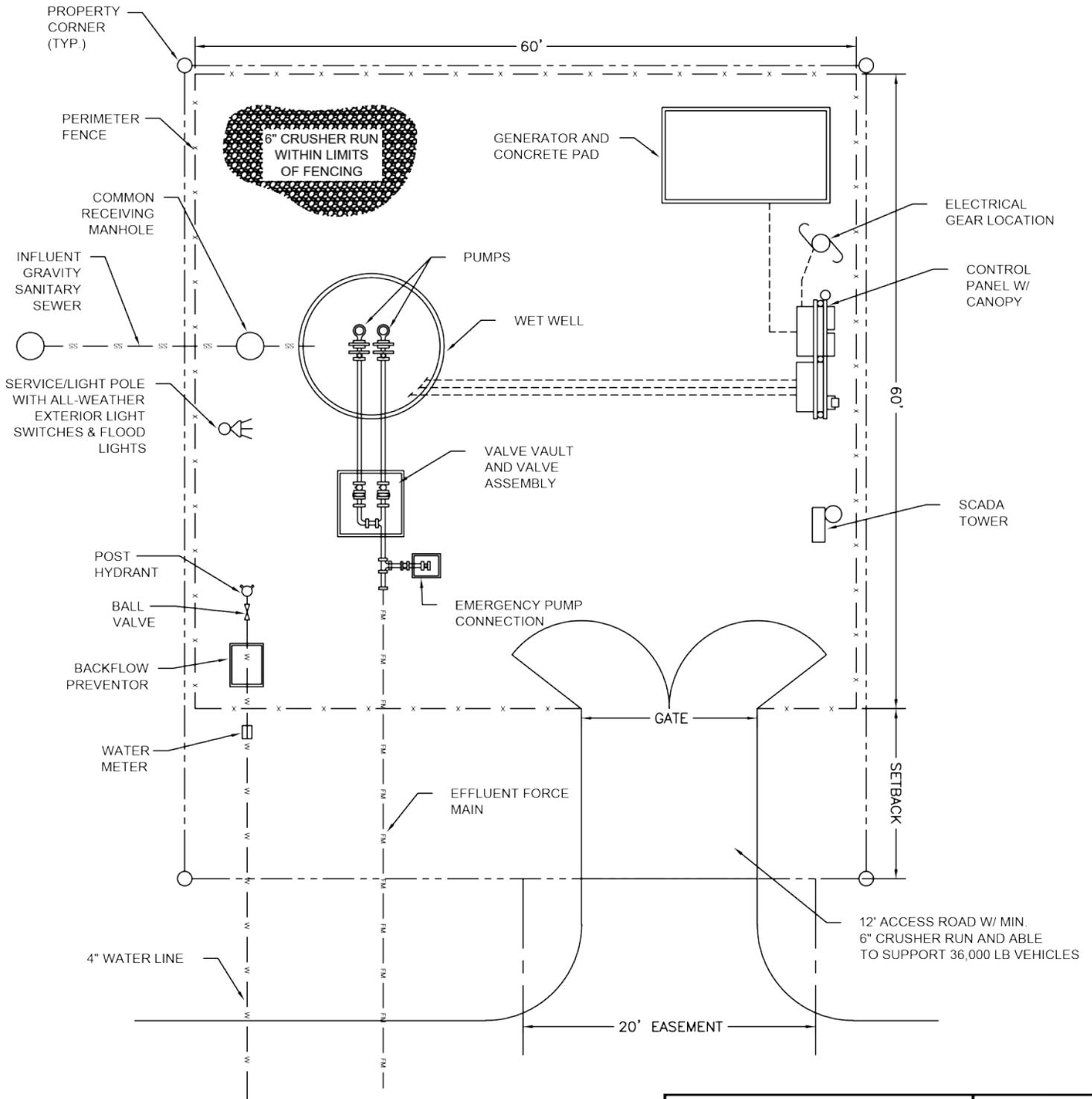
- 3.3.6.5 A training session shall be conducted covering all O&M aspects of the pump station including, but not limited to operational instructions, emergency procedures, maintenance schedules etc. for City staff. The training shall be recorded on video and a copy of the video shall be provided in electronic format.
- 3.3.6.6 The following spare parts are to be delivered to the City before close-out:
 - 3.3.6.6.1 3 sets of o-rings and seals for each pump
 - 3.3.6.6.2 1 spare pump and cable
 - 3.3.6.6.3 1 spare pressure transmitter/level control
 - 3.3.6.6.4 All recommended spare parts as listed in the SCADA/Electrical/Stand-By Power Specifications
- 3.3.6.7 All spare parts shall be delivered to the Metro Wastewater Treatment Plant. A clear record of the items delivered, the date, and who they were delivered to, and a signed notification acknowledging the receipt of each part shall be documented and included in project close-out documentation.
- 3.3.7 STANDARD DETAILS - The following is a list of the standard details for pump stations including electrical details. Electronic versions of these standard details are available on the City website.



WET WELL AND VAULT
 PLAN DETAIL
 N.T.S.

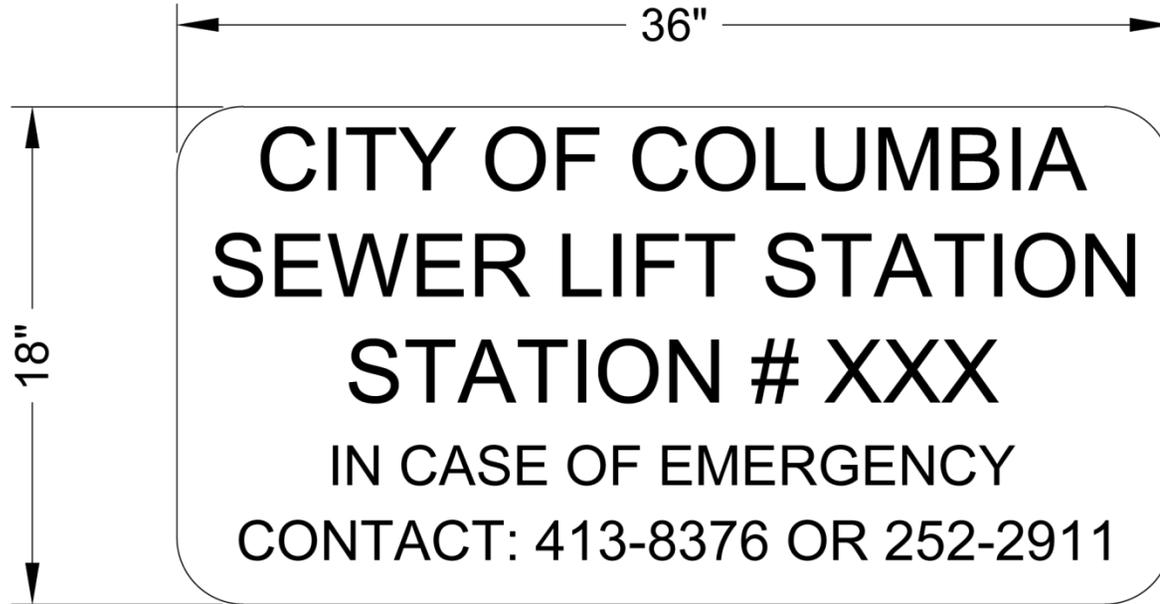
CITY OF COLUMBIA DEPARTMENT OF UTILITIES AND ENGINEERING DIVISION P.O. BOX 147 COLUMBIA, SOUTH CAROLINA 29217	SCALE:	N.T.S.
	DATE:	05/03/16
	REVISED:	---
	DRAWING NO:	PS1C
WET WELL AND VAULT PLAN DETAIL (2)		

3.3.7.4 PS2- Typical Pump Station Site Plan



NOTE: ENGINEER TO DETERMINE IF STEEL BOLLARDS ARE NEEDED TO PROTECT EQUIPMENT AND/OR SITE.

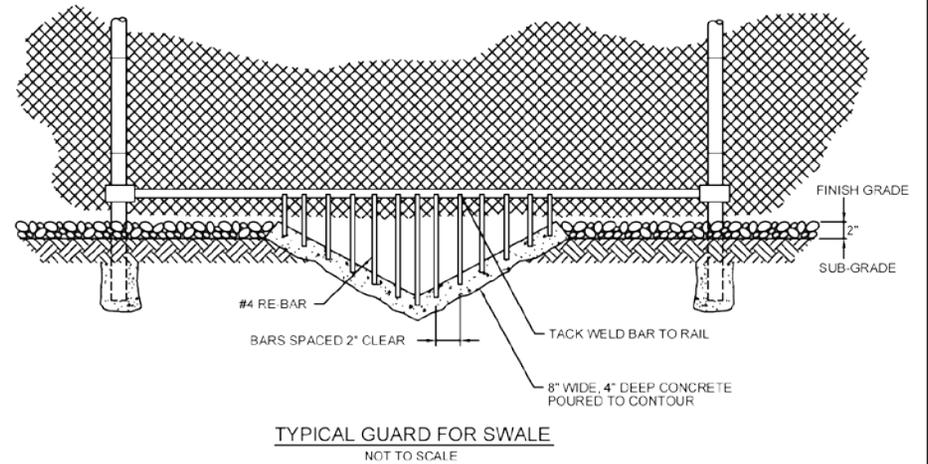
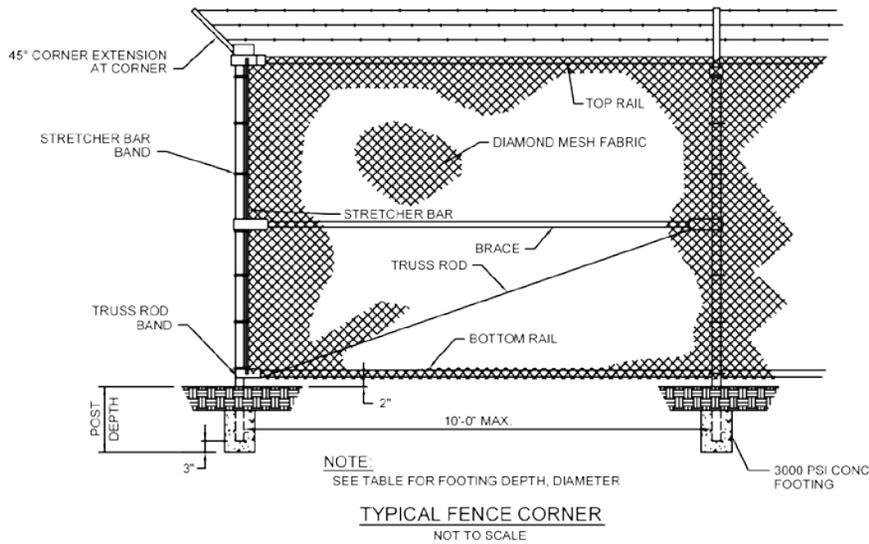
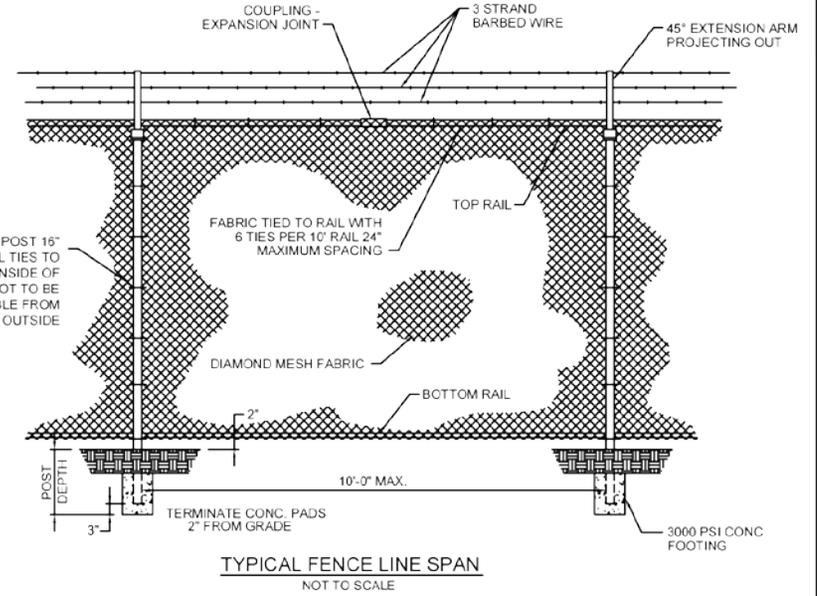
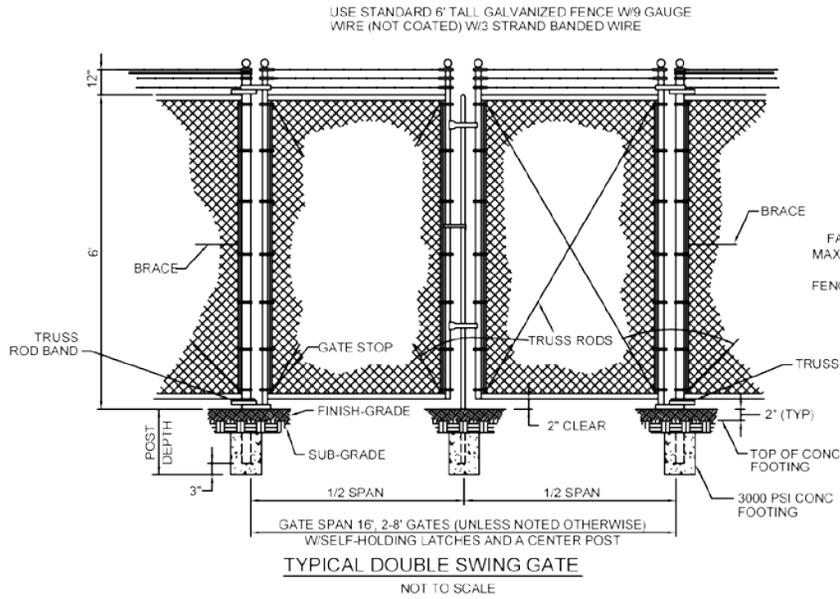
CITY OF COLUMBIA DEPARTMENT OF UTILITIES AND ENGINEERING DIVISION P.O. BOX 147 COLUMBIA, SOUTH CAROLINA 29217	SCALE: N.T.S.
	DATE: 05/03/16
	REVISED: ---
	DRAWING NO: PS2
TYPICAL PUMP STATION SITE PLAN	



EMERGENCY SIGN NOTES:

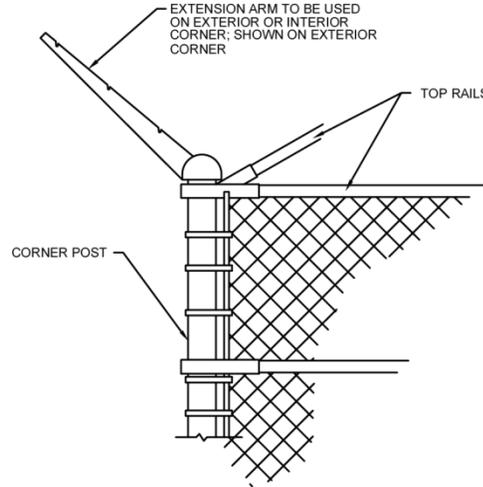
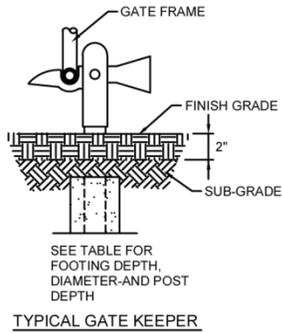
1. SIGNS TO BE 1/8" THICK ALUMINUM
2. BACKGROUND TO BE REFLECTIVE BLUE
3. LETTERING TO BE REFLECTIVE WHITE BLOCK STYLE
4. MINIMUM TEXT DIMENSIONS SHALL BE 4" FOR ADDRESS, 1-1/2" FOR ALL OTHER TEXT. MINIMUM TEXT THICKNESS TO BE 1/4"
5. COORDINATE W/ CITY TO OBTAIN STATION NUMBER.

CITY OF COLUMBIA DEPARTMENT OF UTILITIES AND ENGINEERING DIVISION P.O. BOX 147 COLUMBIA, SOUTH CAROLINA 29217	SCALE: N.T.S.
	DATE: 05/03/16
	REVISED: ---
	DRAWING NO: PS3
WEATHER-DURABLE EMERGENCY CONTACT SIGN	

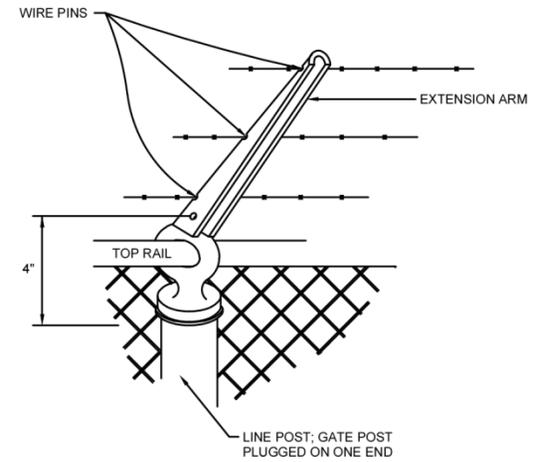


CITY OF COLUMBIA DEPARTMENT OF UTILITIES AND ENGINEERING DIVISION P.O. BOX 147 COLUMBIA, SOUTH CAROLINA 29217	SCALE N.T.S.
	DATE: 05/03/16
	REVISED ---
	DRAWING NO. PS4A

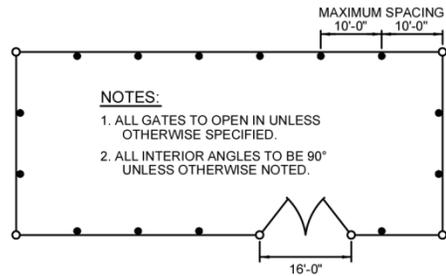
TYPICAL FENCE AND GATE DETAIL(1)



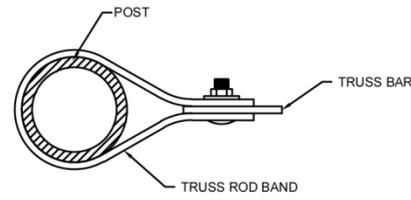
TYPICAL EXTENSION ARM CORNER & ANGLE POSTS
NOT TO SCALE



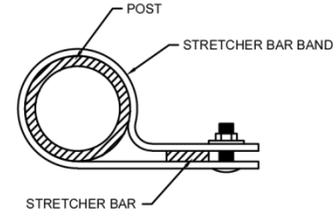
TYPICAL EXTENSION ARM GATE, END, & LINE POSTS
NOT TO SCALE



TYPICAL FENCE LAYOUT PLAN
NOT TO SCALE



TYPICAL TRUSS ROD BAND



TYPICAL STRETCHER BAR BAND

STANDARD DESIGN FOR FENCING
NOT TO SCALE

NAME OF PART	PIPE SIZE NOM. O.D.	POST DEPTH IN FOOTING	MINIMUM FOOTING DIMENSIONS		
			TOP DIA.	BOTTOM DIA.	FOOTING DEPTH
LINE POST	2-1/2	3'-0"	0'-10"	1'-2"	3'-3"
END AND ANGLE POST	3	3'-0"	1'-0"	1'-4"	3'-3"
DOUBLE GATE POST WIDTH OVER 12' TO 26'	4	4'-0"	1'-4"	2'-0"	4'-3"
GATE PLUNGER STOP(OR CATCH)			0'-10"	1'-2"	3'-0"
GATE KEEPER			0'-7"	0'-10"	3'-0"
GATE FRAME	2				
TOP BOTTOM RAIL	1-5/8				
BRACE	1-5/8				
TENSION WIRE	9 GAUGE				

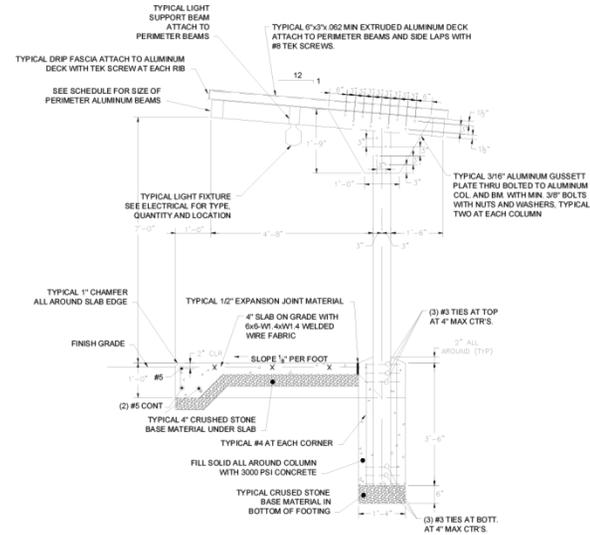
NOTE:
ALL DIMENSIONS ARE IN INCHES EXCEPT AS NOTED.

MINIMUM FOOTING DIMENSIONS AND SIZES OF FENCE PARTS

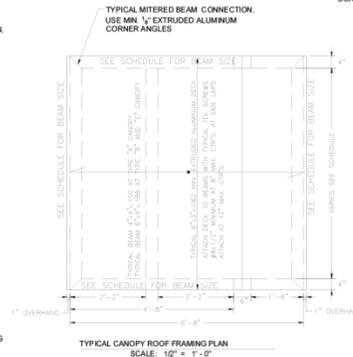
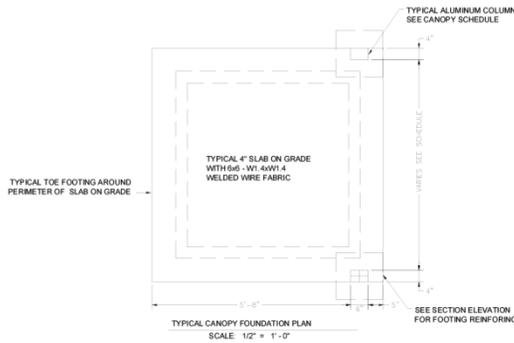
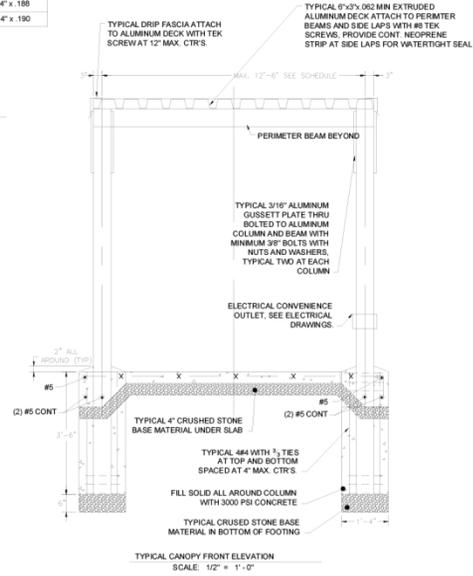
CITY OF COLUMBIA DEPARTMENT OF UTILITIES AND ENGINEERING DIVISION P.O. BOX 147 COLUMBIA, SOUTH CAROLINA 29217	SCALE: N.T.S.
	DATE: 05/03/16
	REVISED: ---
	DRAWING NO: PS4B

GENERAL NOTES:

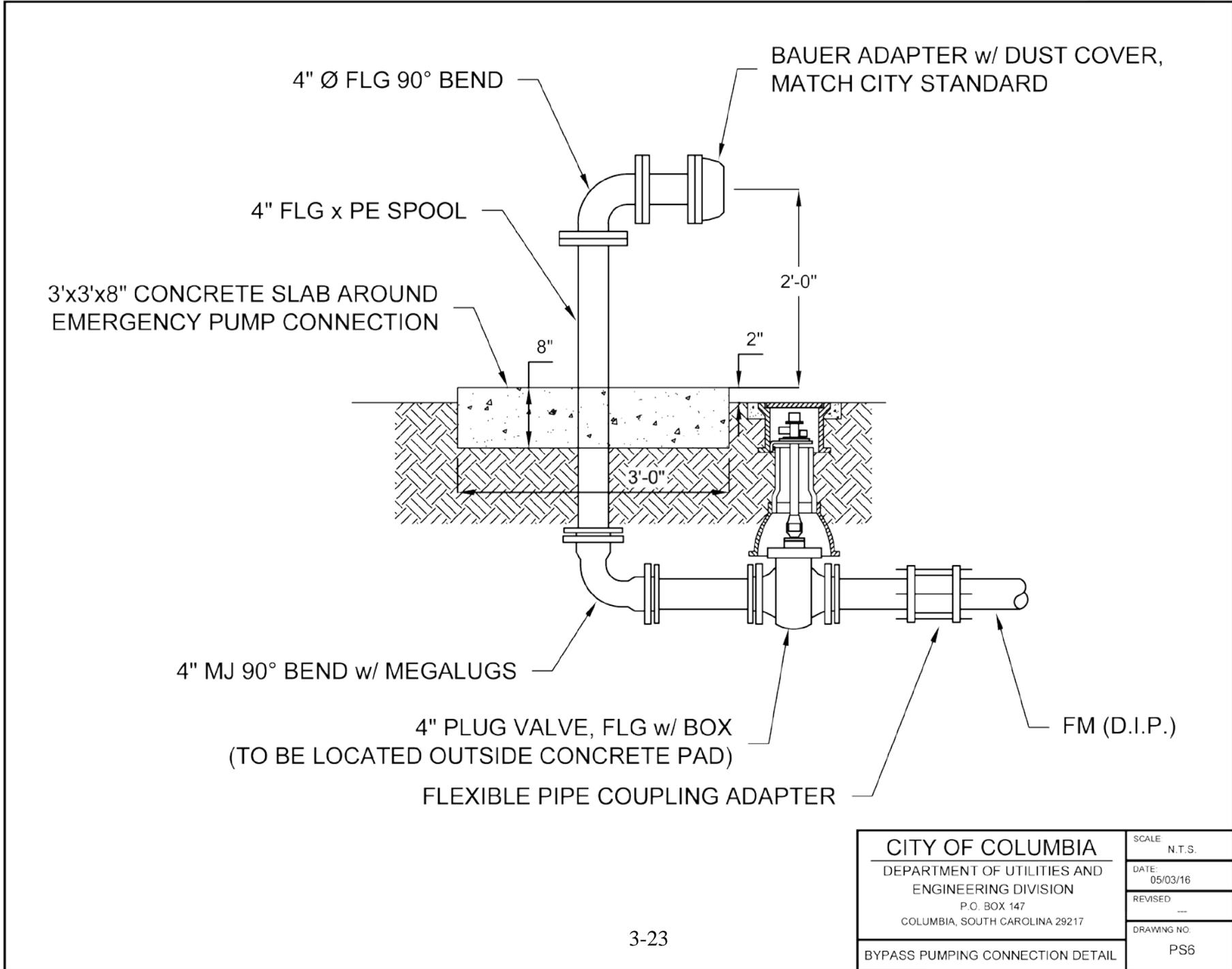
1. A CANOPY SHALL BE PROVIDED ON THE PUMP STATION SITE THAT COVERS THE CONTROL PANELS.
2. THE CANOPY SHALL BE PAINTED TNEPEC MEDIUM BRONZE 85BR, AND SHALL BE ON A MINIMUM 6-INCH PAD THAT SPANS THE EXTENTS OF THE CANOPY.
3. ENGINEER IS RESPONSIBLE FOR REVIEWING THE STANDARD CANOPY DETAIL AND MAKING MODIFICATIONS TO ENSURE THE CANOPY IS STRUCTURALLY SOUND, AND MAKING ADJUSTMENTS AS NEEDED.
4. THE STANDARD DETAIL SHOWN IS A MINIMUM REQUIREMENT AND MAY NOT BE SUFFICIENT FOR ALL SITES.



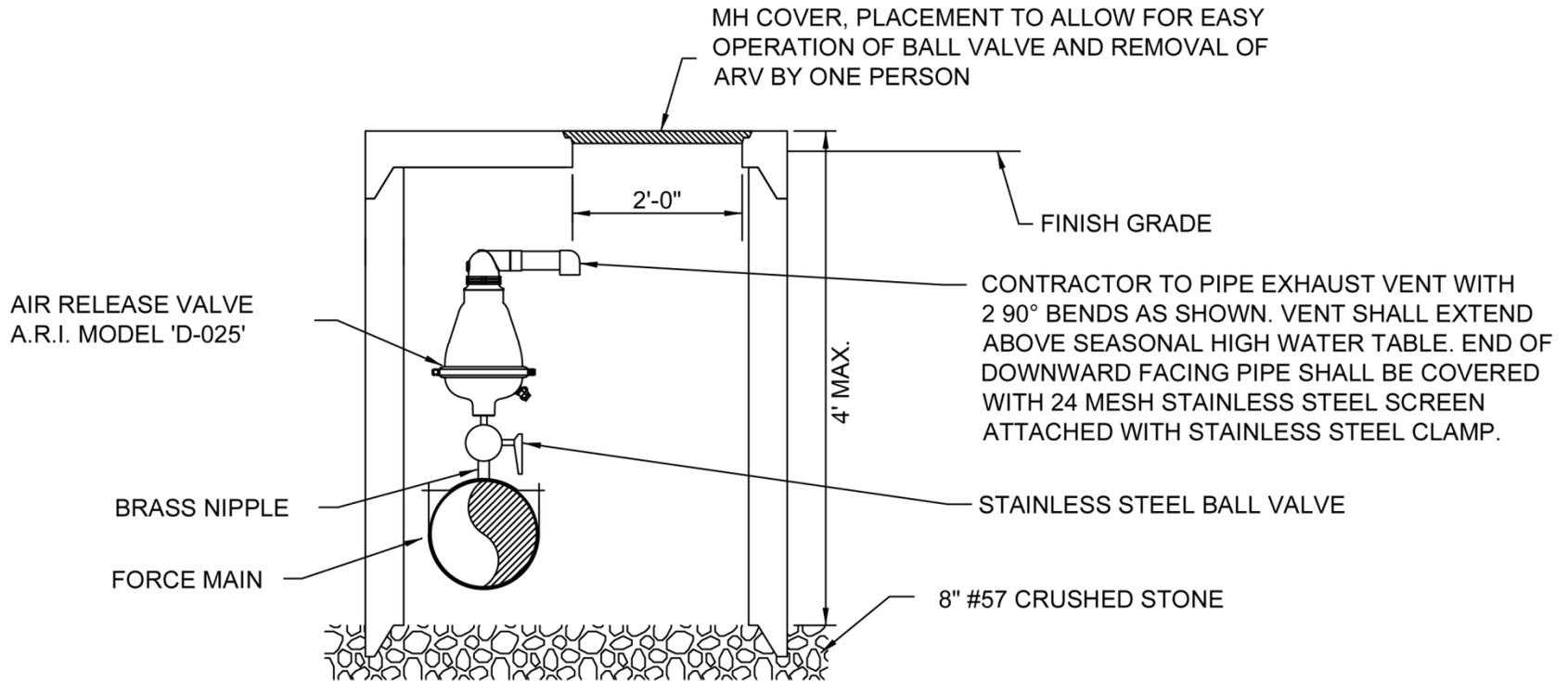
CANOPY BEAM / COLUMN SCHEDULE			
TYPE	CANOPY WIDTH	COLUMN SIZE	BEAM SIZE
A	4'-0" TO 6'-0"	6" x 4" x 125	4" x 4" x 150
B	6'-1" TO 8'-0"	6" x 4" x 188	6" x 4" x 188
C	10'-0" TO 12'-6"	6" x 4" x 188	6" x 4" x 190



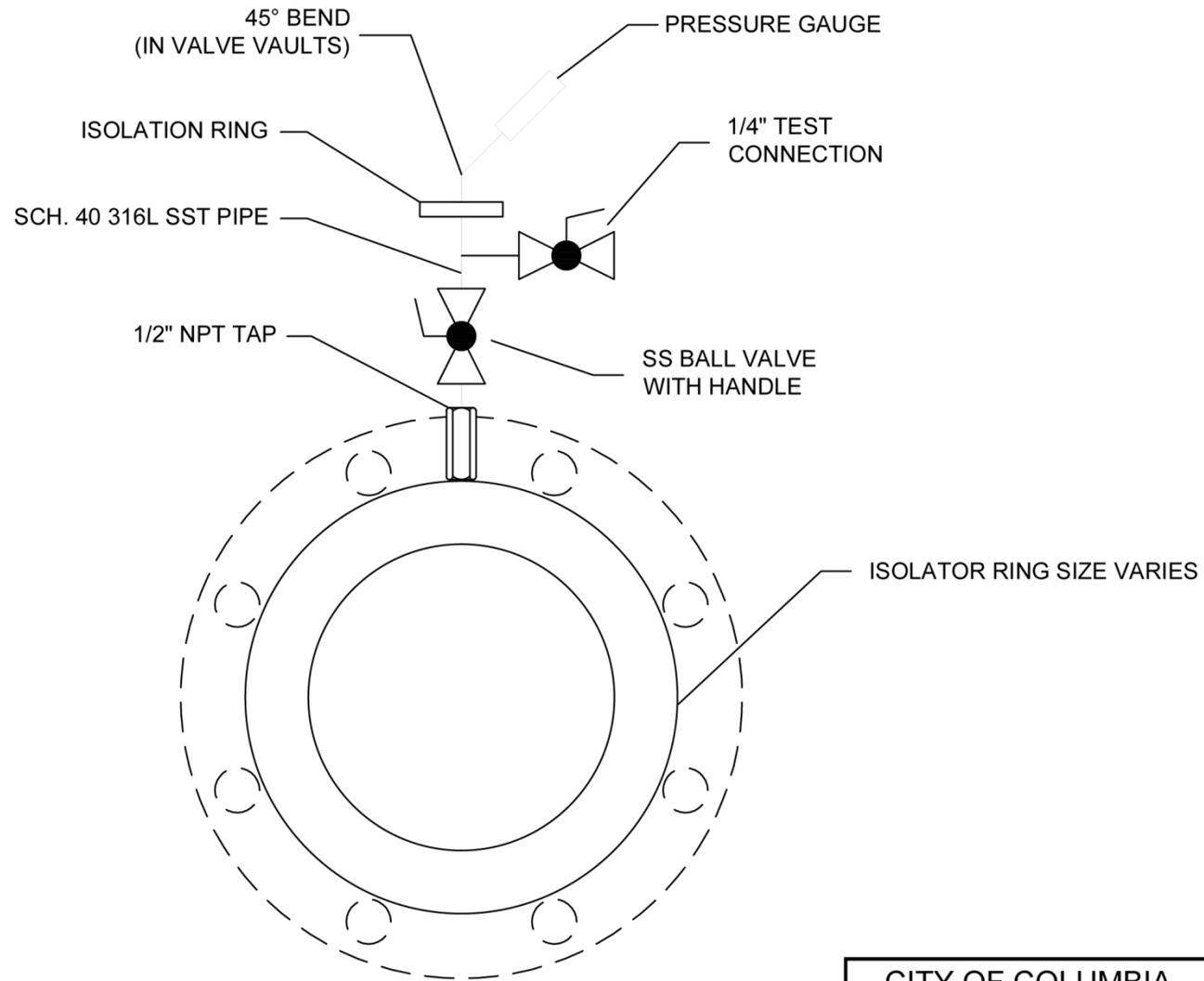
CITY OF COLUMBIA DEPARTMENT OF UTILITIES AND ENGINEERING DIVISION P.O. BOX 147 COLUMBIA, SOUTH CAROLINA 29217 TYPICAL PUMP CONTROLS CANOPY DETAIL	SCALE: N.T.S.
	DATE: 05/03/16
	REVISED: ---
	DRAWING NO: PS5



