

ELECTRICAL

PART 1: GENERAL

1.01. GENERAL

- A. The General Conditions and Requirements, Special Provisions, are hereby made a part of this section.
- B. The Electrical Drawings and Specifications a part of the contract documents. The Drawings and specifications of this contract, as well as supplements issued thereto, information to bidders and pertinent documents issued by the Owner's representative are a part of these drawings and specifications and shall be complied with in every respect. All of the above documents will be on file at the office of the Owner's representative and shall be examined by all bidders. Failure to examine all documents shall not relieve the responsibility or be used as a basis for additional compensation due to omission of details of other sections from the electrical documents.
- C. Furnish all work, labor, tools, superintendence, material, equipment, and operations necessary to provide for a complete and workable electrical system as defined by the contract documents.
- D. Be responsible for visiting the site and checking the existing conditions. Ascertain the conditions to be met for installing the work and adjust bid accordingly.
- E. It is intent of the contract document that upon completion of the electrical work, the entire system shall be in a finished, workable condition.
- F. All work called for in the specifications but not shown on the drawings; or, all work shown on the drawings but not called for in the specifications, shall be performed by the Contractor as if described in both. Should work be required which is not set forth in either document, but which is nevertheless required for fulfilling of the intent thereof; then, the contractor shall perform all work as fully as if it were specifically set forth in the current documents.
- G. The definition of terms used throughout the contract documents shall be as specified by the following agencies:
 - 1. Underwriters Laboratories
 - 2. National Electrical Manufacturers Association
 - 3. American National Standard Institute
 - 4. Insulated Power Cable Engineers Association
 - 5. National Electrical code
 - 6. National Fire Protection Association
- H. The following Contractors have been pre-approved by the Owner to perform the work on Lift Station projects within District 17:

1. T.Morales Company- (254) 793-4344
2. SunTech Electric – (512) 515-0106

- I. Any electrical contractor other than the named pre-approved contractors shall submit a pre-bid request twenty-one (21) days prior to project bid date. Provide four (4) bound copies, with tabbed dividers and contents organized and presented as hereinafter specified.
- J. Pre-Bid approval does not exempt the Contractor from meeting all the requirements of the Contract Documents nor does it give any prior acceptance of any equipment, software or services. The Contract Documents are the final authority for acceptance of the work provided. The Pre-Bid Submittal is not a part of the contract documents and as such does not exempt the Contractor from the requirements of contract submittals described hereinafter.
- K. Information contained in the Pre-Bid Submittal shall be considered public information. All data submitted will become and remain the property of the Owner; none will be returned.
- L. The Engineer's decision as to pre-bid approval shall be final. The Consulting Engineer shall be considered the sole judge of the merits of the alternate system and shall indicate pre-approval of the alternate system via a written addendum to the specifications prior to the actual bid date.
- M. The right is reserved to reject any and all proposals, to waive any informality, irregularity, mistake, error or omission in any proposals received and to accept the proposal, as determined by the Engineer or Owner, deemed most favorable to the Owner's interests.
- N. The Pre-Bid Request shall contain the following:
 1. The Listing of firm's history.
 2. Listing of personnel to be used on the project including job titles and resumes.
 3. List of equipment owned by contractor for use on this project.
 4. Certificates of all insurance complete with expiration dates.
 5. Project personnel: Identify all system supplier personnel with resumes who could be assigned to this project.
 6. Describe provisions for service, technical assistance and re-placement parts for the proposed project. Include the contractor's 1-800-toll free number.
 7. Provide installation list of at least 20 locations of previous similar projects

including telephone numbers, functional description, and contact personnel.

1.02. PERMITS, CODES AND UTILITIES

- A. Secure all permits, licenses, and inspections as required by all authorities having jurisdiction. Give all notices and comply with all laws, ordinances, rules, regulations and contract requirements bearing on the work.
- B. The minimum requirements of the electrical system installation shall conform to the latest edition of the National Electrical Code as well as state and local codes.
- C. Codes and ordinances having jurisdiction and specified codes shall serve as minimum requirements; but, if the Contract Documents indicate requirements which are in excess of those minimum requirements then the requirements of the Contract Documents shall be followed. Should there be any conflicts between the Contract Documents and codes, or any ordinances, report these with bid.
- D. Determine the exact requirements for the utility service connections and metering facilities as set forth by the utilities that will serve the project, and pay for and perform all work as required by those utilities.

1.03. STANDARDS

- A. All materials and equipment shall conform to the requirements of the Contract Documents. They shall be new, free from defects, and they shall conform to the following standards where these organizations have set standards:
 - 1. Underwriters Laboratories, Inc. (UL)
 - 2. National Electrical Manufacturer's Association. (NEMA)
 - 3. American National Standards Association. (ANSI)
 - 4. Insulated Cable Engineers Association. (ICEA)
- B. All material and equipment, of the same class, shall be supplied by the same manufacturer unless specified to the contrary.
- C. All products shall bear UL labels where standards have been set for listing.

1.04. SHOP DRAWINGS AND SUBMITTALS

- A. Shop drawings shall be taken to mean detailed drawings with dimensions, schedules, weights, capacities, installation details and pertinent information that will be needed to describe material or equipment in detail.
- B. Submittals shall be taken to mean catalog cuts, general descriptive information, catalog numbers and manufacturer's name.
- C. Submit for review in sextuplet within sixty (60) days after notice to proceed, all shop drawings and submittals as hereinafter called for. If shop drawings and

submittals are not received in sixty (60) days, the Owner's representative reserves the right to go directly to the manufacturer for the information and any expense incurred shall be borne by the contractor.

- D. Review of submittals or shop drawings shall not remove the responsibility for furnishing materials or equipment of proper dimensions, quantity and quality; nor will such review remove the responsibility for error in the shop drawings or submittals.
- E. Failure to process submittals or shop drawings on any item and/or items specified shall make the Contractor responsible for the suitability of the item and/or items, even though the item and/or items installed appear to comply with the Contract Documents.
- F. Assume all costs and liabilities which may result from the ordering of any material or equipment prior to the review of the shop drawings or submittals, and no work shall be done until the shop drawings or submittals have been reviewed. In case of correction or rejection, resubmit until such time as they are accepted by the owner's representative and or engineer and such procedures will not be cause for delay. Contractor shall have two submittal reviews after which contractor can be charged by owner and or engineer an hourly rate to review submittals. After final review, supply up to six (6) copies, if requested.
- G. Submittals and shop drawings shall be compiled from the manufacturer's latest product data. Should there be any conflicts between this data and the Contract Documents, report this information for each submittal and/or shop drawing.
- H. Contractor shall clearly indicate which items are to be used. Shop drawings and submittals will be returned and unchecked if the specific items proposed are not clearly marked, or if the general contractor's approval stamp is omitted.
- I. When requested, furnish samples of materials for acceptance review. If a sample has been reviewed and accepted, then that item of material or equipment installed on the job shall be equal in quality to the sample; if it is found that the installed item is not equal then replace all such items with the accepted sample equivalent at no additional cost to owner.
- J. Materials to be submitted are as follows:
 - 1. Safety Switches
 - 2. Wiring devices
 - 3. Wire
 - 4. Conduit and Fittings
 - 5. Lighting fixtures
 - 6. Lighting Panels
 - 7. Transformers
 - 8. MPZ
 - 9. Lift Pumps Control Panel
 - 10. Lift Pumps Power Panel
 - 11. RTU Panel

12. Antenna Support Structure (if required)
13. Generator
14. Automatic Transfer Switch

1.05. ACCEPTANCE AND SUBSTITUTIONS

- A. All manufacturers named are a basis as a standard of quality and substitutions of any equal product will be considered for acceptance. The judgment of equality of product substitution shall be made by the Engineer.
- B. Substitutions after award of contract shall be made only within sixty (60) days after the notice to proceed. Furnish all required supporting data. The submittal of substitutions for review shall not be cause for time extensions.
- C. Where substitutions are offered, the substituted product shall meet the product performance as set forth in the specified manufacturer's current catalog literature, as well as meeting the details of the Contract Documents.
- D. The details on the drawings and the requirements of the specifications are based on the first listed item of material or equipment; if any other than the first listed materials or equipment is furnished, then assume responsibility for the correct function, operation, and accommodation of the substituted item. In the event of misfits or changes in work required, either in this Section or other Sections of the Contract, or in both; bear all costs in connection with all changes arising out of the use of other than the first listed item specified.

1.06. EXCAVATION AND BACKFILLING

- A. Do all excavating and backfilling necessary for the installation of the work. This shall include shoring and pumping in ditches to keep them dry until the work in question has been installed. All shoring required to protect the excavation and safeguard employees shall be properly performed.
- B. All excavations shall be made to the proper depth, with allowances made for floors, forms, beams, piping, finished grades, etc. Ground under conduits shall be well compacted before conduits are installed.
- C. All backfilling shall be made with selected soil; free of rock and debris and shall be pneumatically tamped in six (6") inch layers to secure a field density ratio of 90%.
- D. All excavated material not suitable and not used in the backfill shall be removed offsite at the Contractors expense.
- E. Field check and verify the locations of all underground utilities prior to any excavating. Avoid disturbing these as far as possible. In the event existing utilities are broken into or damaged, they shall be repaired so as to make their operation equal to that before the trenching was started at no additional cost to owner.

- F. Where the excavation requires the opening of existing walks, drives, or other existing pavement, these facilities shall be cut as required to install new lines and to make connections to existing lines. The sizes of the cut shall be held to a minimum consistent with the work to be installed. After installation of new work is completed and the excavation has been backfilled in accordance with above, repair existing walks, drives or other existing pavement to match existing installation.

1.07. CUTTING AND PATCHING

- A. Cutting and patching required under this section shall be done in a neat workmanlike manner. Cutting lines shall be uniform and smooth.
- B. Use concrete saws for large cuts in concrete and core drills for small round cuts in concrete.
- C. Where openings are cut through masonry walls, provide lintel or other structural supports to protect the remaining masonry. Adequate support shall be provided during the cutting operation to prevent damage to masonry.
- D. Where large openings are cut through metal surfaces, attach metal angles around the opening.
- E. Patch concrete openings that are to be filled with non-shrinking cementing compound. Finish concrete patching shall be troweled smooth and shall be uniform with surrounding surfaces.

1.08. WATERPROOFING

- A. Provide waterproof flashing for each penetration of exterior walls and roofs.
- B. Flashing for conduit penetrations through built-up roofs shall be made with pitch pans filled with pitch. Conduit penetrations through poured concrete roofs shall be made with sleeves and annulus caulked.
- C. Penetrations through walls at below ground elevations shall be waterproofed by conduit sealing fittings or other methods as indicated.
- D. Interiors of raceways that are likely to have water ingress such as runs from handholes into below-grade installations shall have waterstops installed to prevent water from entering into installations.

1.09. EQUIPMENT PROTECTION

- A. Provide suitable protection for all equipment, work and property against damage during construction.
- B. Assume full responsibility for material and equipment stored at the site.
- C. Conduit openings shall be closed with caps or plugs during installation. All outlet

boxes and cabinets shall be kept free of concrete, plaster, dirt, and debris.

- D. Equipment shall be and tightly sealed against entrance of dust, dirt, and moisture.