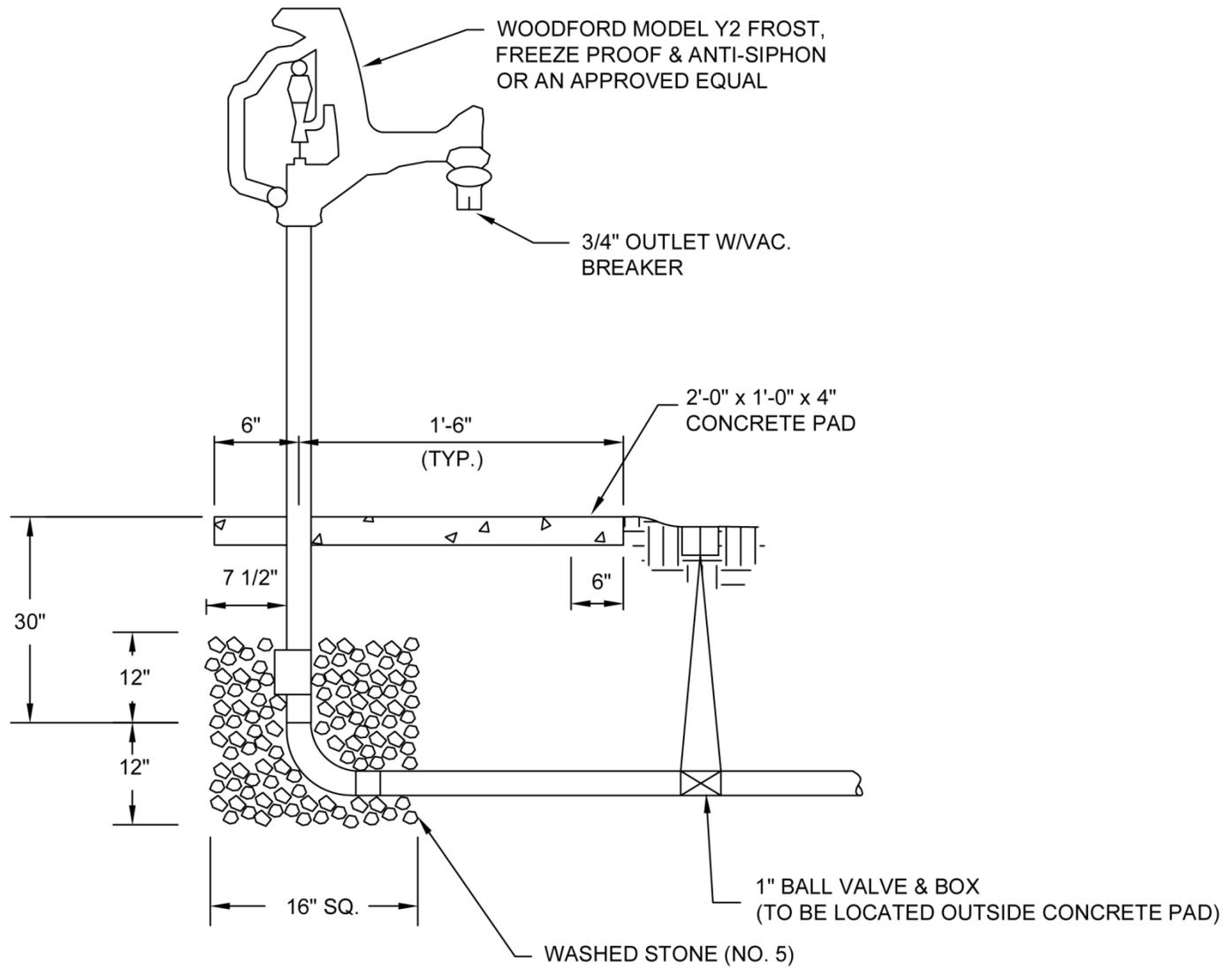
<p>CITY OF COLUMBIA DEPARTMENT OF UTILITIES AND ENGINEERING DIVISION P.O. BOX 147 COLUMBIA, SOUTH CAROLINA 29217</p>	SCALE	N.T.S.
	DATE:	05/03/16
	REVISED	---
	DRAWING NO.	PS6
BYPASS PUMPING CONNECTION DETAIL		



CITY OF COLUMBIA DEPARTMENT OF UTILITIES AND ENGINEERING DIVISION P.O. BOX 147 COLUMBIA, SOUTH CAROLINA 29217	SCALE: N.T.S.
	DATE: 05/03/16
	REVISED: ---
	DRAWING NO: PS7
AIR RELEASE VALVE IN MANHOLE DETAIL	

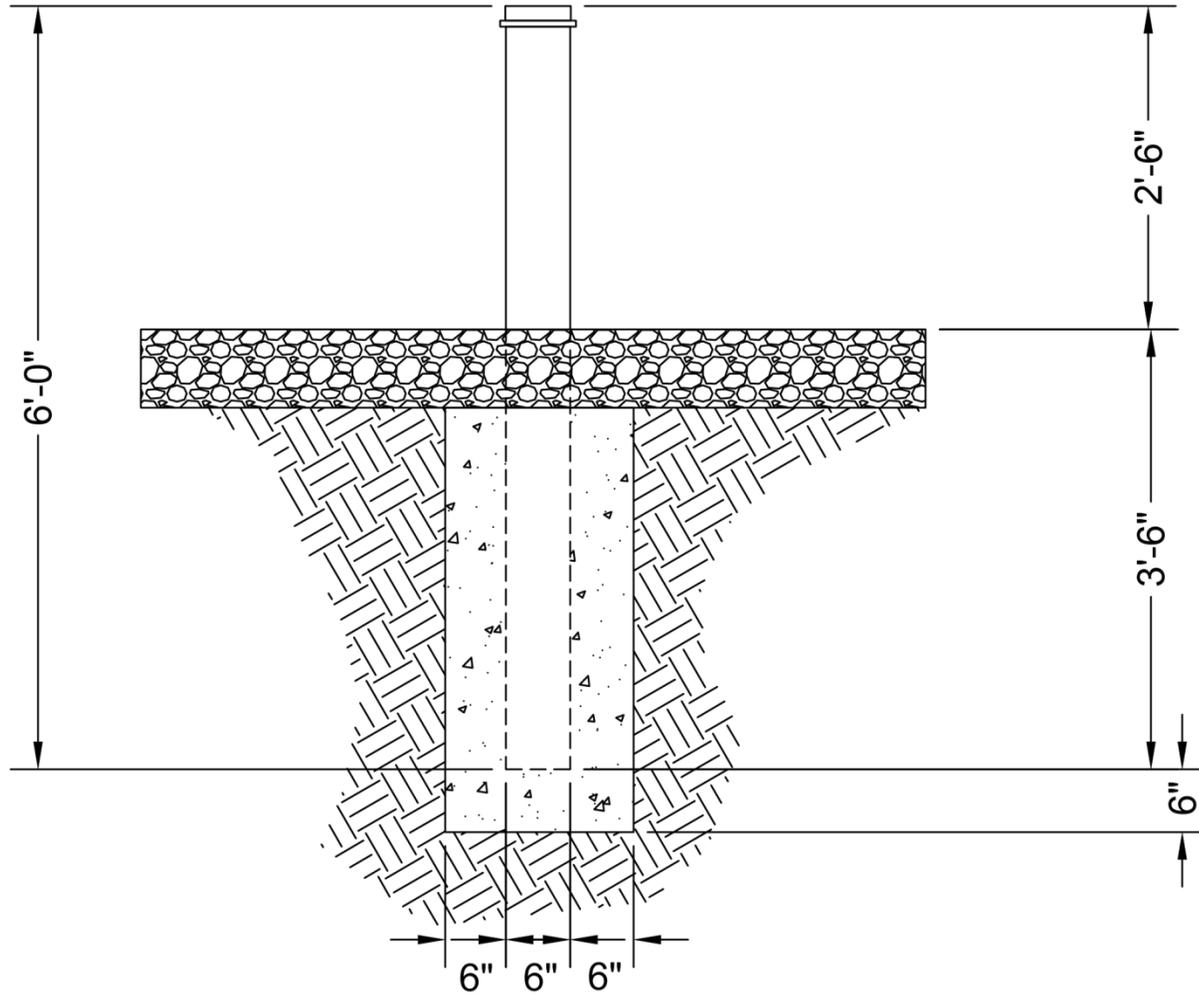


CITY OF COLUMBIA DEPARTMENT OF UTILITIES AND ENGINEERING DIVISION P.O. BOX 147 COLUMBIA, SOUTH CAROLINA 29217	SCALE: N.T.S.
	DATE: 05/03/16
	REVISED: ---
	DRAWING NO: PS8



NOTE: PROVIDE A 25-FOOT 3/4" HOSE W/ADJUSTABLE BRASS SPRAY NOZZLE, ALONG WITH A WEATHER-PROOF HOSE RACK

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	DATE: 05/03/16
	REVISED: ---
	DRAWING NO: PS9
YARD HYDRANT DETAIL	



NOTES:

1. ENGINEER TO DETERMINE IF STEEL BOLLARDS ARE NEEDED TO PROTECT EQUIPMENT AND/OR SITE.
2. BOLLARD TO BE PAINTED WITH SAFETY YELLOW TNEMEC PAINT OR APPROVED EQUAL.

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	REVISED: ---
	DRAWING NO. PS10
STEEL BOLLARD DETAIL	

STANDARD DRAWING MATRIX

DRAWING SERIES DESCRIPTION	BASE DRAWING NUMBER	DRAWING NUMBER			NOTES
		SCHEDULE&NOTES	ONE-LINE DIAGRAM	CONTROL PANEL ELEVATIONS	
DRAWING INDEX & NOTES	E0.1	-	-	-	
LEGEND, SECONDARY GROUNDING DETAIL, EMERGENCY GENERATOR FOUNDATION PAD DETAIL	E0.2	-	-	-	
JUNCTION BOX ELEVATION AT WET WELL	E0.3	-	-	-	
I/O RISER DIAGRAM	E0.4	-	-	-	
LESS THAN 20 HP 240/120V 3-PHASE 4-WIRE SERVICE, FVNR STARTER, EMERGENCY GENERATOR	-	E1.1	E1.2	E1.3	
20HP OR GREATER 480Y/277V 3-PHASE 4-WIRE SERVICE, RVSS STARTER, EMERGENCY GENERATOR	-	E2.1	E2.2	E2.3	

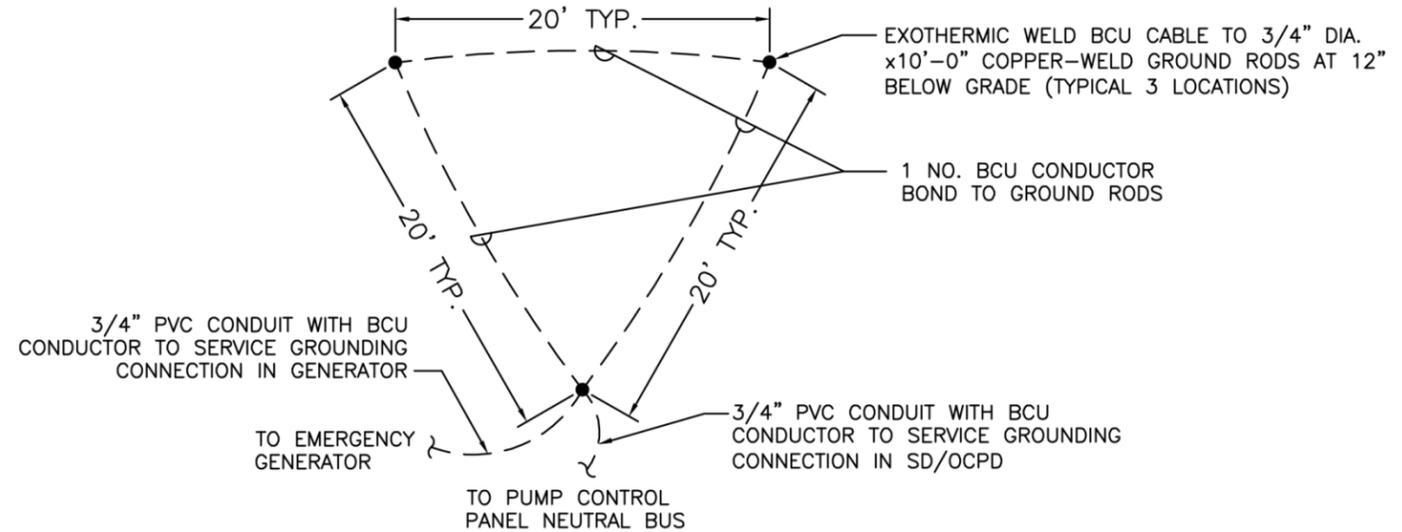
CITY OF COLUMBIA DEPARTMENT OF UTILITIES AND ENGINEERING DIVISION P.O. BOX 147 COLUMBIA, SOUTH CAROLINA 29217	SCALE: N.T.S.
	DATE: 08/17/16
	REVISED: ---
	DRAWING NO. E1A
ELECTRICAL DRAWING INDEX	

LEGEND:

-  EQUIPMENT AS NOTED
-  CIRCUIT BREAKER
- 20A**  DUPLEX RECEPTACLE, NEMA 5-20R, TYPE WR HUBBELL GFR5362SG
- WP** WEATHERPROOF
-  GROUND TO GROUND ROD SYSTEM
- GF** GROUND FAULT CIRCUIT INTERRUPTER PROTECTION
- S** SINGLE POLE, 20 AMP, 277 VOLT TOGGLE SWITCH, NOTE 1
- AIC** INTERRUPTING CAPACITY IN AMPS
- BCU** BARE COPPER CABLE, SOLID OR STRANDED AS NOTED
- SD/OCPPD** SERVICE DISCONNECT/OVERCURRENT PROTECTION DEVICE
-  CONDUIT SYSTEM CONCEALED BELOW GRADE
-  PUMP MOTOR. HORSEPOWER INDICATED
-  SEAL OFF FITTING. O-Z GEDNEY EYAX SERIES
- J** NEMA 4X STAINLESS STEEL JUNCTION BOX WITH STAINLESS STEEL BACKPLATE, NOTE 2
-  AREA LIGHT MOUNTED ON SERVICE POLE, LUMARK CTKRV1A-SR-CARETAKER
- N.T.S.** NOT TO SCALE
- SP** SURGE PROTECTION DEVICE - APT XDS SERIES, MODEL TE-##-XDS-15-4X, NOTE 13
- RVSS** SOLID STATE REDUCED VOLTAGE STARTER WITH SHORTING CONTACTOR, SQUARE D ALTISTART 48
- FVNR** FULL-VOLTAGE JNON-REVERSING NEMA SIZE STARTER WITH SOLID STATE OVERLOAD PROTECTION. SQUARE D 8502S SERIES
-  DRY-TYPE TRANSFORMER INTEGRAL TO PUMP CONTROL PANEL
-  LED PANEL SERVICE LIGHT
- S^D** SERVICE LIGHT DOOR SWITCH

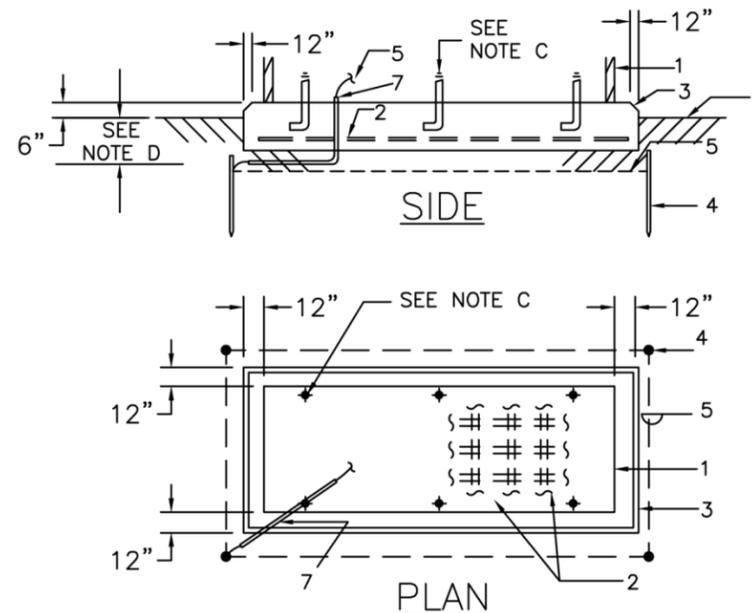
NOTES: LEGEND

1. PROVIDE HUBBELL HBL1281 PRESS-SWITCH WITH HUBBELL HBL17CM50 WEATHERPROOF COVER.
2. PROVIDE PENTAIR INLINE LHC###SS6 SERIES WITH HINGE COVER AND QUARTER-TURN LATCH. PROVIDE WITH POWER TERMINAL BLOCKS AND/OR TERMINAL STRIPS AS REQUIRED.
3. MOUNT WITHIN THE CONTROL PANEL.



SECONDARY ELECTRICAL GROUNDING

NOT TO SCALE



- 1 - GENERATOR SET ENCLOSURE OUTLINE
- 2 - REINFORCING STEEL, NOTE A
- 3 - 1" CHAMFER
- 4 - 3/4" x 10' COPPERCLAD GROUND ROD AND
- 5 - #1/0 CU BARE GROUND CONDUCTOR
- 6 - FINISHED GRADE
- 7 - 3/4" PVC, SEE NOTE B

NOTES:

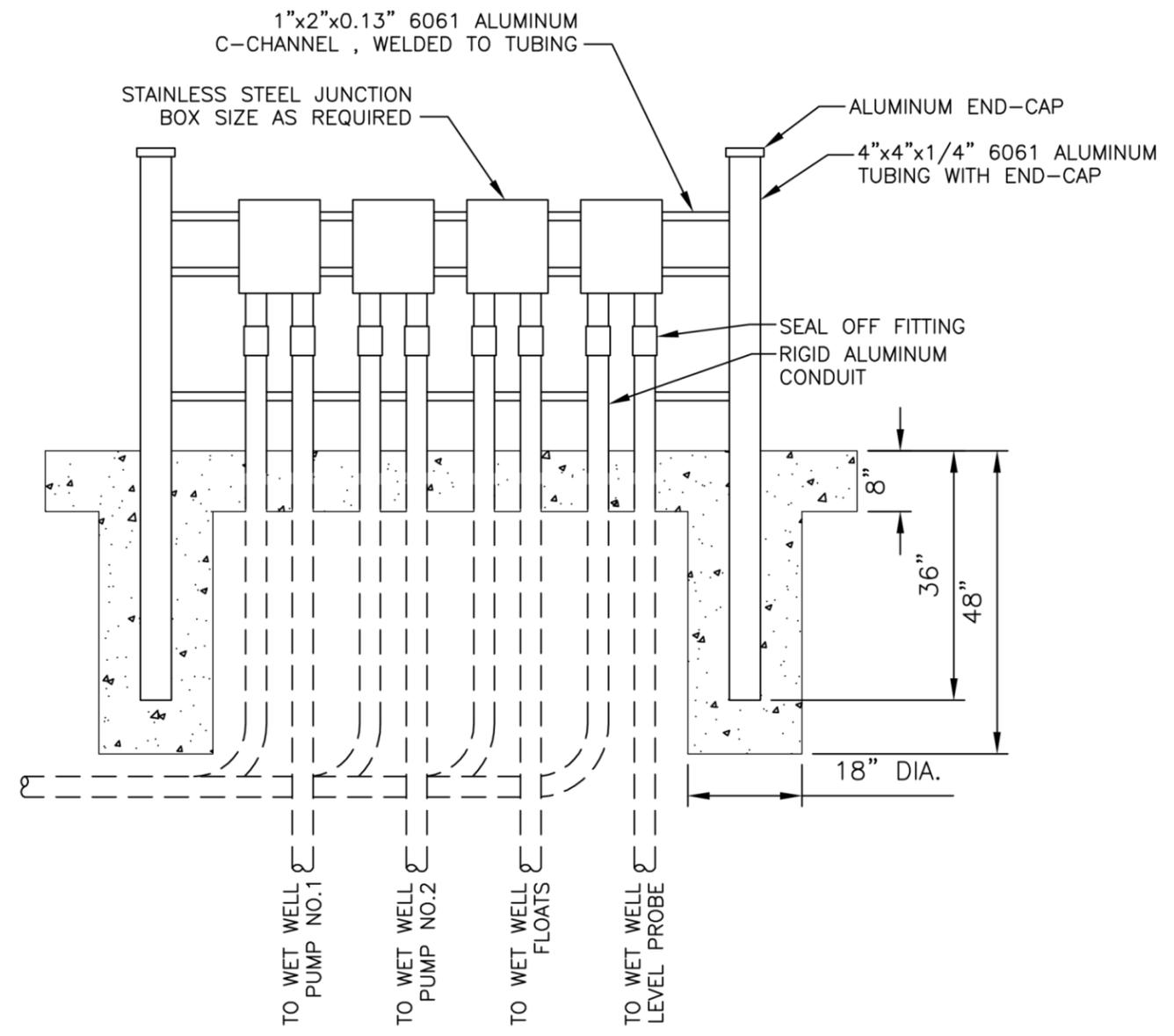
- A. #8 GA. STEEL WIRE MESH 6" O.C., OR #6 REBAR 12" O.C., VERTICALLY AND HORIZONTALLY.
- B. CONNECT TO GENERATOR GROUND CONNECTION LUG. VERIFY STUB UP LOCATION WITH MANUFACTURERS SHOP DRAWINGS. WATERPROOF CONDUIT END WITH SEALING COMPOUND.
- C. ANCHOR BOLTS FURNISHED WITH GENERATOR SET. PROVIDE SIX MINIMUM. TIE TO REINFORCING STEEL.
- D. DIMENSION SHALL BE 6" (12" OVERALL DEPTH) UP TO & INCLUDING 600 KW, 12" (18" OVERALL DEPTH) LARGER THAN 600 KW,

EMERGENCY GENERATOR FOUNDATION

PAD DETAIL

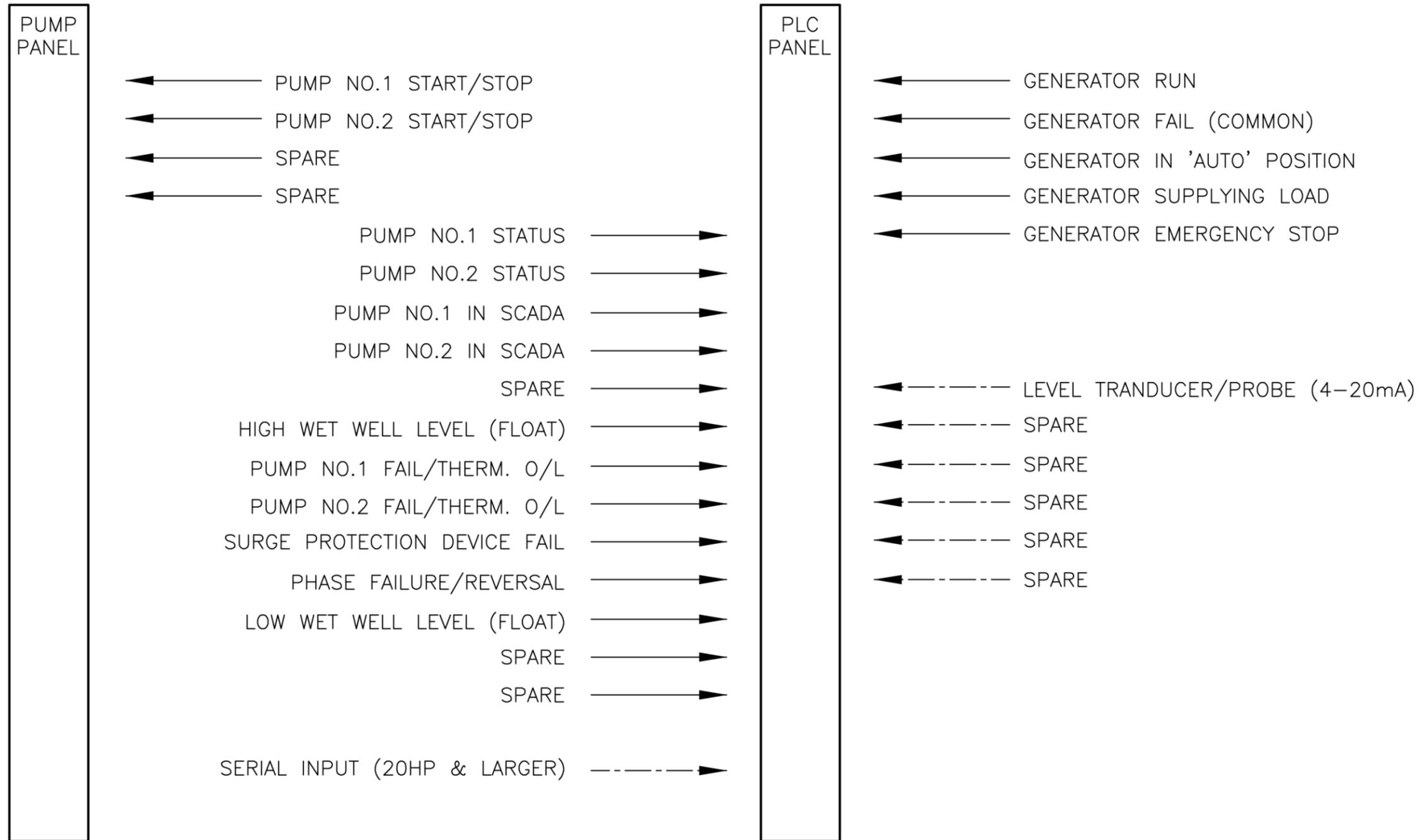
NOT TO SCALE

CITY OF COLUMBIA DEPARTMENT OF UTILITIES AND ENGINEERING DIVISION P.O. BOX 147 COLUMBIA, SOUTH CAROLINA 29217	SCALE: N.T.S.
	DATE: 08/17/16
	REVISED: ---
	DRAWING NO. E1B
LEGEND AND DETAILS	



PUMP STATION JUNCTION
BOX ELEVATION
NOT TO SCALE

CITY OF COLUMBIA DEPARTMENT OF UTILITIES AND ENGINEERING DIVISION P.O. BOX 147 COLUMBIA, SOUTH CAROLINA 29217	SCALE: N.T.S.
	DATE: 08/17/16
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	DRAWING NO. E1C
JUNCTION BOX ELEVATION	



I/O RISER DIAGRAM
NOT TO SCALE

<p>CITY OF COLUMBIA DEPARTMENT OF UTILITIES AND ENGINEERING DIVISION P.O. BOX 147 COLUMBIA, SOUTH CAROLINA 29217</p>	SCALE: N.T.S.
	DATE: 08/17/16
	REVISED: ---
	DRAWING NO. E1D
I/O RISER DIAGRAM	

DUPLEX PUMP STATION ONE LINE SCHEDULE 230V 3PH MOTORS, LESS THAN 20 HP, TYP.	
ITEM#	DESCRIPTION
①	SERVICE FROM POINT OF CONNECTION. NOTE 1
②	SERVICE DISCONNECT/OVERCURRENT PROTECTION DEVICE (SD/OCPD): ENCLOSED CIRCUIT BREAKER IN NEMA 4X 316 STAINLESS STEEL ENCLOSURE. NOTE 5
③	SERVICE FEEDER AFTER SD/OCPD, WITH NEUTRAL
④	SERVICE GROUND IN SCH.80 PVC CONDUIT
⑤	AUTOMATIC TRANSFER SWITCH, NOTE 5,7
⑥	GENERATOR CIRCUIT BREAKER
⑦	CIRCUIT BREAKER FOR SPD, 40A/3P
⑧	CONDUCTORS TO SPD, 4NO.8, 1NO.8 (G)
⑨	THERMAL MAGNETIC CIRCUIT BREAKER
⑩	FULL VOLTAGE NON-REVERSING STARTER, NOTE 8
⑪	MOTOR FEEDER CIRCUIT, NOTE 3,4
⑫	SEAL-OFF FITTING
⑬	NEMA 4X STAINLESS STEEL JUNCTION BOX, NOTE 21
⑭	OMITTED
⑮	OMITTED
⑯	OMITTED
⑰	OMITTED
⑱	15A/1P CIRCUIT BREAKER, 10KAIC MIN. @ 120V
⑲	20A/1P CIRCUIT BREAKER, 10KAIC MIN. @ 120V
⑳	3/4" C. W/2NO.12 1NO. 12(G)
㉑	GENERATOR CONTROL CIRCUITS. THREE 1" CONDUITS WITH CONDUCTORS AS REQUIRED FOR CONTROL AND ALARM.
㉒	2" SCH. 80 PVC CONDUIT WITH FLOAT CABLES STUBBED THROUGH WET WELL WALL. NOTE 4
㉓	3/4" C W/4NO.12, 1NO.12(G) FOR FLOATS, NOTE 3, 4
㉔	2" SCH. 80 PVC CONDUIT WITH PROBE CABLE STUBBED THROUGH WET WELL WALL. NOTE 4
㉕	2" SCH. 80 PVC CONDUIT WITH PROBE CABLE, NOTE 3, 4
㉖	2" SCH. 80 PVC CONDUIT WITH ANTENNA CABLE
㉗	2" C W/NO. 14 THHN/THWN CONDUCTORS AND/OR BELDEN 5240F1 AS CABLE REQUIRED FOR SIGNAL AND CONTROL
㉘	20A/2P CIRCUIT BREAKER, 10KAIC MIN. @ 240V

NOTES:

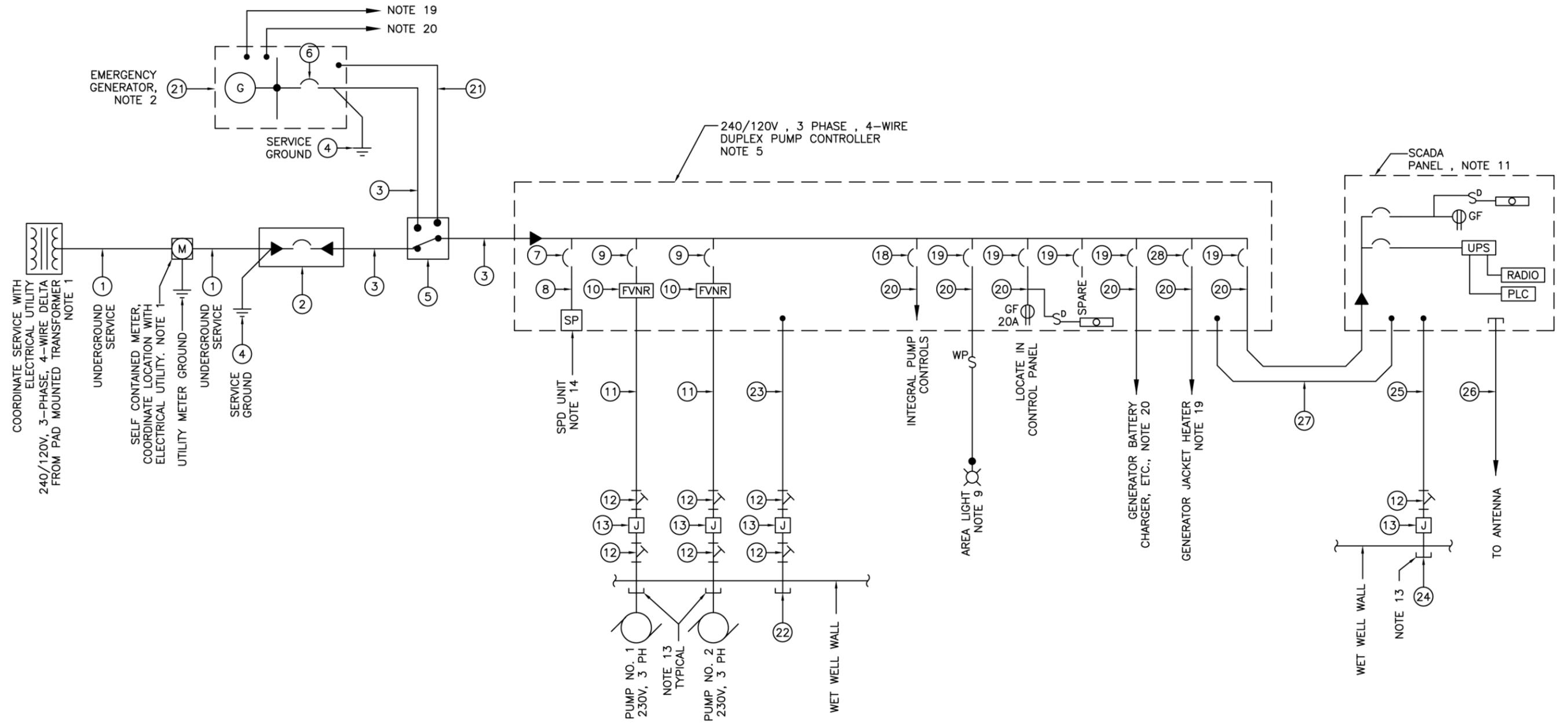
- THE EXACT LOCATION OF THE METER AND SERVICE SHALL BE COORDINATED IN THE FIELD WITH THE UTILITY COMPANY AND WITH OTHER WORK ON THE PROJECT SITE.
- PROVIDE PERMANENT SITE. NATURAL GAS FUELED GENERATOR. FIELD COORDINATE REQUIRED RATING AND CONFIGURATION.
- ALL CONDUITS INSTALLED EXPOSED TO ATMOSPHERE SHALL BE RIGID ALUMINUM, ALL CONDUITS INSTALLED BELOW GRADE SHALL BE SCHEDULE 80 PVC. ALL ELBOWS AND STUB-UPS TO BE RIGID ALUMINUM.
- SEAL BOTH ENDS OF EACH CONDUIT ENTERING THE CONTROL CABINETS FROM THE JUNCTION BOXES. ADJACENT TO THE WET WELL WITH ELECTRICAL DUCT SEAL.
- CIRCUIT BREAKER AND SWITCH OPERATING HANDLES SHALL BE A MAXIMUM OF 66" ABOVE FINISHED GRADE, LOCATE DUPLEX PUMP CONTROL PANEL, MANUAL TRANSFER SWITCH, SERVICE BREAKER, GENERATOR RECEPTACLE AND TVSS DEVICE WHERE INDICATED.
- POSITION ELECTRICAL EQUIPMENT SO THAT ALARM LIGHT CAN BE SEEN FROM THE NEAREST ROAD.
- THE AUTOMATIC TRANSFER SWITCH SHALL BE PROVIDED IN A NEMA 4X 316 STAINLESS STEEL ENCLOSURE, WITH A SWITCHED NEUTRAL, AND A GROUND BUS ATTACHED TO THE SWITCH ENCLOSURE (ONE MECHANICAL TERMINAL FOR EACH CONDUCTOR). PROVIDE PRODUCTS OF ASCO.
- THE FULL VOLTAGE NON-REVERSING STARTER SHALL BE PROVIDED WITH A SQUARE D/SCHNEIDER TESYS T SOLID STATE OVERLOAD PROTECTION. PROVIDE PRODUCTS OF SQUARE D, NO SUBSTITUTIONS PERMITTED.
- MOUNT AREA LIGHT TO THE SCADA ANTENNA POLE, 25' AFG, AIM TOWARDS THE WET WELL.
- EQUIPMENT AND INSTALLATION SHALL CONFORM TO COLUMBIA, SOUTH CAROLINA, METRO WASTE WATER TREATMENT UTILITY CONSTRUCTION STANDARDS AND REQUIREMENTS.
- THE SCADA SYSTEM SHALL BE PROVIDED BY MR SYSTEMS, ATLANTA, GA. CONTACT TOM HOPKINS, (678)325-2829. THE SCADA PANEL SHALL BE MOUNTED ON THE EQUIPMENT FRAME ADJACENT TO THE PUMP POWER CONTROL PANEL. THE CONTRACTOR SHALL EXTEND TWO 2" C W/ 30 NO. 14, 1 NO. 14(G) FROM THE SCADA PANEL TO THE PUMP CONTROL PANEL. THE CONTRACTOR SHALL EXTEND 1" C W/ 6 T.S. PAIR CABLES (BELDEN 5240F1) 16 AWG FROM THE SCADA PANEL TO THE PUMP CONTROL PANEL. THE CONTRACTOR SHALL EXTEND 2" C WITH SCADA ANTENNA CABLE FROM THE SCADA PANEL TO THE SCADA ANTENNA MAST.
- ALL ATTACHMENT HARDWARE SHALL BE STAINLESS STEEL.
- 2" SCH. 40 PVC STUBBED INTO THE WET WELL.
- LOCATE WITHIN CONTROL PANEL. COORDINATE MODEL NUMBER WITH VOLTAGE.
- THE CONTRACTOR SHALL HIRE MR SYSTEMS TO PERFORM A RADIO PATH STUDY OF THE SITE TO DETERMINE THE REQUIRED ANTENNA ELEVATION. FOR BIDDING PURPOSES, THE CONTRACTOR SHALL PROVIDE AN ALLOWANCE FOR A 45' CLASS 5 PRESSURE TREATED WOOD POLE WITH A 20' ALUMINUM MAST TO BE INSTALLED WHERE SHOWN. FINAL REQUIRED ELEVATION SHALL BE DETERMINED FROM THE STUDY.

THE RADIO SURVEY SHALL LOCATE ALL MASTS AND TOWERS ALONG THE PATH. THE DETERMINED ANTENNA ELEVATION SHALL PROVIDE A MINIMUM OF 15 YEARS OF SERVICE AT THE ELEVATION DETERMINED. REFER TO THE SCADA SPECIFICATIONS.
- THE SCADA SYSTEM SHALL MONITOR AND TRANSMIT THE POINTS AND TELEMETRY OUTLINED IN THE SCADA SPECIFICATIONS. PROVIDE BOTH DIGITAL AND ANALOG DATA TRANSMISSION AS SPECIFIED.
- A STAINLESS STEEL BRACKET FOR SUPPORT OF THE MOTOR, FLOAT AND TRANSDUCER CABLES SHALL BE PROVIDED AT THE WET WELL HATCH.
- PROVIDE HEAVY DUTY SUPPORT GRIPS FOR ALL CABLES AND SENSORS IN THE WET WELL. GRIPS SHALL BE DOUBLE WEAVE, CLOSED MESH STAINLESS STEEL. PROVIDE DOUBLE EYE GRIPS FOR PUMP METER CABLES. SINGLE EYE GRIPS FOR FLOAT AND TRANSDUCER CABLES.
- EXTEND CONDUIT AND WIRE FROM THE CONTROL PANEL TO THE GENERATOR TO ENERGIZE THE COOLANT HEATER.
- EXTEND CONDUIT AND WIRE FROM THE CONTROL PANEL TO THE GENERATOR TO ENERGIZE THE BATTERY CHARGER, SERVICE LIGHT, ANTI-CONDENSATION HEATER AND LUBE OIL HEATER.
- REFER TO PLATE E0.2, LEGEND.
- ADD-A-PHASE DEVICES, EITHER CAPACITIVE OR ROTARY, ARE NOT PERMITTED.
- THE CONCRETE PAD UNDER THE EQUIPMENT FRAME SHALL EXTEND A MINIMUM OF 48" IN FRONT OF THE DEEPEST CONTROL PANEL EQUIPMENT FRAME ENCLOSURE.
- ALL ENCLOSURES SHALL BE ATTACHED TO THE EQUIPMENT FRAME USING 316 STAINLESS STEEL FASTENERS (BOLTS, WASHERS AND NUTS), MINIMUM SIZE 1/4". PROVIDE NOT LESS THAN FOUR POINTS OF ATTACHMENT PER ENCLOSURE.

240/120V 3-PHASE 4-WIRE DELTA SERVICE
LESS THAN 20HP STATION
SCHEDULE AND NOTES

NOT TO SCALE

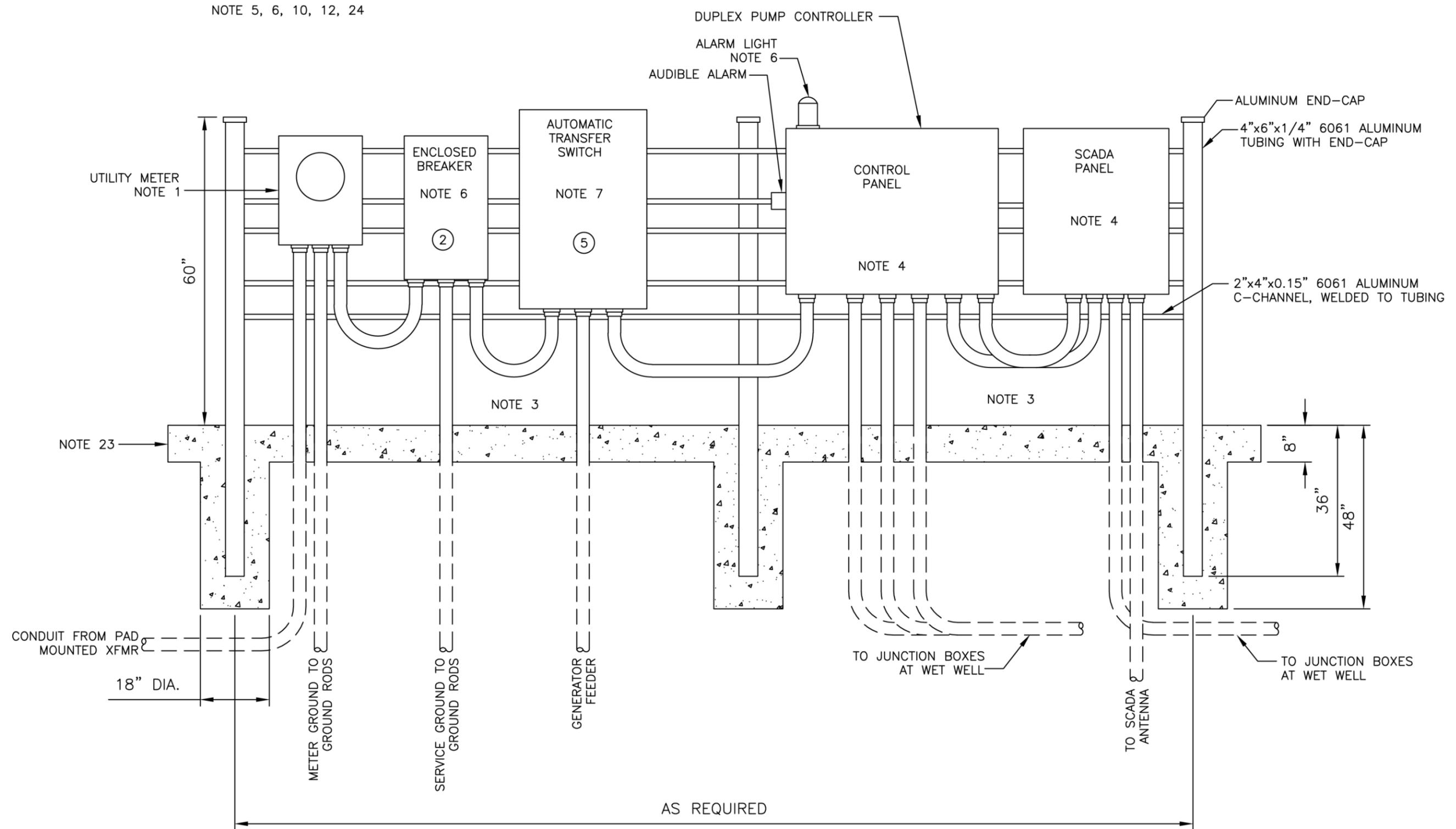
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240/120V 3-PHASE 4-WIRE DELTA SERVICE
LESS THAN 20HP STATION
ONE-LINE DIAGRAM

NOT TO SCALE

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240/120V 3-PHASE 4-WIRE DELTA SERVICE
 LESS THAN 20HP STATION
 CONTROL PANEL ELEVATION

NOT TO SCALE

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DUPLEX PUMP STATION ONE LINE SCHEDULE 460V 3PH MOTORS 20 HP AND GREATER, TYP.	
ITEM#	DESCRIPTION
①	SERVICE FROM POINT OF CONNECTION. NOTE 1
②	SERVICE DISCONNECT/OVERCURRENT PROTECTION DEVICE (SD/OCPD): ENCLOSED CIRCUIT BREAKER IN NEMA 4X 316 STAINLESS STEEL ENCLOSURE. NOTE 5
③	SERVICE FEEDER AFTER SD/OCPD, WITH NEUTRAL
④	SERVICE GROUND IN SCH.80 PVC CONDUIT
⑤	AUTOMATIC TRANSFER SWITCH, NOTE 5, 7
⑥	GENERATOR BREAKER
⑦	CIRCUIT BREAKER FOR SPD, 40A/3P
⑧	CONDUCTORS TO SPD, 4NO.8, 1NO.8 (G)
⑨	THERMAL MAGNETIC CIRCUIT BREAKER, 14KAIC MIN. @480V
⑩	REDUCED VOLTAGE SOLID STATE STARTER, NOTE
⑪	MOTOR FEEDER CIRCUIT, NOTE 3, 4
⑫	SEAL-OFF FITTING
⑬	NEMA 4X STAINLESS STEEL JUNCTION BOX, NOTE 21
⑭	20A/2P CIRCUIT BREAKER, 14KAIC MIN. 480V
⑮	7.5KVA TRANSFORMER
⑯	40A/2P CIRCUIT BREAKER, 10KAIC MIN. @ 240V
⑰	NO.8 BCU TO GROUND RODS
⑱	15A/1P CIRCUIT BREAKER, 10 000 MIN. A.I.C. @ 120V
⑲	20A/1P CIRCUIT BREAKER, 10 000 MIN. A.I.C. @ 120V
⑳	3/4"C. W/2NO.12 1NO. 12(G)
㉑	GENERATOR CONTROL CIRCUITS. THREE 1" CONDUITS WITH CONDUCTORS AS REQUIRED FOR CONTROL AND ALARM.
㉒	2" SCH. 80 PVC CONDUIT WITH FLOAT CABLES STUBBED THROUGH WET WELL WALL. NOTE 4
㉓	3/4"C W/4NO.12, 1NO.12(G) FOR FLOATS, NOTE 3,4
㉔	2" SCH. 80 PVC CONDUIT WITH PROBE CABLE STUBBED THROUGH WET WELL WALL. NOTE 4
㉕	2" SCH. 80 PVC CONDUIT WITH PROBE CABLE, NOTE 3,4
㉖	2" SCH. 80 PVC CONDUIT WITH ANTENNA CABLE
㉗	2"C W/NO. 14 THHN/THWN CONDUCTORS AND/OR BELDEN 5240F1 AS CABLE REQUIRED FOR SIGNAL AND CONTROL
㉘	20A/2P CIRCUIT BREAKER, 10KAIC MIN. @ 240V

NOTES:

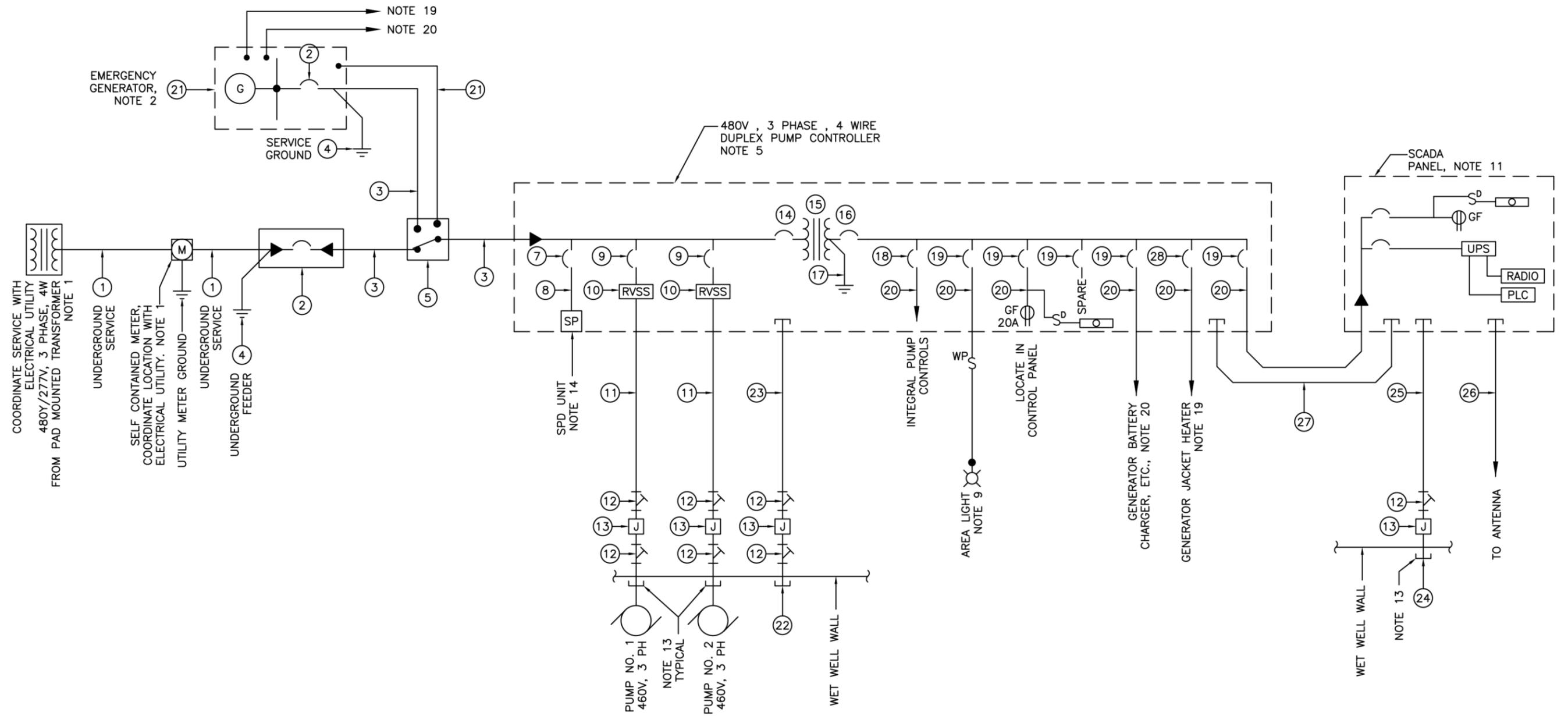
- THE EXACT LOCATION OF THE METER AND SERVICE SHALL BE COORDINATED IN THE FIELD WITH THE UTILITY COMPANY AND WITH OTHER WORK ON THE PROJECT SITE.
- PROVIDE PERMANENT SITE. NATURAL GAS FUELED GENERATOR. FIELD COORDINATE REQUIRED RATING AND CONFIGURATION.
- ALL CONDUITS INSTALLED EXPOSED TO ATMOSPHERE SHALL BE RIGID ALUMINUM, ALL CONDUITS INSTALLED BELOW GRADE SHALL BE SCHEDULE 80 PVC. ALL ELBOWS AND STUB-UPS TO BE RIGID ALUMINUM.
- SEAL BOTH ENDS OF EACH CONDUIT ENTERING THE CONTROL CABINETS FROM THE JUNCTION BOXES. ADJACENT TO THE WET WELL WITH ELECTRICAL DUCT SEAL.
- CIRCUIT BREAKER AND SWITCH OPERATING HANDLES SHALL BE A MAXIMUM OF 66" ABOVE FINISHED GRADE, LOCATE DUPLEX PUMP CONTROL PANEL, MANUAL TRANSFER SWITCH, SERVICE BREAKER, GENERATOR RECEPTACLE AND TVSS DEVICE WHERE INDICATED.
- POSITION ELECTRICAL EQUIPMENT SO THAT ALARM LIGHT CAN BE SEEN FROM THE NEAREST ROAD.
- THE AUTOMATIC TRANSFER SWITCH SHALL BE PROVIDED IN A NEMA 4X 316 STAINLESS STEEL ENCLOSURE, WITH A SWITCHED NEUTRAL, AND A GROUND BUS ATTACHED TO THE SWITCH ENCLOSURE (ONE MECHANICAL TERMINAL FOR EACH CONDUCTOR). PROVIDE PRODUCTS OF ASCO.
- THE REDUCED VOLTAGE SOLID STATE STARTER SHALL BE PROVIDED WITH AN INTEGRAL OR SEPARATE SHORTING CONTACTOR. PROVIDE PRODUCTS OF SQUARE D. ALTISTART 48, NO SUBSTITUTIONS PERMITTED.
- MOUNT AREA LIGHT TO THE SCADA ANTENNA POLE, 25' AFG, AIM TOWARDS THE WET WELL.
- EQUIPMENT AND INSTALLATION SHALL CONFORM TO COLUMBIA, SOUTH CAROLINA, METRO WASTE WATER TREATMENT UTILITY CONSTRUCTION STANDARDS AND REQUIREMENTS.
- THE SCADA SYSTEM SHALL BE PROVIDED BY MR SYSTEMS, ATLANTA, GA. CONTACT TOM HOPKINS, (678)325-2829. THE SCADA PANEL SHALL BE MOUNTED ON THE EQUIPMENT FRAME ADJACENT TO THE PUMP POWER CONTROL PANEL. THE CONTRACTOR SHALL EXTEND TWO 2" C W/ 30 NO. 14, 1 NO. 14(G) FROM THE SCADA PANEL TO THE PUMP CONTROL PANEL. THE CONTRACTOR SHALL EXTEND 1" C W/ 6 T.S. PAIR CABLES (BELDEN 5240F1) 16 AWG FROM THE SCADA PANEL TO THE PUMP CONTROL PANEL. THE CONTRACTOR SHALL EXTEND 2" C WITH SCADA ANTENNA CABLE FROM THE SCADA PANEL TO THE SCADA ANTENNA MAST.
- ALL ATTACHMENT HARDWARE SHALL BE STAINLESS STEEL.
- 2" SCH. 40 PVC STUBBED INTO THE WET WELL.
- LOCATE WITHIN CONTROL PANEL. COORDINATE MODEL NUMBER WITH VOLTAGE.
- THE CONTRACTOR SHALL HIRE MR SYSTEMS TO PERFORM A RADIO PATH STUDY OF THE SITE TO DETERMINE THE REQUIRED ANTENNA ELEVATION. FOR BIDDING PURPOSES, THE CONTRACTOR SHALL PROVIDE AN ALLOWANCE FOR A 45' CLASS 5 PRESSURE TREATED WOOD POLE WITH A 20' ALUMINUM MAST TO BE INSTALLED WHERE SHOWN. FINAL REQUIRED ELEVATION SHALL BE DETERMINED FROM THE STUDY.

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480Y/220V 3-PHASE 4-WIRE DELTA SERVICE
 20HP OR GREATER STATION
 SCHEDULE AND NOTES

NOT TO SCALE

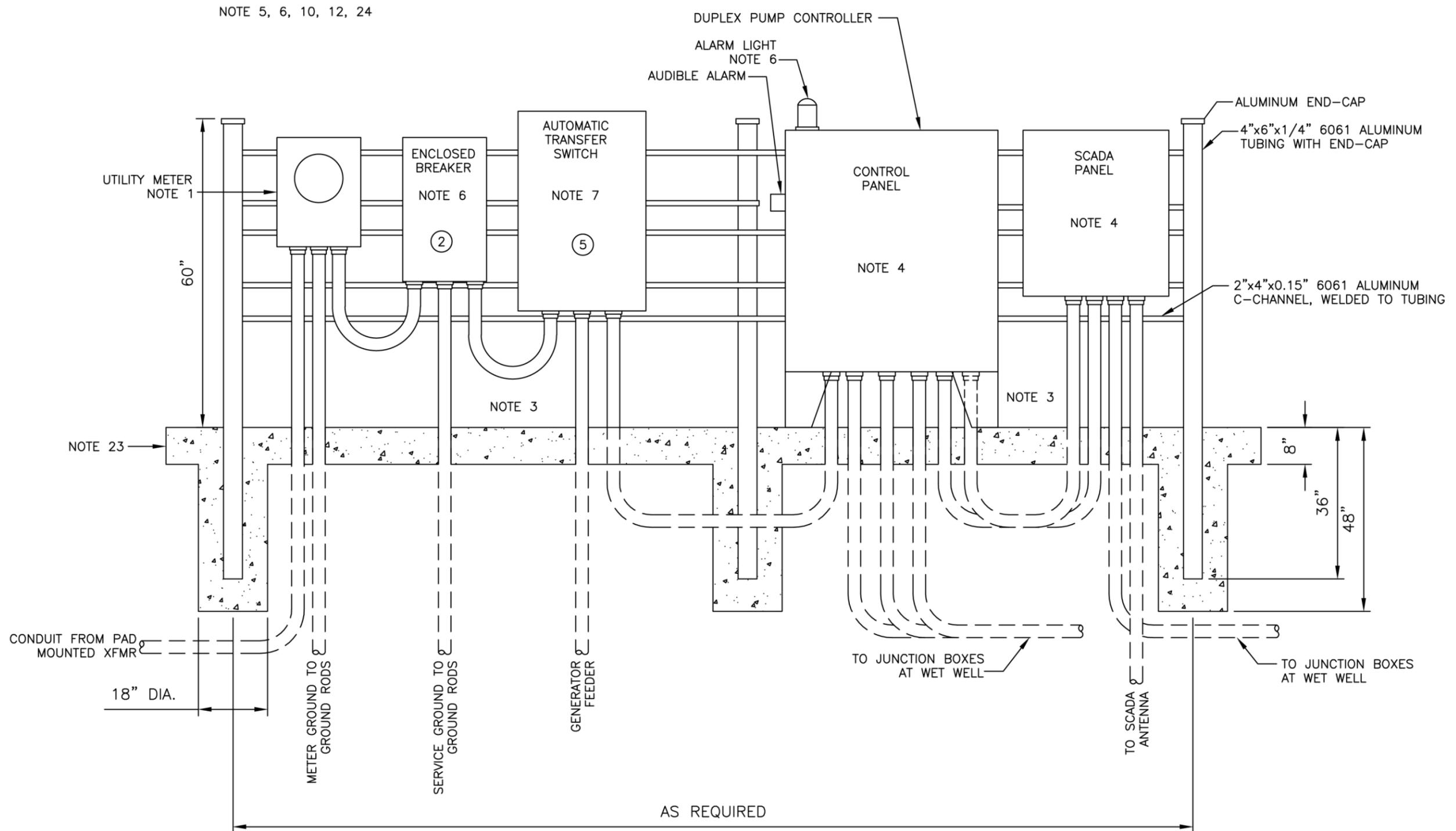
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480Y/220V 3-PHASE 4-WIRE DELTA SERVICE
 20HP OR GREATER STATION
 ONE-LINE DIAGRAM

NOT TO SCALE

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480Y/220V 3-PHASE 4-WIRE DELTA SERVICE
 20HP OR GREATER STATION
 PUMP STATION CONTROL PANEL ELEVATION

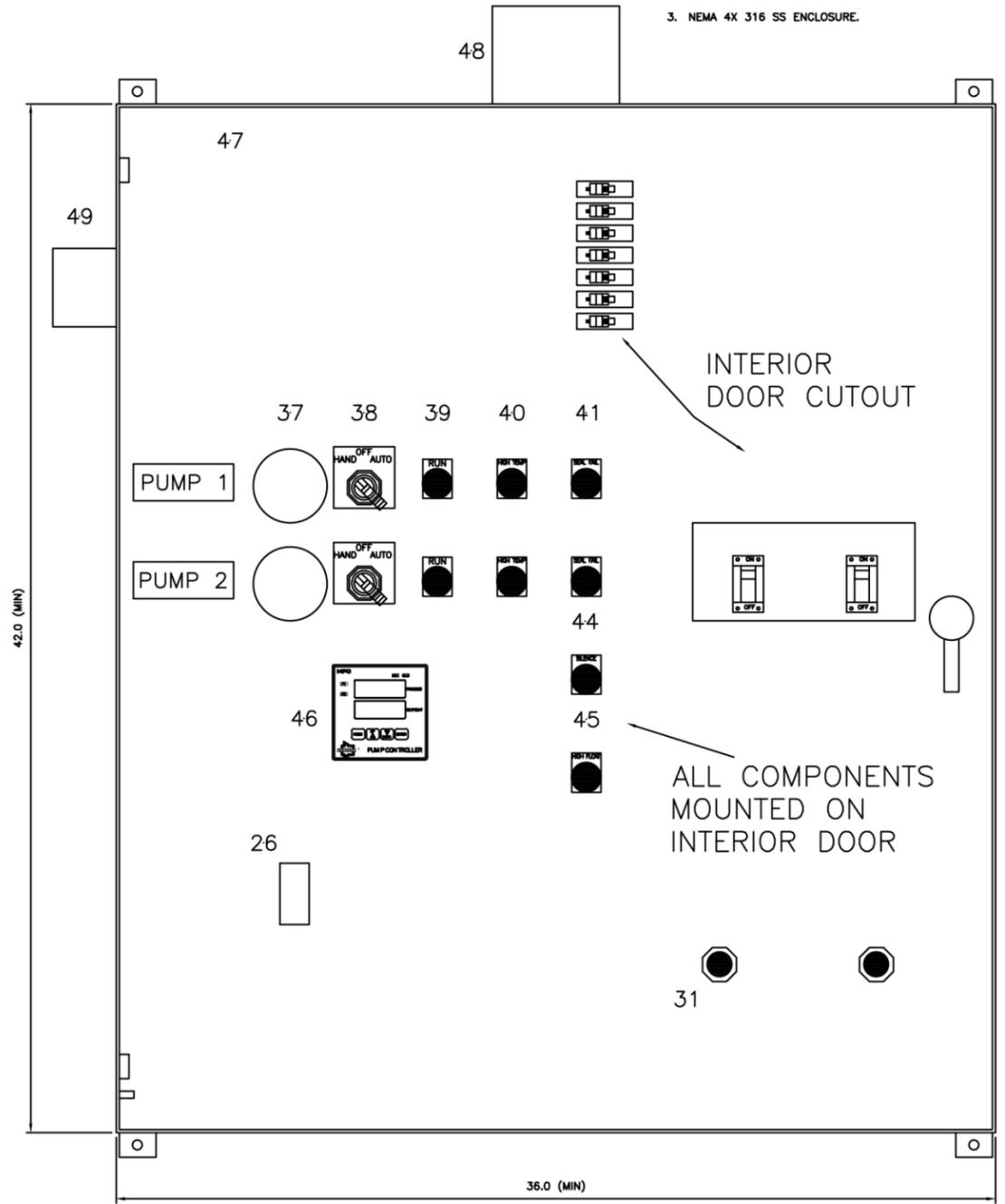
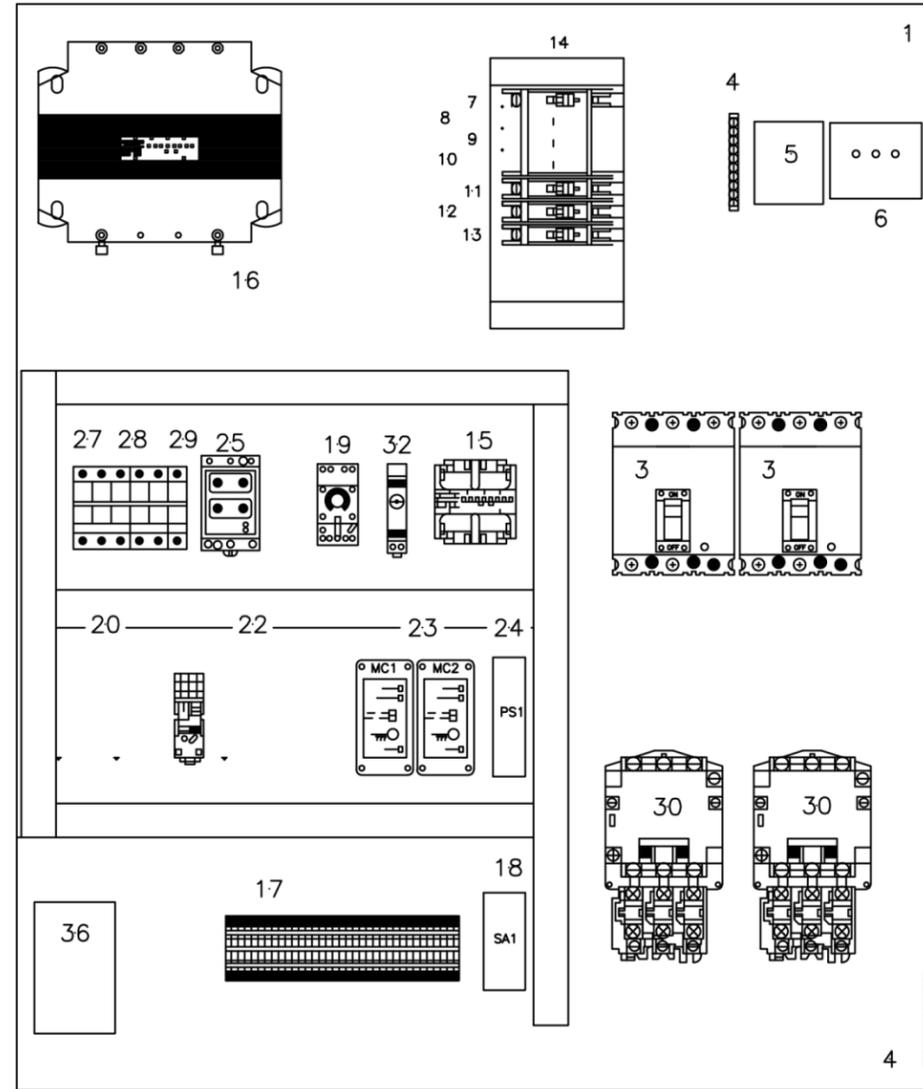
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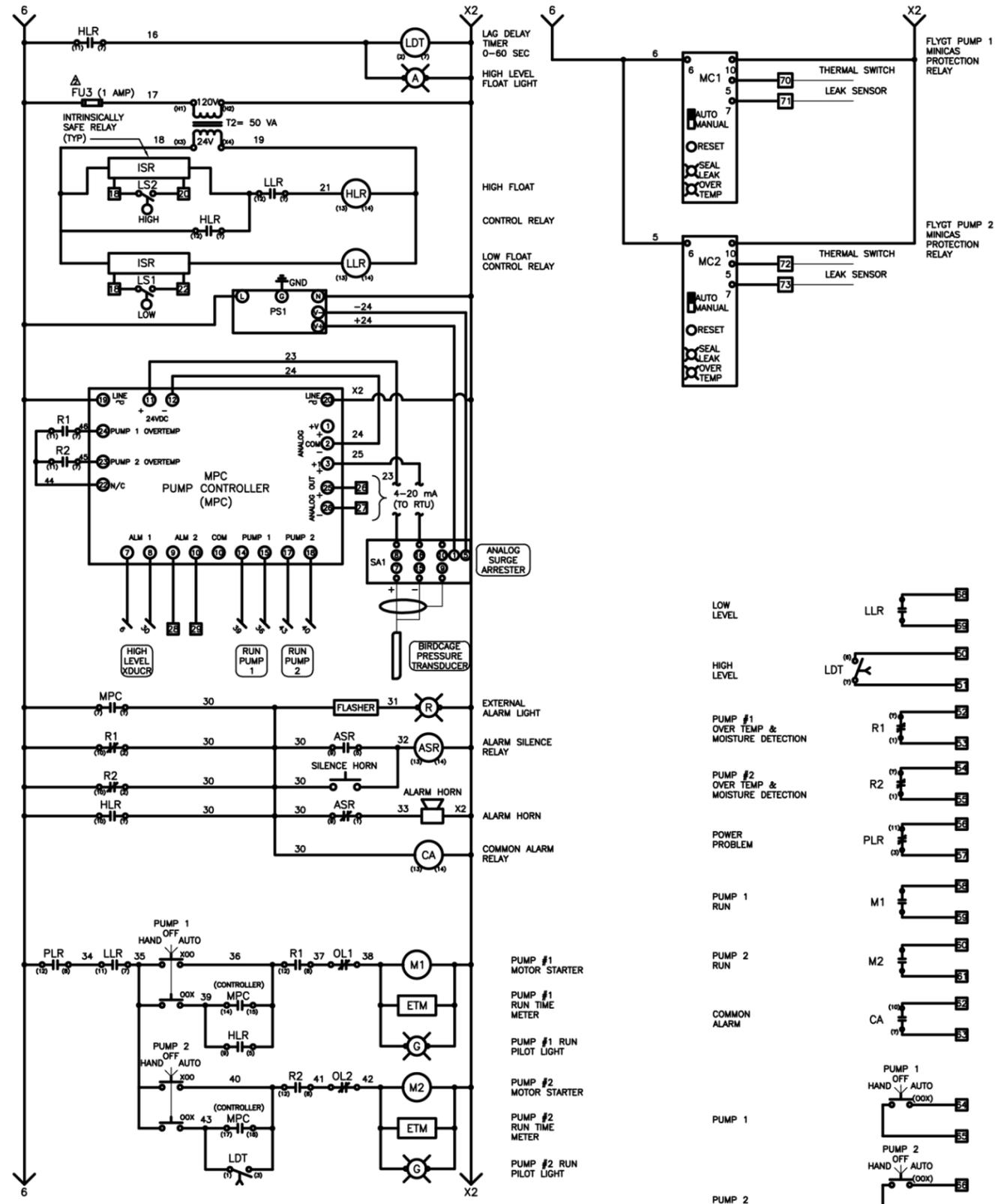
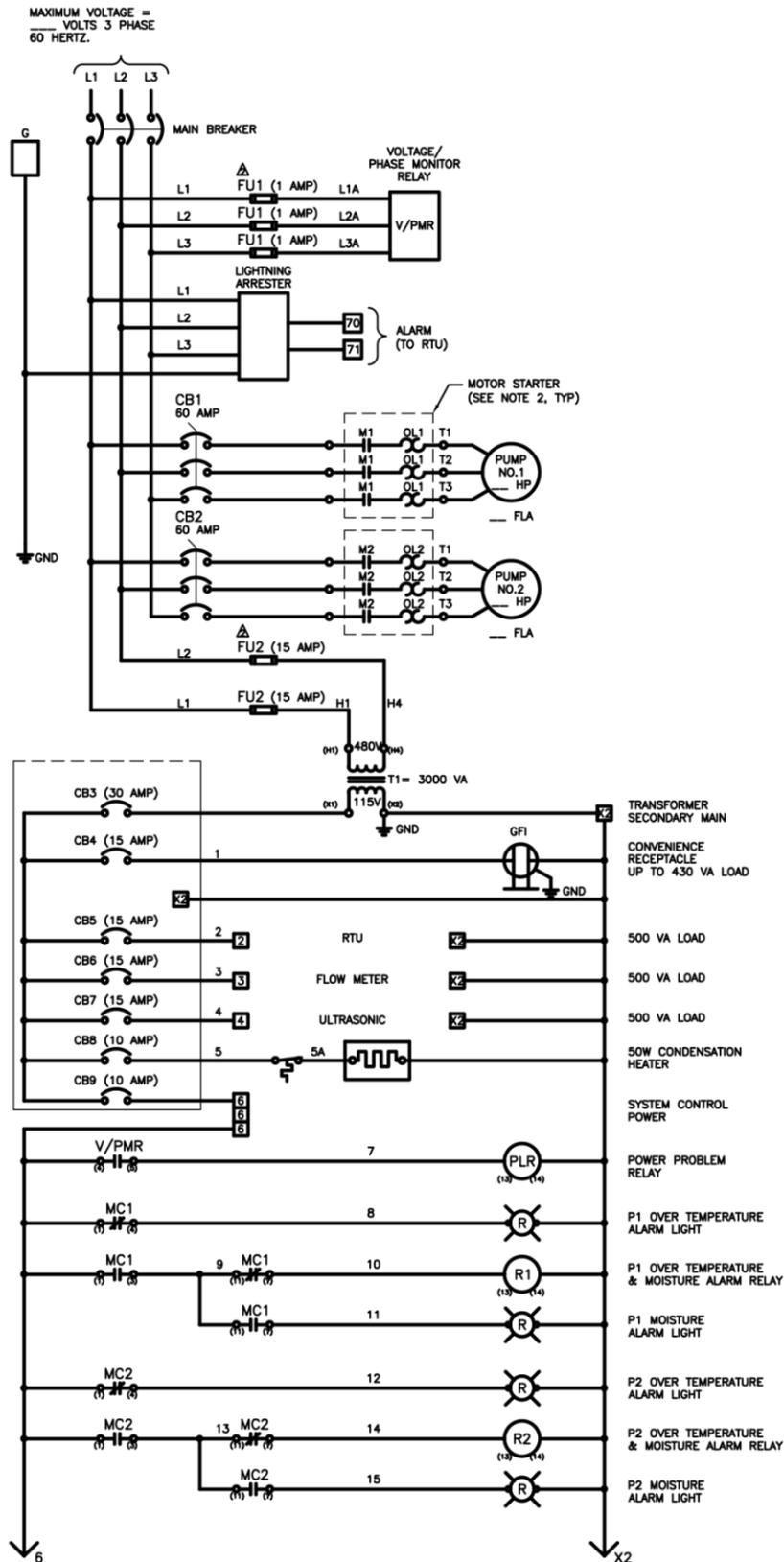
NOTES:

1. SIZE BREAKERS, FUSES, PANEL DIMENSIONS, ETC. BASED ON ACTUAL PUMP STATION HORSEPOWER, VOLTAGE, ETC.
2. SHALL BE BUILT PER UL508A.
3. NEMA 4X 316 SS ENCLOSURE.