1.10. CLEAN-UP

- A. Remove all temporary labels, dirt, paint, grease and stains from all exposed equipment. Upon completion of work, clean equipment and the entire installation so as to present a first class job suitable for occupancy. No loose parts or scraps or equipment shall be left on the premises.
- B. Equipment paint scars shall be repaired with paint kits supplied by the equipment manufacturer, or with an approved paint.
- C. Clean interiors of each item of electrical equipment. At completion of work all equipment interiors shall be free from dust, dirt, and debris.

1.11. TESTS

- A. All equipment shall put through a trial run-in test to ascertain the performance complies with the intent of the specifications. All-in tests shall be made in the presence of the Engineer. All cables shall have an insulation test performed using 600 volt megger.
- B. Cables installed with an insulation reading less than 500 megohms shall be removed and new cable installed and retested at no additional cost to the owner. Cables installed with an unacceptable insulation reading shall be removed and new cable installed and retested at no additional cost to the owner.
- C. No later than two weeks prior to startup an electrical inspection shall be coordinated by contractor with the Engineer. Any punch list items generated from this inspection must be completed prior to contacting WCID No.17 for startup.
- D. The following is a check list to be completed by the contractor before owner's representative and or engineer are called to start up and or final inspection. If all items on the check list are not completed prior to the start up and or final inspection, the owner and or engineer may charge the contractor an hourly rate for inspections until job is completed. This check list is general and only provides a list of the minimum to be completed before owner and or engineer are called for final inspection and or startup. The contractor is still responsible for any and all other items to be installed as set forth by the drawings and specifications that are not on this list.

INSPECTION CHECK LIST

Item to Inspect	Yes	No	N/A	Comments
Wet Well				
Access cover installed properly				
All construction debris removed from wet well				
Safety net installed and secured properly				
Guide rails installed correctly				
Pumps sitting on base 90* properly				
Pump cables routed properly				
Pump cables secured properly				
Chains are stainless steel				
Chains installed and properly secured				
Pumps travel on rail properly				
Pumps fit through access hatch properly				
Confirm proper pump rotation				
Pumps slide down rails properly				
Pumps seat properly				
Discharge piping properly installed				
Inverts installed properly				
Float rack installed properly				
Floats installed and secured properly				
Stilling-well installed properly				
Transducer installed and secured properly				
Transducer adjusted to proper depth				
Minimal slack in wet-well on all cables				
All hardware in wet-well stainless steel				
Vent properly installed with screen				
Valve Vault				
Access cover installed properly				
All construction debris removed from valve vault				
Ladder installed				
1/4" pipe test ports in proper location				
1/4" valves installed on test ports				
Check valves properly installed				
Gate valves properly installed				
Air relief valve properly installed				
Floor drain installed and working properly				
All pipe supports properly installed				

Item to Inspect	Pass	Fail	N/A	Comments
Generator				
No construction debris inside generator cover				
Coolant Levels				
Hoses & Connections				
Fan Drive Pulley in Fan				
Fan Belts				
Jacket Water heater				
Water Pump				
Fuel / Tank				
Water Separator				
Fuel Lines & Connections				
Fuel Filters				
Fuel Pressure				
Air Filter				
Air Inlet System				
Turbocharger				
Exhaust Manifold				
Exhaust System				
Oil Level				
Oil Pressure				
Crankcase Breather				
Batteries				
Battery Charger				
Starting Motor				
Alternator				
E-Stop				
Control Panel				
ATS				
Voltage Output (note voltage)				
Proper Phase				
Transfer Switch				
Turn off station main power				
Did generator start?				
Did transfer switch to emergency?				
Ran pumps on generator power?				
Turn station power back on				
Did transfer switch back to normal?				
Did generator shut down properly?				
Did operator receive				

alarm?				
Item to Inspect	Yes	No	N/A	Comments
General Inspection				
Control panel rack installed properly				
Panel lighting installed and working properly				
All other panels on rack installed properly				
Alarm light installed, working and visible				
All above grade conduit is aluminum				
All unistrut is stainless steel				
All hardware is S.S.				
Yard lights installed and working properly				
Control Panel				
Control panel wired correctly				
Proper incoming voltage from utility company (note voltage)				
Proper incoming voltage from generator (note voltage)				
Check proper operation of back-up floats				
Check proper operation of Liquid Level Controller				
Junction Box at Wet Well				
Junction box installed properly				
Junction box properly vented (including screens)				
Excess cable removed				
All cables from wet well sealed with CGB's				
All conduits sealed between junction box and panel				
Term strip installed properly				
All wires properly labeled				
Tug test all wires				

Travis County WCID #17 SCADA Start-Up Check List

Project Name: _____ **Inspection Date:** _____
General Contractor: _____ **Representative:** _____
WCID 17 Inspector: _____

Item to Inspect	Yes	No	N/A	Comments
Wet Well				
Coated and Clean				
Pumps and wiring Installed				
Floats and transducer installed				
Stilling well installed				
Rails and brackets installed				
Door opens properly with safety net				
Vent with screen				
Valve Vault				
Valves, pig port and check valves with arms installed				
2" air releases installed and plumbed to drain				
Access door OK with pig port				
Piping painted and vault cleaned				
Gauges installed				
Control Panel/ Transfer Switch & Main Disconnect				
Roof installed properly				
Lights installed properly				
Red light can be seen from street				
All wiring, conduit and hubs installed correctly				
All wiring labeled				
Generator				
4 hour load test on site				
Diesel tank full				
Water Service				
Hose bib with RPZ in gravel				
Miscellaneous Items				
All concrete done/ Fence installed and able to be locked after startup				
Force mains- Two way cleanouts, checked				
Main line valve opened				
Cleanouts closed				
Air releases working to the end of the line				
Pre startup completed by all contractors				

Lift Station Overall Start-up Result	Pass	Fail		
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(circle one)				
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Disclaimer: The above checklist is for general WCID 17 Lift Station related items. This list provides the various minimums that we require. The contractor is responsible for any items found that may not be on this list

1.12. RECORD DRAWINGS

- A. At the start and during the progress of the job, keep one separate set of blue-line prints for making construction notes and mark-ups.
- B. Show conduit routing and wiring runs as constructed and identify each.
- C. Record all deviations from the Contract Documents.
- D. Submit set of marked-up drawings for review.

1.13. OPERATIONS & MAINTENANCE MANUAL

- A. Six (6) weeks prior to the completion of the project, compile an operations and maintenance manual on each item of equipment. These manuals shall include detailed instructions and maintenance, as well spare parts lists.
- B. Contractor is to submit one (1) electronic copy containing PDF versions of the operations and maintenance manuals for review.

PART 2: PRODUCTS

2.01. RACEWAYS

- A. Reference Standards
 - 1. ANSI/UL 1 - Safety Standard for Flexible Metal Conduit.
 - 2. UL 5A – Nonmetallic Surface Raceway and Fittings
 - 3. UL 6 Underwriters Laboratories Standard For Safety Electrical Rigid Metal Conduit - Steel
 - 4. UL 6A - Underwriters Laboratories Standard For Electrical Rigid Metal Conduit - Aluminum, Bronze, and Stainless steel
 - 5. UL 467 - Electrical Grounding and Bonding Equipment
 - 6. UL 514B Underwriters Laboratories Standard For Safety
 - 7. ANSI/UL 651 - Safety Standard for Rigid Nonmetallic Conduit.
 - 8. ANSI/UL 870 - Safety Standard for Wireways, Auxiliary Gutters and Associated Fittings.

9. ANSI C80.4 – Fittings for Rigid Metal Conduit and Electric Metallic Tubing
 10. ANSI C80.5 – Specifications for Rigid Aluminum Conduit.
 11. Federal Specification WW-C-540c – Specification for Rigid Metal Aluminum Conduit.
 12. Federal Specification WW-C-581 - Specification for Rigid Metal Steel Conduit
 13. NEC® (2008) Section 250.118(2)
 14. NEMA TC 2 - Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80) and Fittings.
 15. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.
 16. NECA 102-2004 – Standards for Installing Rigid Metal Aluminum Conduit
 17. INTERTEK ETL PVC 001 – Test For Evaluating Coating Adhesion Per ASTM D870 And D1151
- B. Above ground conduit shall be schedule 40 aluminum and shall comply with Article 346 of NEC and U.L. standard UL-6. All couplings and fittings shall conform to this requirement. As manufactured by Allied, Triangle, Wheatland, or approved equal
- C. Below grade conduit shall be non-metallic rigid Type EPC-40-PVC Schedule 40, rated 90 degrees Celsius and conform to NEMA TC-2 and UL-651 Standards, transitions to above ground to be made with PVC coated hot dipped rigid steel conduit. PVC coating shall extend a minimum of 6” above grade. PVC coated conduit shall be as manufactured by Permacote, Plastibond, Kor-Kap, or approved equal.
- D. Connections to motors shall be made using liquid tight flexible conduit and shall consist of galvanized flexible interlocking steel core with thermoplastic cover. Flexible conduit shall not be longer than 36” unless approved otherwise. Flexible conduit shall be Anaconda Sealtite Type EFL, or approved equal.

2.02. CONDUIT FITTINGS

- A. NEMA 1 lock nuts for indoor rigid metallic conduit shall be galvanized steel.
- B. Outdoor field applied hubs for sheet metal enclosures shall be galvanized steel ring, nylon throat, threaded NPT insert and shall be MYERS "SCRU-TITE", or equal.
- C. Conduit hubs for non-metallic enclosures shall be fiberglass polyester reinforced with galvanized steel core, complete with lockout and grounding bushing and

shall be Square D Type NH, or equal.

- D. Aluminum conduit chase nipples, slip fittings, unions, reducers shall be rigid aluminum.
- E. Rigid metallic conduit grounding bushings shall be aluminum with threaded hub, nylon insulated throat, and ground lug.
- F. Liquid tight flexible conduit fittings shall be hot dipped galvanized steel body with internal locking ring.
- G. Crouse-Hinds Type 'EYD drain seals shall be installed where indicated on the drawings and where required by the National Electrical Code. Seals shall be filled with 3M Scotchcast 2123 Re-enterable sealant.

2.03. CONDUIT BODIES AND BOXES

- A. Conduit bodies such as "C", "LB", "T" and the like pulling fittings shall be sand-cast copper free aluminum. Covers shall be gasketed cast metal with stainless steel cover screws and clamp style attachment. Furnish Crouse-Hinds Form 7, or equal.
- B. Conduit bodies such as "GUA", "GUAT", "GUAL", and the like pulling/splicing fittings shall be copper free aluminum with cast metal covers. All such conduit bodies shall be Crouse-Hinds GU/EA series, Appleton "GR" series, equal. Seal shall be filled with 3M Scotchcast 2123 Re-enterable sealant.
- C. Cast metal outlet boxes, pull boxes, and junction boxes whose volume is smaller than 100 cubic inches, and cast metal device boxes, shall be sand-cast copper free aluminum. All boxes shall have threaded hubs. Furnish Crouse-Hinds "FD" style Condulets, Appleton "FD" style Unilets, or equal.
- D. Covers for cast metal boxes shall be gasketed cast metal covers with stainless steel screws.

2.04. WIRE AND CABLE

- A. Reference Standards
 - 1. ICEA S-61-402 (NEMA WC5) - Thermoplastic Wire and Cable for the Transmission and Distribution of Electrical Energy
 - 2. ANSI/UL 83 - Thermoplastic-insulated Wires
- B. All conductors shall be soft-drawn, stranded annealed copper that meets ANSI 44, ASTM B3-74/38-72.
- C. Insulation for all conductors rated 1000 Volts and less shall Type XHHW2 or THWN insulation.

- A. Wiring for instrument signals shall be twisted pair 18 AWG copper conductors (7 strand, Class B); 15 mil 105 deg. C PVC primary insulation rated not less than 300 volts; color coded; 1.25 mil aluminum Mylar tape shield; 20-gauge, 7-strand tinned copper drain wire; 35 mil FR PVC jacket.
- B. Multiconductor power cords shall consist of rubber insulated high-strained copper conductors contained within a neoprene jacket. Furnish type SJO/300V class for 120/240V class applications.

2.05. CONNECTORS

- A. Power connectors shall be insulated tap connectors. Furnish NSI Polaris connectors with no equals.
- B. Insulated spring-wire connectors, "wire-nuts", for small building wire taps and splices shall be plated spring steel with thermoplastic jacket. Connector shall be rated at 150 degrees Celsius continuous. Furnish 3M "Hyflex", T&B "PT" or equal.
- C. Insulated set-screw connectors shall consist of copper body with flame-retardant plastic insulated shield. Furnish Ideal, T&B, or equal.
- D. Connectors for control conductor connections to screw terminals shall be crimp-type with vinyl insulated barrel and tin-plated copper ring-tongue style connector. Furnish T&B "Sta-kon", 3M "Scotchlok", or equal.

2.06. INSULATING PRODUCTS

- A. Tape products shall be furnished as hereinafter specified and shall be Plymouth, Okonite, F.E., 3M, or equal.
- B. General purpose electrical tape shall be 7 mil thick stretchable vinyl plastic, pressure adhesive type, "slipknot Grey", 3M Scotch 33+, or equal.
- C. Insulating void-filling tape and high voltage bedding tape shall be stretchable ethylene propylene rubber with high-tack and fast fusing surfaces. Tape shall be rated for 90 degrees Celsius continuous, 130 degrees Celsius overload, and shall be moisture-proof void filling tape shall be "plysafe", 3M Scotch 23, or equal.
- D. High temperature protective tape shall be rated 180 degrees Celsius continuous indoor/outdoor, stretchable, self-bonding silicone rubber. High temperature tape shall be "Plysil #3445", 3M Scotch 70, or equal.
- E. Insulation putty filler-tape shall be Plymouth #2074, 3M, or equal.

2.07. LABELS

- A. Colored banding tape shall be 5 mil stretchable vinyl with permanent solid color. Color shall be as hereinafter specified. Tape shall be Plymouth "Slipknot 45", 3M

Scotch #35, or equal.

- B. All wiring shall be tagged with heat-shrinkable Brady wire markers or approved equal..
- C. Cable identification labels shall be water resistant polyester with blank write-on space, T&B, Brady, or equal.
- D. Buried conduit marking tape for marking path of buried conduits shall be a four (4") inch nominal width strip of metallic lined polyethylene with highly visible, repetitive marking "CAUTION BURIED CONDUIT", or similar language, along its length. Furnish Seton Style No. 6ELE, or approved equal.
- E. Nameplates shall be micarta lamicoid material, 1/6" thick, black background with 1/4" white engraving. Attachment means shall be made with a minimum of two self-tapping stainless steel screws.

2.08. GROUNDING DEVICES

- A. Exothermally welded joints shall be made with Enrico "cadweld".
- B. Ground bus connectors shall be Square D type "LU", OZ Type "XLH", or equal.
- C. Conduit grounding bushings shall be as specified under CONDUIT FITTINGS.
- D. Ground rods shall be copper clad 3/4" X 10'-0" Copperweld, or approved equal.
- E. Ground plates may be used in lieu of ground rods where permissible.

2.09. SUPPORTING DEVICES

- A. Mounting hardware, nuts, bolts, lock washers, and washers shall be grade 316 stainless steel.
- B. All equipment supports and mounting structures shall be fabricated out of 316 stainless steel with no exceptions.
- C. Plastic saddles for supporting buried conduits shall be interlocking type that provides separation between conduits vertically and laterally and between bottom of conduits and trench floor.

2.10. MISCELLANEOUS MATERIALS

- A. Double bushing for insulating wiring through sheet metal panels shall consist of mating male and female threaded phenolic bushings. Phenolic insulation shall be high-impact "ABB", Gedney type "ABB", or equal.
- B. Cable grips shall be stainless steel, grip-type wire mesh with machined metal support. Furnish Kellems, Appleton, or equal products.

- A. Conduit pull-cords for use in empty raceways shall be glass-fiber reinforced tape with foot-marked along its length. Furnish Thomas, Greenlee, or equal products.
- B. Conduit thread coating compound shall be conductive, non-galling, and corrosion-inhibiting. Furnish Crouse-Hinds type "STL", Appleton type "ST", or equal.
- C. Wire pulling compound shall be non-injurious to insulation and to conduit and shall be lubricating, non-crumbling, and non-combustible. Furnish Gedney "Wire-Quick", Ideal "Yellow", or equal.
- D. Plastic compound for field-coating of ferrous material products shall be PVC in liquid form that sets-up semi-hard upon curing. Furnishing Rob Roy "rob Kote", Sedco "Patch Coat", or equal.
- E. Zinc spray for coating electrogalvanized steel products shall be Research Laboratory type "LPS", Mobil "Zinc-spray", or equal.
- F. Splicing kit shall be provided with insulating and sealing compound to provide a moisture-tight splice. Provide Scotchcast Series 82 or equal splicing kit.

2.11. LIGHTING

- A. Lighting fixtures shall be as indicated on the drawings.
- B. Each fixture shall be complete with its appropriate hardware, finish trim, and appurtenances as required for a finished installation.
- C. All fixtures shall be LED Type.

2.12. WIRING DEVICES

- A. All wiring devices shall be specification grade and shall meet NEMA WD 1-1971 requirements. Furnish following types unless otherwise indicated.
- B. Two-pole, 3-wire grounding, 15A/125V, NEMA 5-15R duplex receptacle shall be Arrow-Hart #5662-S, Hubbell #5262, or equal.
- C. Two-pole, 3-wire grounding, 20A/125V, NEMA 5-20R duplex receptacle shall be Arrow-Hart #5739-S, Hubbell #5362, or equal.
- D. GFI receptacle shall be duplex receptacle in a duplex body containing reset and test push-buttons. Furnish Square D "GFSR", or equal.
- E. Two-pole, 3-wire grounding, #20A/250V NEMA 6-20R single receptacle shall Arrow-Hart #5861, Hubbell #5461, or equal.
- F. Single-pole, single throw, 20A toggle switch shall be Arrow-Hart #1791, Hubbell #1221, or equal.

- G. Single-pole, double throw (three-way) 20A toggle switch shall be Arrow-Hart #1994, Hubbell #1224, or equal.
- H. Double-pole, double-throw (four-way) 20A toggle switch shall be Arrow-Hart #1994, Hubbell #1224, or equal.
- I. Double-pole, single-throw 29A toggle switch shall be Arrow-Hart #1992, Hubbell #1222, or equal.
- J. Single-pole, double-throw, momentary/centeroff, 20A toggle switch shall be Arrow-Hart #1995, Hubbell #1556, or equal.
- K. Door switch, single-throw pressure sensitive shall be Pass & Seymour #1205, or equal.

2.13. PANELBOARDS

- A. The equipment included in this Section consists of several panel types designated as lighting and power panelboards for use in applications up to 600 volts with interrupting ratings of 10,000 through 100,000 amps. Cabinets are galvanized code gauge steel and trims shall be door-in-door with one door over the interior and an additional door over the wiring gutters. Fast mounting type with release mechanisms mounted behind locked door which are keyed alike. The finished product shall bear an Underwriters Laboratory label and any panel, whether service entrance or not, shall bear a "Suitable for Service Entrance" label if it has the minimum number of disconnects to so classify it.
- B. Ratings shall be as shown on the drawings. Interrupting rating shall be as indicated on the drawings or as required to withstand the available fault current, whichever is greater.
- C. Unless otherwise noted on the drawings, all breakers shall have the following minimum ratings according to Federal Spec WP375A or better:

WP Breaker Type	375	Trip Range	Poles	Interrupting Capacity
Bolted	2a	0-100	1	10,000 @ 277V
Bolted	2d	0-100	2&3	14,000 @ 480V
Bolted	3B	101-225	2&3	STD
Bolted	4B	226-400	2&3	STD
Bolted	5A	401-800	2&3	STD

- D. Breakers shall be bolt-on quick-make, quick-break type having thermal and magnetic elements. Two and three pole circuit breakers shall be common-trip type with one handle. Handle ties are not acceptable.
- E. Breakers shall be fully rated for operation at 40 C with no derating necessary.
- F. Lugs: Approved for 75° C copper rated conductors.

- G. Provide any test kits necessary to calibrate and test the circuit breakers.
- H. 120/240 V panelboard shall be Cutler Hammer PRL 1a, or approved equal by Schneider Square D or General Electric.
- I. 277/480 V panelboard shall be Cutler Hammer PRL 2a, or approved equal by Schneider Square D or General Electric..
- J. Each panel shall have a separate copper ground bus.
- K. All busses shall be tin plated copper with full capacity neutral where required of a type and size as shown on the drawings. Minimum bus ampacity shall be 100 Amps unless otherwise noted.
- L. Bussing shall be full size distributed phase sequence type extending the full length of the panel.
- M. All breakers shall be installed in panels in the same sequences shown in the schedules.
- N. Minimum box width is 20-inches.
- O. Box length shall be sufficient for 42 circuits unless otherwise noted on the Plans.
- P. Code gauge steel per NEMA PB1-1977 and UL 67.
- Q. Nema 12 enclosure for indoor locations.
- R. NEMA 4X 316 SS for outdoor locations.

2.14. DRY-TYPE TRANSFORMERS

- A. Transformers shall be manufacturers' premium quality dry-type and suitable for outdoor installation.
- B. Transformers shall have ratings indicated on the Plans. Primary and secondary voltages shall be as shown.
- C. Enclosures shall include a wiring compartment at the bottom. Transformers 25 KVA and larger shall be floor mount type. Transformers shall have ventilation openings, corrosion resistance, cable bending space, grounding provisions, surface temperature rise, wiring compartment temperature rise, and terminations per UL 506 specifications. Furnish lifting lugs for each transformer 25 KVA and above. All exposed metal parts shall be cleaned, phosphatized, primed and finished with gray baked enamel.
- D. Transformer coils shall be machine wound copper windings impregnated with high temperature varnish for protection against moisture and heat build-up.

- E. Taps shall be furnished as follows:
 - 1. 15 KVA and below: 2 - 5% taps below rated voltage
 - 2. 25 KVA and above: 6 - 2½% taps: Two above rated voltage and four below rated voltage.
- F. Sound levels shall be equal to or lower than ANSI standard C89 levels. Each transformer 30 KVA and above shall have an integral noise isolation system.
- G. Temperature Rise to be 80o C above 40o C ambient. Capable of carrying 30% continuous overload at less than 150o C rise in a 40o C ambient. Insulation per NEMA ST20 for 220o C system.
- H. Transformers shall be installed in a Nema 3R 316 SS enclosure with ventilation openings as required.
- I. Transformers shall be Eaton Cutler Hammer, Schneider Square D, General Electric, or approved equal.