BILL OF MATERIALS (SEE NOTE 1)			
ITEM	QUAN	DESCRIPTION	MANUFACTURER
1	1	MOUNTING PANEL CAT# A-42P36	HOFFMAN
2			
3	2	MOLDED CASE BREAKERS CAT# FAL34060	SQUARE D
4	2	GROUND BAR CAT# PK7GTA	SQUARE D
5	1	POWER DISTRIBUTION BLOCK CAT# 1323580	MARATHON
6	1	LIGHTING ARRESTER SQUARE D HWA SERIES	SQUARE D
7	1	TRANSFORMER SECONDARY MAIN CAT# QO130	SQUARE D
8	1	CONVENIENCE RECEPTACLE BREAKER CAT# QO115	SQUARE D
9	1	RTU BREAKER CAT# QO115	SQUARE D
10	1	FLOWMETER BREAKER CAT# QO115	SQUARE D
11	1	ULTRASONIC BREAKER CAT# QO115	SQUARE D
12	1	SPACE HEATER BREAKER CAT# QO110	SQUARE D
13	1	SYSTEM CONTROL POWER CIRCUIT BEAKER CAT# QO110	SQUARE D
14	1	LOAD CENTER INTERIOR CAT# QONB-16L100	SQUARE D
15	1	CONTROL POWER TRANSFORMER 120-24 CAT# 9070 T50D23	SQUARE D
16	1	480-120VAC, 3000VA CONTROL POWER TRANS. CAT# 9070 T3000D1	SQUARE D
17	46	TB1 TERMINAL BLOCKS CAT# 102010	WEIDMULLER
18	1	ANALOG SURGE ARRESTER CAT# BCP3000	BIRDCAGE
19	1	LAG PUMP START TIMER/BASE CAT# RTEP1AF20/RUZC2M	IDEC/SQUARE D
20	5	4 POLE DT 120 VAC RELAY/BASE CAT# RXM4AB2F/RXZE2S114M	SQUARE D
21			
22	2	4 POLE DT 24 VAC RELAY/BASE CAT# RXM4AB2B7/RXZE2S114M	SQUARE D
23	2	MINICAS RELAYS/BASE CAT# 14-407129	FLYGT/SQUARE D
24	1	120VAC TO 12VDC 1 AMP POWER SUPPLY CAT# MDR-20-24	MANWELL
25	1	PHASE LOSS & UNDERVOLTAGE RELAY CAT# 460-14	SYMCOM
26	1	GFI RECEPTACLE CAT# 1595-1	P&S
27	1	FU1 3 POLE FUSE BLOCK/FUSES CAT# CHCC3D/FNQ-R-1	BUSSMANN
28	1	FU2 2 POLE FUSE BLOCK/FUSES CAT# CHCC2D/FNQ-R-15	BUSSMANN
29	1	FU3 1 POLE FUSE BLOCK/FUSE CAT# CHM1D/FNM-1	BUSSMANN
30	2	20 HP NEMA SIZE 2 STARTER CAT# B536 SDO1V02S	SQUARE D
31	2	OVERLOAD RESET CAT# 9066 RA1	SQUARE D
32	1	HEATER THERMOSTAT CAT# 7T810000	FINDER
33			
34			
35			
36	1	50 WATT SPACE HEATER CAT# AHC-50	INGRAM
37	2	ELAPSED TIME METER CAT# 711-0160	REDDINGTON
38	2	"HAND-OFF-AUTO" SELECTOR SWITCH CAT# 9001 SKS43FBH13	SQUARE D
39	2	"RUN" GREEN PILOT LIGHT CAT# APW199D-G-120V	IDEC
40	2	"HIGH TEMP" RED PILOT LIGHT CAT# APW199D-R-120V	IDEC
41	2	"SEAL FAIL" RED PILOT LIGHT CAT# APW199D-A-120V	IDEC
42			
43			
44	1	"SILENCE" PUSHBUTTON CAT# ZB4BA68/ZB4BZ101	TELEMECANIQUE
45	1	"HIGH FLOAT" AMBER, PILOT LIGHT CAT# APW199D-A-120V	IDEC
46	1	PUMP CONTROLLER CAT# MPC	DWYER
47	1	ENCLOSURE, NEMA 4X CAT# A-42H3612SSLP3PT	HOFFMAN
48	1	EXTERNAL ALARM LIGHT CAT# LRX40	INGRAM
49	1	SIDE MOUNTED NEMA 4X ALARM HORN CAT# 855P-B10LE22	ALLEN-BRADLEY
50			



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- NOTES:**
1. SIZE BREAKERS, FUSES, ETC. SIZES, BASED ON ACTUAL MOTOR HORSEPOWER, VOLTAGE, ETC.
 2. STARTERS WITH MOTORS 20HP AND LARGER SHALL BE REDUCED VOLTAGE SOLID STATE (RVSS).

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3.3.8 Attachment A: Natural Gas Fueled Engine Driven Generator

ATTACHMENT A
NATURAL GAS FUELED ENGINE DRIVEN GENERATOR

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials and equipment and incidentals, and install one natural gas fueled engine driven standby generator unit with automatic transfer switch and appurtenances and required supporting systems in a factory type skin tight weatherproof sound attenuating enclosure as specified herein. The manufacturer or manufacturer's representative shall furnish installation technical assistance, start-up operation, field testing, operator training, first year service contract, and operation and maintenance manuals.
- B. The engine driven generator shall have a stand-by power rating (site rated) of not less than ____ kVA, ____ kW, at 80 percent lagging power factor, with 480 Volt, three phase, 60 Hertz output. The alternator shall be three wire, grounded wye connected, complete with excitation system and controls.
- C. Arrange the generator for automatic starting and stopping and load transfer upon failure of the normal source of power. Closed transition or parallel operation with the Electric Utility Power Company is not required. Transfer of generator power to and from connected facility electrical loads will be open transition transfer.
- D. All equipment and controls specified in this Section shall be new and be considered part of the engine driven generator package. The generator manufacturer or his/her licensee shall furnish the generator package in its entirety as specified. The engine driven generator package shall be complete and shall include all equipment and controls necessary for a fully operational standby electric power supply.
- E. Furnish the following for each unit:
 - 1. Industry standard pipeline natural gas fueled, spark ignited engine with attached alternator.
 - 2. Generator main circuit breaker.
 - 3. Unit mounted radiator with engine driven fan, for cooling of the engine jacket water including engine mounted and engine driven circulating pump.
 - 4. Entire exhaust system including catalyst and air fuel ratio controls if required to meet US EPA emissions regulations,
 - 5. Engine exhaust silencer, flexible connection, exhaust pipe, hangars, pipe supports

and rain mounted inside the enclosure.

6. Fuel system piping, appurtenances and accessories installed inside of the generator outdoor enclosure, including the natural secondary fuel regulator, battery operated gas fuel inlet solenoid valve, filter, pressure gauge, and flexible connector as specified herein installed in the fuel supply piping.
 7. Skid mounted factory-piping, wiring, and valves.
 8. Flexible connectors and/or expansion joints for field piping connections to the generator unit.
 9. Factory manufactured weather protective, sound attenuating, skintight enclosure for outdoor installation of the generator set equipment.
 10. Combination engine/alternator instrument and control panel wired, tested and shock mounted at the alternator end of the unit.
 11. Engine mounted electric starter with battery, battery cables, and battery charger.
 12. Generator structural steel base including neoprene pad type vibration isolators.
- F. Provide the services of the generator manufacturer's representative for delivery, installation technical support, set-up, start-up, testing, and training of the Owner's personnel.

1.02 SUBMITTALS

- A. Submit shop drawings and product data to establish compliance with this section, including the following:
1. Shop drawings, catalog cuts, brochures, and other materials required to completely describe the systems and equipment.
 2. Assembly drawings with identification, description, and dimensions of each separately installed sub-assembly or piece of equipment and associated piping connection schematics.
 3. Certificate of Compliance for Seismic Design of Non-Structural Components and Systems in accordance with ASCE 7, Section 13 and the IBC, for the generator assembly, enclosure, and accessory components attached to the generator assembly and enclosure, demonstrating that the equipment and its mounting system and anchorage have been tested or analyzed to withstand specified seismic demands.
 4. Equipment base drawings indicating the size and location of bolt holes for

mounting and anchorage, and location of conduit stub-ups.

- a. Details of anchorage of the equipment to the foundation including anchor bolt type, size, material, embedment depth, and minimum edge distance.
 - b. Summary of maximum vertical and horizontal reactions at each anchor bolt considering all applicable loads and load combinations.
5. Performance specifications of all items of equipment.
 6. Description of the generator control panel showing panel layout, location, functional description, features, and options.
 7. Internal electrical, instrumentation, control, and wiring diagrams.
 8. Identification of all wiring connections to external systems and equipment, including numbered terminal strip identification.
 9. Details of the proposed battery charger and starting battery, including cold cranking amps and ampere hour ratings.
 10. Information on the proposed generator set engine jacket water treatment chemicals and generator starting battery electrolyte, including Material Safety Data Sheets.
 11. The manufacturer, model, size, attenuation curve, and design back pressure for the silencing equipment as offered to accomplish the specified sound silencing for this installation.
 12. Details of the main generator circuit breaker showing location, dimensions, ratings, trip curves, and enclosure details.
 13. Details of the catalytic system for engine emissions control showing the manufacturer, manufacturer's experience, construction of the catalytic unit, and catalyst performance data if required to assure that the exhaust emissions of the generator unit are in accordance with the specification limitations.
 14. Details of the jacket water heater and jacket water treatment.
 15. Load analysis utilizing the loads as specified herein, to demonstrate that the proposed unit will start and carry the specified loads.
 16. Alternator rating data sheet showing the alternator selection of frame size, output rating, efficiency, temperature rise, windings, reactances, resistances, full load current, and full load heat rejection.
 17. Copy of EPA Certificate of Conformity of engine emissions in accordance with

40 CFR 1048.

18. Description of the factory manufactured, weather protected, sound attenuating enclosure including dimensions, materials and methods of construction, conformance to standards, description of all accessories and components, color charts of available colors, and enclosure circuit wiring diagrams.
19. Details of the arrangement of the exhaust piping system within the enclosure.
20. Statement certifying the maximum combined noise level from the engine exhaust and the mechanical noise from the enclosure when the generator unit is operating at full rated standby load, stated in dbA at 50 feet from the unit in any direction.
21. Manufacturer's certified shop test record of the engine driven generator unit performed in accordance with specifications.
22. Draft copy of the written service contract specified herein.
23. Draft copy of the warranty specified herein.

B. Submit responses to the following:

1. Engine Data
 - a. Manufacturer
 - b. Model
 - c. Number and arrangement of cylinders
 - d. RPM
 - e. Bore x stroke (inches)
 - f. Displacement (cubic inches)
 - g. Maximum power at rated rpm (brake horsepower)
 - h. Brake Mean Effective Pressure (BMEP) at rated kilowatt output (including any parasitic loads and alternator efficiency)(psi)
 - i. Piston speed (feet per minute)
 - j. Aspiration
 - k. Make and model of governor

- l. Make and model of overspeed shutdown device.
 - m. Maximum allowable engine exhaust back pressure (inches water column)
 - n. Engine cold cranking amperes
 - o. Minimum and maximum engine fuel gas supply pressure (inches water column)
2. Alternator Data
- a. Manufacturer
 - b. Model
 - c. Rated kVA
 - d. Rated kW
 - e. Voltage
 - f. Rated Amperes
 - g. Power Factor
 - h. Temperature rise above 40 degrees C ambient
 - 1) Stator by thermometer (degrees C)
 - 2) Field by resistance (degrees C)
 - i. Class of insulation
 - j. Alternator efficiency including excitation losses and at 80 percent power factor
 - 1) Full load (percent)
 - 2) Three-quarters load (percent)
 - 3) Half load (percent)
 - k. Subtransient reactance (x_d'')(per unit) or (ohms)
3. Guaranteed fuel consumption rate (at generator terminals with natural gas fuel @ 905 BTU/cubic foot low heat value)

- a. Full load (cubic feet per hour)
 - b. Three-quarters load (cubic feet per hour)
 - c. Half load (cubic feet per hour)
4. Generator unit and accessories
- a. Weight of skid mounted unit (pounds)
 - b. Overall length (inches)
 - c. Overall width (inches)
 - d. Overall height (inches)
 - e. Exhaust pipe size (inches)
5. Enclosure
- a. Total weight of enclosure and generator (pounds)
 - b. Length (inches)
 - c. Width (inches)
 - d. Height (inches)
6. Exhaust gas emission data at full load at engine exhaust outlet:
- a. Temperature (degrees F)
 - b. Flow (ACFM)
 - c. Carbon Monoxide (CO) (grams/BHP-hr)
 - d. Nitrogen Oxides (NO_x) (grams/BHP-hr)
 - e. Non-methane, non-ethane hydrocarbons (NMNEHC) (grams/BHP-hr)
 - f. Exhaust oxygen (percent)
7. Exhaust gas emission data at full load at catalyst outlet:
- a. Temperature (degrees F)
 - b. Flow (ACFM)

- c. Carbon Monoxide (CO) (grams/BHP-hr)
 - d. Nitrogen Oxides (NO_x) (grams/BHP-hr)
 - e. Non-methane, non-ethane hydrocarbons (NMNEHC) (grams/BHP-hr)
 - f. Exhaust oxygen (percent)
- 8. Radiator fan cooling air volume (CFM)
 - 9. Radiator fan power (BHP)
 - 10. Radiator fan pressure rise (inches water column)
 - 11. Combustion air volume (CFM)
 - 12. Full load heat rejection to enclosure by engine and alternator (BTU/min)
 - 13. Full load heat rejection to engine coolant (BTU/min)
 - 14. Nominal cold cranking ampere rating of the starting battery

1.03 REFERENCE STANDARDS

- A. Design, manufacture, and assembly of elements of the equipment herein specified shall be in accordance with published standards of the following:
 - 1. American Gear Manufacturers Association (AGMA)
 - 2. American Institute of Steel Construction (AISC)
 - 3. American Iron and Steel Institute (AISI)
 - 4. American National Standards Institute (ANSI)
 - 5. American Petroleum Institute (API)
 - 6. American Society of Civil Engineers (ASCE)
 - 7. American Society of Mechanical Engineers (ASME)
 - 8. American Society for Testing and Materials (ASTM)
 - 9. American Welding Society (AWS)
 - 10. American Bearing Manufacturers Association (ABMA)

11. Factory Mutual Engineering and Research Corp. (FM)
12. Institute of Electrical and Electronics Engineers (IEEE)
13. Instrument Society of America (ISA)
14. International Building Code (IBC)
15. International Standards Organization (ISO)
16. National Electrical Code (NEC)
17. National Electrical Manufacturers Association (NEMA)
18. National Fire Protection Association (NFPA)
19. Occupational Safety and Health Administration (OSHA)
20. Society of Automotive Engineers (SAE)
21. The Society for Protective Coatings (SPC)
22. Underwriters Laboratories (UL)

- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 QUALITY ASSURANCE

- A. Build the generator from components that are coordinated and prototype tested to operate as a unit. The manufacturer shall maintain a permanent service organization and supply of spare parts in place at the time of the bid within 100 miles of the project site.
- B. Design and build the unit in accordance with NFPA 110, Standard for Emergency and Standby Power Systems, Level 2, Type 60; NFPA 37, Standard for Installation and Use of Stationary Combustion Engines and Gas Turbines; and NEC 701, Legally Required Standby Systems. Build and certify the unit construction is in accordance with UL 2200, Stationary Engine Generator Assemblies. The generator set shall be manufacturer certified to be EPA certified for stationary emergency standby use, and shall comply with the requirements of US EPA CFR 40 part 1048 and 40 CFR 60, Subpart JJJJ as applicable for spark ignited engines utilized in generator set applications.
- C. The load on the standby generator may include motors started on solid state starters that represent up to 90% percent of the generator's standby rating. Coordinate design of the generator and its voltage regulation system with the supplier of the solid state

starters and other non-linear devices to assure that sufficient alternator reactance is provided to limit the line harmonics to acceptable levels as specified in IEEE Standard 519 and to assure that the voltage regulation system will provide stable operation in the presence of such harmonics.

- D. The engine will be equipped with a speed control as installed on the engine shall meet ISO 8528-5 Class 1 response and stability performance specification requirements and shall provide +/- 0.25% steady state frequency variation during steady state operating conditions from no load to full load. The furnished generator set shall meet all applicable requirements of *BS5514, SAE J1349, ISO3046, and DIN6271 standards*
- E. The unit shall be of such physical dimensions to fit into the space provided as indicated on the Drawings.
- F. Should equipment that differs from the equipment described in this section be offered and determined to be equal to that specified such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc., required to accommodate such a substitution shall be made at no additional cost to the Owner and be as approved by the Engineer. Modifications required to accommodate product substitutions shall not extend the contract time.
- G. Design and build the engine driven generator for standby service at all points within the specified range of operation, without overheating or excessive vibration or strain. Components shall require only that degree of maintenance as applicable to the specific type of equipment. Design and build all parts and components for interchangeability so that replacement parts may be installed without additional fitting or machining.
- H. Furnish the services of a factory trained service technician, specifically trained on the type of equipment specified. Submit qualifications of the service technician for approval. The service technician shall be present on-site for a total of one man-day, exclusive of travel time, to perform equipment check-out, leveling and alignment, coordination of electrical and gas piping field connections, start-up, testing, and calibration of the unit.

1.05 service contract

- A. Provide to the Owner at the time of acceptance of the unit a written [five (5)] year service contract for the engine driven generator and support systems, as furnished, commencing on the date of acceptance of the unit. Include all costs associated with the service contract in the price bid and furnish a copy of this contract to the Owner at the time of acceptance. This service contract does not supersede or replace the manufacturer's equipment warranty as specified herein.
 - 1. The service contract provided by the generator set manufacturer's authorized service organization shall provide performance of the manufacturer's

recommended preventive maintenance requirements and guidelines, and shall include quarterly equipment inspections of the generator equipment and an engine lubricating oil filter and oil change and disposal of removed engine oil on the forth visit. to assure the safe and dependable operation for the standby power system throughout the first year of operation for standby service with up to 300 hours per year of operation.

2. The preventive maintenance shall include all maintenance service at the recommended service intervals as published in the manufacturer's literature, and as required to maintain the equipment warranty in full effect. The service contract shall include as a minimum an inspection to sample and analyze lubricating oil; change lubricating oil and filters; check/replace air filters; check belts; sample and analyze coolant; check coolant level and condition, inspect ignition system; inspect governor and control system; check heaters; inspect fuel supply system, exhaust system, starting battery, battery charger, and battery charging alternator; check and adjust output voltage and frequency; and operate the unit to confirm proper operation.

1.06 WARRANTY

- A. Furnish a written five year (60 months) extended warranty from the equipment manufacturer to the Owner, on all defects in material, parts, or workmanship of the generator set equipment furnished under this Section when operated as a standby unit for up to 300 hours per year. The warranty shall extend from the date of acceptance of the equipment and shall include all parts, labor, and transportation for replacing any defective components of the equipment as furnished.

1.07 SPARE PARTS ALLOWANCE

- A. The generator supplier shall include in the bid price an allowance of \$[_____] for spare parts that are not covered under the equipment warranty, to be selected by the Owner. Submit a spare parts list that includes manufacturer's recommended spare parts, with parts prices current to the date of submittal, and information relevant to parts supply and ordering. Submit this information in time for review and approval prior to start-up and site testing of the unit.

1.08 MAINTENANCE

- A. Submit operating and maintenance instructions covering all equipment furnished under this Section. Prepare the instructions specifically for this installation and include all required cuts, drawings, equipment lists, descriptions, etc., that are required to instruct operating and maintenance personnel unfamiliar with such equipment.

1.09 UNIT PERFORMANCE

- A. Select the engine driven generator to be adequate to start one [__]HP, three phase,

Code Letter [___], pump motor using a [full voltage] [solid state reduced in-rush] starter, along with [___] kVA of single phase miscellaneous load at 0.9 power factor; and with a transient voltage dip not to exceed thirty percent of rated voltage.

- B. The unit rating shall not be less than [___] kW. Provide an oversized alternator or enhanced voltage regulator as required for motor starting and to carry non-linear loads. The specified unit site rating is the minimum acceptable for the specified loads, and shall be increased if required to meet the load starting or running requirements as specified herein.
- C. The engine driven generator set and all of its components shall provide stable operation under all operating conditions that the station load may impose.
- D. Under steady load conditions, from zero load to full-rated load, voltage regulation shall be within plus or minus one percent, and frequency regulation shall be within plus or minus 0.25 percent (0.15 Hertz).
- E. Upon application or removal of 75 % rated resistive load in one step, the transient voltage dip or overshoot shall not exceed 25 percent of rated voltage and recovery to steady state operation shall be within ten seconds.

1.10 DELIVERY, STORAGE AND HANDLING

- A. All mechanical and electrical equipment shall be coated, wrapped and otherwise protected from snow, rain, drippings of any sort, dust, dirt, mud, flood and condensed water vapor during shipment and while installed in place during construction. The protective coverings shall remain in place until the work areas are substantially free of all construction dust and debris.
- B. Package and crate the unit for shipment and provide treatment for long periods of storage.

1.11 PROJECT/SITE REQUIREMENTS

- A. House the complete engine driven generator unit in a factory type skin tight weather protective sound attenuating enclosure for outdoor installation. Arrange the unit for automatic unattended operation and for positive and successful quick starting within an outdoor ambient temperature down to minus 20 deg. C. Design all equipment housed within the generator enclosure for a maximum operating temperature based upon a maximum ambient temperature of 40 deg. C plus the temperature rise that will occur within the enclosure either during generator operation or with maximum solar heating when the generator is not in operation. Factory assemble the generator unit with the outdoor enclosure, mounting frame, and accessories as specified herein, ready for installation on a concrete foundation with available connection for electric and gas supply pipe. The unit shall not require field assembly.

- B. The engine driven generator unit within its enclosure, in combination with the engine exhaust silencer, with the generator in operation at full load, shall have an average overall sound pressure level of not more than 70 dB(A), reference 21 micro-newtons per square meter, measured at a distance of 50 feet from the enclosure in any horizontal direction at an elevation of 5 feet above ground level, measured in accordance with NEMA standards.. There shall be no pure tone. It shall be the responsibility of the engine driven generator unit manufacturer to choose the engine exhaust silencer and the sound attenuating properties of the enclosure to meet these criteria.
- C. The altitude at the project site will not be in excess of 1000 feet above sea level.
- D. The heat sink for rejection of heat from the engine jacket shall be a unit mounted closed loop radiator utilizing an engine mounted and engine driven fan to discharge air through the radiator core and through a generator room wall mounted radiator discharge air louver to outdoors. Design the radiator and engine fan to dissipate all required heat loads with the generator running at full rated output and with 40 deg. C ambient outdoor air. No other source of cooling as available or will be permitted.
- E. Certify engine exhaust emissions in compliance with EPA Designation Emissions Standard under the provisions of 40 CFR 1048, control of Emissions for New, Large Non-road Spark-Ignition Engines, 40 CFR 60.4231, 40 CFR 90.103, and 40 CFR 60, Subpart JJJJ and current amendments as they apply to non-road stationary spark ignited emergency engines. Design the engine and fuel control system to limit the exhaust emissions of the engine to the limits imposed by these regulations.
- F. Design and build all non-building structures and provide seismic restraint of nonstructural components to withstand seismic demands to provide post seismic event functionality in accordance with ASCE 7, Section 13 and the IBC.
- G. Design the enclosure base and attachment to the concrete foundation to support the gravity loads, dynamic loads, wind loads and seismic forces to conform to ASCE 7, Section 13 and the IBC. Furnish and install anchorage in accordance with the manufacturer's requirements, sized and quantity as determined by the anchorage calculations required in this Section.
- H. Enclosure exterior length and width dimensions shall fit in the space available on site.

PART 2 PRODUCTS

2.01 GENERAL

- A. The spark ignited engine driven generator set shall be a factory assembled unit and shall be as manufactured by Caterpillar/Olympian. Units offered at a kilowatt rating in excess of their published rating are not acceptable.

- B. The generator shall be rigid, neat in appearance and shall allow easy access to the various parts for maintenance purposes. Enclose all parts to prevent the throwing or dripping of oil.
- C. The generator shall be pre-piped and pre-wired to the greatest extent possible. Provide separate pre-wired terminal boxes on the generator skid for AC and DC wiring. All wiring terminations for connection to field wiring shall be within terminal boxes utilizing numbered terminal strips.
- D. Mount the close coupled engine and alternator assembly on a rigid, welded, fabricated steel base, sized to maintain the correct alignment of all system components. Fabricate the base of steel I-beam, channel, or box section, braced and reinforced as required to maintain alignment between the engine and the alternator. Mount the engine-alternator assembly on the base utilizing rubber pad type vibration isolators and felt washers. Mount the engine radiator and battery support separately on the base, independent of the engine-alternator assembly. The complete generator unit shall be free from harmful torsional or excessive vibration during all ranges of generator set operation, from no load to full load. Shop prime and finish paint all exposed surfaces of the structural steel members of the fabricated base frame in accordance with the manufacturer's standard practice.

2.02 ENGINE

- A. The spark ignited engine shall be water cooled, four stroke cycle, naturally aspirated or turbo-charged, with controlled ignition gas regulation, variable timing control, and calibrated carburetion system, manufacturer specifically designed and equipped for operation on natural gas fuel (905 BTU/cu ft low heat value). Provide a carburetor calibrated to the fuel supply, secondary gas pressure regulator sized and set for the gas flow and pressure requirement of the engine, and electronic solid state spark ignition system. The engine shall develop sufficient power output rating for the alternator output, alternator efficiency, radiator fan power, and other miscellaneous parasitic loads.
- B. The engine shall have a digital ignition system with an automatic fuel carburetor. The timing system shall include an electronic magneto. The engine shall be equipped with a secondary gas pressure regulator to accept an industry standard pipeline natural gas fuel supply of between 10 – 15 inches of H₂O pressure and volume of gas required for continuous full load generator set operation. Furnish an engine installed gas solenoid valve which shall be activated by the generator set controls to be automatically energized to open anytime the generator set is cranking and running and shall automatically close anytime the generator is shutdown for any reason, either normally or in safety or emergency shutdown conditions. The valve is to be controlled and operated by the generator's DC battery control voltage and generator set operational controls.
- C. Intake and exhaust valves shall be heat-resisting alloy steel with high tungsten-chrome

alloy steel exhaust valve seat inserts.

- D. An engine driven gear type lube oil pump complete with a replaceable element full flow oil filter shall provide full pressure, full flow lubrication to all engine components. Furnish an installed oil drain line valve inside the enclosure and piped to the outside of the enclosure for easy access when draining the engine oil. Provide a crankcase breather in accordance with emissions limitations as specified in this Section.
- E. Provide dry type combustion air intake filter(s) to protect working parts of the engine from dirt and grit. Filters shall have replaceable elements and shall be equipped with service indicators.
- F. Provide a 12 or 24 VDC generator set battery ignition system, including engine starting motor and solenoid, distributor/ignition coil, radio suppression and an automatic battery charging alternator with transistorized voltage regulator.
- G. Design the engine and fuel control system, in conjunction with use of an oxidation catalyst after treatment, to limit the exhaust emissions of the engine as required per current EPA standards.

2.03 SYSTEMS

A. Governor

- 1. The governor actuator shall be electronic type, DC motor driven, capable of maintaining isochronous regulation from no load to full rated load within 0.25 percent of rated frequency.
- 2. The governor controller shall be all electric, mounted in the generator control panel. The governor controller shall have the capability for manual adjustment of speed setting, speed droop, and load limit. Speed droop shall be adjustable from zero to five percent from no load to full load. The governor controller shall not cause electromagnetic interference.
- 3. The governor actuator and the governor controller shall be as manufactured by Woodward Governor Co., Barber Coleman, or equal, and shall operate on the direct current voltage from the engine starting battery.
- 4. Furnish a separate overspeed shutdown device that shall instantly stop the engine in case of preset overspeed or the operation of various protective devices as later specified.

B. Fuel System

- 1. The spark ignited engine will be connected to a utility furnished industry pipeline

natural gas service complete with meter and primary regulator located outside the enclosure. Natural gas supplied to the engine will have a low heat value of 905 BTU per standard cubic foot, and will be at a minimum pressure of ten to fourteen inches of water column at the maximum gas flow rate required by the generator set during all ranges of operation. CONTRACTOR shall confirm with the Utility gas company that the appropriate natural gas volume and pressure is to be supplied and available for consumption use by the generator set engine during all ranges of generator set operation, from no load to full load, and at all times.

2. The gas supply piping inside the enclosure shall include an appropriately sized diameter gas pressure gauge with a scale of 0 to 30 inches of water column complete with petcock, one electric (DC) solenoid operated natural gas fuel shut-off valve, one wye-type dry fuel strainer, and one flexible connector to the engine fuel supply connection. Provide a vent to outdoors from the secondary regulator if required by the regulator design. Furnish all fuel piping completely piped inside the enclosure, ready for single point connection of field piping external to the enclosure. Interior piping shall be black steel and of a size recommended by the engine manufacturer.
3. For an engine requiring an exhaust catalyst system to conform to the specified exhaust emissions limitations, provide an air-to-fuel ratio controller on the engine fuel system to maintain the correct air to fuel ratio for operation of the exhaust catalytic system.
4. All parts of the fuel system shall be installed in full compliance with OSHA Standard 1910.106 and shall meet the approval of, and be installed in complete compliance with, all applicable local, State and Federal codes, laws and regulations.
5. Generators shall be capable of starting and operating at temperatures below freezing. Fuel system shall be capable of satisfactory operation at a minimum of 20-degrees Fahrenheit below freezing (12-degrees F). Generator fuel system shall be heated as required for low temperature operations.

C. Radiator Cooling System

1. The engine shall be radiator cooled with a blower or pusher type fan mechanically driven by the engine. The engine driven radiator fan and generator enclosure intake and discharge louvers shall provide a static pressure restriction of less than 0.5 inches of water in addition to the losses through the radiator, to move the required air flow through the intake louver and discharge plenum and louver to provide the cooling required by the unit. The radiator shall incorporate flanges for attachment of a flexible duct connection to the exhaust plenum. Provide guards for fan, belts, and hot surfaces in accordance with OSHA regulations and UL 2200. The cooling system shall be adequate for cooling the engine at full rated load with an outdoor ambient temperature of 40 degrees C plus the temperature

rise corresponding to the heat given off by the alternator and equipment hot surfaces. Provide a coolant low level switch in the radiator top tank, wired to the low coolant alarm on the generator control panel.

2. Furnish an engine driven, centrifugal coolant pump equipped with a mechanical seal to circulate the coolant through the engine and radiator. Provide an automatic temperature regulator for the engine coolant that will maintain pre-set temperature without restricting the rates of flow of coolant through the engine.
3. Coolant shall be for use in ambient temperatures which may range from -20 to 40 degrees C, and shall be a 50 percent ethylene glycol antifreeze solution conforming to ASTM D-4985 and D-5345. The coolant shall be premixed extended life type and shall contain additives as recommended by the engine manufacturer for the prevention of both scale formation and corrosion in the engine water jackets and cooling system components that are in contact with the engine coolant. Coolant with additives shall be as manufactured by the NALCO Chemical Company, Dow Chemical, Aqua Laboratory, or approved equal.
4. Provide an engine mounted thermostatically controlled heater for the engine coolant system to maintain not less than 32 degrees C in the engine jacket to assure quick start and load transfer with an ambient temperature of -20 degrees C. The heater shall include valves or quick disconnects to allow isolation and removal of the heater without draining the engine cooling system. The heater shall have a minimum rating of 1000 watts when operated on a 120 Volt AC single phase power supply. Provide a grounded plug to connect to a 120 Volt AC receptacle.
5. Provide a valved drain on the cooling system piped to the exterior of the enclosure. Provide flexible connectors at all connections of off-skid piping to the engine.

D. Electric (Battery) Starting System

1. Provide an engine mounted, 12 or 24 Volt DC solenoid shift electric starter with solenoid capable of withstanding six (6) consecutive cranking periods of fifteen seconds cranking each separated by fifteen seconds of rest.
2. The starting battery shall be low maintenance, long life, lead acid type, especially designed for spark ignited engine cranking service. Battery shall be of a capacity as recommended by the battery manufacturer for the necessary break-away current, cold cranking amperes, and ampere hour capacity for six consecutive cranking periods of fifteen seconds each, or for ninety seconds of continuous cranking without being recharged and with a battery temperature of ten degrees C and with the engine jacket maintained at 30 degrees C. The battery shall be manufactured by Delco, Exide, Caterpillar, or equal.

3. Furnish a skid mounted battery box specifically designed for battery service. Furnish full insulated battery covers. Furnish and install battery cables with terminals and connections for connecting the battery to the electric starter. Furnish all connectors and hardware, cables, grease, and lifting device.
4. Furnish an automatic battery charger for charging the starting battery. The charger shall be UL listed, solid state, electronic, fully automatic, float/equalize-type. The battery charger shall have automatic voltage sensing determined by the state of the battery and reducing to milliamp current on fully charged battery. Charger shall be for 120 volt AC, single phase, 60 Hertz alternating current input. Provide conduit and wire for the charger to a junction box installed inside of the enclosure for field wiring service power connection by the CONTRACTOR. The charger shall be not less than five (5) Amperes D.C. output capacity. Arrange the charger for wall mounting inside the generator enclosure. The battery charger shall provide control power to the generator control panel when the generator is not running with correct voltage and current output to provide proper battery charge rate for maximum battery life and control panel power requirements.
5. Provide an automatic thermostatically controlled battery pad heater rated 120 Volt, single phase power supply to maintain the battery temperature at a minimum of 10 degrees C when the ambient temperature is -20 degrees C. The heater shall automatically shut off when the battery temperature attains 30 degrees C. Provide a grounded plug to connect to a 120 Volt AC receptacle located inside of the enclosure.

E. Exhaust System

1. Furnish an exhaust silencer as manufactured by GT Exhaust, Silex innovations, Donaldson; Nelson, or equal, of aluminized steel construction, mounted and piped inside the enclosure. The silencer shall have not less than a critical rating and in combination with the catalyst, if used, shall attenuate the sum of the octave band levels converted to A-weighted sound pressure levels such that the noise level from the engine exhaust plus mechanical noise from the enclosure will conform to the noise limitation specified herein. There shall be no puretone. Size the silencer to operate within the maximum allowable backpressure of the engine, when installed in the exhaust piping system as furnished.
2. Furnish a three-way, non-selective catalytic reduction unit for stoichiometric spark ignited engines, if required to meet the emissions requirements specified herein. The catalyst shall be a separate unit or shall be permanently built into the silencer housing. The catalyst housing shall be of stainless steel to provide the corrosion resistance required to allow the housing to be insulated to control heat rejection from the surface of the housing. The housing shall include 1/2 inch pipe taps before and after the catalytic element to allow monitoring of the exhaust gas flow upstream and downstream of the catalytic element.

3. Connect the exhaust silencer to the engine with a stainless steel bellows type exhaust expansion joint. The expansion joint shall be as recommended by the engine manufacturer for the maximum operating temperature of the exhaust, engine vibration, and for expansion of the exhaust system caused by a 650 deg. C temperature change. The expansion joint shall adapt to the engine exhaust outlet connection, and shall provide a flanged or threaded connection to the exhaust silencer.
4. Exhaust pipe shall be light wall exhaust tube as manufactured by GT Exhaust Systems, of Type 304 stainless steel, with clamp type joints. Exhaust pipe shall be of the size recommended by the engine manufacturer. All exhaust line elbows shall be long radius.
5. The exhaust pipe roof penetration shall be with an insulated Type 321 stainless steel or aluminum thimble designed to accommodate the specified exhaust pipe and allow a minimum 1-in air gap between the thimble and the pipe. There shall be no heat conduction path between the exhaust pipe and the roof. The roof thimble shall project above the finished roof and shall include Type 321 stainless steel or aluminum exterior rain flashing and insulation as required to protect the enclosure. Roof thimble shall be as manufactured by GT Exhaust Systems or equal. All portions of the exhaust system above the rain collar and exposed to the weather shall be of aluminum or Type 321 stainless steel construction. The open space between the exhaust pipe and the roof thimble shall allow for ventilation and shall include screening or mesh to prevent the entrance of insects.
6. Terminate the exhaust pipe vertically with a Type 321 stainless steel counterbalanced raincap with bronze bushings. The raincap shall be weighted such that the cap will open completely out of the exhaust air flow, causing no obstruction or deflection when the engine is running at rated speed without load.
7. Cover the interior exhaust system with insulation to limit the interior temperature rise of the enclosure and shield heat sensitive components from the exhaust pipe heat, and provide operator protection in accordance with UL 2200 during generator operation. The insulation shall not contain asbestos or asbestos bearing products. Furnish and install all required steel support framing and hanger bands for supporting the silencer from the interior of the enclosure.
8. The entire installation shall meet with the Engineer's approval. It is the intent of this specification to provide complete compliance with all applicable local, State and Federal codes, laws and regulations.

2.04 ENGINE INSTRUMENTATION AND CONTROLS

- A. The engine driven generator shall include a combination engine/alternator control panel, shock mounted in a unit-mounted NEMA 1 enclosure located at the alternator end of the unit, and oriented to be easily viewed through the open weatherproof

enclosure doors. The control panel shall be all electronic type with two line alpha-numeric digital displays visible in any lighting condition. Panel construction shall conform to UL 508 for industrial control panels. Provide all interconnecting wiring between the engine/alternator set and the control panel. Direct communication with the control panel shall be with an environmentally sealed membrane keypad. The control system shall be PLC based. Furnish all software, instructions, and interconnecting cables required for PC communication with the control panel for adjustment and diagnostics.

1. Information displayed on the face of the panel shall include, but not be limited to, the following indications:
 - a. Lubricating oil pressure
 - b. Coolant temperature
 - c. AC volts, 0.5 percent accuracy
 - d. AC Amperes, 0.5 percent accuracy
 - e. Frequency meter, 0.5 percent accuracy
 - f. Output power (kW and kVA) (total and per phase)
 - g. Power factor
 - h. Non-resetting elapsed time meter calibrated in hours and tenths of hours
 - i. DC volts
 - j. Tachometer
 - k. Diagnostics for servicing
 - l. Emergency shutdown condition indication lamps for each shutdown condition with logic to maintain lockout condition and fault light until reset.
2. Operators on the panel shall include:
 - a. RUN-OFF-AUTO selector switch
 - b. Emergency stop mushroom type push button.
 - c. Voltage control
 - d. Alarm test/reset pushbuttons.

- e. Phase selector switch
3. The panel shall also include:
 - a. Necessary fuses
 - b. Alternator voltage regulator
 - c. Engine control module.
 - d. Governor controller.
- B. The control panel shall include a complete automatic engine start control that operates in response to closing a remote contact and stop control that operates in response to opening the remote contact.
1. The engine control module shall provide automatic cyclic cranking for at least four 15 second cranking periods separated by 15 second rest periods. If the engine fails to start after the last cranking cycle, the cranking limiter shall terminate further cranking and activate the overcrank alarm. The cranking limiter shall automatically disengage the starter when the engine fires and accelerates to operating speed.
 2. The generator controls shall include a three-position switch with the following positions: RUN-OFF-AUTO. In RUN, the engine shall start and run with load transfer controlled from a remote location; in OFF, the engine shall stop and shall not start; in AUTO, the engine shall start, run and stop from a remote two-wire signal from the automatic transfer switch furnished. Load transfer shall occur when the unit attains rated voltage and frequency.
 3. The generator controls shall include an automatic cool-down timer, to allow the engine to continue to operate after load transfer back to the normal power supply, to cool down prior to automatic shut-down. The timer shall be adjustable from zero to ten minutes and shall be engaged when the selector switch is in the AUTO position.
 4. Should any of the protective sensors on the generator activate, the engine control shall immediately shut down the engine.
- C. Control panel face shall include an installed emergency stop pushbutton. Arrange the controls to accept operation of a remote contact to provide for remote emergency stop. Emergency stop shall over-ride all other controls to immediately shut off the fuel supply and shutdown /stop the generator set concurrently with tripping open the generator circuit breaker.

- D. Furnish a remote emergency stop switch mounted on the exterior of the generator enclosure in an easily accessible location as determined by the OWNER. The remote emergency stop switch shall be mushroom head type, housed in a NEMA 4X wall mount enclosure, permanently labeled as “Generator Emergency Stop”.
- E. Provide automatic shutdowns with fault light alarm indicators for each of the following conditions:
1. High coolant temperature
 2. Low coolant level
 3. Low lubricating oil pressure
 4. Engine overspeed
 5. Engine overcrank
 6. Over voltage
 7. Low natural gas supply (Gas pressure sensing switch provided by Contractor and wired to generator controls)
 8. Emergency Stop
- F. The controls shall include automatic pre-alarms for the following conditions with fault lights for each:
1. Low coolant temperature
 2. Approach high coolant temperature
 3. Approach low lube oil pressure
 4. Switch not in AUTO position
 5. Low battery voltage
 6. Generator breaker tripped
 7. Battery charger alarm
- G. The control panel shall include an audible alarm horn to signal any of the alarm shut down or pre-alarm conditions. Alarms shall not reset and the alarm horn shall not shut off until manually acknowledged, and fault lights shall not reset until the fault is resolved. Provide lamp test pushbutton and alarm acknowledge pushbutton.

- H. Arrange the control panel to accept remote dry contact closure for generator circuit breaker tripped alarm and battery charger failure alarm and remote emergency stop, and low natural gas supply; display the alarm condition as an individual labeled alarm on the alarm panel; and include the alarm condition in the remote common pre-alarm output.
- I. The controls shall include one normally open and one normally closed electrical relay dry contact rated 10 amperes at 120 volts A.C., for operation of a remote alarm on activation of any one or more of the pre-alarm conditions listed above, and shall include one normally open and one normally closed electrical relay dry contact, rated 10 amperes at 120 volts A.C., for operation of a remote alarm on activation of any one or more of the shut-down conditions listed above.
- J. The control panel shall include three sets of normally open/normally closed dry contacts, rated 10 amperes at 120 volts A.C. that shall activate upon engine run.
- K. Arrange the generator control panel for the following field wiring connections. Provide numbered terminal strip connections for each.
1. Remote start/stop - dry contact closure input from the automatic transfer switch - battery voltage pair
 2. Remote emergency stop - dry contact open input from the remote emergency stop station – battery voltage pair.
 3. Generator breaker open - dry contact closure input from the generator main breaker –battery voltage pair.
 4. Engine run - three dry contact open/close output from the generator control panel for remote connection – 120 Volt pairs
 5. Generator shut-down alarm – dry contact open/close output from the generator control panel for remote connection – 120 Volt pair
 6. Generator trouble alarm – dry contact open/close output from the generator control panel for remote connection – 120 Volt pair.
 7. Battery charger fault – dry contact closure input from the battery charger – battery voltage pair.
 8. Natural gas supply fault – dry contact closure input from CONTRACTOR furnished gas supply sensing switch- battery voltage pair
 9. Generator control switch in remote – dry contact closed when Auto/Manual switch is in the Remote position

2.05 ALTERNATOR AND EXCITATION SYSTEM

- A. The alternator shall be of the open drip-proof bracket type, especially designed for connection to the engine and shall be for the power output characteristics as described herein, designed to start and operate the specified loads. The alternator shall have Class H insulation with a temperature rise in accordance with NEMA MGI-22.40 under full rated load operation, but in no case shall exceed 125 Deg. C rise. The alternator shall have Amortisseur windings.
- B. The alternator shall be as manufactured by Caterpillar/Olympian. It shall have a forged or cast alloy steel flanged shaft for direct connection through a flywheel type coupling or adapter and disc coupling to the engine, and shall be of the single bearing type with anti-friction bearing.
- C. Brace the alternator windings to withstand any possible short circuit stresses. The windings shall withstand overheating or stresses caused by harmonics generated by pulse width modulated variable frequency drives and solid state starters. The alternator shall be "Radio Interference Proof" (RIP) and the "Telephone Influence Factor" (TIF) shall be within the limits of Section 9, ANSI C50.12.
- D. The alternator shall be brushless with a rotating permanent magnet generator type excitation system with Class H insulation.
- E. The alternator shall include a complete voltage regulating system that shall hold the alternator voltage output within the limits specified herein. The voltage regulator shall be solid state digital (Volts/Hz) with RFI filters and associated controls. The voltage regulator shall provide regulation within 0.25 percent no load to full load, with temperature drift of not more than 0.5 percent. The regulator shall maintain precise control of the alternator output with up to 20 percent harmonic distortion in the output voltage. Provide means in the control panel for a minimum of plus or minus five percent manual voltage adjustment while the unit is running.
- F. The alternator stator core shall be 2/3 pitch. Stator, rotor, and exciter insulation shall all be NEMA Class H insulation system as defined by NEMA MG1-1.65. The alternator insulation must be certified under UL 1446 Standard. Stator copper windings shall be random or form wound construction. Provide 100% epoxy varnish impregnation and a coat of epoxy asphalt insulating material to increase resistance to abrasive dust or sand, high humidity, and light acidic, oil, or salt-laden atmospheres, as well as to prevent fungus growth. Enclosure shall be drip-proof guarded and shall include rodent screens.
- G. Alternator rotor poles shall be of individually insulated steel punchings. Poles shall be vacuum impregnated with fungus resistant thermosetting synthetic varnish and baked for maximum moisture resistance, high dielectric strength and high bonding qualities. Braze cage connections for strong construction and permanent electrical

characteristics.

- H. Provide a directional blower on the alternator shaft to draw cooling air from the exciter end, over the rotor poles and through louvered openings in the drive end.
- I. The alternator shall have a permanently lubricated anti-friction bearing. The designed bearing life, based on the B-10 curve of the American Bearing Manufacturers Association, shall be not less than 40,000 hours.
- J. Provide an automatically controlled generator anti-condensation space heater rated 120 Volt AC, single phase power supply to maintain not less than 32 degrees C temperature within the alternator enclosure with an outdoor ambient temperature of minus 23 degrees C to prevent the accumulation of condensation within the alternator enclosure under outdoor ambient conditions. Provide conduit and wire for the jacket water heater to a junction box installed inside of the enclosure for field wiring service power connection by the CONTRACTOR
- K. The alternator shall include a NEMA I terminal box, sized to NEC clearances, and located to provide convenient arrangement inside the enclosure for access to the circuit breaker and wiring terminations. Provide potential transformers and current transformers in the terminal box for on board monitoring of generator output voltage and current.
- L. At any balanced load between 75 and 100 percent rated output, the difference in line-to-neutral voltage among the three phases shall not exceed one percent of the average line-to-neutral voltage. Under an unbalanced load, consisting of 25 percent load at 1.0 power factor placed between any phase and neutral and zero load on each of the other two phases, the maximum simultaneous difference in voltage between the three line-to-neutral phases shall not exceed three percent of rated line to neutral voltage.

2.06 GENERATOR MAIN CIRCUIT BREAKER

- A. Furnish one, three pole, circuit breaker for three phase overloads and/or short-circuit protection. Current ratings shall be as required to protect the generator unit from overload or short circuit and shall be as shown on the Electrical Drawings. The circuit breaker shall operate automatically during overload and short-circuit conditions. Circuit breaker shall be UL listed and rated per NEC requirements to carry the full ampere load of the generator. The circuit breaker shall include auxiliary contacts wired to the generator control panel to provide alarm if the breaker is in the “Tripped” position. The short circuit rating of the generator circuit breaker shall be not less than 35,000 Amps RMS symmetrical.
 - 1. Provide a generator mounted UL/CSA Listed main line AC circuit breaker, solid state trip, 3 pole molded case, NEMA 1/IP22 for the purpose of providing an AC electrical load circuit interrupting and protection device for the generator. The circuit breaker shall have an LS or LI adjustable electronic trip with current

sensors that shall monitor each phase for each pole of the circuit breaker. Generator exciter field circuit breakers do not meet this requirement and are not acceptable. The breaker shall be furnished with a shunt trip to be connected to engine/generator safety shutdowns for safety trip opening of the circuit breaker with the occurrence of any generator set safety or emergency shutdown. Breaker shall be housed in an extension terminal box which is isolated from vibrations induced by the generator set. Mechanical type lugs, sized for the circuit breaker feeders shown on Drawings, shall be supplied on the load side of breaker.

2.07 SOUND ATTENUATED WEATHERPROOF HOUSING

- A. Enclose the skid mounted generator unit, battery, battery charger, and exhaust silencer in a factory manufactured sound attenuated weather protected skin tight enclosure designed to meet the conditions set forth below. The enclosure shall comply with the National Electrical Code (NEC), and the National Fire Protection Association (NFPA) for clearance around electrical equipment as specified. The enclosure shall conform to the following design criteria:
1. Rigidity wind test equal to 115 mph
 2. Roof load equal to 50 lbs per sq. ft.
 3. Rain test equal to 4-in per hour
 4. The enclosure shall bear a label certifying compliance with UL 2200.
- B. The enclosure shall have an interior width as required to provide minimum clearances on the sides and end of the generator set. The enclosure shall provide for continuous, unobstructed access on the two sides of the generator. The dimensions of the enclosure shall be such as to provide space for and NEC clearances for the generator set, the generator circuit breaker, and the generator control panel.
- C. The enclosure shall be of lift-off design, consisting of a roof, walls, louvers, and hoods/baffles of frameless panel construction epoxy powder coated steel sheet minimum thickness of 0.080-in. All fasteners shall be concealed stainless steel self-tapping screws. Camber the roof to aid in rain run-off. Provide insulation in the walls and roof as required to meet the specified noise limitation criteria specified herein. Color shall be manufacturer's standard. Submit available color options.
- D. The base and underframe shall consist of two wide flange "I" beam or channel longitudinal skids, with fabricated steel cross members. Overlay cross members with 1/8-in thick steel plate welded to the cross members to provide a solid floor. A 3/4 inch pressure treated wood subfloor may be used between the cross members and the steel deck to provide further sound attenuation and for acoustic isolation of the generator and base assembly. Provide mounting to attach the lift-off enclosure to the base. Provide steel tapping plates coordinated with the generator set manufacturer, for

anchoring the equipment within the enclosure. Provide floor openings for electric conduit stub-up where required for conduit wiring access to the equipment within the enclosure. The floor shall incorporate a diked perimeter to form a containment area for spilled fluids such as coolant and lubricating oil. The diked volume shall be at least 150 percent of the greatest fluid volume contained within the engine. The dike shall have steel edges welded and/or caulked to the floor. The conduit stub-up and any other floor penetrations shall be diked. The diked area may form the containment within itself, or it may slope and drain to a storage volume. All portions of the diked area shall be accessible for cleaning without removing covers or floor plates.

- E. Provide four-point lifting lugs at or near the corners of the enclosure base, with capacity for rigging the entire assembly. Provide two electrical grounding lugs mounted on the base for connection of the grounding system.
- F. Provide access doors on each side of the enclosure of sufficient quantity and opening to provide full access to each side of the generator set for maintenance and NEC required access and clearances to the generator circuit breaker. Doors shall consist of a steel frame with skin material matching the enclosure. Doors shall be fully gasketed to form a weather tight perimeter seal and include interior insulation the same as the wall insulation. Hinges shall be forged aluminum or stainless steel with stainless steel pins. Door handles/latches shall be of stainless steel, shall firmly latch the door closed, and shall incorporate means to apply a padlock. Doors shall provide a full 180 degree swing to provide unobstructed access to the enclosure interior when open. Provide a stainless steel hold-open latch on each door.
- G. Air handling during operation of the generator set shall be as follows: Air shall enter the enclosure through a louver, flow past the alternator and engine, pass through the radiator fan and radiator, and discharge through a louver. The system shall not exceed 0.5 inch w.g. total external static pressure to ensure adequate airflow for cooling and combustion. Louvers shall be of formed and extruded steel and shall be screened with stainless steel coarse mesh screen. Louvers shall incorporate hoods or baffles as required to provide the specified sound attenuation.
- H. The enclosure shall include hardware to internally mount the specified exhaust silencer and maintain the weatherproof integrity of the system.
- I. Power supply for the jacket water heater, alternator space heater, battery charger, and one duplex grounded ground fault protected convenience outlet shall be hard wired to junction boxes for field wiring connection of AC service power by the CONTRACTOR. Furnish a four gang GFCI outlet box located to power the jacket heater, battery charger, and battery heater and for easy accessibility for use with portable equipment with conduit and wire extending to the junction box. All wiring shall be XHHW type and shall run within galvanized rigid steel conduit.
- J. All openings in the enclosure shall be screened, baffled, or otherwise closed to prevent

the entrance of insects and rodents.

- K. The housing shall have OSHA approved signs on all four sides of the enclosure reading "Danger-High Voltage".
- L. It is the intent of this Specification to provide complete compliance with all applicable codes, laws and regulations.

2.08 AUTOMATIC TRANSFER SWITCH

- A. Furnish, install, test and place into operation the automatic transfer switch with features, accessories and enclosure as specified herein. Automatic transfer switches shall be rated for [___] amperes, 480 volts, 3 phase, 4 wire, solidly grounded, 65,000 AIC withstand/closing rating. The automatic transfer switch shall consist of an inherently double throw, 3 pole power transfer switch unit and a controller interconnected to provide complete automatic operation, and shall have three-position operation: closed to normal source, open, closed to standby source. Time delay between opening of the closed contacts and closing of the open contacts shall be a minimum of 400 milliseconds to allow for voltage decay before transfer is complete.
- B. Submit shop drawings and product data as follows:
 - 1. Equipment outline drawings and master drawing index showing elevation, plan and interior views, dimensions, weight, anchor bolt pattern and front panel layouts.
 - 2. Provide a list of all options, special features and ratings.
 - 3. Conduit entrance drawings.
 - 4. Furnish complete Bill of Materials indicating manufacturer's part numbers.
 - 5. Assembly ratings including short circuit rating, voltage and continuous current.
 - 6. Cable terminal sizes.
 - 7. Instruction and renewal parts books.
- C. Quality Assurance
 - 1. The automatic transfer switches shall be UL 1008 listed for use in standby systems in accordance with Sections 517, 700, 701 and 702 of the National Electrical Code.
 - 2. The automatic transfer switch 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.

3. The automatic transfer switch shall be ASCO 300 Series.

D. Features and Accessories

1. The following accessories shall be furnished:
 - a. An adjustable time delay of 0 to 30 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals, factory set at 3 seconds.
 - b. Adjustable time delay on retransfer to normal shall be provided. Time delay shall be automatically bypassed if the generator fails and the normal source is available. Time delay shall be field adjustable from 0 to 30 minutes. (Set at 30 minutes).
 - c. An unloaded running time delay for generator cool down shall be provided. Time delay shall be field adjustable from 0 to 60 minutes. (Factory set at 5 minutes).
 - d. Time delayed neutral position with field adjustable timer. Neutral position shall delay transfer switch operation in a neutral state to prevent re-energizing the system while motors are spinning. Timing shall be set in the field based on each specific site motors.
 - e. A time delay on transfer to standby shall be provided, factory set at 5 seconds but field adjustable up to 5 minutes.
 - f. Auxiliary contact to close when normal fails (for engine start).
 - g. Close differential adjustable relay under voltage protection on all three phases of the normal and standby sources, set to drop out at 80 percent of rated voltage and pick up at 90 percent of rated voltage. Over voltage relay protection shall drop out at 104 percent of rated voltage and pick up at 2 percent below trip.
 - h. Close differential adjustable relay under frequency sensing on all three phases of the generator source, set to drop out at 85 percent of rated frequency and pickup at 90 percent rated frequency. Over frequency relay protection shall drop out at 104 percent of rated frequency and pick up at 2 percent below trip.
 - i. Voltage unbalance relay shall be set to drop out at 5 percent and pick up at 1 percent below drop out.

j. Auxiliary Contacts

- 1) One to close when normal fails (Status to computer)
- 2) One to open on standby (Combustion air damper control)
- 3) One to close on standby (Status to computer)
- 4) One to close on standby (Generator Supplying Load)
- 5) One to open on standby (Spare)
- 6) One to close on normal (Status to computer)
- 7) One to open on normal (Spare)

- k. A green pilot light to indicate when the automatic transfer switch is connected to the normal source. A red pilot light to indicate when the automatic transfer switch is connected to the standby source.

E. Enclosure

1. The automatic transfer switch shall be furnished with a NEMA 4X, 316 stainless steel enclosure.

F. Signage

1. The automatic transfer switch shall be furnished with a sign on all doors marked DANGER - 480 VOLTS - KEEP OUT. Letters shall not be less than 1-in high, 1/4-in stroke. Signs shall be laminated plastic, engraved white letters with a red background.

G. Field Testing

1. Perform the following minimum tests and checks on the automatic transfer switch:
 - a. Megger incoming line terminals and buses, phase-to-phase and phase-to-ground after disconnecting devices sensitive to megger voltage.
 - b. Check polarity and continuity.
 - c. Check mechanical interlocks for proper operation.
 - d. Test ground connections for continuity and resistance.
 - e. Adjust unit doors.

- f. Check control circuit interlocking and continuity. Provide external source of control power for this test.
- g. Adjust timing devices to their correct settings.
- h. Simulate power failure and demonstrate that the engine-generator automatically starts and the electrical load is transferred to standby power.
- i. Simulate restoration of normal power.

2.09 SURFACE PREPARATION AND SHOP PAINTING

- A. The engine driven generator set and associated equipment shall be shop primed and finished coated in accordance with the manufacturer's standard practice prior to shipment. Furnish an adequate supply of touch-up paint.

2.10 SHOP TEST

- A. Shop test the complete engine driven generator unit and the generator control panel prior to shipment. Submit the complete certified test record. The tests shall demonstrate that the unit will operate successfully and meet the specified operational requirements. The manufacturer shall furnish all instruments, filters, fuel gas, electric power and load banks for the test.
- B. The shop test shall include operation on a reactive load bank at 0.8 power factor at rated standby load. During operation, test and record voltage and frequency regulation, and voltage and current balance to confirm compliance with this specification. Perform tests to demonstrate transient response from zero load to full load, zero load to half load, and half load to full load. Test each of the automatic alarm and shut-down devices and record the settings at which the automatic devices actually alarmed and/or stopped the engine. Submit copies of the shop test record.
- C. During the factory test, take readings and record results for each of the following:
 - 1. Time
 - 2. Ambient temperature.
 - 3. Load:
 - a. Volts [for each phase]
 - b. Amps [for each phase]
 - c. Kilowatts

- d. Frequency
 - e. [Power Factor]
 - f. Engine Speed
- 4. Engine jacket water temperature
 - 5. Lubricating oil pressure
- D. The model generator to be furnished shall be manufacturer factory prototype tested in accordance with IEEE Standard 115 with report data included in the Submittals and generator Operation and Maintenance manuals. Testing shall include the following:
- 1. Cold resistance of all windings
 - 2. Insulation resistance of all windings
 - 3. Polarity of field coils
 - 4. High potential on all windings
 - 5. Open circuit saturation

PART 3 EXECUTION

3.01 INSTALLATION

- A. Provide the services of a factory field representative to check the installation of the generator unit and appurtenances, to ensure installation in accordance with the manufacturer's recommendations, perform check-out and start-up services, and conduct the field test.
- B. Mount the generator enclosure skid base on a concrete foundation and level to provide equal bearing for all supports as work of this section. Utilize grout or other approved means to level the mounting surface of the foundation to provide equal bearing for all supports. Furnish and install anchors in accordance with the submitted foundation design. Connect the unit to field wiring and to fuel supply piping.
- C. Installation shall include furnishing all required coolant and lubricants in accordance with the manufacturer's recommendations.

3.02 EQUIPMENT START-UP

- A. After installation and manufacturer's representative check of the installed equipment, operate the unit to demonstrate its ability to operate continuously without vibration,

jamming, leakage or overheating and to perform specified functions.

- B. Comply with manufacturer's operating and maintenance instructions during start-up and operation.
- C. Promptly correct improper installation of equipment.
- D. Cooperate with supplier of equipment at time of start-up and in making of all final adjustments necessary to place equipment in satisfactory working order. Start-up shall not commence without the presence of the manufacturer's representative.

3.03 FIELD TEST

- A. Upon completion of installation and as soon as conditions permit, test the generator unit, controls, and appurtenances for acceptance, including load bank testing and operation under actual operating conditions, to demonstrate that operation is satisfactory. Before conducting the on-site field tests, submit a copy of the proposed field test log sheet. Prior to scheduling the test, notify the Engineer in writing that all requirements and provisions of the Contract Documents have been fulfilled, that all apparatus has been cleaned, properly adjusted, and is ready for operation, and that the Operation and Maintenance manuals have been submitted. Perform testing in the presence of the Engineer.
- B. The test shall consist of four (4) hours of continuous operation of the engine driven generator unit at unity power factor using a temporary portable resistive load bank. Load bank testing load on the generator set shall be adjusted, starting with half hour intervals each at 1/4 load, 1/2 load, and 3/4 load followed by the remaining time at full load. Furnish the load bank plus all connecting cables, metering equipment, and other equipment or devices required, and fuel to perform the load bank testing. During the test, take and record the same readings as outlined under Shop Test, at fifteen minute intervals.
- C. As part of the field test, test each of the automatic alarm and shutdown devices and record the respective values at which the devices will alarm and/or stop the engine. Perform any adjustments required in the alarm settings to make the operating values correspond to those recommended by the engine manufacturer and as recorded during the shop test. Verify that each alarm point activates the designated remote alarm contact and that the monitoring and alarm connections to the SCADA system will activate the corresponding indications at the SCADA panel. Test the remote emergency stop. Testing shall include verification of proper voltage regulation, transient voltage dip and recovery time, and voltage and current balance.
- D. After the load bank test has been completed, connect the generator to the facility load, and perform additional testing utilizing the main circuit breaker to simulate a utility power failure, to demonstrate the generator unit's ability to meet the automatic starting, load transfer, and motor starting requirements as specified herein, utilizing

facility load as available. Operate the facility on generator power for at least 30 minutes then restore utility power via the main circuit breaker, to cause the transfer switching to reset and shut down the generator. Record generator operating parameters as specified above.

- E. The CONTRACTOR shall provide a person qualified to conduct sound pressure level testing, and test instrumentation, to take and record octave band sound pressure level readings at the time of the on-site field test, when operating the generator at maximum available station load (no load bank operation). The sound pressure readings shall be within the limits permitted by this specification. If changes are necessary to accomplish the required silencing, perform revisions as required and retest.
- F. If the standby power supply system fails to fulfill the requirements of this specification, perform corrections and retest the system to assure full compliance at no additional cost to the Owner.

3.04 TRAINING

- A. The equipment manufacturer shall furnish the services of a factory representative who has complete knowledge of proper operation and maintenance for a minimum of one, eight hour working day to instruct representatives of the Owner and the Engineer in the proper operation and maintenance of the equipment.
- B. Training shall be provided at the site and timed to accommodate all working shifts, including some late evenings, and early mornings. The instruction period shall be scheduled at least ten working days in advance with the Owner and shall take place prior to start-up and acceptance of the equipment by the Owner. Training shall include system operations, preventive maintenance, and troubleshooting.
- C. Submit, at least 30 working days prior to the start of training, a training syllabus that includes the above requirements, proposed dates and times for training, and instructor resume. Training may not commence until the first draft of the O&M manual has been submitted for review.

END OF ATTACHMENT A

3.3.9 Attachment B: Diesel Engine Driven Generator

ATTACHMENT B
DIESEL ENGINE DRIVEN GENERATOR

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. Furnish all labor, materials, and equipment and incidentals, and install, one new skid mounted diesel engine driven generator unit with a sub-based diesel fuel tank, an automatic transfer switch, appurtenances and required supporting systems in a factory type skin tight weatherproof sound attenuated enclosure as specified herein. Require the manufacturer or manufacturer's representative to furnish installation assistance, start-up operation, field test, operator training, first year service contract, and operation and maintenance manuals.
- B. The engine driven generator shall have a stand-by power rating (site rated) of not less than ____ kVA, ____ kW, at 80 percent lagging power factor, with 480 Volt, three phase, 60 Hertz output. The alternator shall be three wire, grounded wye connected, complete with excitation system and controls.
- C. Arrange the generator for automatic starting and stopping and load transfer upon failure of the normal source of power. Parallel operation with Power Company is not required. Transfer to and from facility load will be open transition transfer.
- D. All equipment and controls specified in this Section shall be new and be considered part of the engine driven generator package. The generator manufacturer or his/her licensee shall furnish the package in its entirety as specified. The engine driven generator package shall be complete and shall include all equipment and controls necessary for a fully operational standby power supply.
- E. Furnish the following for each unit:
 - 1. Diesel engine with attached alternator.
 - 2. Generator main circuit breaker.
 - 3. Unit mounted radiator with engine driven fan, for cooling of the engine jacket water including engine mounted and engine driven circulating pump.
 - 4. Entire exhaust system including silencer, flexible connection, exhaust pipe, and pipe supports mounted inside the enclosure.
 - 5. Fuel system piping, tanks and appurtenances.

6. Skid mounted, factory-piping, wiring and valves.
 7. Flexible connectors and/or expansion joints for field piping.
 8. Automatic control valves.
 9. Factory manufactured weatherproof, sound attenuating, skintight enclosure for outdoor installation of the unit.
 10. Combination engine/alternator instrument and control panel wired, tested and shock mounted at the alternator end of the unit.
 11. Engine mounted electric starters with battery and battery charger.
 12. Generator structural steel base including rubber pad type vibro isolators.
 13. UL listed sub-base fuel tank.
- F. Provide the services of the generator manufacturer's representative for delivery, installation, set-up, start-up testing, and training of the Owner's personnel.

1.02 SUBMITTALS

- A. Submit shop drawings and product data to establish compliance with this section, including the following:
1. Shop drawings, catalog cuts, internal wiring schematics and other materials required to completely describe the systems and equipment being furnished.
 2. Assembly drawings with identification, description, and dimensions of each separately installed sub-assembly or piece of equipment and associated piping connection schematics.
 3. Certificate of Compliance for Seismic Design of Non-Structural Components and Systems in accordance with ASCE 7, Section 13 and the IBC, for the generator assembly, enclosure, and accessory components attached to the generator assembly and enclosure, demonstrating that the equipment and its mounting system and anchorage have been tested or analyzed to withstand specified seismic demands.
 4. Equipment base drawings indicating the size and location of bolt holes for anchorage, and location of conduit stub-ups.
 - a. Details of anchorage of the equipment to the foundation including anchor bolt type, size, material, embedment depth, and minimum edge distance.
 - b. Summary of maximum vertical and horizontal reactions at each anchor bolt

considering all applicable loads and load combinations.

5. Performance specifications of all items of equipment.
6. Description of the generator control panel showing panel layout, location, functional description, features, and options.
7. Internal electrical, instrumentation, control, and wiring diagrams.
8. Identification of all wiring connections to external systems and equipment, including numbered terminal strip identification.
9. Details of the proposed battery charger and starting battery, including cold cranking amps and ampere hour rating.
10. Information on the proposed jacket water treatment including Material Safety Data Sheets.
11. The manufacturer, model, size, attenuation curve, and design back pressure for the silencing equipment as offered to accomplish the specified silencing for this installation.
12. Details of the main generator circuit breaker showing location, dimensions, ratings, and enclosure details.
13. Details of the jacket water heater and jacket water treatment.
14. Load analysis utilizing the loads as specified herein, to demonstrate that the proposed unit will start and carry the specified loads.
15. Alternator rating data sheet showing the alternator selection of frame size, output rating, efficiency, temperature rise, windings, reactances, resistances, full load current, and full load heat rejection.
16. Certification of conformity with engine emissions tier level.
17. Details of the sub-base fuel tank and fuel system piping.
18. Description of the factory manufactured, weather protected, sound attenuating enclosure including dimensions, materials and methods of construction, conformance to standards, description of all accessories and components, color charts of available colors, and enclosure circuit wiring diagrams.
19. Details of the arrangement of the exhaust piping system within the enclosure.
20. Statement certifying the maximum combined noise level from the engine exhaust and the mechanical noise from the enclosure when the generator unit is

operating at full rated standby load, stated in dbA at 50 feet from the unit in any direction.

21. Manufacturer's certified shop test record of the engine driven generator unit performed in accordance with specifications.
22. Draft copy of the written service contract specified herein.
23. Draft copy of the warranty specified.

B. Submit the following design data:

1. Engine Data

- a. Manufacturer
- b. Model
- c. Number and arrangement of cylinders
- d. RPM
- e. Bore x stroke
- f. Displacement (cubic inches)
- g. Maximum power at rated RPM (brake horsepower)
- h. BMEP at rated kw (including any parasitic loads and generator efficiency)
- i. Piston speed, feet per minute
- j. Aspiration
- k. Make and model of governor
- l. Make and model of overspeed shutdown device.
- m. Maximum allowable engine exhaust back pressure
- n. Engine cold cranking amperes

2. Alternator Data

- a. Manufacturer
- b. Model

- c. Rated KVA
 - d. Rated KW
 - e. Voltage
 - f. Rated Amperes
 - g. Power Factor
 - h. Temperature rise above 40 degrees C ambient
 - 1) Stator by thermometer (degrees C)
 - 2) Field by resistance ___ degrees C
 - i. Class of insulation (degrees C)
 - j. Alternator efficiency including excitation losses and at 80 percent PF
 - 1) Full load (percent)
 - 2) Three-quarters load (percent)
 - 3) Half load (percent)
 - k. Subtransient reactance (x_d'') (per unit) or (ohms)
3. Guaranteed fuel consumption rate (at generator terminals)
- a. Full load (gal/hr)
 - b. Three-quarters load (gal/hr)
 - c. Half load (gal/hr)
4. Generator unit and accessories
- a. Weight of skid mounted unit (lbs).
 - b. Overall length (inches)
 - c. Overall width (inches)
 - d. Overall height (inches)
 - e. Exhaust pipe size (inches)

5. Exhaust gas emissions data, maximum values at loads varying from full to 1/4 load:
 - a. Temperature (degrees F)
 - b. Flow (ACFM)
 - c. Carbon Monoxide (CO) (grams/BHP-hr)
 - d. Nitrogen Oxides (NOx) (grams/BHP-hr)
 - e. Hydrocarbons (HC) (grams/BHP-hr)
 - f. Sulfur Dioxide (SO2) (grams/BHP-hr)
6. CFM of air required for combustion and ventilation based upon inlet air temperature of 40 degrees C: (CFM)
7. Heat radiated to room by engine and generator: (BTU/min)
8. Heat rejected to jacket water including lubricating oil (BTU/min)
9. Radiator (engine driven) fan cooling air volume and required BHP (BHP)
10. Nominal cold cranking ampere rating of the starting battery.