2.15. SAFETY SWITCHES

- A. Safety switches shall be fused or non-fused as indicated. Each fused type switch shall be equipped with class R refection clips.
- B. Switch mechanism in each safety switch shall be quick-make, quick-break, heavy-duty type that meets Federal Specification W-S-865C.
- C. Operating handle shall be lockable in both the "ON" and "OFF" positions.
- D. Enclosures shall be NEMA 12 for indoor locations and Nema 4X 316 SS for outdoor installations.
- E. Each enclosure shall be equipped with ground lug.
- F. Where indicated furnish disconnect switches with switch handle activated auxiliary control disconnect contact rated 10 amp make, 6 amp break 120V A. C., 35% p.f.
- G. Where indicated furnish safety switches with integrally mounted pilot operators.
- H. Safety switches shall be 600 V, heavy duty type as manufactured by Eaton Cutler Hammer, Schneider Square D or General Electric, or approved equal.

2.16. CIRCUIT BREAKERS

- A. The molded case circuit breakers and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of the following:
 - 1. UL 489 – Molded Case Circuit Breakers

2. NEMA AB1 – Molded Case Circuit Breakers
 3. NEMA 250 – Enclosures for Electrical Equipment
- A. Protective devices shall be molded case circuit breakers with inverse time and instantaneous tripping characteristics and shall be Cutler-Hammer type Series C or approved equal.
 - B. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make quick-break over-center switching mechanism that is mechanically trip-free.
 - C. Automatic tripping of the breaker shall be clearly indicated by the handle position. Contacts shall be nonwelding silver alloy and arc extinction shall be accomplished by means of DE-ION arc chutes. A push-to-trip button on the front of the circuit breaker shall provide a local manual means to exercise the trip mechanism.
 - D. Circuit breakers shall have a minimum symmetrical interrupting capacity as indicated on the drawings.
 - E. Circuit breakers 800 ampere frame and below shall be Cutler-Hammer type Series C with thermal-magnetic trip units and inverse time-current characteristics.
 - F. Circuit breakers 800 ampere through 2000-ampere frame shall be Cutler-Hammer type Series C with microprocessor-based RMS sensing trip units.
 - G. Provide ground fault protection on breakers rated 1000 Amps and above.
 - H. Where indicated circuit breakers shall be UL listed for series application.
 - I. Breakers located indoors shall be provided in a Nema 12 enclosure. Breakers located outdoors shall be installed in a Nema 4X 316 SS enclosure.
 - J. Operating handle shall be provided with provisions for locking in both the “ON” and “OFF” positions.
 - K. Breakers shall be Eaton Cutler Hammer, Schneider Square D. General Electric, or approved equal.

2.17. SELF-CONTAINED POWER CENTERS

- L. The power center shall consist of a primary circuit breaker, a dry type transformer and a secondary panelboard all assembled in one enclosure. All interconnecting wiring between the primary breaker and the transformer and between the transformer and the secondary panelboard shall be factory wired so that the only connections necessary in the field will be to the line side of the main circuit

breaker and to the load side of the branch circuit breakers in the secondary panelboard.

- M. The power center shall have the following ratings:
 - 1. Primary Voltage - 480 volts, single phase.
 - 2. Secondary Voltage - 120/240 volts, single phase, three wire.
 - 3. Transformer – as noted on the plans.
 - 4. Primary Breaker – Continuous rating, as noted on the plans, with an interrupting rating of 18,000 amps at 480 volts.
 - 5. Main Secondary Breaker – Continuous rating, as noted on the plans, with an interrupting rating of 10,000 amps at 240 volts.
 - 6. Branch Circuit Breakers - Continuous current rating as shown on the drawings with an interrupting rating equal to the main secondary breaker.
- N. Units shall be designed for continuous 24 hours a day operation, 365 days per year with normal life expectancy per ANSI C57.96.
- O. Transformer shall be manufacturers' standard self-ventilated dry-type suitable for outdoor installation.
- P. Insulation shall be 185 C, flame retardant and will not support combustion as defined in ASTM Standard Test Method D635.
- Q. Core shall be high-grade silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Coils shall be continuously wound electrical grade copper. Core and coil assembly shall be resin encapsulated to provide a moisture proof shock resistant seal and to minimize the sound level.
- R. Main breaker shall be molded case thermal magnetic sized to provide short circuit and overload protection for the transformer.
- S. Secondary main circuit breaker shall be of the same type as the primary circuit breaker and shall be sized to provide protection for the panelboard.
- T. The panelboard shall contain the number of circuit breakers indicated on the panel schedule. Breakers shall be one-inch plug-in molded case, thermal magnetic with the continuous current rating as indicated on the schedule.
- U. Totally enclosed, non-ventilated in a Nema 3R Stainless Steel enclosure.
- V. Equipped with a wiring compartment large enough to allow convenient wiring.
- W. Maximum temperature not to exceed 90 C.

- X. Core grounded to the enclosure.
- Y. Sound levels shall not exceed the following ANSI and NEMA levels for the self-cooled ratings:
 - 1. Up to 9 kVA - 40 Db
 - 2. Above 9 kVA - 45 Db
- Z. Power center shall be Eaton Cutler Hammer, Schneider Square D, General Electric, or approved equal.

2.18. SURGE PROTECTION

A. REFERENCE STANDARDS

- 1. ANSI/IEEE C62.11, C62.41 and C62.45.
- 2. Federal Information Processing Standards Publication FIP Pub. 94.
- 3. NEMA LS-1.
- 4. NFPA 20, 70, 75 and 78.
- 5. UL 1449.

B. ACCEPTABLE MANUFACTURERS

- 1. MCG Electronics, Inc.
- 2. Innovative Technologies, Inc.
- 3. Surge Suppression, Inc.
- 4. Eaton/Cutler-Hammer
- 5. Engineer Approved Equal

C. Surge protection shall be installed on the incoming line to provide protection against lightning strikes and switching surges that could otherwise damage electrical and electronic equipment.

D. Surge Protection shall be mounted either on panel with aluminum nipple between panel and TVSS or inside switchgear, motor control center compartment.

E. Surge protection shall be MCG Electronics Co. Model 200LS, or approved equal, having the following features:

- 1. 200,000 transient amps per phase surge protection.

2. Protection in all modes, L-N, L-G, L-L, N-G.
 3. LED's on front panel to indicate power present and reduced protection. LED's internal to pinpoint problem areas.
 4. Event counter with reset and automatic memory backup.
 5. Low impedance installation cable.
 6. Audible fault alarm with silence switch.
 7. Fused protection elements within the protection module to provide backup protection of the module.
 8. 200 kAIC fusing.
 9. Remote alarm relay contacts.
 10. Integral deadfront disconnect.
 11. Ten year warranty.
 12. Protection modules that can be removed and replaced when damaged.
- F. Protection unit shall be provided in a NEMA 4X 316 SS enclosure for outdoor installations and NEMA 12 for indoor, with description label.
- G. Furnish one set of spare fuses and one spare protection module with each protection unit furnished.

2.19. EMERGENCY GENERATOR

A. GENERAL:

1. Contractor shall furnish and install complete outdoor weather proof enclosed emergency power supply systems consisting of diesel engine-generators, automatic transfer switches and associated controls and wiring as shown on the drawings and specified herein.

B. RATING:

1. Rating of the diesel engine-generator set shall be based on operation of the set when equipped with all necessary operating accessories such as radiator, fan, air cleaners, lubricating oil pump, fuel transfer pump, fuel injector pump, jacket water pump, governor, charging alternator, alternating current generator, and exciter regulator. The diesel engine-generator set shall be capable of producing at least XXX KW at 0.8 power factor standby rating or sized as required for step starting of the loads shown on the plans, at 480/277 Volts, 3 phase, 4 wire, 60 HZ.

C. SUBMITTALS:

1. Contractor shall submit the following information:
2. Drawings of the diesel generator set offered hereunder. Literature describing the diesel engine generator set and indicating its current production status.
3. Drawings and/or literature describing auxiliary equipment to be furnished.
4. The following data in tabulated form:
 - a. Make of engine
 - b. Number of cylinders
 - c. Bore, inches (millimeters)
 - d. Stroke, inches (millimeters)
 - e. Piston displacement, cubic inches (liters)
 - f. Piston speed, feet per minute (liters/mim.) at rated RPM
 - g. BMEP rated KW output
 - h. Make and type of generator
 - i. Generator electrical rating, KVA or KW .8 power factor
 - j. Number and type of bearings
 - k. Exciter type
 - l. Generator insulation class and temperature rise
 - m. Parts and service support
 - n. Engine manufacturer's certified engine BHP curve and certified gen set fuel consumption curve
 - o. Electrical loading and performance calculations
5. Foundation design for each location

D. ENGINE SPECIFICATIONS:

1. TYPE
 - a. The engine shall be compression ignition engine. It shall be a four stroke cycle, water cooled, solid-injection engine of either vertical in-line or V-type.
2. HORSEPOWER
 - a. Certified engine horsepower curves shall submitted showing the manufacturer's approval of the engine rating for generator set standby and prime power application. Special ratings or "maximum" ratings will not be acceptable.
3. SPEED
 - a. The engine shall not exceed 1800 RPM at normal full load operation.

4. FUEL

- a. The engine fuel shall be capable of satisfactory performance on a commercial grade of distilled petroleum fuel oil such as No. 2 diesel fuel.

5. GOVERNOR

- a. The engine speed shall be controlled by an electronic or hydraulic governor to maintain constant speed from no load to full load. The frequency at any constant load, including no load, shall remain within a steady state band width of +0.25% of rated frequency. The governor shall not permit frequency modulation (defined as the number of times per second that the frequency varies from the average frequency in cyclic manner) to exceed one cycle per second.

6. FUEL SYSTEM

- a. Furnish and install a double walled 142 UL Listed base mounted fuel tank with sufficient capacity for 24 hours operation at full load complete with a fuel level gauge and one (1) full tank of fuel.

7. LUBRICATION

- a. The engine shall have a gear-type lubricating oil pump for supplying oil under pressure to main bearings, crank-pin bearings, piston pins, timing gears, camshaft bearings, and valve rocker. Threaded spring-on type full flow lubricating oil filters, conveniently located for servicing, shall be provided. Filters shall be equipped with a spring loaded bypass valve to insure oil circulation if filters are clogged.

8. AIR CLEANERS

- a. The engine shall be provided with one or more dry type replaceable element, air cleaners.

9. STARTING

- a. The engine shall be equipped with an electric starting system of sufficient capacity to crank the engine at a speed which will allow diesel starting of the engine. Lead acid batteries shall be furnished having sufficient capacity for cranking the engine for at least 40 seconds at firing speed in the ambient temperature specified. A battery rack and necessary cables and clamps shall be provided. A suitable battery charging alternator shall be provided with sufficient capacity to recharge the batteries back to normal starting requirements quickly. An automatic battery trickle

charger (5 amp capacity minimum) shall be provided to maintain the batteries at full capacity.

10. ENGINE INSTRUMENTS

- a. An engine or generator mounted instrument panel shall contain the following gauges for proper engine surveillance and maintenance:
 - i. Engine Coolant Temperature
 - ii. Engine Lube Oil Pressure
- b. Engine Lube Oil Temperature
- c. Engine Running Hourmeter
- d. Battery Charging Indicator
- e. Engine Fault Indicator for Oil Pressure, Coolant Temperature, and Engine Overspeed
- f. Fuel Level

11. COOLING

- a. The engine shall be furnished with a cooling system having sufficient capacity for cooling the engine when the diesel generator set is delivering full-rated load at the ambient temperature and altitude. The engine shall be equipped with an engine driven, centrifugal-type water circulating pump and thermostatic valve to maintain the engine at recommended temperature level. The engine cooling system shall include one or more spin-on type engine water filters which will treat the coolant and prevent corrosion and scale deposits inside the cooling system. The engine cooling system shall be filled with a minimum concentration of 33% ethylene glycol. The engine shall be equipped with a radiator, 240 Volt single phase engine block heater, blower fan, and close fitting venturi shroud of a type and capacity recommended by the engine manufacturer. A rigid guard shall enclose both top and sides of all moving parts between the engine and radiator.

12. EXHAUST SYSTEM

- a. A suitable silencer, of the Critical type shall be furnished with the engine.

13. SAFETY CONTROLS

- a. The engine shall be equipped with automatic safety controls which will shut down the engine in the event of low lubricating oil pressure, high coolant temperature, engine overspeed, engine overcrank, and make electrical contacts for alarm light on the control panel. In addition, pre-alarm signals for high coolant temperature and low lube oil pressure shall be provided.

14. MOUNTING

- a. The engine and generator shall be equipped with suitable full length sub-base for mounting the engine generator unit on a concrete foundation. The engine shall be equipped with spring type vibration isolators between the sub-base and the concrete foundation unless they are integrated into genset design.

15. ATTENUATED ENCLOSURE

- a. The complete diesel engine generator set, including generator control panel, engine starting batteries and fuel oil tank, shall be enclosed in a factory assembled, sound attenuated enclosure mounted on the fuel tank base.
- b. A weather resistant, sound attenuated enclosure of steel with electrostatically applied powder coated baked polyester paint. The enclosure shall have a resulting sound level of 78 dba @ 23ft with the genset running under full load. It shall consist of a roof, side walls, and end walls. Fasteners shall be either zinc plated or stainless steel.
- c. Enclosure Sound Attenuation: Acoustical foam shall be provided between all supports and inside doors and sound baffles on air intake and air discharge.

E. GENERATOR SPECIFICATIONS

1. CONSTRUCTION

- a. The generator shall be a brushless, revolving field type, coupled directly to the engine flywheel through a flexible driving disc for positive alignment. The generator housing shall bolt directly to the engine flywheel housing. The generator housing shall have a single ball bearing support for the rotor. The rotor shall be dynamically balanced up to 25% overspeed. The generator shall comply with NEMA standard MG-1978, Parts 16 22. Insulation shall be class B or F as recognized by NEMA. The rotor and stator temperature rise for the class insulation being furnished, and as measured by the resistance method at the voltage specified shall be in accordance with NEMA standard MG-116.40 and MG1-22.40 for standby (prime power) operation. The generator shall be fully guarded per NEMA MG1-1.25. The rotating brushless exciter shall incorporate a full wave, three phase rotating rectifier with hermetically sealed, metallic type, silicon diodes to supply main field excitation. A multiplate selenium surge protector shall be connected across the diode network to protect against transient conditions. The rotor shall be layer wound with thermosetting epoxy between each layer plus a final coat of epoxy for moisture and abrasion resistance. Amortisseur windings shall be integral with the rotor coil support. The rotor shaft bearing shall

be shielded type with provisions for easy servicing through grease pipes which extend to the exterior of the generator frame. The bearing shall be designed for a minimum B-10 bearing life of 40,000 hours. The stator winding shall be of 2/3 pitch design to eliminate the third harmonic wave form distortion and minimize the harmful neutral circulating current when operation in parallel. The stator windings shall be given five dips and bakes of varnish plus a final coating of epoxy for moisture and abrasion resistance. The wave form harmonic distortion shall not exceed 5% total RMS measured line to line at rated load. The generator shall be furnished with an end mounted, ventilated load connection box such that load conductors can enter the bottom of the junction box. The voltage regulator shall be of the solid state construction type with SCR control. It shall be mounted inside the generator terminal box or in the control cabinet. A built-in voltage adjusting rheostat shall provide 10% voltage adjustment.

2. GENERATOR SET PERFORMANCE

- a. The voltage regulation from no load to rated shall be within a bank of +1% of rated voltage. The steady state voltage stability shall remain within a 0.5% band of rated voltage. Steady state voltage modulation shall not exceed one cycle per second. The regulator printed circuit board and power control diodes shall be hermetically sealed for moisture protection. For any addition of load up to and including 100 percent of rated load, at 0.8 power factor, the voltage dip shall not exceed 20% of rated voltage for the loads shown on the plans. The voltage shall recover to and remain within the steady state band in not more than 5.0 seconds. The frequency regulation from on load to rated load shall be in accordance with that defined by the engine governor performance. For any addition of load up to 100% of rated load, the frequency shall recover to the steady state frequency band within 6.0 seconds. The balanced telephone influence factor (TIF) shall not exceed 50. Alternator shall be equipped with permanent magnet or AREP excitation for improved motor starting capabilities.

F. GENERATOR CONTROL PANEL

1. The generator control panel shall be mounted on the generator terminal box in a NEMA-1 enclosure by means of vibration isolators and contain, at a minimum, a voltmeter, ammeter, frequency meter, combination ammeter-voltmeter phase selector switch, and engine instrumentation.
2. Accessory equipment shall be provided on the generator control panel:
 - a. Alarm Lights
 - b. Pre-Alarm Features per NFPA 76A
 - c. Watt-meter
 - d. Automatic Start Control with Cycle Cranking

1. The basic panel shall be equipped with minimum features as follows:
 - a. Enclosure - NEMA 1
 - b. AC Ammeter - 3 1/2 inch (89mm) dial type, 2% accuracy
 - c. Ac Voltmeter - 3 1/2 inch (89mm) dial type, 2% accuracy
 - d. Frequency Meter -3 1/2 inch (89mm) dial type, 2% accuracy
 - e. Ammeter/Voltmeter Phase Selector Switch
 - f. Three Current Transformers
 - g. Solid State Circuit Breaker
 - h. Nameplates, Control Wiring, Fuses, and Terminal Blocks
 - i. Global alarm dry contacts for genset run & genset failure.

G. OVERLOAD PROTECTION CIRCUIT BREAKER

1. A main line molded case 3-pole circuit breaker shall be installed as a load circuit interrupting and protection device. It shall operate both manually as an isolation switch and automatically during overload and short circuit conditions. The trip unit for each pole shall have elements providing inverse time delay during overload conditions and instantaneous magnetic tripping for short circuit protection. The circuit breaker shall meet standards established by Underwriter's Laboratories, National Electric Manufacturer's Association, and National Electric Code. The circuit breaker shall be mounted in NEMA-1 type enclosure in or adjacent to the generator control panel.

H. AUTOMATIC START-STOP SYSTEM

1. The engine starting panel shall automatically provide a minimum of four cranking and three rest periods. Operation shall be initiated by the closing of contacts in the automatic transfer switch. The automatic starting panel control switch shall include the positions of "Automatic", "Off", and "Test". The automatic starting panel shall contain 24-volt alarm lights energized by the safety controls. A 24-volt visual light shall also be energized if the engine has started by the end of the final cranking cycle. The panel and selector switch shall be mounted in the generator control panel. A green light shall indicate when the selector switch is in the "automatic" power.

I. TESTING

1. All performance and temperature rise data submitted by the manufacturer above and shall be the result of actual test of the same or duplicate generator. Temperature rise data shall be the result for full load, 0.8 power factor heat runs at the rated voltage and frequency. This testing shall be done in accordance with MIL-STD-705 and IEEE standard 115. Before the equipment is installed, a factory test log of the generator set showing a minimum of 3/4 hour testing with 1/2 hour at 100 percent rated load at 0.8 power factor, continuously, shall be submitted to the purchaser. Voltage and frequency stability and transient response at 1/4, 1/2 and full load shall also be recorded. Normal preliminary engine and

generator tests shall have been performed before unit assembly. Prior to acceptance of the installation, the equipment shall be subjected to an onsite test at full load with resistive load banks for a minimum of 4 hours. All consumables necessary for this test operation shall be furnished by the contractor. Any defects which become evident during this test shall be corrected by the contractor at this own expense.

- J. Generator shall be Caterpillar with no equals. Contact Mr. Tom Tarbox at Holt Power Systems (210) 648-8407.

2.20. AUTOMATIC TRANSFER SWITCHES

- A. An automatic transfer switch shall be installed as shown. It shall be rated at the current indicated on the drawings, at 480 Volts and 60 HZ. It shall be mechanically held and electrically operated by a single solenoid mechanism energized from the source to which the load is to be transferred and capable of manual operation by one person. The switch shall be mechanically and electrically interlocked to ensure one of the two positions - normal or emergency. The switch shall be applicable to 50 Hz or 60 Hz and suitable for all common voltages from 110 to 600. Switch shall be service entrance rated and shall conform with the provisions of underwriter's Laboratories 1008 Standards and meet the National Electric Code (NEC) requirements for critical applications.
- B. Accessories- Transfer switches shall be equipped with the following accessories:
 - 1. Time delay, normal to emergency, and (adjustable 0.6 to 60 seconds)
 - 2. Time delay, emergency to normal, (adjustable 0.6 to 60 seconds)
 - 3. Time delay on engine cooling, (fixed, non-adjustable 5 minutes, -1 to +2 minutes tolerance)
 - 4. Time delay on engine starting, (adjustable 0.5 to 60 seconds)
 - 5. A test switch to simulate a normal power source failure
 - 6. Pilot contact to initiate engine starting controls
 - 7. Pilot lights to visually indicate the transfer switch position
 - 8. Relay contacts as required plus one spare set of normally open and normally closed relay contacts
 - 9. Provide solid state exerciser clock to set the day, time, and duration of generator set exercise/test period. Provide a with/without load selector switch for the exercise period.
- C. Automatic transfer switch shall be ASCO Bulletin 300, with no equals. Enclosed in a Nema 4X, 316SS housing, deadfront construction with outer door. Controls shall be conformally coated and the operator's interface shall be mounted on the

interior swingout door.

PART 3: INSTALLATION

3.01. RACEWAYS

- A. Install the conduit system to provide the facility with the utmost degree of reliability and maintenance free operation. The conduit system shall have the appearance of having been installed by competent workmen. Kinked conduit, conduit inadequately supported or carelessly installed, do not give such reliability and maintenance free operation and will not be accepted.
- B. Raceways shall be installed for all wiring runs except as otherwise indicated.
- C. Conduit sizes, where not indicated, shall be N.E.C. code-sized to accommodate the number and diameter of wires to be pulled into the conduit. Unless otherwise indicated, 3/4" trade-size shall be minimum size conduit.
- D. Unless otherwise noted, conduit runs shall be installed exposed. Such runs shall be made parallel to the lines of the structure. Where aluminum conduit or supporting devices come in contact with concrete, the conduit and or supporting devices shall be coated with zinc chromate or other suitable coating to prevent galvanic action.
- E. Conduit runs installed below-grade in earth shall be PVC. Use manufacturer's approved cement for joining couplings and adapters. Runs shall be installed so that TOPS of conduits are a MINIMUM OF TWENTYFOUR (24") INCHES BELOW FINISHED GRADE. Support conduit runs on plastic spacers and encase conduits with 2500 PSI reinforced concrete. Concrete shall be a minimum of 3" beyond conduits on all sides. Cover top of concrete with red colored concrete dye and backfill to finished grade with selected soil that is free from clods, debris, rocks and the like. Pneumatically tamp backfill in six (6") inches to eight (8") inches below finished grade, install continuous run of "BURIED CABLE" marking taped. Contractor shall coordinate inspections with JRSA Engineering (512) 452-8789 before concrete is poured and before conduit runs are backfilled.
- F. Conduit stubups from below grade shall be made with PVC coated rigid metallic conduit. PVC coating shall extend a minimum of 6" above finished grade.
- G. Rigid metallic conduit runs shall have their couplings and connections made with screwed fittings and shall be made up wrench-tight. Check all threaded conduit joints prior to wire pull.
- H. All conduit runs shall be watertight over their lengths of run except where drain fittings are indicated. In which cases, install specified breather-drain fittings.
- I. Plastic jacketed flexible steel conduit shall be used to connect wiring to motors, limit switches, bearing thermostats, and other devices that may have to be removed for servicing. Unless otherwise indicated, maximum lengths of flex shall

be three (3') feet.