1.03 REFERENCE STANDARDS

- A. Design, manufacturing and assembly of elements of the equipment herein specified shall be in accordance with but not limited to published standards of the following, as applicable:
 1. American Gear Manufacturers Association (AGMA)
 2. American Institute of Steel Construction (AISC)
 3. American Iron and Steel Institute (AISI)
 4. American Society of Mechanical Engineers (ASME)
 5. American National Standards Institute (ANSI)
 6. American Society for Testing Materials (ASTM)
 7. American Welding Society (AWS)
 8. Anti-Friction Bearing Manufacturers Association (AFBMA)

9. Institute of Electrical and Electronics Engineers (IEEE)
10. National Electrical Code (NEC)
11. National Electrical Manufacturers Association (NEMA)
12. Occupational Safety and Health Administration (OSHA)
13. Steel Structures Painting Council (SSPC)
14. Underwriters Laboratories, Inc. (UL)

- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.04 QUALITY ASSURANCE

- A. Build the generator from components that are coordinated and prototype tested to operate as a unit. The manufacturer shall maintain a permanent service organization and supply of spare parts in place at the time of the bid within 100 miles of the project site.
- B. Design and build the unit in accordance with NFPA 110, Standard for Emergency and Standby Power Systems, Level 2, Type 60; NFPA 37, Standard for Installation and Use of Stationary Combustion Engines and Gas Turbines; and NEC 701, Legally Required Standby Systems. Build and certify the unit construction is in accordance with UL 2200, Stationary Engine Generator Assemblies.
- C. The load on the standby generator may include motors started on solid state starters that represent up to 90% percent of the generator's standby rating. Coordinate design of the generator and its voltage regulation system with the supplier of the solid state starters and other non-linear devices to assure that sufficient alternator reactance is provided to limit the line harmonics to acceptable levels as specified in IEEE Standard 519 and to assure that the voltage regulation system will provide stable operation in the presence of such harmonics.
- D. The unit shall be of such physical dimensions to fit into the space provided as indicated on the Drawings.
- E. Should equipment that differs from the equipment described in this section be offered and determined to be equal to that specified such equipment shall be acceptable only on the basis that any revisions in the design and/or construction of the structure, piping, appurtenant equipment, electrical work, etc., required to accommodate such a substitution shall be made at no additional cost to the Owner and be as approved by the Engineer. Modifications required to accommodate product substitutions shall not extend the contract time.

- F. Design and build the engine driven generator for standby service at all points within the specified range of operation, without overheating or excessive vibration or strain. Components shall require only that degree of maintenance as applicable to the specific type of equipment. Design and build all parts and components for interchangeability so that replacement parts may be installed without additional fitting or machining.
- G. Furnish the services of a factory trained service technician, specifically trained on the type of equipment specified. Submit qualifications of the service technician for approval. The service technician shall be present on-site for a total of one man-day, exclusive of travel time, to perform equipment check-out, leveling and alignment, coordination of electrical connections, start-up, testing, and calibration of the unit.

1.05 service contract

- A. Provide to the Owner at the time of acceptance of the unit a written five (5) year service contract for the engine driven generator and support systems, as furnished, commencing on the date of acceptance of the unit. Include all costs associated with the service contract in the price bid and furnish a copy of this contract to the Owner at the time of acceptance. This service contract does not supersede or replace the manufacturer's equipment warranty as specified herein.
 - 1. The service contract shall include inspections of the installation and performance of the manufacturer's recommended preventive maintenance to assure the safe and dependable operation for the standby power system throughout the first year of operation for standby service with up to 300 hours per year of operation.
 - 2. The preventive maintenance shall include all maintenance service at the recommended service intervals as published in the manufacturer's literature, and as required to maintain the equipment warranty in full effect. The service contract shall include as a minimum an inspection to sample and analyze lubricating oil; change lubricating oil and filters; check/replace air filters; check belts; sample and analyze coolant; check coolant level and condition, inspect ignition system; inspect governor and control system; check heaters; inspect fuel supply system, exhaust system, starting battery, battery charger, and battery charging alternator; check and adjust output voltage and frequency; and operate the unit to confirm proper operation.

1.06 WARRANTY

- A. Furnish a written five year (60 Months) extended warranty from the equipment manufacturer to the Owner, on all equipment furnished under this Section when operated as a standby unit for up to 300 hours per year. The warranty shall extend from the date of acceptance of the equipment and shall include all parts, labor, and

transportation for replacing any defective components of the equipment as furnished.

1.07 SPARE PARTS ALLOWANCE

- A. The generator supplier shall include in the bid price an allowance of \$[_____] for spare parts that are not covered under the equipment warranty, to be selected by the Owner. Submit a spare parts list that includes manufacturer's recommended spare parts, with parts prices current to the date of submittal, and information relevant to parts supply and ordering. Submit this information in time for review and approval prior to start-up and site testing of the unit.

1.08 MAINTENANCE

- A. Submit operating and maintenance instructions covering all equipment furnished under this Section. Prepare the instructions specifically for this installation and include all required cuts, drawings, equipment lists, descriptions, etc., that are required to instruct operating and maintenance personnel unfamiliar with such equipment.

1.09 UNIT PERFORMANCE

- A. Select the engine driven generator to be adequate to start one [__]HP, three phase, Code Letter [__], pump motor using a [full voltage] [solid state reduced in-rush] starter, along with [__] kVA of three phase additional load and [__] kVA of single phase miscellaneous load at 0.9 power factor; and with a transient voltage dip not to exceed thirty percent of rated voltage.
- B. The unit rating shall not be less than [__] kW. Provide an oversized alternator or enhanced voltage regulator as required for motor starting and to carry non-linear loads. The specified unit site rating is the minimum acceptable for the specified loads, and shall be increased if required to meet the load starting or running requirements as specified herein.
- C. The engine driven generator set and all of its components shall provide stable operation under all operating conditions that the station load may impose.
- D. Under steady load conditions, from zero load to full-rated load, voltage regulation shall be within plus or minus one percent, and frequency regulation shall be within plus or minus 0.25 percent (0.15 Hertz).
- E. Upon application or removal of full rated resistive load in one step, the transient voltage dip or overshoot shall not exceed 25 percent of rated voltage and recovery to steady state operation shall be within ten seconds.

1.10 DELIVERY, STORAGE AND HANDLING

- A. All mechanical and electrical equipment shall be coated, wrapped and otherwise protected from snow, rain, drippings of any sort, dust, dirt, mud, flood and condensed water vapor during shipment and while installed in place during construction. The protective coverings shall remain in place until the work areas are substantially free of all construction dust and debris.
- B. Package and crate the unit for shipment and provide treatment for long periods of storage.

1.11 PROJECT/SITE REQUIREMENTS

- A. House the complete engine driven generator unit in a factory type skin tight weatherproof sound attenuating enclosure for outdoor installation. Arrange the unit for automatic operation and for positive and successful quick starting at a minus 20 deg. C outdoor ambient temperature. Design all equipment housed within the generator enclosure for a maximum operating temperature based upon a maximum ambient temperature of 40 deg. C plus the temperature rise that will occur within the enclosure either during generator operation or with maximum solar heating when the generator is not in operation. Factory assemble the generator unit with enclosure and accessories as specified herein, ready for installation on a concrete foundation with openings for conduit risers. The unit shall not require field assembly.
- B. The engine driven generator unit within its enclosure, in combination with the engine exhaust silencer, with the generator in operation at full load, shall have a sound pressure level of not more than 70 dbA measured at a distance of 50 feet from the enclosure in any horizontal direction. There shall be no pure tone. It shall be the responsibility of the engine driven generator unit manufacturer to choose the engine exhaust silencer and the sound attenuating properties of the enclosure to meet these criteria.
- C. The altitude at the project site will not be in excess of 1000 feet above sea level.
- D. The heat sink for rejection of heat from the engine jacket shall be a unit mounted radiator utilizing an engine mounted and engine driven fan to discharge air through the radiator and through a louver to outdoors. Design the radiator and engine fan to dissipate all required heat loads with the generator running at full rated output and with 40 deg. C ambient outdoor air. No other source of cooling as available or will be permitted.
- E. Certify engine exhaust emissions in compliance with applicable EPA Tier rating for new stationary emergency diesel engine driven generator sets in the power range specified herein. Design the engine and fuel control system to limit the exhaust emissions of the engine to the limits imposed by these regulations.
- F. Design and build all non-building structures and provide seismic restraint of nonstructural components to withstand seismic demands to provide post seismic event

functionality in accordance with ASCE 7, Section 13 and the IBC.

- G. Design the enclosure base and attachment to the concrete foundation to support the gravity loads, dynamic loads, wind loads and seismic forces to conform to ASCE 7, Section 13 and the IBC. Furnish and install anchorage in accordance with the manufacturer's requirements, sized and quantity as determined by the anchorage calculations required in this Section.
- H. Enclosure exterior length shall fit in the space available on site.

PART 2 PRODUCTS

2.01 GENERAL

- A. The engine-generator set shall be a factory assembled unit, specifically designed and equipped for operation on No. 2 diesel fuel oil, and shall be Caterpillar/. The engine and generator shall be directly connected with a semi-flexible steel coupling, shall be free from injurious torsional or other vibration and shall be vibro-mounted with a heavy steel sub-base. The diesel engine shall be four stroke cycle, using engine jacket water, full diesel, mechanical injection, arranged for direct connection to an alternating current generator. The unit shall operate at a rotative speed of not more than 1800 rpm and shall develop its full KW rating including radiator fan. Units offered at ratings in excess of their published ratings are not acceptable and will not be approved.
- B. The engines shall be rigid, neat in appearance and shall allow easy access to the various parts for maintenance purposes. The bed plate and frame shall be of heavy construction. All parts shall be properly enclosed to prevent the throwing or dripping of oil.
- C. The engine-generator sets shall be pre-piped and pre-wired insofar as possible. Separate pre-wired terminal boxes shall be provided on the engine-generator skid for A.C. and D.C. wiring. All wiring terminations for connection to field wiring shall be within terminal boxes utilizing numbered terminal strips.
- D. Mount the close coupled engine and alternator assembly on a rigid, welded, fabricated steel base, sized to maintain the correct alignment of all system components. Fabricate the base of steel I-beam or box section, braced and reinforced as required to maintain alignment between the engine and the alternator. Mount the engine-alternator assembly on the base utilizing rubber pad type vibration isolators and felt washers. Mount the engine radiator and battery support separately on the base, independent of the engine-alternator assembly. The complete generator unit shall be free from harmful torsional or other vibration. Shop prime and finish paint all exposed surfaces of the structural steel members of the fabricated base frame in accordance with the manufacturer's standard practice.

2.02 ENGINES

A. General

1. The engines shall be capable of withstanding a 10 percent overload for two hours out of every 24 hours without harmful detonation, overheating or other evidence of distress.
2. The complete engine-generator unit shall be free from harmful torsional or other vibration throughout the entire operation range of speed and load.
3. The engines shall use in-cylinder combustion technology, as required, to meet applicable EPA NSPS rule for stationary reciprocating compression ignition engines. The engine shall also comply with the State Emission regulations at the time of installation /commissioning. Actual engine emissions values must be in compliance with applicable EPA emissions standards per ISO 8178 – D2 Emissions Cycle at specified kW/bHP rating. Utilization of the “Transition Program for Equipment Manufacturers” (also known as “Flex Credits”) to achieve EPA certification is not acceptable. The in-cylinder engine technology must not permit unfiltered exhaust gas to be introduced into the combustion chamber. Emissions requirements / certifications of this package: EPA T4 Interim.

2.03 SYSTEMS

A. Governor

1. The governor shall be an electronic engine control module with 24-volt DC electric actuator. Speed droop shall be adjustable from 0 to 10%, from no load to full rated load. Steady state frequency regulation shall be plus or minus 0.25%. A provision for remote speed adjustment shall be included.
2. Furnish also a separate overspeed shutdown device which shall, in case of predetermined overspeed or the operation of various protective devices as later specified, instantly stop the engine without the fuel injection system losing its prime.

B. Supporting Structure

1. The diesel engine-generator shall be directly bolted, doweled, and aligned on a rigid, fabricated steel base, suitably sized to maintain the correct alignment, supported by Korfund or equal heavy duty rubber pad type vibration isolators, anchored to the level surface of a concrete pad.
2. Furnish required quantity of generator manufacturer supplied heavy duty rubber pad vibration isolators, Korfund or approved equal, installed between the bottom

of the engine generator set base and the top of the sub base generator mounting surface.

2.04 SYSTEMS

A. Fuel Oil Systems

1. The fuel system shall be integral with the engine. It shall consist of a fuel filtration system; engine mounted mechanically driven transfer pump, injection pumps, supply and return fuel lines, and fuel injectors. The transfer pump shall be engine driven and shall deliver fuel under low pressure to individual injection pumps. The generator set shall be installed on top of the sub base diesel fuel oil tank and the designed and installed fuel system shall be capable of delivering fuel flow from the sub-base fuel tank to the engine fuel inlets or nozzles, at any level of fuel within the tank, sufficient for full rated operation of the engine under all ambient temperature conditions and shall return any unused fuel to the sub base tank
2. Provide a fuel filter/water separator system installed on the engine and flexibly connected to the sub base tank engine fuel supply. The filter shall be of the replaceable filter type, with clear water/sediment trap bowls for each. Fuel shall be piped with flexible connections from the filter/water separator system to the intake of the engine fuel pump and then from the engine's fuel return to the sub base tank engine fuel return. Provide a foot valve at the bottom of the sub base tank engine supply tube.
3. Provide fuel lines as required to complete the connections of the fuel supply and fuel return between the engine and the sub base tank. Use diesel fuel oil impervious flexible connections at the engine fuel supply and return connections.
4. The generator set shall be equipped with a double walled sub base diesel fuel oil tank, UL142 Listed and nameplate labeled for stationary installation. A sub base tank electronic leak detection system shall be provided and an alarm contact shall be provided for annunciation at the automatic transfer switch. The sub base tank and all parts of the fuel system shall meet the approval of, and be installed in complete compliance with, all applicable local, state and federal codes, laws and regulations.
5. Diesel fuel oil generator set sub base fuel oil tank construction.
 - a. The UL 142 generator set sub base tank shall be of all corrosion-resistant steel construction and double walled for 110% secondary containment. The sub base tank shall be designed and constructed in accordance with UL requirements to support the total wet weight of the generator set and contained fuel. The primary tank shall be sized so as to provide a minimum

quantity of useable diesel fuel oil to allow seventy two (72) hours of generator set operation at full generator set rated load. The tank design shall allow for additional capacity in the top of the tank to prevent spillage as fuel heats and additional capacity at the bottom of the tank to prevent entry of fuel sludge buildup into the engine.

- b. The sub base fuel oil tank shall be designed and constructed so as to allow proper installation of the generator set on the sub base tank.
- c. The tank shall incorporate steel plate lifting points constructed so as to lift the installed sub base tank and generator set, less fuel oil weight. The tank shall be manufacture red with four (4) lifting points, approved by UL with a 4 to 1 safety factor consisting of minimum of 1.25 inch thick (nominal) steel plates welded into the tank base perimeter with eyelets designed and installed so as to allow single point lifting of the empty sub base tank with the generator set installed on top of the sub base tank.
- d. The sub base tank shall incorporate appropriately spaced external cross support channels installed on the bottom of the tank across the width of the sub base tank as required to properly support the sub base tank, generator set, and fuel weight and provide a two inch air space between the bottom of the tank and the top of the concrete foundation. Each cross support channel shall include mounting restraint points on both ends to allow for adequate attachment of the sub base tank to the site's mounting foundation. Provide drawing indicating dimensional locations for each of the foundation mounting attachment points for the sub base tank.
- e. The tank shall incorporate suitable internal stiffeners to create a smooth tank top surface and to limit the accumulation of water. The outer tank shall be abrasive blast cleaned and shall be properly surface prepared and coated with high build polyester glass flake and finish coated with a long lasting, weather and UV resistant aliphatic polyurethane enamel. The tank shall be constructed with no sharp edges to insure uniform coating coverage on all surfaces. No external support beams for the generator set shall be permitted on top of the tank.
- f. The tank shall be provided with a minimum of generator supply and return, lockable covered fuel fill, mechanical fuel level gage, required primary and secondary tank primary and emergency vents, low fuel level, high fuel level, and fuel leakage float sensors, primary and secondary tank drains with fittings. It shall include inner and outer tank standard and emergency venting with vent caps as required by UL142 and NFPA. Engine fuel supply and return fuel line flexible connections are to be furnished and installed. Furnish a removable foot valve in the bottom of the sub base tank's engine supply drop tube piping.

- g. The tank shall be furnished with low fuel level, high fuel level and fuel leak float sensors/switches. These alarm contacts shall be provided for annunciation at the automatic transfer switch. The low and high level switches shall monitor the primary fuel tank and the leak detector switch shall sense the interstitial tank. All tank level sensor penetrations shall exit the top of the tank. All level switches / sensors and wiring and conduit are to be installed in the sub base tank and wired to the generator set for local and remote alarms.
- h. Provide an approved sub base tank installed and an interior-located covered fuel fill/overspill lockable fuel oil containment box, minimum of seven (7) gallon capacity positive fuel containment box with approved anti-siphon valve and mechanical fuel fill limiter with tight fill connection inside of the containment box to shut off the flow of filling fuel at 95 % of tank capacity. Provide a spring loaded drain pull to allow fuel contained within the fill box to be returned directly into the primary fuel tank.
- i. Provide an installed mechanical fuel level gage to monitor fuel tank fuel level range from empty to full. The gage shall be suitable for outdoor use and shall be located and installed on top of the sub base tank near the tank's fuel fill location.
- j. Provide complete dimensional and weight information for the generator set and sub base tank assembly, including detailed mounting information for generator site foundation construction considerations.

B. Air Intake Systems

- 1. The engines shall be equipped with suitably sized dry type air intake filter(s) to protect working parts of the engine from dirt and grit with replaceable type filter element. In-line air inlet silencers shall be provided between the turbocharger and the air inlet filter. A crankcase breather shall be included.

C. Lubrication System

- 1. The engines shall be provided with a full pressure lubricating oil system arranged to cool the pistons and to distribute oil to all moving parts of the engine including the turbocharger bearings and including full flow filter of the replaceable element type and a suitably sized shell and tube type oil cooler and an AMOT or equal automatic temperature regulator. An engine driven lubricating oil circulating pump shall be provided for the engine. This pump shall be of the positive displacement type, and shall have ample capacity to circulate the amount of lubricating oil and cooling oil required by the engine and turbocharger. The engines shall be provided with a sump type crankcase arrangement of sufficient capacity to suit the requirements of the engine.

D. Radiator Cooling System

1. The engine shall be radiator cooled with a blower or pusher type fan mechanically driven by the engine. The fan shall provide a static pressure rise of not less than 0.5 inches of water in addition to the losses through the radiator, to move the required air flow through the intake louver and discharge plenum and louver to provide the cooling required by the unit. The radiator shall incorporate flanges for attachment of a flexible duct connection to the exhaust plenum. Provide guards for fan, belts, and hot surfaces in accordance with OSHA regulations and UL 2200. The cooling system shall be adequate for cooling the engine at full rated load with an outdoor ambient temperature of 40 degrees C plus the temperature rise corresponding to the heat given off by the alternator and equipment hot surfaces. Provide a coolant low level switch in the radiator top tank, wired to the low coolant alarm on the generator control panel.
2. Furnish an engine driven, centrifugal coolant pump equipped with a mechanical seal to circulate the coolant through the engine and radiator. Provide an automatic temperature regulator for the engine coolant that will maintain pre-set temperature without restricting the rates of flow of coolant through the engine.
3. Coolant shall be for use in ambient temperatures which may range from -20 to 40 degrees C, and shall be a 50 percent ethylene glycol antifreeze solution conforming to ASTM D-4985 and D-5345. The coolant shall be premixed extended life type and shall contain additives as recommended by the engine manufacturer for the prevention of both scale formation and corrosion in the engine water jackets and cooling system components that are in contact with the engine coolant. Coolant with additives shall be as manufactured by the NALCO Chemical Company, Dow Chemical, Aqua Laboratory, or equal.
4. Provide an engine mounted thermostatically controlled heater for the engine coolant system to maintain not less than 32 degrees C in the engine jacket to assure quick start and load transfer with an ambient temperature of -20 degrees C. The heater shall include valves or quick disconnects to allow isolation and removal of the heater without draining the engine cooling system. The heater shall have a minimum rating of 1000 watts when operated on a 120 Volt single phase power supply. Provide a grounded plug to connect to a 120 Volt receptacle.
5. Provide a valve drain on the cooling system piped to the exterior of the enclosure. Provide flexible connectors at all connections of off-skid piping to the engine.

E. Electric (Battery) Starting Systems

1. Provide an engine mounted, 12 Volt DC solenoid shift electric starter capable of withstanding four, consecutive cranking periods of fifteen seconds cranking

each separated by fifteen seconds of rest.

2. The starting battery shall be low maintenance, long life, lead acid type, especially designed for spark ignited engine cranking service. Battery shall be of a capacity as recommended by the battery manufacturer for the necessary break-away current, cold cranking amperes, and ampere hour capacity for four consecutive cranking periods of fifteen seconds each, or for sixty seconds of continuous cranking without being recharged and with a battery temperature of ten degrees C and with the engine jacket maintained at 30 degrees C. The battery shall be manufactured by Caterpillar.
3. Furnish a skid mounted battery box specifically designed for battery service. Furnish full insulated battery covers. Furnish and install battery cables with terminals and connections for connecting the battery to the electric starter. Furnish all connectors and hardware, cables, grease, and lifting device.
4. Furnish an automatic battery charger for charging the starting battery. The charger shall be UL listed, solid state, electronic, fully automatic, float/equalize-type. The battery charger shall have automatic voltage sensing determined by the state of the battery and reducing to milliamp current on fully charged battery. Charger shall be for 120 volt, single phase, 60 Hertz alternating current input. Provide conduit and wire for the charger to a junction box installed inside of the enclosure for field wiring service power connection by the installing CONTRACTOR. The charger shall be not less than five (5) Amperes D.C. output capacity. Arrange the charger for wall mounting inside the generator enclosure. The battery charger shall provide control power to the generator control panel when the generator is not running with correct voltage and current output to provide proper battery charge rate for maximum battery life and control panel power requirements.
5. Provide an automatic thermostatically controlled battery pad heater rated 120 Volt, single phase power supply to maintain the battery temperature at a minimum of 10 degrees C when the ambient temperature is -20 degrees C. The heater shall automatically shut off when the battery temperature attains 30 degrees C. Provide a grounded plug to connect to a 120 Volt receptacle

F. Exhaust System

1. Furnish an exhaust silencer as manufactured by Maxim; Donaldson; Nelson, or equal, of aluminized steel construction, mounted and piped inside the enclosure. The silencer shall have not less than a critical rating and[, in combination with the catalyst,] shall attenuate the sum of the octave band levels converted to A-weighted sound pressure levels such that the noise level from the engine exhaust plus mechanical noise from the enclosure will conform to the noise limitation specified herein. There shall be no puretone. Size the silencer to operate within the maximum allowable backpressure of the engine, when installed in the

exhaust piping system as furnished.

2. Furnish a three-way, non-selective catalytic reduction unit for stoichiometric spark ignited engines, if required to meet the emissions requirements specified herein. The catalyst shall be a separate unit or shall be permanently built into the silencer housing. The catalyst housing shall be of stainless steel to provide the corrosion resistance required to allow the housing to be insulated to control heat rejection from the surface of the housing. The housing shall include 1/2 inch pipe taps before and after the catalytic element to allow monitoring of the exhaust gas flow upstream and downstream of the catalytic element.
3. Connect the exhaust silencer to the engine with a stainless steel bellows type exhaust expansion joint. The expansion joint shall be as recommended by the engine manufacturer for the maximum operating temperature of the exhaust, engine vibration, and for expansion of the exhaust system caused by a 650 deg. C temperature change. The expansion joint shall adapt to the engine exhaust outlet connection, and shall provide a flanged or threaded connection to the exhaust silencer.
4. Exhaust pipe shall be light wall exhaust tube as manufactured by GT Exhaust Systems, of Type 304 stainless steel, with clamp type joints. Exhaust pipe shall be of the size recommended by the engine manufacturer. All exhaust line elbows shall be long radius.
5. The exhaust pipe roof penetration shall be with an insulated Type 321 stainless steel or aluminum thimble designed to accommodate the specified exhaust pipe and allow a minimum 1-in air gap between the thimble and the pipe. There shall be no heat conduction path between the exhaust pipe and the roof. The roof thimble shall project above the finished roof and shall include Type 321 stainless steel or aluminum exterior rain flashing and insulation as required to protect the enclosure. Roof thimble shall be as manufactured by GT Exhaust Systems or equal. All portions of the exhaust system above the rain collar and exposed to the weather shall be of aluminum or Type 321 stainless steel construction. The open space between the exhaust pipe and the roof thimble shall allow for ventilation and shall include screening or mesh to prevent the entrance of insects.
6. Terminate the exhaust pipe vertically with a Type 321 stainless steel counterbalanced raincap with bronze bushings. The raincap shall be weighted such that the cap will open completely out of the exhaust air flow, causing no obstruction or deflection when the engine is running at rated speed without load.
7. Cover the interior exhaust system with insulation to limit the interior temperature rise of the enclosure and shield heat sensitive components from the exhaust pipe heat, and provide operator protection in accordance with UL 2200 during generator operation. The insulation shall not contain asbestos or asbestos

bearing products. Furnish and install all required steel support framing and hanger bands for supporting the silencer from the interior of the enclosure.

8. The entire installation shall meet with the Engineer's approval. It is the intent of this specification to provide complete compliance with all applicable local, State and Federal codes, laws and regulations.

2.05 ENGINE INSTRUMENTATION AND CONTROLS

A. The engine driven generator shall include a combination engine/alternator control panel, shock mounted in a unit-mounted NEMA 1 enclosure located at the alternator end of the unit, and oriented to be easily viewed [through the open enclosure doors] [when entering the generator room]. The control panel shall be all electronic type with two line alpha-numeric digital displays visible in any lighting condition. Panel construction shall conform to UL 508 for industrial control panels. Provide all interconnecting wiring between the engine/alternator set and the control panel. Direct communication with the control panel shall be with an environmentally sealed membrane keypad. The control system shall be PLC based. Furnish all software, instructions, and interconnecting cables required for PC communication with the control panel for adjustment and diagnostics.

1. Information displayed on the face of the panel shall include, but not be limited to, the following indications:
 - a. Lubricating oil pressure
 - b. Coolant temperature
 - c. AC volts, 0.5 percent accuracy
 - d. AC Amperes, 0.5 percent accuracy
 - e. Frequency meter, 0.5 percent accuracy
 - f. Output power (kW and kVA) (total and per phase)
 - g. Power factor
 - h. Non-resetting elapsed time meter calibrated in hours and tenths of hours
 - i. DC volts
 - j. Tachometer
 - k. Diagnostics for servicing
 - l. Emergency shutdown condition indication lamps for each shutdown

condition with logic to maintain lockout condition and fault light until reset.

2. Operators on the panel shall include:
 - a. RUN-OFF-AUTO selector switch
 - b. Emergency stop mushroom type push button.
 - c. Voltage control
 - d. Alarm test/reset pushbuttons.
 - e. Phase selector switch
 3. The panel shall also include:
 - a. Necessary fuses
 - b. Alternator voltage regulator
 - c. Engine control module.
 - d. Governor controller.
- B. Control panel shall include a complete automatic engine start control that operates in response to closing a remote contact and stop control that operates in response to opening the remote contact.
1. The engine control module shall provide automatic cyclic cranking for at least four 15 second cranking periods separated by 15 second rest periods. If the engine fails to start after the last cranking cycle, the cranking limiter shall terminate further cranking and activate the overcrank alarm. The cranking limiter shall automatically disengage the starter when the engine fires and accelerates to operating speed.
 2. The generator controls shall include a three-position switch with the following positions: RUN-OFF-AUTO. In RUN, the engine shall start and run with load transfer controlled from a remote location; in OFF, the engine shall stop and shall not start; in AUTO, the engine shall start, run and stop from a remote two-wire signal from the automatic transfer switch furnished. Load transfer shall occur when the unit attains rated voltage and frequency.
 3. The generator controls shall include an automatic cool-down timer, to allow the engine to continue to operate after load transfer back to the normal power supply, to cool down prior to automatic shut-down. The timer shall be adjustable from zero to ten minutes and shall be engaged when the selector switch is in the AUTO

position.

4. Should any of the protective sensors on the generator activate, the engine control shall immediately shut down the engine.
- C. The control panel shall include an emergency stop pushbutton. Arrange the controls to accept operation of a remote contact to provide for remote emergency stop. Emergency stop shall over-ride all other controls to immediately shut off the fuel supply and shutdown/stop the generator set concurrently with tripping open the generator circuit breaker.
- D. Furnish a remote emergency stop switch mounted on the exterior of the generator enclosure in an easily accessible location as determined by the OWNER. The remote emergency stop switch shall be mushroom head type, housed in a NEMA 4X wall mount enclosure, permanently labeled as “Generator Emergency Stop”.
- E. Provide automatic shutdowns with fault light alarm indicators for each of the following conditions:
1. High coolant temperature
 2. Low coolant level
 3. Low lubricating oil pressure
 4. Engine overspeed
 5. Engine overcrank
 6. Over voltage
 7. Emergency Stop
- F. The controls shall include automatic pre-alarms for the following conditions with fault lights for each:
1. Low coolant temperature
 2. Approach high coolant temperature
 3. Approach low lube oil pressure
 4. Switch not in AUTO position
 5. Low battery voltage

6. Generator breaker tripped
 7. Battery charger alarm
- G. The control panel shall include an audible alarm horn to signal any of the alarm shut down or pre-alarm conditions. Alarms shall not reset and the alarm horn shall not shut off until manually acknowledged, and fault lights shall not reset until the fault is resolved. Provide lamp test pushbutton and alarm acknowledge pushbutton.
- H. Arrange the control panel to accept remote dry contact closure for generator circuit breaker tripped alarm and battery charger failure alarm; display the alarm condition as an individual labeled alarm on the alarm panel; and include the alarm condition in the remote common pre-alarm output.
- I. The controls shall include one normally open and one normally closed electrical relay dry contact rated 10 amperes at 120 volts A.C., for operation of a remote alarm on activation of any one or more of the pre-alarm conditions listed above, and shall include one normally open and one normally closed electrical relay dry contact, rated 10 amperes at 120 volts A.C., for operation of a remote alarm on activation of any one or more of the shut-down conditions listed above.
- J. The control panel shall include three sets of normally open/normally closed dry contacts, rated 10 amperes at 120 volts A.C. that shall activate upon engine run.
- K. Arrange the generator control panel for the following field wiring connections. Provide numbered terminal strip connections for each.
1. Remote start/stop - dry contact closure input from the automatic transfer switch - battery voltage pair
 2. Remote emergency stop - dry contact open input from the remote emergency stop station – battery voltage pair.
 3. Generator breaker open - dry contact closure input from the generator main breaker –battery voltage pair.
 4. Engine run - three dry contact open/close output from the generator control panel for remote connection – 120 Volt pairs
 5. Generator shut-down alarm – dry contact open/close output from the generator control panel for remote connection – 120 Volt pair
 6. Generator trouble alarm – dry contact open/close output from the generator control panel for remote connection – 120 Volt pair.
 7. Battery charger fault – dry contact closure input from the battery charger – battery

voltage pair.

8. Generator control switch in remote – dry contact closed when Auto/Manual switch is in the Remote position

2.06 ALTERNATOR AND EXCITATION SYSTEM

- A. The alternator shall be of the open drip-proof bracket type, especially designed for connection to the engine and shall be for the power output characteristics as described herein, designed to start and operate the specified loads. The alternator shall have Class H insulation with a temperature rise in accordance with NEMA MG1-22.40 under full rated load operation. The alternator shall have Amortisseur windings.
- B. The alternator shall be as manufactured by Caterpillar/Olympian. It shall have a forged or cast alloy steel flanged shaft for direct connection through a flywheel type coupling or adapter and disc coupling to the engine, and shall be of the single bearing type with anti-friction bearing.
- C. Brace the alternator windings to withstand any possible short circuit stresses. The windings shall withstand overheating or stresses caused by harmonics generated by pulse width modulated variable frequency drives and solid state starters. The alternator shall be "Radio Interference Proof" (RIP) and the "Telephone Influence Factor" (TIF) shall be within the limits of Section 9, ANSI C50.12.
- D. The alternator shall be brushless with a rotating permanent magnet generator type excitation system with Class H insulation.
- E. The alternator shall include a complete voltage regulating system that shall hold the alternator voltage output within the limits specified herein. The voltage regulator shall be solid state digital (Volts/Hz) with RFI filters and associated controls. The voltage regulator shall provide regulation within 0.25 percent no load to full load, with temperature drift of not more than 0.5 percent. The regulator shall maintain precise control of the alternator output with up to 20 percent harmonic distortion in the output voltage. Provide means in the control panel for a minimum of plus or minus five percent manual voltage adjustment while the unit is running.
- F. The alternator stator core shall be 2/3 pitch, built of low carbon steel laminations, precision-punched, deburred and individually insulated. Insert the stator coils into insulated core slots. Wound core shall be vacuum impregnated with fungus resistant thermosetting synthetic varnish and baked for maximum moisture resistance, high dielectric strength and high bonding qualities. Armature lamination followers and frame ribs shall be welded integral with frame. Enclosure shall be drip-proof guarded and shall include rodent screens.
- G. Alternator rotor poles shall be of individually insulated steel punchings. Poles shall be vacuum impregnated with fungus resistant thermosetting synthetic varnish and baked

for maximum moisture resistance, high dielectric strength and high bonding qualities. Braze cage connections for strong construction and permanent electrical characteristics. Bolt each pole to the rotor shaft

- H. Provide a directional blower on the alternator shaft to draw cooling air from the exciter end, over the rotor poles and through louvered openings in the drive end.
- I. The alternator shall have a permanently lubricated anti-friction bearing. The designed bearing life, based on the B-10 curve of the American Bearing Manufacturers Association, shall be not less than 40,000 hours.
- J. Provide an automatic thermostatically controlled space heater rated 120 volt, single phase power supply to maintain not less than 32 degrees C temperature within the alternator enclosure with an outdoor ambient temperature of minus 23 degrees C to prevent the accumulation of condensation within the alternator enclosure under outdoor ambient conditions. Provide a grounded plug to connect to a 120 Volt receptacle or terminate the heater connection wiring in a junction box including a separate manual disconnect switch when the heater is not required for field wiring connection by the installing CONTRACTOR.
- K. The alternator shall include a NEMA I terminal box, sized to NEC clearances, and located to provide convenient arrangement inside the enclosure for access to the circuit breaker and wiring terminations. Provide potential transformers and current transformers in the terminal box for on board monitoring of generator output voltage and current.
- L. At any balanced load between 75 and 100 percent rated output, the difference in line-to-neutral voltage among the three phases shall not exceed one percent of the average line-to-neutral voltage. Under an unbalanced load, consisting of 25 percent load at 1.0 power factor placed between any phase and neutral and zero load on each of the other two phases, the maximum simultaneous difference in voltage between the three line-to-neutral phases shall not exceed three percent of rated line to neutral voltage.

2.07 GENERATOR MAIN CIRCUIT BREAKER

- A. Furnish one molded case, three pole, circuit breaker for three phase overloads and/or short-circuit protection. Current ratings shall be as required to protect the generator unit from overload or short circuit and shall be as shown on the Electrical Drawings. The circuit breaker shall operate either manually or electrically for normal switching functions and automatically during overload and short-circuit conditions. Circuit breaker shall be UL listed and rated per NEC requirements to carry the full ampere load of the generator. A manually actuated circuit breaker shall include contacts wired to the generator control panel to provide alarm if the breaker is in the "Tripped" or "Off" position. The short circuit rating of the generator circuit breaker shall be not less than 42,000 Amps RMS symmetrical.

1. The molded case circuit breaker shall provide inverse time and instantaneous tripping characteristics, shall be listed per UL 489 for applications at 100 percent of its continuous ampere rating in its installed enclosure.
2. The trip mechanism shall be quick-make, quick-break, mechanically trip-free over-center switching mechanism operated by a toggle-type handle. Handle shall indicate breaker position. A push-to-trip button mounted on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.
3. Trip units shall be adjustable, microprocessor-based, electronic overcurrent trip device with true three phase RMS sensing of sinusoidal and non-sinusoidal currents, with the following minimum features and functions:
 - a. Adjustable rating plugs interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed.
 - b. Trip mode indicators for ground fault, overload and short circuit.
 - c. An operator interface display panel showing diagnostic information and metering information.
4. Provide means to apply a padlock to lock the circuit breaker in the "OFF" position.