- J. Each flex connector shall be made-up tightly so that the minimum pull-out resistance is at least 150 lbs.
- K. Empty conduits shall have pull-tape installed. Identify each end with a stainless steel tag with stamped on lettering identifying the location of the other end. Cap exposed ends of empty conduit with approved conduit plugs.
- L. Conduit runs into boxes, cabinets, and enclosures shall be set in a neat manner. Vertical runs shall be set plumb. Conduits set cocked or out of plumb will not be acceptable.
- M. Conduit entrances into equipment shall be carefully planned. Cutting away of enclosure structure, torching out sill or braces, and removal of enclosure structural members, will not be acceptable.
- N. Use approved hole cutting tools for entrances into sheet metal enclosure. Use of cutting torch or incorrect tools will not be acceptable. Holes shall be cleanly cut free from burrs, ragged edges, and torn metal.
- O. All raceways shall be swabbed clean after installation. There shall be no debris left inside. All interior surfaces shall be smooth and free from burrs and defects that would injure wire insulation. All conduits shall be sealed after cable installation with electrical insulation putty.
- P. Conduit entries into metal enclosures shall be made with the use of Myers watertight conduit hubs.

3.02. CONDUIT BODIES AND BOXES

- A. Conduit bodies such as "LB", "T", etc., shall be installed in exposed runs of conduit wherever indicated and where required to overcome obstructions and to provide pulling access to wiring. Covers for such fittings shall be accessible and unobstructed by the adjacent construction.
- B. Covers for conduit bodies installed shall be gasketed cast metal type.

3.03. RACEWAY SUPPORT

- A. All raceway systems shall be adequately and safely supported. Loose, sloppy and inadequately supported raceways will not be acceptable. Supports shall be installed at intervals not greater than those set forth under Article 300 of N.E.C., unless shorter intervals are otherwise indicated, or unless conditions require shorter intervals of supports.
- B. Surface mounted runs of conduit on concrete or masonry surfaces shall be supported off the surface by means of stainless steel slotted channels and conduit clamps. Attach each slotted channel support to concrete surface by means of two (2) 1/4" diameter stainless steel bolts into drilled expansion shields.

- C. Conduit runs that are installed along metallic structures shall be supported by means of beam clamps or other methods as may be indicated. Coat each beam clamp with PVC prior to installation.
- D. Below-grade conduits shall be supported with plastic saddles. Install saddles at 3'-0" spacing minimum.

3.04. WIRING

- A. Color-coded wire shall be used on 600 volts and below.
- B. An equipment grounding wire run in conduit shall have an identifying green covering. Ground conductor shall be sized per NEC 250-94 and 250-95. Minimum service ground shall be #6 AWG.
- C. A green 600 volt conductor used for grounding purposes with single conductor cables of higher voltage requirements will be permitted.
- D. Conductor terminations No. 8 AWG and smaller shall be made with pressure-connected lugs, Buchanan "Termend" or equal. Conductor terminations larger than No. 8 AWG shall be made with solderless, compression-type copper terminals equivalent to Burndy type YA-L. Compression shall be made with a die set that will make a circumferential crimp. Wire strands shall be thoroughly cleaned before lug is applied.
- E. Bolted connections for electrical conductors without noncorrosive surfaces shall be thoroughly cleaned and tinned or covered with a light film of commercial paste to prevent oxidation.
- F. Where mechanical assistance is used for pulling conductors, a wire pulling compound, Polywater J, or equal, having inert qualities that do not harm the wire insulation or covering shall be applied to the conductors before they are pulled into raceways. The interior of all raceways shall be free from grease, filings or foreign matter before conductors are pulled.
- G. No wire smaller than No. 12 shall be installed except as furnished with standard packaged equipment or specified herein for low voltage control systems or fixture wiring. No. 14 may be used for control wiring where adequately protected by properly sized fuses.
- H. All wiring shall be run in conduits or raceways except in special cases. No wire shall be installed until the conduit system is completed and the construction work has progressed beyond the stage where the wire may be damaged.
- I. Where the capacity of a single feeder is so great as to require parallel conductors in more than one conduit, each conduit must contain the same number and length of conductors in all phases (legs) of the feeder, including any neutral conductors.

- J. In circuits of 600 volts and below, control wiring may be pulled in the same conduit with the power wiring if the control wiring is rated for the same voltage as the power wiring and if the conduit size is adequate. Unless otherwise indicated on the drawings, motors 30 HP and larger shall have separate conduit systems for the motor leads and control wiring.
- K. Wiring shall be continuous between outlets. Keep splices to a minimum. Splice only in accessible junction boxes. Make splices to carry full capacity of conductors without perceptible temperature rise. Do not pull splices into conduit.
- L. Wiring shall be tagged with heat shrinkable Brady Wire Markers or equal at panel-boards, with suitable numbers for use in identification. All control wiring shall be tagged likewise.
- M. One conductor of each lighting circuit shall be identified. The identified conductor shall be connected to the screw shell of the lamp socket.
- N. No more than three lighting circuits shall be installed in any conduit for 4-wire, 3-phase systems, or two circuits for 3-wire single-phase systems. Each of the circuits shall be of a different phase.
- O. Continuity tests shall be performed on all power and control circuit conductors using an ohmmeter and megohmmeter. Proper phasing connections shall be verified.
- P. The manufacturer's recommended pulling tension shall not be exceeded when installing wiring.
- Q. Control wiring connections to stud type and screw type terminals shall be made with ring-tongue type crimp connectors. Label each terminal jacket with heat shrinkable wire marking label at each connection. Label shall correspond to the labeling shown on the approved schematic diagrams.
- R. Each wire connection shall be made up tightly so that resistance of connection is as low as equivalent length of associated conductor resistance.
- S. Phase label black pigmented power wires with color banding tape. Color of tape applies shall be that specified below.

CONDUCTOR	120/240V SYSTEMS	480V SYSTEMS
Phase A	Black	Brown
Phase B	Red	Yellow
Phase C	Blue	Purple
Neutral	White	Gray
Equipment Ground	Green	Green

- T. Numbered labels shall be installed to identify circuit numbers from panel boards. Install heat shrinkable labels on each wire in each panelboard, junction, and pullbox, and device connection.

- U. All wiring inside enclosures will be neatly trained and laced with nylon tie-wraps.

3.05. INSTRUMENT WIRING

- A. Analog signals shall be separated physically from control and power wiring. A separate conduit shall be used for each.
- B. Twenty-four and 48 Vdc shall be used in separate conduits from 115 VAC wiring.
- C. Wiring shall be arranged neatly with terminations located directly opposite the terminals. Wire loops shall be not less than 6 inches long in each outlet box. Frayed terminals and exposed wire shall be taped.
- D. Shields shall be grounded at only one end of each cable run. Shields shall be continuous throughout the run. Jumpers shall be provided at terminals blocks to ensure continuity.
- E. Brady or equal heat shrink wire markers shall be provided to identify each wire at both the terminal block and the device, i.e., at both ends.
- F. Color code as follows:
 - 1. Line and load circuits AC or DC power – Black
 - 2. AC control circuits – Red
 - 3. DC control circuits – Blue
 - 4. Interlock control circuits on the panel energized from an external source – Yellow
 - 5. Equipment grounding conductors – Green
 - 6. Neutral conductor – White

3.06. WIRING DEVICES

- A. Install wiring devices where indicated. Wiring devices shall be type as indicated.
- B. Each wiring device shall be set with axis plumb and installed with yoke screw so as to adequately support device yokes to the box.
- C. Device boxes shall be cast metal condulets or equal.
- D. Use ganged boxes for ganged devices.
- E. Each device box shall be equipped with specified cast metal cover.
- F. Receptacles shall be installed a minimum of 3'-0" above floor or above grade as applicable. Switches shall be installed 4'-0" above floor or above grade as applicable.

3.07. GROUNDING

- A. Safety grounding of equipment shall be accomplished by providing an equipment ground wire, as shown on the drawings which will be no less than the size recommended in Article 250 of the National Electric Code. This ground will extend throughout the system by means of insulated green ground wires connected to ground buses in each switchgear, motor control center, panelboard and terminal on each outlet box, light fixture housing or grounding terminal of the motor. Install bonding jumpers from ground lugs on conduit grounding bushings to ground buses.
- B. Each ground bus, in addition to connecting to its feeder ground, will be grounded to the building ground rods or ground plates where applicable.
- C. Connect ground wires entering outlet boxes in a manner which will allow removal of the receptacle without interrupting the continuity of the grounding circuit. A grounding screw attached to the interior of the box, and used for no other purpose, will accomplish this.
- D. Install a ground strap from all panels to a grounding screw on their respective doors.
- E. Install a bonding jumper from the grounding lug on each conduit to the ground bar or ground bus.
- F. The grounding electrode conductor for each electrical equipment enclosure shall be bonded to the system grounding electrode(s), and shall be connected to the equipment ground bus or bar.
- G. Electrical racks and shelters shall be bonded to the system ground.
- H. Where the equipment has no facility to attach an equipment ground wire, use a Burndy Quicklug or equal. Clean the metal surface under the lug to bright metal so that good contact can be made.
- I. Connect equipment grounds to motors using a grounding stud threaded into the stationary frame of the motor and not the end bell.
- J. Make ground connections to equipment by using ground lugs; or, ground bars where they are provided. Do not make connections to equipment anchor bolts.
- K. Connect equipment ground wires to grounding lugs in the lighting panel. **DO NOT CONNECT EQUIPMENT GROUNDS AND NEUTRALS AT THE PANEL-BOARD.**
- L. All underground cable connections and taps shall be made by a thermoweld process similar or equal to the Cadweld process. Coat connections with Koppers Bitumastic No. 505, or equal.

- M. Furnish a separate dedicated insulated ground conductor and ground rod for the instrumentation and telemetry system. Connect ground wire to a dedicated insulated ground bus in the Control Panel.
- N. General items to be grounded shall consist of enclosures and/or frames for motor starters, circuit breakers, transformers, safety switches, switchgear, panelboards, motors, capacitors and exposed metal parts of similar equipment. These items shall have solidly grounded cable connections to the grounding system.
- O. Connect the X_0 terminal of the lighting transformer to building steel or underground metallic water piping where available. Otherwise connect to ground loop.
- P. Ground cable termination to enclosure and frames shall be similar to Thomas and Betts 71000 Series.
- Q. Ground wires installed above grade to be insulated and in conduit for protection. Bare ground wires shall be installed in Schedule 80 PVC conduit, where ground wire passes through concrete slab.
- R. In general, resistance to ground shall not exceed 5 Ohms; however, resistance to ground of the instrument ground shall not exceed 1 Ohms.
- S. Ground bushings shall be bonded to the equipment ground conductor and to the equipment ground bus.
- T. Shields of instrumentation signal wiring shall be grounded at the panel only. The other end shall be cut and taped.

3.08. LABELING

- A. Apply numbered heat shrinkable wire marking labels to control wires; power wiring in panelboards, pull and junction boxes, and at outlets to identify circuit numbers. Each control wire shall be labeled at each connection.
- B. Apply stainless steel identification labels to wiring sets in each hand-hole to identify function.
- C. Install 3-Ply phenolic nameplates, black with white engraving, to identify function and/or load served for the following:
 - 1. Panelboards
 - 2. Overcurrent Devices
 - 3. Safety Switches
 - 4. Control Panel
 - 5. Automatic Transfer Switch
 - 6. Float Switch Junction Box
 - 7. Motor starter enclosures.
 - 8. Switches
 - 9. Receptacles

- D. Phenolic nameplates shall be attached with stainless steel screws, use two (2) per each nameplate.
- E. Submit for review a schedule for engraving along with size for each proposed micarta nameplate. Do not fabricate nameplate until review has been completed.
- F. Type circuit directory information on circuit directory cards on all panelboards and laminate.

END OF ELECTRICAL SECTION

INSTRUMENTATION & CONTROLS

PART 1: GENERAL

1.01. SCOPE

- A. Furnish and install electrical equipment in the locations shown on the plans.
- B. Furnish and install instrumentation and control systems as indicated on the plans.
- C. Products and installations shall comply with the electrical section specifications.
- D. Contractor to coordinate his construction activities with the local electrical utility.

1.02. EQUIPMENT FIELD SERVICE

- A. Provide the services of factory trained personnel to assist in the installation and start-up of the control system.

1.03. MANUFACTURER QUALIFICATIONS

1.04. Pump control panels are to be manufactured by an approved manufacturer.

- A. Approved pump control panel manufacturer follows:
 - 1. Control Panels USA. (512-863-3224).
 - 2. Prime Controls (512-375-3580)
- B. Any pump control panel manufacturer other than the named approved manufacturer desiring to be approved must submit to the engineer for approval a pre-bid submittal document no later than twenty-one (21) days prior to project bid date. Submissions that fail to include a complete submittal as detailed shall be deemed unresponsive.
- C. Approval does not exempt the Contractor from meeting all the requirements of the Contract Documents nor does it give any prior acceptance of any equipment, software or services.
- D. The Contract Documents are the final authority for acceptance of the work provided. Information contained in the Pre-Bid Submittal shall be considered public information.
- E. All data submitted will become and remain the property of the Owner; none will be returned.
- F. The Engineer's decision as to pre-bid approval shall be final. The Consulting Engineer shall be considered the sole judge of the merits of the pump control panel manufacturer and shall indicate pre-approval of the control panel

manufacturer via a written addendum to the specifications prior to the actual bid date.

- G. The right is reserved to reject any and all proposals, to waive any informality, irregularity, mistake, error or omission in any proposals received and to accept the proposal, as determined by the Engineer or Owner, deemed most favorable to the Owner's interests.
- H. Provide four (4) bound copies, with tabbed dividers and contents organized and presented as hereinafter specified.
 - 1. Listing of firm's history.
 - 2. Listing of personnel to be used on the project including job titles and resumes
 - 3. Certificates of all insurance complete with expiration dates.
 - 4. Describe provisions for service, technical assistance and re-placement parts for the proposed project. Include the company's 1-800-toll free number.
 - 5. Provide installation list of at least 30 locations of previous similar projects including name and telephone numbers of Owner and Consulting Engineer, functional description, and contact personnel.
 - 6. Provide a "statement of compliance" detailing paragraph by paragraph bill of material, parts list and schematic drawing to be used on this project, along with his compliance or exception to these specifications.
 - 7. Provide a product performance data sheet for each proposed component in the system (i.e. antennas, radios, coaxial cables & arrestors, remote unit equipment, central terminal unit equipment, power supplies, time delays, relays, pilot devices, instruments, surge arrestors, controllers, and the various sensors required).
 - 8. UL 508A Certification.

PART 2: PRODUCTS

2.01. PUMP CONTROL PANEL

A. GENERAL

- 1. The panel shall contain the items shown on the schematic diagrams including the following:
 - a. Level Indicator
 - b. Circuit breakers.
 - c. Control relays.
 - d. Surge protection.
 - e. Control terminal blocks.
 - f. Fuse terminal blocks.
 - g. Wireway.
 - h. Cabinet light and switch.
 - i. Cabinet receptacle.
 - j. Ammeters and switches.

- k. Voltmeter and switch
 - l. Elapsed time meters
 - m. Indicating ON and OFF lights.
 - n. SSRV Fail lights and Reset pushbuttons.
 - o. Seal fail relays.
 - p. Overtemp relays.
 - q. Wiring and miscellaneous.
2. The panel is to be completely assembled and wired at the factory such that installation can be accomplished by connecting field wiring to terminal strips located on the lower portion of the interior panel.

B. ENCLOSURES

1. Panels are to be constructed to the approximate dimensions and instrument arrangement as shown on the Plans. Submit alternate arrangements and recommendations to the Engineer for review.
2. All instruments, devices and wiring are to be arranged such that everything can be installed, removed and serviced through the door.
3. Wire entering the panels is to enter via conduits with bushings. All wiring is to be terminated on terminals located on an interior panel prior to being connected to any instrument or switch.
4. The interior of each panel is to be painted white.
5. Each panel is to be equipped with a print pocket for storing applicable drawings.
6. Panel doors are to have heavy gauge continuous hinges. Hinges and doors are to be capable of supporting weight of equipment mounted on doors.
7. Mounting channels, swing panels and interior panels are to be provided in the cabinets for mounting pushbuttons, indicating lights, meters, instruments, terminals, relays, etc.
8. The panel is to be completely assembled and wired at the factory such that installation can be accomplished by connecting field wiring to terminal strips located on a lower portion of the interior panel.
9. Panel is to be Nema 3R 304 Stainless Steel construction, deadfront, with lights, switches, indicators, etc. located on an interior swing out panel.
10. Panels are to be constructed from minimum 14-gauge steel. Seams are to be continuously welded with no holes or knockouts. Doors are to have rolled lip around three sides and are to be equipped with a hasp and staple for padlocking. Doors on outdoor enclosures are to have a watertight seal. All doors are to have an oil resistant gasket.

11. A full size steel back panel is to be provided inside each enclosure. Relays, terminal blocks, etc., are to be mounted on the back panel. Enclosure shall be Hoffman Concept Series, with full length hinge and a pad lockable handle.
12. Cut, punch or drill cutouts for face-of-panel mounted instruments and smoothly finish with rounded edges.
13. Provide steel stiffeners on the back of the panel face as may be required to prevent deflection due to instruments, operation of equipment, or opening/closing of doors. Use 0.25 inch high by 1 inch wide by 0.5-inch deep minimum stiffeners and tack welded to the panel.
14. Provide internal condensation and freezing protection with thermostatically controlled heater on outdoor enclosures. Thermostat adjustable between 40° F to 80° F.
15. Each panel is to contain a weatherproof duplex receptacle (1P, 20A, 120V, 3W polarized), ground fault interrupter (GFIR) type.
16. Furnish outdoor enclosures with thermostatically controlled vent fan and filtered louvers.
17. Provide each panel with a copper ground bus.

C. CONTROL COMPONENTS

1. Pushbuttons, selector switches and pilot lights are to be heavy-duty oil tight industrial type as manufactured by Square D, Allen Bradley, General Electric or Eaton Cutler Hammer. NEMA 4 pushbuttons, selector switches and pilot lights are to be provided for outdoor panels. Pilot lights shall be LED type, push to test.
2. Legend Plates: Manufacturer's standard with lettering indicated on the Plans. To be of the same manufacture as the respective pushbutton, selector switch or pilot light.
3. Control Relays: Allen-Bradley, or equal, 11 pin octal base relay with on/off pilot light, 120 VAC, 60 Hz coil, 10 amp, 3 PDT contacts. With screw terminal socket.
4. Timing Relays: Magnacraft TDRSOXP, or equal. On or off delay as required. 120 VAC, 60 Hz coil, 10 amp, DPDT contacts. Timing range of .1 secs. to 10 hrs. Plug in tube base type.
5. Circuit Breakers: Circuit breakers shall be molded case type with thermal magnetic trip. Breakers shall be Siemens, or approved equal. Mounting brackets shall be provided to mount breakers on the back panel.

6. Ammeter: Transformer rated, 0-5 Amp input. Display range as indicated on plans. Scale as shown. Yokagawa #250-340-LPZ, or approved equal.
7. Ammeter Switch: Electros witch #3110C, or approved equal.
8. Voltmeter: Transformer rated, 600:150V, unless otherwise noted. Yokagawa #250344PJSJ, or approved equal.
9. Voltmeter Switch: Electros witch #3104C, or approved equal.
10. Elapsed Time Meters: ENM Company/Allied Electronics Model T50A2/207-0039, or approved equal. Non resettable type.
11. Seal Fail Relays: SSAC #LLC54AA, or approved equal.
12. Indicating Lights: LED push-to-test type, 30 mm, Nema 4/4X/13. Allen Bradley Type 800H, or equal by Cutler Hammer, Square D or G.E.
13. Pushbuttons: Momentary contact type, 30 mm, Nema 4/4X/13. Flush mounted. Allen Bradley Type 800H, or equal by Cutler Hammer, Square D or G.E.
14. Selector Switches: Maintained contact type, two and three position as shown, Nema 4/4X/13, 33 mm. Allen Bradley Type 800H, or equal by Cutler Hammer, Square D or G.E.
15. Level Indicator/Controller: Level indicator/controllers shall be Precision Digital Model PD6000-6R7, 120 Vac, with 4-20mAdc input, four form C alarm relay contacts (0-100% deadband) and a 4-20mAdc output equal to the input. Furnish with a PDA-1004 four relay expansion module.
16. 24 VDC Power Supply: Power supply shall be rated 24 VDC, 2.5 A, with current limiting short circuit an overload protection. Delta Electronics DRP024V0660W1AZ, or approved equal.
17. Transient Voltage Surge Suppressors: Suppressors shall be Control Concepts IC+105, or approved equal, 120VAC, 5Amp, filtering, 45KA, 10yr warranty.
18. Analog Signal Loop Isolators: Turck, or approved equal, as follows:
 - a. Accuracy: +/-0.075% of span
 - b. Stability: +/-0.2% of reading per year
 - c. Isolation: 500Vrms between input and output
 - d. Output loop powered
 - e. DIN rail mountable

19. Isolating Modules: Diversified Model ISO-120-ACE. 120VAC, 4 outputs
20. Uninterruptable Power Supply: UPS shall be APC Model BE650G1, or approved equal, rated 390 Watts/650 VA. With 3 surge protected outlets and 3 battery backed outlets.
21. Alarm Horn: Panel mounted vibrating horn, NEMA Type 4X. Heavy duty die-cast housing. Operating range of -20% to +10% of nominal voltage. 18" (457mm) wire with molex connector. Adjustable output of 78 to 103 dB and a 400 hour rating at 50% duty cycle. Edwards #870P-N5, or approved equal.