2.08 SOUND ATTENUATED WEATHERPROOF HOUSING

- A. Enclose the skid mounted generator unit, battery, battery charger, and exhaust silencer in a factory manufactured sound attenuated weather protected skin tight enclosure designed to meet the conditions set forth below. The enclosure shall comply with the National Electrical Code (NEC), and the National Fire Protection Association (NFPA) for clearance around electrical equipment as specified. The enclosure shall conform to the following design criteria:
 1. Rigidity wind test equal to 115 mph
 2. Roof load equal to 50 lbs per sq. ft.
 3. Rain test equal to 4-in per hour
 4. The enclosure shall bear a label certifying compliance with UL 2200.
- B. The enclosure shall have an interior width as required to provide minimum clearances on the sides and end of the generator set. The enclosure shall provide for continuous, unobstructed access on the two sides of the generator. The dimensions of the enclosure shall be such as to provide space for and NEC clearances for the generator set, the

generator circuit breaker, and the generator control panel.

- C. The enclosure shall be of lift-off design, consisting of a roof, walls, louvers, and hoods/baffles of frameless panel construction epoxy powder coated steel sheet minimum thickness of 0.080-in. All fasteners shall be concealed stainless steel self-tapping screws. Camber the roof to aid in rain run-off. Provide insulation in the walls and roof as required to meet the specified noise limitation criteria specified herein. Color shall be manufacturer's standard. Submit available color options.
- D. The base and underframe shall consist of two wide flange "I" beam or channel longitudinal skids, with fabricated steel crossmembers. Overlay crossmembers with 1/8-in thick steel plate welded to the crossmembers to provide a solid floor. A 3/4 inch pressure treated wood subfloor may be used between the crossmembers and the steel deck to provide further sound attenuation and for acoustic isolation of the generator and base assembly. Provide mounting to attach the lift-off enclosure to the base. Provide steel tapping plates coordinated with the generator set manufacturer, for anchoring the equipment within the enclosure. Provide floor openings for electric conduit stub-up where required for conduit wiring access to the equipment within the enclosure. The floor shall incorporate a diked perimeter to form a containment area for spilled fluids such as coolant and lubricating oil. The diked volume shall be at least 150 percent of the greatest fluid volume contained within the engine. The dike shall have steel edges welded and/or caulked to the floor. The conduit stub-up and any other floor penetrations shall be diked. The diked area may form the containment within itself, or it may slope and drain to a storage volume. All portions of the diked area shall be accessible for cleaning without removing covers or floor plates.
- E. Provide four-point lifting lugs at or near the corners of the enclosure base, with capacity for rigging the entire assembly. Provide two electrical grounding lugs mounted on the base for connection of the grounding system.
- F. Provide access doors on each side of the enclosure of sufficient quantity and opening to provide full access to each side of the generator set for maintenance and NEC required access and clearances to the generator circuit breaker. Doors shall consist of a steel frame with skin material matching the enclosure. Doors shall be fully gasketed to form a weathertight perimeter seal and include interior insulation the same as the wall insulation. Hinges shall be forged aluminum or stainless steel with stainless steel pins. Door handles/latches shall be of stainless steel, shall firmly latch the door closed, and shall incorporate means to apply a padlock. Doors shall provide a full 180 degree swing to provide unobstructed access to the enclosure interior when open. Provide a stainless steel hold-open latch on each door.
- G. Air handling during operation of the generator set shall be as follows: Air shall enter the enclosure through a louver, flow past the alternator and engine, pass through the radiator fan and radiator, and discharge through a louver. The system shall not exceed 0.5 inch w.g. total external static pressure to ensure adequate airflow for cooling and

combustion. Louvers shall be of formed and extruded steel and shall be screened with stainless steel coarse mesh screen. Louvers shall incorporate hoods or baffles as required to provide the specified sound attenuation.

- H. The enclosure shall include hardware to internally mount the specified exhaust silencer and maintain the weatherproof integrity of the system.
- I. Power supply for the jacket water heater, alternator space heater, battery charger, and one duplex grounded ground fault protected convenience outlet shall be hard wired by separate power supplies from a remote circuit breaker panel. Provide conduit and wire for these units to junction boxes for field wiring connection of AC service power by the installing CONTRACTOR. Furnish a four gang GFCI outlet box located to power the jacket heater, battery charger, and battery heater and for easy accessibility for use with portable equipment with conduit and wire extending to the junction box. All wiring shall be XHHW type and shall run within galvanized rigid steel conduit.
- J. All openings in the enclosure shall be screened, baffled, or otherwise closed to prevent the entrance of insects and rodents.
- K. The housing shall have signs on all four sides of the enclosure reading "Danger-High Voltage".
- L. It is the intent of this specification to provide complete compliance with all applicable codes, laws and regulations.

2.09 AUTOMATIC TRANSFER SWITCH

- A. Furnish, install, test and place into operation the automatic transfer switch with features, accessories and enclosure as specified herein. Automatic transfer switches shall be rated for [___] amperes, 480 volts, 3 phase, 3 wire, 65,000 A withstand/closing rating. The automatic transfer switch shall consist of an inherently double throw, 3 pole power transfer switch unit and a controller interconnected to provide complete automatic operation, and shall have three-position operation: closed to normal source, open, closed to standby source. Time delay between opening of the closed contacts and closing of the open contacts shall be a minimum of 400 milliseconds to allow for voltage decay before transfer is complete.
- B. Submit shop drawings and product data as follows:
 - 1. Equipment outline drawings and master drawing index showing elevation, plan and interior views, dimensions, weight, anchor bolt pattern and front panel layouts.
 - 2. Provide a list of all options, special features and ratings.

3. Conduit entrance drawings.
4. Furnish complete Bill of Materials indicating manufacturer's part numbers.
5. Assembly ratings including short circuit rating, voltage and continuous current.
6. Cable terminal sizes.
7. Instruction and renewal parts books.

C. Quality Assurance

1. The automatic transfer switches shall be UL 1008 listed for use in standby systems in accordance with Sections 517, 700, 701 and 702 of the National Electrical Code.
2. The automatic transfer switch 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.
3. The automatic transfer switch shall be ASCO 300 Series or equal.

D. Features and Accessories

1. The following accessories shall be furnished:
 - a. An adjustable time delay of 0 to 30 seconds shall be provided to override momentary normal source outages and delay all transfer and engine starting signals, factory set at 3 seconds.
 - b. Adjustable time delay on retransfer to normal shall be provided. Time delay shall be automatically bypassed if the generator fails and the normal source is available. Time delay shall be field adjustable from 0 to 30 minutes. (Set at 30 minutes).
 - c. An unloaded running time delay for generator cool down shall be provided. Time delay shall be field adjustable from 0 to 60 minutes. (Factory set at 5 minutes).
 - d. A time delay on transfer to standby shall be provided, factory set at 5 seconds but field adjustable up to 5 minutes.
 - e. Auxiliary contact to close when normal fails (for engine start).
 - f. Close differential adjustable relay under voltage protection on all three phases of the normal and standby sources, set to drop out at 80 percent of rated voltage and pick up at 90 percent of rated voltage. Over voltage relay

protection shall drop out at 104 percent of rated voltage and pick up at 2 percent below trip.

- g. Close differential adjustable relay under frequency sensing on all three phases of the generator source, set to drop out at 85 percent of rated frequency and pickup at 90 percent rated frequency. Over frequency relay protection shall drop out at 104 percent of rated frequency and pick up at 2 percent below trip.
- h. Voltage unbalance relay shall be set to drop out at 5 percent and pick up at 1 percent below drop out.
- i. Auxiliary Contacts
 - 1) One to close when normal fails (Status to computer)
 - 2) One to open on standby (Combustion air damper control)
 - 3) One to close on standby (Status to computer)
 - 4) One to close on standby (Generator Supplying Load)
 - 5) One to open on standby (Spare)
 - 6) One to close on normal (Status to computer)
 - 7) One to open on normal (Spare)
- j. A green pilot light to indicate when the automatic transfer switch is connected to the normal source. A red pilot light to indicate when the automatic transfer switch is connected to the standby source.

E. Enclosure

- 1. The automatic transfer switch shall be furnished with a NEMA 4X, 316 stainless steel enclosure.

F. Signage

- 1. The automatic transfer switch shall be furnished with a sign on all doors marked DANGER - 480 VOLTS - KEEP OUT. Letters shall not be less than 1-in high, 1/4-in stroke. Signs shall be laminated plastic, engraved white letters with a red background.

G. Field Testing

- 1. Perform the following minimum tests and checks on the automatic transfer

switch:

- a. Megger incoming line terminals and buses, phase-to-phase and phase-to-ground after disconnecting devices sensitive to megger voltage.
- b. Check polarity and continuity.
- c. Check mechanical interlocks for proper operation.
- d. Test ground connections for continuity and resistance.
- e. Adjust unit doors.
- f. Check control circuit interlocking and continuity. Provide external source of control power for this test.
- g. Adjust timing devices to their correct settings.
- h. Simulate power failure and demonstrate that the engine-generator automatically starts and the electrical load is transferred to standby power.
- i. Simulate restoration of normal power.

2.10 SURFACE PREPARATION AND SHOP PAINTING

- A. The engine driven generator set and associated equipment shall be shop primed and finished coated in accordance with the manufacturer's standard practice prior to shipment. Furnish an adequate supply of touch-up paint.

2.11 SHOP TEST

- A. Shop test the complete engine driven generator unit and the generator control panel prior to shipment. Submit the complete certified test record. The tests shall demonstrate that the unit will operate successfully and meet the specified operational requirements. The manufacturer shall furnish all instruments, filters, fuel, electric power and load banks for the test.
- B. The shop test shall include operation on a reactive load bank at 0.8 power factor at rated standby load. During operation, test and record voltage and frequency regulation, and voltage and current balance to confirm compliance with this specification. Perform tests to demonstrate transient response from zero load to full load, zero load to half load, and half load to full load. Test each of the automatic alarm and shut-down devices and record the settings at which the automatic devices actually alarmed and/or stopped the engine. Submit copies of the shop test record.
- C. During the factory test, take readings and record results for each of the following:

1. Time
 2. Ambient temperature.
 3. Load:
 - a. Volts [for each phase]
 - b. Amps [for each phase]
 - c. Kilowatts
 - d. Frequency
 - e. [Power Factor]
 4. Engine jacket water temperature
 5. Lubricating oil pressure
- D. Shop test the alternator in accordance with IEEE Standard 115. Testing shall include the following:
1. Cold resistance of all windings
 2. Insulation resistance of all windings
 3. Polarity of field coils
 4. High potential on all windings
 5. Open circuit saturation

PART 3 EXECUTION

3.01 INSTALLATION

- A. Provide the services of a factory field representative to check the installation of the generator unit and appurtenances, to ensure installation in accordance with the manufacturer's recommendations, perform check-out and start-up services, and conduct the field test.
- B. Mount the generator enclosure skid base on a concrete foundation and level to provide equal bearing for all supports as work of this section. Utilize grout or other approved means to level the mounting surface of the foundation to provide equal bearing for all supports. Furnish and install anchors in accordance with the submitted foundation design. Connect the unit to field wiring and to fuel supply piping.

- C. Installation shall include furnishing all required coolant and lubricants in accordance with the manufacturer's recommendations.

3.02 EQUIPMENT START-UP

- A. After installation and manufacturer's representative check of the installed equipment, operate the unit to demonstrate its ability to operate continuously without vibration, jamming, leakage or overheating and to perform specified functions.
- B. Comply with manufacturer's operating and maintenance instructions during start-up and operation.
- C. Promptly correct improper installation of equipment.
- D. Cooperate with supplier of equipment at time of start-up and in making of all final adjustments necessary to place equipment in satisfactory working order. Start-up shall not commence without the presence of the manufacturer's representative.

3.03 FIELD TEST

- A. Upon completion of installation and as soon as conditions permit, test the generator unit, controls, and appurtenances for acceptance, including load bank testing and operation under actual operating conditions, to demonstrate that operation is satisfactory. Before conducting the on-site field tests, submit a copy of the proposed field test log sheet. Prior to scheduling the test, notify the Engineer in writing that all requirements and provisions of the Contract Documents have been fulfilled, that all apparatus has been cleaned, properly adjusted, and is ready for operation, and that the Operation and Maintenance manuals have been submitted. Perform testing in the presence of the Engineer.
- B. The test shall consist of four hours of continuous operation of the engine driven generator unit at unity power factor using a temporary portable resistive load bank. Load shall be adjusted, starting with half hour intervals each at 1/4 load, 1/2 load, and 3/4 load followed by the remaining time at full load. Furnish the load bank plus all connecting cables, metering equipment, and other equipment or devices required, and fuel to perform the load bank testing. During the test, take and record the same readings as outlined under Shop Test, at fifteen minute intervals.
- C. As part of the field test, test each of the automatic alarm and shutdown devices and record the respective values at which the devices will alarm and/or stop the engine. Perform any adjustments required in the alarm settings to make the operating values correspond to those recommended by the engine manufacturer and as recorded during the shop test. Verify that each alarm point activates the designated remote alarm contact and that the monitoring and alarm connections to the SCADA system will activate the corresponding indications at the SCADA panel. Test the remote emergency stop. Testing shall include verification of proper voltage regulation,

transient voltage dip and recovery time, and voltage and current balance.

- D. After the load bank test has been completed, connect the generator to the facility load, and perform additional testing utilizing the main circuit breaker to simulate a utility power failure, to demonstrate the generator unit's ability to meet the automatic starting, load transfer, and motor starting requirements as specified herein, utilizing facility load as available. Operate the facility on generator power for at least 30 minutes then restore utility power via the main circuit breaker, to cause the transfer switching to reset and shut down the generator. Record generator operating parameters as specified above.
- E. Provide a person qualified to conduct sound pressure level testing, and test instrumentation, to take and record octave band sound pressure level readings at the time of the on-site field test, when operating the generator at maximum available station load (no load bank operation). The sound pressure readings shall be within the limits permitted by this specification. If changes are necessary to accomplish the required silencing, perform revisions as required and retest.
- F. If the standby power supply system fails to fulfill the requirements of this specification, perform corrections and retest the system to assure full compliance at no additional cost to the Owner.

3.04 TRAINING

- A. The equipment manufacturer shall furnish the services of a factory representative who has complete knowledge of proper operation and maintenance for a minimum of one, eight hour working day to instruct representatives of the Owner and the Engineer in the proper operation and maintenance of the equipment.
- B. Training shall be provided at the site and timed to accommodate all working shifts, including some late evenings, and early mornings. The instruction period shall be scheduled at least ten working days in advance with the Owner and shall take place prior to start-up and acceptance of the equipment by the Owner. Training shall include system operations, preventive maintenance, and troubleshooting.
- C. Submit, at least 30 working days prior to the start of training, a training syllabus that includes the above requirements, proposed dates and times for training, and instructor resume. Training may not commence until the first draft of the O&M manual has been submitted for review.

END OF ATTACHMENT B

3.3.10 Attachment C: Remote Telemetry Unit, Instrumentation and SCADA System Interface

ATTACHMENT C
REMOTE TELEMETRY UNIT, INSTRUMENTATION
AND SCADA SYSTEM INTERFACE

PART 1 GENERAL

1.01 SCOPE OF WORK

- A. The Contractor shall utilize the services of the pre-selected Instrumentation and Control System Integrator to furnish a new remote telemetry unit (RTU), instrumentation and control devices, and system integration of the new RTU into the City’s existing SCADA system. Primary components of this system shall include:
- B. The new RTU will monitor the new Pump Control Panel via hardwired I/O and serial or Ethernet communications as specified below. The RTU shall include a programmable logic controller (PLC), communications devices (radio, cellular and/or fiber optics), and other ancillary components as required to interface to the City’s existing supervisory control and data acquisition (SCADA) system.
- C. Communication shall be by cellular unless cellular communication is unavailable on the site.
- D. If radio communication is utilized, the new RTU will communicate with the existing SCADA system using the Owner’s existing radio telemetry infrastructure. . If required, a wooden pole or galvanized steel antenna tower shall be supplied to mount an antenna to a height sufficient to attain a received signal strength indication (RSSI) at the site of at least -90 dBm.
- E. Programming for the human machine interface (HMI) software and PLC-based RTU shall follow the Metro Wastewater Treatment SCADA Standards and Conventions document.

1.02 DUPLEX PUMP STATIONS – LESS THAN 100 HP

- A. For pump stations using motors of less than 100 horsepower, the following I/O originating in either the RTU or the Pump Control Panel shall be monitored by the SCADA system:
 - Digital Input #1: Pump #1 - Run Status
 - Digital Input #2: Pump #1 - In Auto
 - Digital Input #3: Pump #1 – Failure/Thermal Overload Alarm
 - Digital Input #4: Pump #2 - Run Status
 - Digital Input #5: Pump #2 - In Auto
 - Digital Input #6: Pump #2 – Failure/Thermal Overload Alarm

Digital Input #7:	High Wet Well Level Alarm
Digital Input #8:	Spare
Digital Input #9:	Low Wet Well Level Alarm
Digital Input #10:	Generator Run Status
Digital Input #11:	Generator Common Alarm
Digital Input #12:	Generator in Auto Mode
Digital Input #13:	Generator Emergency Stop
Digital Input #14:	Generator Supplying Load
Digital Input #15:	AC Power Surge Protection Device Failure
Digital Input #16:	Pump Control Panel AC Power Loss, Phase Failure, or Phase Reversal
Digital Input #17:	Automatic Transfer Switch Position (<i>See Note 1 below.</i>)
Digital Input #18:	Spare
Digital Input #19:	RTU Loss of AC Power
Digital Input #20:	RTU Door Open/Closed Status
Analog Input #1:	Wet Well Level
Analog Input #2:	Spare
Analog Input #3:	Spare
Analog Input #4:	Spare

Note 1: The position of the Automatic Transfer Switch (ATS) is to be monitored for stations which have permanently installed generators.

1.03 DUPLEX PUMP STATIONS – EQUAL TO OR GREATER THAN 100 HP

- A. For pump stations using motors of equal to or greater than 100 horsepower, the following I/O originating in either the RTU or the Pump Control Panel shall be monitored by the SCADA system:

Digital Input #1:	Pump #1 - Run Status
Digital Input #2:	Pump #1 - In Auto
Digital Input #3:	Pump #1 - Failure/Thermal Overload Alarm
Digital Input #4:	Pump #2 - Run Status
Digital Input #5:	Pump #2 - In Auto
Digital Input #6:	Pump #2 - Failure/Thermal Overload Alarm
Digital Input #7:	High Wet Well Level Alarm
Digital Input #8:	Spare
Digital Input #9:	Low Wet Well Level Alarm
Digital Input #10:	Generator Run Status
Digital Input #11:	Generator Common Alarm
Digital Input #12:	Generator in Auto Mode
Digital Input #13:	Generator Emergency Stop
Digital Input #14:	Generator Supplying Load
Digital Input #15:	AC Power Surge Protection Device Failure
Digital Input #16:	Pump Control Panel AC Power Loss, Phase Failure, or

	Phase Reversal
Digital Input #17:	Automatic Transfer Switch Position (<i>See Note 1 below.</i>)
Digital Input #18:	Spare
Digital Input #19:	RTU Loss of AC Power
Digital Input #20:	RTU Door Open/Closed Status
Analog Input #1:	Wet Well Level
Analog Input #2:	Spare
Analog Input #3:	Spare
Analog Input #4:	Spare
Serial Input #1:	Pump #1 - Ground Current Fault
Serial Input #2:	Pump #1 - Thermal Overload Fault
Serial Input #3:	Pump #1 – Jam Fault
Serial Input #4:	Pump #1 - Current Phase Imbalance Fault
Serial Input #5:	Pump #1 - Overcurrent Fault
Serial Input #6:	Pump #1 - Current Phase Loss Fault
Serial Input #7:	Pump #1 – Motor Temperature Sensor Fault
Serial Input #8:	Pump #1 - Voltage Phase Imbalance Fault
Serial Input #9:	Pump #1 - Voltage Phase Loss Fault
Serial Input #10:	Pump #1 – Voltage Phase Reversal Fault
Serial Input #11:	Pump #1 – Undervoltage Fault
Serial Input #12:	Pump #1 - Overvoltage Fault
Serial Input #13:	Pump #1 – Overpower Fault
Serial Input #14:	Pump #1 – Controller Internal Temperature
Serial Input #15:	Pump #1 - Line 3 to Line 1 Voltage
Serial Input #16:	Pump #1 - Line 1 to Line 2 Voltage
Serial Input #17:	Pump #1 - Line 2 to Line 3 Voltage
Serial Input #18:	Pump #1 - Power Factor
Serial Input #19:	Pump #1 - Active Power
Serial Input #20:	Pump #1 - Reactive Power
Serial Input #21:	Pump #1 - Line 1 Current
Serial Input #22:	Pump #1 - Line 2 Current
Serial Input #23:	Pump #1 - Line 3 Current
Serial Input #24:	Pump #1 – Altistart Thermal Overload Alarm
Serial Input #25:	Pump #2 - Ground Current Fault
Serial Input #26:	Pump #2 - Thermal Overload Fault
Serial Input #27:	Pump #2 – Jam Fault
Serial Input #28:	Pump #2 - Current Phase Imbalance Fault
Serial Input #29:	Pump #2 - Overcurrent Fault
Serial Input #30:	Pump #2 - Current Phase Loss Fault
Serial Input #31:	Pump #2 – Motor Temperature Sensor Fault
Serial Input #32:	Pump #2 - Voltage Phase Imbalance Fault
Serial Input #33:	Pump #2 - Voltage Phase Loss Fault
Serial Input #34:	Pump #2 – Voltage Phase Reversal Fault

Serial Input #35:	Pump #2 - Undervoltage Fault
Serial Input #36:	Pump #2 - Overvoltage Fault
Serial Input #37:	Pump #2 – Overpower Fault
Serial Input #38:	Pump #2 – Controller Internal Temperature
Serial Input #39:	Pump #2 - Line 3 to Line 2 Voltage
Serial Input #40:	Pump #2 - Line 2 to Line 2 Voltage
Serial Input #41:	Pump #2 - Line 2 to Line 3 Voltage
Serial Input #42:	Pump #2 - Power Factor
Serial Input #43:	Pump #2 - Active Power
Serial Input #44:	Pump #2 - Reactive Power
Serial Input #45:	Pump #2 - Line 1 Current
Serial Input #46:	Pump #2 - Line 2 Current
Serial Input #47:	Pump #2 - Line 3 Current
Serial Input #48:	Pump #2 – Altistart Thermal Overload Alarm

Note 1: The position of the Automatic Transfer Switch (ATS) is to be monitored for stations which have permanently installed generators.

1.04 TECHNICAL SERVICES:

- A. The Instrumentation and Control System Integrator shall provide both engineering and system integration services during the course of this project as described herein.
- B. Provide all project management and system design services required to insure a fully functional SCADA system which meets the intended system functionality as described herein.
- C. Prepare and submit detailed shop drawings as submittals for approval.
- D. Develop and fully annotate all PLC programming. As-built PLC program and configuration files shall be furnished to the Owner in their native formats.
- E. Develop and fully document all HMI applications software. As-built HMI program and configuration files shall be furnished to the Owner in their native formats.
- F. Provide the onsite services of a factory trained field service engineer to startup, calibrate, and place into service all computer hardware, instrumentation, communication equipment, PLC-based control panels, and other ancillary devices and equipment as required to achieve a fully operational and functional system.
- G. Provide the onsite services of a factory trained software engineer to startup the system and to work with the factory trained field service technician to thoroughly test the entire system. Results of all testing shall be documented in writing on a site by site basis, and record copies shall be furnished to the Owner.
- H. Provide the onsite services of a factory trained field service technician to perform

training of personnel in the area of troubleshooting the specific equipment supplied.

- I. Provide the onsite services of a factory trained software engineer to perform training of personnel in the area of the human-machine-interface (HMI) applications software as applied specifically to this system.
- J. Provide the onsite services of a factory trained field service technician and factory trained software engineer to make repairs to the system during the one year warranty period.

1.05 QUALITY ASSURANCE:

- A. The Instrumentation and Control System Integrator shall maintain a staff of service engineers and technicians that are full-time employees of the integrator and are headquartered within a 100-mile radius of the City of Columbia, South Carolina.
- B. The Instrumentation and Control System Integrator shall provide or supply all testing, calibration, start-up, preparation of operation and maintenance manuals, and operator training specified herein, without additional cost to the OWNER.
- C. The Instrumentation and Control System Integrator shall design and furnish a complete, integrated and functionally operating system warranted to perform the intended functions as herein specified.
- D. The Instrumentation and Control System Integrator shall be a certified member of the Control System Integrator Association (CSIA).
- E. The pre-approved Instrumentation and Control System Integrators are:
 - 1. CITI, LLC, Charlotte, North Carolina.
 - 2. MR Systems, Inc. with office in Charlotte, North Carolina.
- F. Alternative suppliers must submit a minimum of three (3) references of projects of similar scope and size completed in the last five years, the name of the licensed Professional Engineer on staff who will seal the design, and the firm's South Carolina Certificate of Authorization to practice consulting engineering in the State and a copy of their South Carolina Electrical Contractor's License.

1.06 SUBMITTALS

- A. Comply with other pertinent provisions of this specification.
- B. Product data: Within 60 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
 - 1. Component manufacturing data sheet indicating pertinent data and identifying

each component by item number and nomenclature as indicated on the drawings and in the specifications.

2. Component drawing showing dimensions, mounting and external connection details.
3. System wiring schematics, each on a single drawing with full description of operation. Component identification on the schematic shall be as indicated above.
4. A system schematic of the hardware with the component manufacturing data sheets for each item, including all system peripherals.
5. A printed copy of each control and monitoring screen and each regulator report form. A complete description of each screen shall accompany the print.

C. Provide Operation and Maintenance manuals.

1. Operating instructions shall incorporate a functional description of the entire system, including the system schematics which reflect “as-built” modifications.
2. Special maintenance requirements particular to the system shall be clearly defined along with special calibration and test procedures.
3. As part of the operation and maintenance manuals, provide three hard copies of the program used to program the programmable logic controller, fully commented and documented.

D. Purchase any and all software packages required for the system in the name of the Owner. All warranties associated with the hardware and software shall be in the name of the Owner.

E. Provide to Engineer for approval any changes, additions, corrections, etc. required to the Bid Documents that are needed to accommodate the system being proposed. The changes, additions, corrections, etc. shall be at the Contractor's expense and shall be included in his Bid.

1.07 COORDINATION OF WORK

A. Coordinate work of this Section with work of other sections.

The Instrumentation and Control System Integrator shall be responsible for reviewing the contract documents that could affect this portion of the work.

B. Plans and specifications, especially instrumentation/electrical and wiring requirements, have been formulated in an attempt to satisfy the conditions for any system proposed. However, a vendor may find that some changes or additional conduit and wiring from that indicated may be required to accommodate particular

equipment being proposed. Should this be the case, the vendor shall include in his bid price, all changes or additional requirements necessary for the system. After award of contract, revised drawings must be submitted for approval indicating any changes prior to any changes being implemented.

1.08 PRODUCT DELIVERY, HANDLING AND STORAGE

- A. Schedule the delivery of the equipment to coordinate with the project completion schedule. Each item of equipment to be tagged with identifying number shown on the Shop Drawings.
- B. Contractor's attention is directed to the fact that equipment has delicate components and extreme care shall be taken in handling to avoid internal and/or external damages.
- C. Damaged equipment will not be accepted.
- D. Equipment not for immediate use shall be stored inside a building, with enclosures under protective coverings and shall be fully protected from moisture, extreme heat and vibration.

1.09 WARRANTY

- A. Systems supplier shall furnish a hardware and software maintenance contract for the computer system, providing a response 24 hours a day, 7 days a week, 365 days a year, for the length of the one (1) year warranty period, from written acceptance.
 - 1. For any service visit during this period, provide the Owner and Engineer with a written report stating the reason for equipment failure and recommendations to prevent recurrence.
- B. At the end of this period, the maintenance contract shall be made available for transfer to the Owner.

PART 2 PRODUCTS

2.01 GENERAL

- A. The total control and monitoring system shall consist of a series of individual control and monitoring sub-systems, each configured to perform a specific function associated with the total plant operational scheme.
- B. All equipment and materials shall be new, unused and proved by previous use of similar products to be completely suitable for the service intended.
- C. All of the equipment shall be the manufacturer's latest and proven design. Specifications and drawings call attention to certain features but do not purport to cover all details entering into the design of the SCADA system. The completed

system shall be compatible with the functions required and other equipment furnished by the Contractor.

- D. All electrical components of the system shall be powered by 120V, single phase, 60 cycle current, except as otherwise indicated or specified.
- E. All contacts for control, remote motor operated, or electrically operated equipment shall be rated not less than 10 amperes on 120V unless otherwise specified herein.
- F. All systems and individual components, whether panel or field mounted units, shall be protected from voltage and/or current surges which may originate as a result of lightning or other external causes.
 - 1. Protective equipment to be provided by the Instrumentation and Control System Integrator and installed in accordance with his recommendations.
 - 2. Schematics of the instruments submitted for approval to the Engineer shall indicate how this protection will be provided and identify the items of equipment which shall be used for this purpose.
- G. System manufacturer to supply “as-built” drawings containing all necessary information for proper maintenance and operation of the system.
 - 1. Wire log table showing connections (wire terminations) between all furnished components to be supplied to facilitate field wiring.
 - 2. Interconnection information between system components and equipment found in other sections of these Specifications shall be complete with all necessary interconnection information.
 - 3. Notes which refer to equipment manufacturer’s drawings for proper interconnection will not be acceptable.
 - 4. Provide within 30 days after startup and after any field modifications.

2.02 PLC-BASED REMOTE TELEMETRY UNITS (RTUs)

- A. General: Each PLC-based Remote Telemetry Unit (RTU) shall be comprised of a programmable logic controller (PLC) with radio, modem, or fiber transceiver, surge arrestors, relays, power supplies, terminal strips, solar shields, heater and thermostat, circuit breakers, utility light, GFI utility outlet, enclosure, and other appurtenances as required for a fully functioning and fully operational system.
- B. Enclosure
 - 1. The programmable logic controller (PLC) and associated required components shall be housed in a metallic enclosure and shall be constructed in accordance

with the following requirements.

2. **Materials of Construction and Rating for Outdoor Panels:** For panels mounted outdoors, the RTU enclosure shall be constructed of #304 stainless steel unless otherwise noted and shall meet or exceed the NEMA 4X rating. Access doors shall have continuous stainless steel hinges and approved latching. Internal bracing shall be supplied as required for rigidity. Provide 3-point padlockable door handle.
 - a. **Solar Shields:** For panels mounted outdoors, each RTU enclosure shall be provided with top, front, and side solar shields. Solar shields shall be constructed of aluminum and shall be painted white.
 - b. The top solar shield shall overhang the side solar shields.
 - c. Four (4) 1½” long by ¼” diameter weld studs shall be stud-welded to the RTU enclosure for each solar shield.
 - d. For sites which will have a canopy covering the RTU panel only a front solar shield will be required.
3. **Materials of Construction and Rating for Indoor Panels:** For panels mounted indoors, the RTU enclosure shall be constructed of painted carbon steel unless otherwise noted and shall meet or exceed the NEMA 4 rating. Access doors shall have continuous stainless steel hinges and 3-point latch. Internal bracing shall be supplied as required for rigidity.
4. **Heat Load Calculations:** The Instrumentation and Control System Integrator shall perform heat load calculations and will insure that the enclosure is properly sized to allow for adequate cooling.
5. **RTU Door Open/Closed Limit Switch:** A single pole double throw (SPDT) limit switch shall be mounted on the door of the RTU enclosure. When the RTU door is open (i.e. “normal” state), the normally closed contact of the limit switch will be wired to operate the RTU LED utility light. When the RTU door is closed, the normally open contact of the limit switch will “make” to generate an “RTU Door Closed” signal directly wired to one of the PLC’s digital inputs.
6. **Heater and Thermostat:** An electronic heater and thermostat shall be supplied inside each RTU enclosure to prevent condensation.
7. **Corrosion Protection:** Anti-corrosion inhibitor blocks shall be mounted inside each RTU enclosure to reduce corrosion. Corrosion inhibitors shall be Hoffman Model A-HCI10E or equal.
8. **Utility Light:** An LED linear light bar fixture shall be mounted to the top inside of

the RTU panel using stud welds. When the RTU door is opened, the LED utility light will be switched on by the SPDT door limit switch specified above.

C. Power Distribution

1. AC Power Surge Protector: An Edco AC power surge protector shall be installed integral to the RTU to provide transient and surge protection for incoming AC power.
2. Circuit Breakers: Two (2) circuit breakers shall be provided integral to the RTU panel. One circuit breaker shall provide branch circuit protection for the RTU's internal DC power supplies. The second circuit breaker shall provide protection for the duplex GFI utility outlet specified below.
3. Duplex GFI Utility Outlet: A separate duplex GFI utility outlet, protected by the AC power surge protector and a circuit breaker, shall be installed in the RTU enclosure to provide AC power for test equipment or other uses.

Uninterruptible Power Supply (UPS): The RTU must remain powered for a limited time in the event of commercial AC power failure. A 120VAC UPS unit shall be provided in accordance with UL requirements. Furnish the APC BE750G

4. DC Power Supplies: All DC power supplies shall be protected via indicating 3 AG size fast acting fuses. Indicating fuse holders shall be utilized and shall be DIN-rail-mounted.

D. Programmable Logic Controller and I/O

1. Programmable Logic Controller: Provide one (1) Allen-Bradley MicroLogix 1400 programmable logic controller (#1766-L32AWA).
2. Minimum I/O Complement: As a minimum, the PLC supplied for each RTU shall support the following minimum available I/O complement: 16 digital (120VAC discrete) inputs, 4 analog inputs (4-20 mA or 1-5 VDC). Analog input module #1762-IF4 shall be used. Actual I/O shall be supplied in accordance with the table included herein.
3. Digital Input Signal Surge Protection: All PLC digital inputs, including spare digital inputs, shall be individually fused. A minimum of four (4) spare digital inputs shall be provided and fully wired to accommodate utility signals such as AC power failure and RTU door open/closed.
4. Analog Input Signal Surge Protection: Each PLC analog input, including spare analog inputs, shall be protected from field generated current or voltage transients or surges using 3-stage surge/transient suppression devices. The first level of protection shall be via a 1/4 Amp 3AG size fast acting fuse. Secondary and

tertiary protection shall be fulfilled using a combination of a three terminal gas discharge tube and a metallic oxide varistor (MOV) surge protector with current limiting resistors. Analog signal surge protectors shall be Phoenix Contact or equal.

5. Field Wiring Terminations: All field wiring terminations for digital signals shall be made to terminal strips capable of accommodating up to #12 AWG wire. Terminal strips shall be mounted using DIN rails. Acceptable terminal strips shall be manufactured by Weidmuller, Phoenix Contact, Allen-Bradley, or Square D. Factory-printed wire labels shall be used to identify the panel terminal number for each field wire terminated in the panel.

E. Communications:

1. The RTU shall support the following communications hardware. The specific communications supplied shall be based upon the results of a radio path analysis performed by the Instrumentation and Control System Integrator and his subsequent recommendation.
 - a. Primary communication method (Cellular):
 - i. Cellular Modem: Sierra Wireless (Verizon)
 - ii. Cellular Router: Mikrotik RB/750 or approved equal.
 - iii. Cellular Antenna: Furnish and mount an antenna as required to achieve -80dB or better signal strength.
 - b. Secondary communication method (Radio): GE iNet-II or GE SD9, 900MHz.
2. Communications Protocol: The RTU shall be capable of communicating with the SCADA system using the following industry standard communications protocols: Modbus Serial or RTU, Modbus TCP/IP, or Ethernet/IP.
3. RF Surge Protector: For RTUs utilizing a radio, provide one (1) bulkhead mounting RF Surge protectors mounted in the bottom of the RTU enclosure. This device will provide voltage and current transient and surge protection for the radio signal from the antenna and will also facilitate conversion of the antenna feedline cable to the RTU panel.
4. RF Jumper Cable: For RTUs utilizing a radio, provide and install one (1) superflex RF jumper cable between the RF surge protector bulkhead adapter and the radio.