D. WIRING

1. General Wiring: Use #16 AWG, 19 strand copper with Type MTW insulation.
2. Flexible Wiring: Use #16 AWG, 41 strand copper Type SIS for wiring from terminal blocks to 120 VAC devices located on cabinet doors, i.e., pushbuttons, selector switches, pilot lights and annunciator. Leave sufficient slack to allow for full opening of cabinet door.
3. Instrument Wiring: Twisted pair, #18 AWG, stranded copper. Dekoron No. 1852, or equal. Ground shield only at terminal board. Leave sufficient slack for full opening of door.
4. Segregate dc signal wiring from ac control wiring, group functionally and arrange neatly to facilitate tracing of circuits.
5. Use Panduit, or equal, wiring ducts where possible, and provide a minimum of 20 percent spare space. Run ac and dc in separate ducts.
6. Use plastic wiring wraps to bundle wires outside of ducts. Secure to panel steel at maximum 12-inch intervals. Bundle ac and dc separately.
7. Provide Brady, or equal, wire markers to identify each wire at both the terminal block and the device, i.e., at both ends.
8. Color code as follows:
 - a. Line and load circuits ac or dc power - Black
 - b. AC control circuits - Red
 - c. DC control circuits - Blue
 - d. Interlock control circuits on the panel energized from an external source - Yellow
 - e. Equipment grounding conductors - Green
 - f. Neutral conductor - White
9. Terminal Blocks:

- a. Factory assembled on a Din rail or suitable mounting channel.
- b. Provide a minimum of 25 percent spare terminals on each strip. In addition, provide terminal blocks for terminating spare wires being installed on this project.
- c. Continuous marking strip.
- d. Separate terminal for each shield wire.
- e. Reserve one side of each strip for incoming field wiring. Do not make common connections and jumpers required for internal wiring on the field side of the terminal.
- f. Do not terminate more than two wires under any one terminal.
- g. Provide separate terminal blocks for ac and dc wiring respectively.
- h. Space terminal block strips no closer than 4 inches center to center.
- i. Control terminal blocks shall be Phoenix Contact Type UK5, or approved equal.
- j. Fused terminal blocks shall be Phoenix Contact Type UK6, 3-HESI, or approved equal.
- k. Power terminal blocks shall be Square D Class 9080, Type K, or approved equal.
- l. Power fuse blocks shall be Square D Class 9080, Type FB, or approved equal.
- m. Power distribution blocks shall be Square D Class 9080, Type LB, or approved equal.

10. Grounding:

- a. Provide one ground bus for signal grounds and one for equipment grounds.
- b. Provide each bus with grounding lugs for connection to the external grounding system.
- c. Overload: 15% for 2 minutes.
- d. Waveform: Step sine wave with count peak and RMS.
- e. Frequency: 60 Hz., +/-0.6 Hz.

E. INSTRUMENT AND CONTROL PANEL IDENTIFICATION

- 1. All devices on the panel are to be permanently identified. The device designations are to agree with those shown on the drawings. Each device is to be provided with permanent type identifying nameplate. Nameplates, unless specified otherwise, are to be approximately one inch by four inches, constructed of black and white laminated phenolic material having engraved letters approximately 1/4 inch high extending through the black face into the white layer. Nameplates, where specified, may be omitted if nameplate description of approximately the same dimension is more convenient and suitable located on the instrument door or face. Nameplates located on the panel face are to be secured with two brass screws. Nameplates, which are mounted on the outside of an enclosure, exposed to weather, are to be adhesive backed type.

2.02. PUMP POWER PANEL

A. GENERAL

1. The Pump Power Panel shall contain the following:
 - a. Main breaker
 - b. Phase monitor
 - c. Solid state reduced voltage motor starters (SSRV).
 - d. Solid state overload relays.
 - e. HMCP breakers
 - f. Current transformers.
 - g. Potential transformers
 - h. Surge arrester.
 - i. Wireways.

B. ENCLOSURE

1. Enclosures for the Pump Power Panel shall be the same as those specified above for Pump Control Panel.

C. COMPONENTS

1. Main Breaker: Siemens Type FD6. Molded case, magnetic trip, rated 50K AIC. With adjustable trip range 2.5 – 5 times breaker rating.
2. Phase Monitor: Diversified Electronics #SLA-440-ASA, or approved equal.
3. Soft Starters: Siemens Type 3RW, or equal by Cutler Hammer, Square D or G.E, with remote reset.
4. Overload Relays: Solid state type. Siemens Type 48BT. Provide with auxiliary contacts.
5. HMCP Breakers: Siemens Type FXD, 22K AIC, with shunt trip, adjustable trip range, and auxiliary status switch.
6. Current Transformers: Flex Core Type 2SFT. CT ratio as indicated.
7. Potential Transformers: Flex Core Type 3VTL-460-480. 4:1 ratio. One case/enclosure with three transformers. Provide primary and secondary fuses.
8. Control Relays: Allen-Bradley, or equal, 11 pin octal base relay with on/off pilot light, 120 VAC, 60 Hz coil, 10 amp, 3 PDT contacts. With screw terminal socket.
9. Surge Arrester: Delta #LA603, or approved equal.

D. WIRING

1. Wiring shall comply with the applicable specifications for Pump Control Panels described above

2.03. RTU PANEL

A. GENERAL

1. The RTU Panel shall contain the following:
 - a. UPS
 - b. PLC
 - c. PLC control relays
 - d. Coax Surge Protector
 - e. Wireways.

B. ENCLOSURE

1. Enclosures for the Pump Power Panel shall be the same as those specified above for Pump Control Panel.

C. COMPONENTS

1. UPS: APC BE650G1, or approved equal. 390Watts/ 650 VA, with three surge protected outlets and three battery back-up outlets.
2. PLC: Motorola ACE 3640 CPU, with minimum three I/O slot frame: one 16 DI card, one 16 DI/4DO/4AI mixed I/O card, one 8 DI/4DO mixed I/O card. 120 AC power supply with battery charger and 6.5AH battery backup.
3. Radio: UHF Radio. Cal Amp Viper SC+
4. Control Relays: Allen-Bradley, or equal, 11 pin octal base relay with on/off pilot light, 120 VAC, 60 Hz coil, 10 amp, 3 PDT contacts. With screw terminal socket.
5. Coax Surge Protector: PolyPhaser IS-B50LN-C2, or approved equal. Type N/F/F bulkhead coaxial surge protector, with 10Mhz- 1GHz frequency range, 1.5 kW and 3.5mJ rating.

2.04. SUBMERSIBLE LEVEL TRANSDUCER

- A. The transducer shall sense the liquid level or pressure variation and convert these variations into a linear analog output 4-20 mA. Furnish Mission Controls WWLP. Furnish with pressure range and cable length as required on plans.
- B. The transmitter shall consist of a transducer attached to a polyurethane vented cable by a molded connection, with sealed breather system.

- C. The transmitter cable shall consist of two, 22AWG conductors, with a shield, and housing conductor with a vent tube.
- D. The transmitter shall be furnished with a cable hanger.
- E. Surge/lightning over voltage protection at both the sensor and electrical connection points will be provided and carry a lifetime warranty against over voltage.

2.05. FLOAT SWITCHES

- A. The float shall be a direct acting switch. Each float shall consist of a snap acting switch, activated by a steel ball rolling back and forth within the tubing, which actuates when the longitudinal axis of the float is horizontal, and deactivates when the liquid level falls below the differential angle of 30 degrees.
- B. The float shall be a chemical resistant polypropylene casing with a firmly bonded electrical cable protruding. One end of the cable shall be permanently connected to the enclosed mercury-free switch and the entire assembly shall be encapsulated to form a completely water tight and impact resistant unit. The float shall be suspended with built in weight. The float shall be equipped with one normally-open and one normally-closed contact.
- C. Floats shall be Anchor-Scientific Model GSIXXNC (normally closed) and GSI1XXNO (normally open), or approved equal. (XX denotes cable length).
- D. Float cable shall be as specified and required by the specific project.

END OF INSTRUMENTATION AND CONTROLS SECTION

SCADA SYSTEM

PART 1: GENERAL

1.01. SCOPE

- A. Contractor shall contract with one of the following to furnish and install the SCADA system described herein:
 - 1. Control Panels USA. (512-863-3224).
 - 2. Prime Controls (512-375-3580)
- B. Contractor shall contract with the following to furnish and install the radio:
 - 1. Alpha Omega Wireless, Inc (800-997-9250)
- C. The work to be provided by the SCADA System Contractor shall include:
 - 1. Programming the system PLC including all control programming and all data base entry as shown on the drawings and as otherwise necessary for a complete and satisfactorily operating system. PLC will be installed in the RTU panel by the control panel manufacturer.
 - 2. Furnishing a self-supporting antenna tower to the Contractor for installation by the Contractor as shown on the drawings. SCADA Contractor shall furnish and connect the antenna, coax between the antenna, and the radio. SCADA Contractor shall coordinate antenna installation requirements with the General Contractor.
 - 3. Testing the system and making any changes necessary to correct any defects.
 - 4. HMI programming shall be completed by the SCADA Contractor.
 - 5. The Contractor shall include the cost of the SCADA Contractors work in the Base Bid.
 - 6. The radio shall be installed in the RTU panel. Radio shall be furnished and installed by Alpha Omega.

1.02. SUBMITTALS

- A. Submit shop drawings in accordance with the Contract drawings. Include the following:
 - 1. Antenna
 - 2. Antenna Support Structure
 - 3. Antenna cable and connectors

PART 2: PRODUCTS

2.01. ANTENNA

- A. 450-470 Mhz, 6-element 10.2 dB. Laird: YB4506.

2.02. COAXIAL CABLE

- A. Times LMR-600 flexible low-loss type. With quick connect style cable connectors and grounding cable kit.

2.03. ANTENNA SUPPORT STRUCTURE

- A. Antenna heights shall be 30'-0" (min. required): Rohn type 25G per electrical plans.

2.04. FABRICATION

- A. All appropriate measures shall be taken to ensure that electronic equipment is not damaged due to discharges of static electrical charges.
- B. Each cabinet-mounted device shall be so mounted and wired that removal or replacement may be accomplished without interruption of service to adjacent devices. All devices mounted inside the enclosure shall be so located that terminals and adjustment devices are readily accessible without use of special tools and with terminal markings clearly visible.

2.05. MAINTENANCE

- A. A list of all the recommended spares for maintenance of the entire control system shall be provided and each item shall be separately priced. The list shall include all the special tools and test equipment necessary for the maintenance of the complete system,
- B. The Control System Vendor shall guarantee the availability of spares for a minimum period of 10 years.

PART 3: EXECUTION

3.01. The contractor shall verify in the presence of the owner's representative that the SCADA system is operating properly and communicating with the owner's other SCADA equipment.

3.02. SCADA startup shall be done in two phases, local startup and remote startup.

A. Local start up

- 1. All operations are to be tested locally onsite.

B. Remote startup

1. Contractor has a maximum of 48 hours from completion of local startup to demonstrate to the owner's representative that the telemetry is working at the main office.
2. Addressing must be provided at this time for the owner's alarming systems.

END OF SCADA SECTION