F. Options:

1. Where identified herein provide one or more of the following options.
 - a. Ethernet switch, unmanaged.
 - b. Ethernet switch, managed.
 - c. Other custom or special options as identified herein or as shown on the contract drawings.

2.03 DIRECTIONAL (YAGI) ANTENNA FOR RADIO COMMUNICATION

- A. For remote sites which shall communicate via 900 MHz radio, provide and install Yagi antennas as specified below.

Frequency Range	890 to 960 MHz
Nominal Gain	10 dB, minimum (RSSI to be -90 dB or better)
Maximum Power Input	100 watts
Nominal Impedance	50 ohms
Radiator Material	Aluminum 6061-T6
Mounting Method	Clamp Set
Rated Wind Velocity	150 mph
Wind Loading	0.71 square feet
Overall Length	5 feet
Connector Type	N female

- B. Yagi antennas shall be Laird Technologies Model Y1505.

2.04 RF TRANSMISSION CABLE

- A. The transmission cable connecting the radio transceiver with the antenna shall be a low-loss foam-dielectric type. Coaxial cable shall be sized upon the distance of cable run between radio and antenna in accordance with the following table:

Distance	Cable Type
0 to 100 feet	1/2" Foam CELLFLEX
100 to 225 feet	7/8" Foam CELLFLEX Ultra-flexible
225 to 350 feet	1-1/4" CELLFLEX Premium Attenuation Cable

- B. Provide two (2) Andrew ground strap kits to match coaxial cable size and Andrew cable hangers as required. Install one ground strap just below the antenna at top of mast and one ground strap at bottom of mast.

- C. Provide a six-foot section of "super-flex" transmission cable at the radio antenna port. Make this section pass through the enclosing panel and the control building exterior wall. Provide standard Type N connectors for connection to a continuous piece of cable extending to the antenna. Provide weatherproof transmission cable, suitable for direct environmental exposure. Use "O" ring seals on connections. The System shall utilize appropriate bulkhead RF transmission cable surge suppression devices at cable entrances, Phoenix Contact, Polyphaser, or equivalent.

2.05 Bulkhead-mounted RF Surge Protector and RF Surge Protector Enclosure

- A. Provide one bulkhead-mounted Phoenix Contact CoaxTrab RF Surge Protector mounted in the bottom of the RTU enclosure. This device will provide a weather proof termination for the antenna feedline to the RTU. The Instrumentation and Control System Integrator shall securely waterproof this connection using weatherproof heat-shrink product suitable for outdoor exposure.
- B. Provide an RF Surge Protector Enclosure consisting of a Phoenix Contact CoaxTrab RF surge protector housed in a NEMA 4X polycarbonate enclosure with ground bus bar.
- C. The RF Surge Protector Enclosure shall be mounted at the base of the antenna pole or tower and shall be bonded to the system ground of the pump station.

2.06 ANTENNA MOUNTING POLES OR TOWERS

- A. For an antenna mounted less than 52 feet above grade a wooden pole may be supplied.
- B. For an antenna mounted more than 52 feet above grade a galvanized antenna tower shall be supplied.
- C. Provide grounding in accordance with NEC 2008 requirements. This includes bonding of the antenna ground to the system ground of the pump station. The grounding conductor shall be #6 AWG solid copper minimum.
- D. Run the coaxial antenna cable on the opposite side of the antenna structure from the ground conductor.
- E. Each wooden utility pole shall be treated with Pentachlorophenol wood preservative. All utility poles shall adhere strictly to AWWA Standards to provide quality controlled pressure treated wood.
- F. Provide a 2" galvanized mast for each antenna pole.
- G. Provide grounding kits and other required accessories as required for a neat and professional installation.
- H. Utility poles shall be supplied and installed for the various locations as identified in

the Telemetry System

2.07 COMPUTERIZED RADIO PATH ANALYSIS AND ONSITE RADIO TESTING

- A. When radio communication is to be used, the Instrumentation and Control System Integrator shall perform a computerized radio path analysis to determine whether radio communications are feasible between the new facility and the Owner's existing radio telemetry system.
- B. The design goal is for the received signal strength indication (RSSI) to be better than -90 dBm at the new facility.
- C. If the results of the Computerized Radio Path Analysis are marginal (i.e. not less than -90 dBm when foliage is considered) then the Instrumentation and Control System Integrator shall perform an onsite radio test using a bucket truck to verify the height of antenna required to achieve the minimum RSSI of better than -90 dBm.
- D. If the results of both the Computerized Radio Path Analysis and the Onsite Radio Testing indicate that an acceptable RSSI (better than -90 dBm) cannot be achieved with an antenna height at the new station of no greater than 80 feet, the Owner and Engineer, working with the Instrumentation and Control System Integrator, will identify an alternative means of communications. Such alternatives may include an antenna mast or tower greater than 80 feet in height, cellular communications or other alternatives. Additional costs for the selected alternative shall be borne by the Owner.

PART 3 EXECUTION

3.01 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

3.02 INSTALLATION

- A. Coordinate as required with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.
- B. Install the work of this Section in strict accordance with the original design and the manufacturer's recommended installation procedures as approved by the Engineer, anchoring all components firmly into position for long life under hard use.
- C. Perform all wiring.
 - 1. Final connections and/or terminations for all 120 volt and higher power wiring indicated on the electrical drawings and in this division of the specifications shall

be made by the electrical contractor unless otherwise noted.

2. Final connections and/or terminations for all signal, data and low voltage control wiring indicated on the electrical drawings and in this division of the specifications (shielded cable, fiber optic cable and #14 AWG wiring) shall be made by the appropriate system or equipment vendor or integrator unless noted otherwise.
3. Equipment supplied under other divisions of the specifications that require electrical connections under this division shall be provided with Engineer approved wiring and termination diagrams.

3.03 APPLICATIONS SOFTWARE DEVELOPMENT

- A. The existing Wonderware InTouch application shall be modified as required to include 3-D graphics displays for each new or improved remote site. Reports, graphics displays, real-time trends, historical trends, security, and alarming shall be developed or modified by the Instrumentation and Control System Integrator via a collaborative effort including the Engineer and Owner. Graphics displays shall be designed by the Instrumentation and Control System Integrator for each new or improved remote site.
- B. Graphics displays shall be fully colorized representations of the various plant facilities and shall be based upon plan and elevation representations of the facilities taken from AutoCad drawings provided by the Owner/Engineer.
- C. Screen development and attribute names shall comply with the Metro Wastewater Treatment SCADA Standards and Conventions document.

3.04 GRAPHIC DISPLAY DESIGN MEETING AND SUBMITTALS

- A. A two (2) hour graphic display design meeting shall be held with the Engineer and Owner's personnel to discuss specific details of overall design of the graphic displays including discussions of the particular signals which are to be displayed on each graphic display.
- B. Prior to the meeting the instrumentation and control system vendor shall submit detailed sketches of the proposed graphics displays to the Engineer for review.
- C. This meeting can be conducted via conference call or onsite at the Owner's or Design Engineers Office.

3.05 PROCESS CONTROL STRATEGY DESIGN MEETING AND SUBMITTALS

- A. A two (2) hour process control strategy design meeting shall be held with the Engineer and Owner's personnel to discuss specific details of the control strategies which are to be developed for the system.

- B. Prior to the meeting the instrumentation and control system vendor shall submit a detailed narrative for each of the proposed control strategies to the Engineer for review.
- C. This meeting can be conducted via conference call or onsite at the Owner's or Design Engineers Office.

3.06 REPORT DEVELOPMENT DESIGN MEETING AND SUBMITTALS

- A. A two (2) hour report strategy design meeting shall be held with the Engineer and Owner's personnel to discuss specific details of integration of RTU data into HACH WIMS.
- B. This meeting can be conducted via conference call or onsite at the Owner's or Design Engineers Office.

3.07 PLC APPLICATION DEVELOPMENT

- A. The Instrumentation and Control System Integrator will coordinate with the Owner and Engineer to develop the following PLC application features for interface with the SCADA system.
 - 1. Estimated inflow calculations.
 - 2. Pump draw down estimates for each cycle of each pump.
 - 3. Elapsed run time and start counter calculations for each pump. These values shall be displayed in the SCADA graphic display screens.
 - 4. Other features as desired by the Owner.
- B. PLC naming conventions and program elements shall comply with the Metro Wastewater Treatment SCADA Standards and Conventions document.

3.08 SPARE PARTS

- A. Provide qty.(5) fuses of the type used for digital inputs.
- B. Spare parts shall be delivered to the owner at time of final acceptance and before final payment.

3.09 TRAINING

- A. System supplier to provide operation and maintenance training for Owner's personnel to ensure their adequate knowledge of use of the system.
- B. Training to be conducted on-site by instructors thoroughly familiar with operation of

the system, with training divided into three general areas as follows:

1. Analog and digital hardware maintenance training:
 - a. Instruct Owner's maintenance personnel in the proper preventative maintenance and repair tasks associated with system maintenance.
 - b. For analog instrumentation, include detailed instruction of calibration and checking along with familiarization training for basic repair and maintenance tasks that are expected to be encountered.
 - c. For computer hardware maintenance, include general familiarization with computer hardware and peripheral devices with instruction in preventative maintenance tasks associated primarily with peripheral devices. It is not intended that this course will produce trained computer maintenance technicians.
 - d. Include detailed instruction in maintenance and repair work associated with the computer process I/O sub-system.
2. Operator familiarization training:
 - a. Instruct Owner's operating personnel in the proper use of the analog and digital process control system.
 - b. Include instruction in the system control steps and basic interface with the computer system.
 - c. Provide sufficient training to Owner's operating personnel so they can respond to the normal tasks required for operation of the plant.
3. Supervisor and application software training:
 - a. Provide supervisory personnel with a working knowledge of all application software supplied.
 - b. Include basic digital and computer concepts, process control concepts, database configuration, report configuration, graphic display configuration, and control strategy development.
4. Follow-up Training:
 - a. Approximately 60 days after system start-up follow-up training shall be provided.
 - b. The training shall answer any questions on the day to day use of the system.

3.10 START-UP SERVICES

- A. Upon final completion of all components determine date of start-up jointly with Engineer, Owner and Contractor.
- B. System supplier to be responsible for placing of SCADA equipment and systems in operation.
- C. System supplier to provide qualified personnel on the job site until successful operation of system is attained.
- D. Technical services: Upon completion of equipment installation, the Instrumentation and Control System Integrator shall provide services of a field service engineer for a period of not less than one (1) 8-hour days for start-up of the SCADA and telemetry system.

END OF ATTACHMENT C

3.3.11 Attachment D: Pump Station Electrical Requirements

ATTACHMENT D
PUMP STATION ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 DESCRIPTION

- A. The work covered by this specification section includes but is not necessarily limited to the following items of work:
 - 1. Electrical service, distribution equipment and control equipment for pump station construction.
 - 2. Coordination with the electric utility for power and metering.

1.02 SCOPE OF WORK

- A. This specification section covers the construction requirements for the complete electrical system and shall be used in conjunction with the Standard Plate Details and Drawings. Provide all materials, labor, equipment, and supervision to install electrical systems. The work shall consist of, but shall not be limited to, the installation of the following:
 - 1. Install new service, electrical distribution, emergency generator and control equipment for a new pump station.
 - 2. Coordination with utility for power service indicated.

1.03 CODES AND PERMITS

- A. All work shall be done in accordance with the 2014 Edition of the National Electrical Code (NEC), applicable local ordinances and regulations of local utility company. All permits and inspections certificates shall be paid for by the Contractor.
- B. Installation at the wet well shall conform to the requirements of NFPA 820.

1.04 WARRANTY

- A. The contractor shall warrant to the owner that all work shall be free from defects and will conform to the contract documents. This warranty shall extend not less than one year from the date of beneficial use.

1.05 WORKMANSHIP AND MATERIAL

- A. Workmanship: All work necessary to complete the project shall be executed in a thorough, neat and workmanlike manner.
- B. Materials: All materials shall be new and equipment included in Underwriters Label Service shall bear that label.
- C. Substitutions: Model numbers indicated herein or shown on the drawings are the Basis of Design. The Contractor may submit for review complete manufacturer information necessary for evaluation of proposed equal equipment. The owner or owner's representative shall have the sole discretion and approval/disapproval authority in this matter. Her/his decisions are final. The approval or disapproval of any submitted item will be considered only if submitted ten days before the bid. Each request shall include a description of the proposed substitute, the name of material or equipment for which it is to be substituted, drawings, cuts, performance and test data for an evaluation and a statement from the equipment manufacturer's representative that the items to be substituted meet or exceed the specifications of the item specified.
- D. Costs: If the contractor chooses to provide approved substitute equipment, which meets all the aforementioned requirements but has different characteristics, which causes any additional costs, he shall bear all costs associated with that substitution. All changes shall be coordinated with the engineer, owner and general contractor.

1.06 COMPLETION OF WORK

- A. Testing: At the completion of work, a test shall be made and the entire system shall be shown to be in perfect working condition. The following shall be made available to personnel conducting the test:
 - 1. Electrician with hand tools
 - 2. Accurate voltmeter
 - 3. Clamp-on ammeter
 - 4. Test lamp
 - 5. Phase rotation indicator
 - 6. Complete electrical specifications and drawings with addenda and revisions.
- B. Submittal: Upon completion of work, submit for approval three bound copies of the following:
 - 1. Certificate of Final Inspection from local authorities
 - 2. Details of operations and maintenance of equipment. This shall include

corrected shop drawings, wiring diagrams, spare parts list and recommended maintenance procedure.

3. Grounding Testing Results

- C. Instruction: After completion and at a time convenient to the Owner, qualified mechanics shall thoroughly familiarize the Owner's personnel with the operation and the maintenance of the items listed under "Submittal".
- D. Guarantee: All equipment and materials furnished and all work performed under this section of specifications shall be guaranteed to be free of defective materials and workmanship for a period of one year (unless a longer period is specified elsewhere herein) after final acceptance of the work by the Owner. Upon notice from the Owner of failure of any part of the guaranteed equipment or failure of systems to operate properly during the guarantee period, the affected part or parts shall be promptly replaced with new parts by the Contractor at no additional cost to the Owner. All labor required to perform guarantee shall be included as part of the complete guarantee warranty.
- E. Warranties: Provide manufacturer's equipment warranties prior to final inspection.

1.07 EQUIPMENT REQUIRING ELECTRICAL SERVICE

- A. Review all specification sections and drawings for equipment requiring electrical service. Provide service to and make connections to all such equipment.
- B. Drawings are based on design loads of one manufacturer. If equipment actually furnished have loads, numbers of connections, or voltages other than those indicated on the drawings, then control equipment, feeders, and overcurrent devices shall be adjusted as required, at no additional cost to the owner. Such adjustments are subject to review by the engineer.
- C. Catalog numbers indicated with equipment, devices and lighting fixtures are for convenience only. Errors or obsolescence shall not relieve the furnishing of items which meet the technical description given in specifications, noted, or required by function designated.

1.08 PRODUCT DELIVERY, STORAGE, HANDLING, AND PROTECTION

- A. Provide a dry, weather-tight space for storing materials. Store packaged materials in original undamaged condition with manufacturer's labels and seals intact. Handle and store material in accordance with standards to prevent damage. Equipment and materials shall not be installed until such time as the environmental conditions of the job site are suitable. Replace damaged materials.

1.09 CORROSION PROTECTION

- A. Coat rigid aluminum conduit and vertical structural aluminum supports with two coats of 3M Scotchrap pipe primer and two overlapping layers of 3M Scotchrap 51 tape.

1.10 DRAWINGS

- A. The drawings indicate the general arrangement of electrical equipment, based on one manufacturer's product. Coordinate installation of equipment with all other trades. Do not scale drawings for connection locations. Bring all discrepancies to the immediate attention of the engineer.
- B. Contractor shall install and circuit all electrical work as indicated on drawings unless specific building construction requires a change or rerouting of this work. He shall keep a record of the location of all concealed work, including the underground utility lines. He shall document all changes in the manner specified by the General Conditions, Special Conditions and Supplementary General Conditions to the Mechanical and Electrical Work.

1.11 CUTTING, PATCHING, EXCAVATING & BACKFILLING

- A. All cutting and patching required to carry out the work shall be provided under other Specification Sections.
- B. All excavation and backfilling required to install conduit shall be provided under this Section. Backfill shall be compacted as required under other Specification Sections.

1.12 MATERIALS

- A. Materials specified by manufacturer's name shall be used unless written permission for substitution is issued by the owner or owner's representative.
- B. All materials shall be new and in accordance with applicable standards, i.e., Underwriters' Laboratories National Electrical Manufacturer Association (N.E.M.A.), Institute of Electrical and Electronic Engineers (I.E.E.E.), United States of American Standards Institute (U.S.A.S.I.), U.L. approved equipment shall bear U.L. label. Similar material shall be the product of one manufacturer.
- C. Materials of the same type shall be the product of one manufacturer.

1.13 SHOP DRAWINGS

- A. The Contractor shall submit for review by the Engineer a complete schedule and data of materials and equipment to be incorporated in the work. Submittals shall be supported by descriptive material, such as catalogs, cuts, diagrams,

performance curves, and charts published by the manufacturer, to show conformance to specification and drawing requirements; model numbers alone will not be acceptable. Complete electrical characteristics shall be provided for all equipment.

- B. Submittals shall be made for each of the following items:
- Enclosed Circuit Breakers
 - Material List
 - Automatic Transfer Switches
 - Wiring Devices
 - Generator
 - Junction Boxes
 - Lighting Fixtures
 - Surge Protection Device
 - Reduced Voltage Solid State Starters
 - CADA System
 - Pump Control Panel
 - Cable Support Grips
 - Full Voltage Non-Reversing Starters
 - Cable Support Bracket
 - Float Switches
 - Level Transducer
- C. Each individual submittal item for materials and equipment shall be marked to show specification section and paragraph number which pertains to the item.
- D. Prior to submitting shop drawings, review the submittal for compliance with the Contract Documents and place a stamp or other confirmation thereon which states that the submittal complies with Contract requirements. Submittals without such verification will be returned disapproved without review.

1.14 SERVICE

- A. The electrical service shall be coordinated with the electrical utility.
1. Aerial services shall originate in a weatherhead installed adjacent to termination of a utility furnished secondary service drop.
 2. Underground service shall originate in the secondary compartment of a utility furnished pad mounted transformer or a utility pedestal.
- B. The electrical service shall be either 240/120V, 3 phase, 4 wire Delta or 480/277V, 3 phase, 4 wire Wye.
- C. Complete metering systems shall be provided. Install the system in accordance with the utility standards. Coordinate meter location with local utility and provide channel rack for mounting of meter.
- D. Application and payment of fees related to the electrical service and meter shall be paid by the contractor and/or the developer. Upon project acceptance, ownership and billing will be transferred to the City of Columbia.

1.15 RECORD DRAWINGS

- A. At the time of final inspection, provide three (3) sets of data on electrical equipment used in the project. This data shall be in bound form (two sets) and electronic (PDF on CD), and shall include the following items:
1. Shop drawings on equipment listed above.
 2. Data sheets indicating electrical characteristics of all devices.
 3. Data sheets on all lighting fixtures indicating voltage, lamp, and ballast used in each fixture.
 4. Test results required by “Electrical Systems Operation Test.”
 5. As-Built laminated schematic drawing.

1.16 ELECTRICAL SYSTEMS OPERATIONAL TEST

- A. Prior to final inspection, the following systems or equipment shall be tested and reported as herein specified.
1. Each ground rod installation shall be tested after all connections to ground rods are made. Ground rod installations shall be tested by “fall of potential” measuring method using ground resistance test meter and two auxiliary electrodes driven into the earth, interconnected through the meter with the ground rod installation being tested. Placement of auxiliary electrodes shall be in accordance with operating instructions of test meter, but in no case shall auxiliary current electrodes be placed within seventy feet of the grounding system being tested. Test data shall indicate placement of auxiliary electrodes with respect to system being tested, data readings were taken and lowest resistance recorded.
 2. Three (3) typewritten copies of the test shall be submitted to the Engineer for approval.

1.17 SITE INVESTIGATION

- A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions which may affect the cost of the project.

PART 2 PRODUCTS

2.01 BRANCH CIRCUIT BREAKERS - DUPLEX PUMP CONTROLLER

- A. Provide circuit breakers as an integral part of the Duplex pump controller.
- B. Branch circuit breakers shall be bolt-on, quick-make, quick-break, NEMA Rated thermal magnetic type. Two and three pole breakers shall be common internal

trip. Tie handles are not acceptable. Breakers shall be ambient compensated type at 50 degrees C.

- C. Each circuit shall be identified.
- D. Provide an equipment grounding bar for termination of equipment ground conductors.
- E. Minimum interrupting rating shall be as shown on the drawings.
- F. Provide products of Square D, Eaton, or GE.

2.02 DEVICES

- A. Duplex receptacles shall be a NEMA 5-20R type WR ground fault type installed within duplex pump control panel. Provide Hubbell GFR5362SG.

2.03 GROUNDING

- A. Grounding conductors shall be green insulated copper, bare copper conductor or black insulated conductor with green tape.
- B. Ground rods shall be 3/4 inch x 10 foot copper-bonded. Provide products of Eritech.

2.04 CONDUIT SYSTEM

- A. Provide complete conduit system including boxes, fittings, supports, etc. Conduits shall be rigid aluminum conduits above grade and schedule 80 PVC below grade.
- B. Transition from below grade PVC to above grade rigid aluminum shall be made with a rigid aluminum elbow and not a PVC elbow. Provide corrosion protection per paragraph 1.09.
- C. Rigid aluminum fittings shall be standard aluminum threaded couplings, threaded hubs and elbows; set screw or on-threaded fittings are not permitted. Non-metallic conduit fittings shall be of the same material as the conduit furnished and shall be the product of the same manufacturer.
- D. Rigid aluminum conduit shall be utilized for all conduits routed to the pump station wet wells or any other classified areas.

2.05 CONDUCTORS

- A. Provide all conductors specified or required for proper operation of systems. Conductors shall be copper and shall be No. 12 AWG unless otherwise indicated. For No. 12 and No.10, use Type XHHW solid conductor, for No.8 through No.

4/0, use Type XHHW stranded, for No.250MCM and larger use Type RHW.

- B. All conductors shall have size, grade of insulation, voltage and manufacturer's name permanently marked on the outer cover at regular intervals and shall be readable from all junction boxes and panels.

2.06 JUNCTION BOXES

- A. Junction boxes shall be stainless steel NEMA 4X with hinged door and quarter-turn latch.

2.07 CIRCUIT BREAKERS

- A. Circuit breakers shall be of the ampacity, class, and NEMA Rated as shown on the drawings, terminals shall be suited for 60 degrees C or 75 degrees C conductors. All separately mounted breakers shall be in NEMA 4X 316 stainless steel enclosures. Breakers used for service disconnects shall be labeled as such. Factory installed ground terminals and neutrals (S/N) shall be provided in all enclosures. Breakers shall be Eaton, Square D or G.E.

2.08 FLOAT SWITCHES & LEVEL TRANSDUCER

- A. Refer to the SCADA specifications for acceptable float switches and level transducer manufacturers and products.

2.09 FULL VOLTAGE/NON-REVERSING (FVNR) MAGNETIC STARTERS

- A. Magnetic starters shall be across-the-line non-combination type.
- B. Magnetic starters shall be NEMA size one unless other size is shown on the drawings or unless larger size is required by actual motor controlled. Starters shall be provided in the open frame configuration for mounting in the pump control panel. Starters shall be for operation on a three-phase 460-volt system, the control coil shall be coordinated with/by the control panel fabrication shop.
- C. Each magnetic starter shall have solid state overload protection. Control voltage shall be 120 volts provided from a separate source. Provide fuse for control coil. Provide hand-off-automatic switch. Interlocks shall be provided to provide control sequence indicated on the drawings and in these specifications.
- D. Solid state overload protection shall be Square D TeSysT.

2.10 REDUCED VOLTAGE SOLID STATE STARTER (RVSS)

- A. Reduced voltage solid state starter shall be NEMA sized for use with the specific horsepower, three phase 460 volt squirrel cage induction motor indicated on the plans. The reduced voltage solid state starter shall be of the solid state type using

SCR's to provide reduced voltage starting with high starting torque and smooth stepless acceleration to full speed. Maximum motor in-rush current during starting shall be 250% of normal motor full load amps. Acceleration shall be set for 30 seconds from start to full voltage. Reduced voltage starter shall be mounted in the pump control panel.

- B. Provide shorting contactor to remove SCR's from the system once the motor reaches full speed.
- C. Current sensing for motor overload shall be electronic type set at 115% of normal motor full load amps. The electronic overload device shall allow for motor starting current up to 350% of motor full load amps for not more than 40 seconds. Overload beyond limits specified herein shall trip the motor control circuit in less than 1 Hz. The electronic current sensing device shall also provide phase imbalance protection to remove the motor from the line should voltage levels be unbalanced more than 7-1/2%. The control system shall also remove the motor from the line within 45 seconds should the motor become stalled for any reason.
- D. Provide programmable controlled stop on torque ramp, 0.5 to 60 seconds.
- E. Control power shall be 120 volts AC from the pump control panel. The electronic control shall contain pilot lamps to indicate the following:
 - 1. Control Power On
 - 2. Trip Condition Due to Load Unbalance.
 - 3. Trip Condition Due to Overload or Locked Rotor
- F. An oil-tight pilot lamp indicating motor running shall be mounted on the compartment door.
- G. Provide products of Square D (Altistart 48), no substitutions permitted.

2.11 PUMPING STATION CONTROL PANELS

- A. Furnish and install control panel housed in a NEMA 4X 316 stainless steel enclosure, with heavy duty three-point latch, door-within-door construction for operation on 480/277 volt, 3 phase, 4 wire Wye 60 hertz service or 240/120 volt, 3 phase, 4 wire Delta, 60 hertz service, as indicated on the engineers construction drawings. The enclosure shall include an inner door for the mounting of control and indication devices. The control panel shall bear a U.L. service entrance label.
- B. Provide panel with insulated neutral bus and ground bus attached to the panel interior. Provide copper braided jumper between interior (back plate) and enclosure ground bus.

- C. For each pump motor there shall be included an individual motor circuit breaker, FVNR starter or reduced voltage solid state starter, as indicated on the drawings, manual reset, hand-off-auto selector switch, green running light and elapsed time meter and amp meter for Phase B. Provide door mounted pilot lamps for a high level alarm and phase failure/under voltage alarm. Provide alarm light mounted as shown on drawings. Provide 20 amp single pole breakers in control panel to serve auxiliary loads shown on the drawings. Provide phase failure/under voltage relay to de-energize motors and to provide signal alarm to SCADA. All components shall be NEMA rated.
- D. Units shall be pre-calibrated to match motors and control characteristics and factory sealed to ensure trip setting in tamperproof. A 24 volt control circuit transformer with disconnect and overload protection shall be included with an automatic electrical alternator for use with the level sensor function.
- E. Note that only the 24 volt control voltage shall be used in the wet well sensor circuits. Provide intrinsically safe barriers on float conductors. The remainder of the controls shall be designed to operate on 120 volt, 60 hertz, single phase. The complete unit shall be completely tested and inspected at the factory prior to shipment. Complete electrical diagrams, dimensional drawings, and functional description shall be provided for approval by the Engineer.
- F. Provide field terminals for remote indication in the separate RTU Control Panel. Provide the digital and analog signals specified in Attachment C.
- G. Contract documents show separately mounted main breaker, generator breaker and automatic transfer switch.
- H. Panel Components:
 - 1. Pump Controller, as described herein.
 - 2. Elapsed Time Meters: Per pump required - door mounted.
 - 3. Hand-off-Auto Switch per pump - door mounted.
 - 4. Pump Running pilot lamp (LED) per pump – door mounted.
 - 5. Pump Fault pilot lamp (LED) per pump – door mounted.
 - 6. High level pilot lamp (LED) - door mounted.
 - 7. Phase failure/under voltage pilot lamp (LED) - door mounted.
 - 8. AMP Meter-B Phase-Door Mounted.

9. FVNR/RVSS starters for each pump provided.
10. Motor Circuit breaker for each pump provided.
11. Protective relays and auxiliary relays. Relays shall be 8 or 11 pin round.
12. Terminal blocks for all connections.
13. Vaportight and waterproof alarm beacon (LED) with wire guard mounted as shown on drawings.
14. Intrinsically safe relays and panel barriers for all float switches.
15. Pump Over Temperature Alarm pilot lamp (LED) per pump – door mounted.
16. Pump Moisture Alarm pilot lamp (LED) per pump – door mounted.

2.12 CONTROLS

- A. The following control features shall be furnished:
 1. Lead/Lag Pump Control based upon wet well level.
 2. Pump Alternation.
 3. Back-up Pump Control by the local Pump Control Panel in the event of failure of either the PLC or the analog level transducer.
 4. Pumps shall not operate 1 minute after loss and restoration of power. Set the controls so only one pump can start at a time.

2.13 PUMP CONTROLLER

- A. Provide one (1) Mercoid series MPC level controller for primary control of the pumps.
- B. The pump controller shall utilize the submersible level transducer for pump control in a Lead/Lag configuration with automatic alternation. Level setpoints shall be determined at the time of field installation and testing.

2.14 SUBMERSIBLE LEVEL TRANSDUCER

- A. Provide one (1) submersible level transducer with 4 to 20 mA analog output proportional to wet well level. Provide a minimum of 40 feet of polyurethane cable or optional length as required by site conditions.
- B. The submersible level transducer shall be the Bird Cage Model BC001 as

manufactured by Blue Ribbon Corporation.

2.15 FLOAT SWITCHES

- A. Provide two (2) ITT Flygt ENM-10 level regulator switches with adequate cable length for this application.
- B. Floats shall be used for independent secondary pump control in the event of the failure of the pump controller or submersible level instrument. One float switch shall detect high level and shall start all pumps; the second float switch shall detect low level and shall stop all pumps. Float elevations shall be determined at the time of field installation and testing, nominally to be outside the normal operating range of the primary pump controller.

PART 3 EXECUTION

3.01 CONDUIT SYSTEMS

- A. Exposed conduits shall be installed parallel or at right angles to structures.
- B. Support exposed conduits at 5 foot intervals. Individual runs of conduits shall be supported by one whole conduit straps; groups of conduits shall be supported on B-Line B24AL channel, or approved equal.
- C. Conduit support devices shall be B-Line B2000 series Stainless Steel Conduit clamps or approved equal.
- D. Rigid aluminum conduit shall be attached to sheet metal enclosures with threaded hubs.
- E. All conduits installed below grade shall be schedule 80 PVC and shall be installed 24 inches below finished grade. Where conduits turn up provide rigid aluminum elbow.
- F. Protect conduits against dirt, plaster, etc., with conduit plugs. Plug shall remain in place until all masonry is complete.
- G. All rigid aluminum conduits entering or exiting concrete, rigid aluminum elbows below grade/buried, and aluminum structural support members embedded in concrete, shall be protected with two coats of Scotchrap Pipe Primer and two overlapping layers of Scotchrap 51 tape. Protection shall extend through concrete to 6" above concrete or grade.
- H. All conduits entering electrical equipment from below grade and wet well shall be sealed with electrical putty in accordance with the NEC.

3.02 CONDUCTORS

- A. All conductors shall be color-coded as follows:

System Voltage	Phase A	Phase B	Phase C	Neutral
480/277V, 3 phase, 4 wire Wye	Brown	Orange	Yellow	Grey
240/120V, 3 phase, 4 wire Delta	Black	Orange (High Leg)	Red	White
240/120V, 1 phase, 3 wire	Black	Red	---	White
Ground: Green				

Branch circuits must be connected as indicated.

- B. Splices in branch circuit conductors shall be made with Scotchlok insulated connectors, Ideal Wing Nuts, or Buchanan Steel Crimping Sleeves, and nylon caps. Splices in motor junction boxes, wiring troughs and splices in conductors larger than No. 8 AWG shall be made with long barrel, tin plated compression crimps and insulated with heavy wall, 600V rated heat shrinkable tubing.
- C. Only one conductor shall be installed under terminal of individual circuit breaker or mechanical lug.
- D. All field control wiring shall be labeled with type-written, heat-shrinkable wire markers.

3.03 EQUIPMENT CONNECTIONS

- A. All equipment requiring electrical connections shall be connected under this section of these specifications. Where electrical connection to equipment requires specific locations, such locations shall be obtained from shop drawings. Do not scale drawings for location of conduit stub-ups to serve specific equipment.
- B. Electrical circuits to equipment furnished under other sections of these specifications are based on design loads. If actual equipment furnished has loads other than design loads, electrical circuits and protective devices shall be revised to be compatible with equipment furnished and in compliance with the National Electrical Code at no additional cost to the Owner.
- C. Equipment furnished under other sections of these specifications to be connected under this section of the specifications shall consist of, but not be limited to, the following:
- D. Pumping Station Equipment
- E. The Contractors attention is directed to other sections of these specifications, where equipment requiring electrical service is specified, to become aware of the scope of work under this section of these specifications requiring electrical service

and connections to equipment specified elsewhere.

3.04 GROUNDING

- A. The neutral conductor shall be grounded to a ground rod system. The system grounding conductors shall be Bare Copper size as indicated on the plans. Provide three ground rods in a delta configuration 20' apart.
- B. All non-current carrying parts of electrical equipment shall be grounded. The continuity of the ground shall be maintained using a green insulated grounding conductor installed in all raceways.
- C. Ground rods shall be installed with the top of the rod 12 inches below finished grade. Connections to ground rods shall be made with chemical weld connections.
- D. Upon completion of the ground rod installation the Contractor shall record the ground reading. This ground reading shall not be taken within 48 hours of rainfall. Results of ground readings shall be forwarded immediately to the Engineer. Provide additional rods as required. The resistance to ground shall be below 5 OHMS.
- E. Grounding terminal of receptacles shall be grounded to grounding conductor and to outlet box with green insulated pigtail with 10/32 washer head machine screw.

3.05 SURGE PROTECTION

- A. Surge protection device (SPD) equipment shall be mounted where shown on the drawings. Overcurrent protection and connections shall be made with conductors as recommended by the manufacturer.
- B. Grounding shall be provided in accordance with manufacturer's recommendations and requirements.
- C. SPD's shall include status dry contacts for use at remote PLC/RTU's.

3.06 EQUIPMENT IDENTIFICATION

- A. All electrical equipment shall be identified with engraved plastic nameplates or engraved device plates. Surface mounted equipment shall have identification attached to the outside cover. Pull boxes and junction boxes shall be identified. Outlet boxes for fixtures and devices need not be identified.
- B. Nameplate shall be affixed to enclosures with stainless steel screws.

3.07 SPARE PARTS

- A. Provide one complete set of fuses, four control relays, one intrinsically safe barrier, and one full set of thermals for motor starters.
- B. Spare parts shall be delivered to the owner at time of final acceptance and before final payment.

3.08 GUARANTEE AND TEST

- A. Upon completion of the project all systems shall be tested for proper operation as directed by the Engineer or his representative. Equipment covers, i.e., panelboard, motor controls, etc., shall be removed where required for inspection of internal wiring. The Contractor shall furnish the personnel, tools and necessary equipment to inspect and test the system.
- B. Where ground readings are required, the Contractor shall provide a typewritten copy of certification of ground reading. Data shall indicate date readings were taken and lowest resistance recorded.
- C. All systems and component parts shall be guaranteed for one year from date of final acceptance of the completed project. Defects found during this guarantee period shall be promptly corrected at no additional cost to the Owner.

3.09 PREPARATION OF FINAL APPLICATION FOR PAYMENT

- A. Fill in Application for Payment form as specified for progress payments.
- B. Submit all Project Record Documents.
- C. Submit all test reports.

END OF ATTACHMENT D