DIVISION 16 - ELECTRICAL

SECTION 16010

GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide all labor, materials, equipment and services necessary for and incidental to the complete installation and operation of all electrical work.

B. All work under this Division is subject to the General Conditions and Special Requirements for the entire contract.

C. Unless otherwise specified, all submissions shall be made to, and acceptances and approvals made by, the Engineer.

D. Conform to the requirements of all rules, regulations, and codes of local, state, and federal authorities having jurisdiction. Conform to the National Electrical Code, and NECA - Standards of Installation.

E. Perform the work in a first-class, substantial and workmanlike manner. Any materials installed which do not present an orderly and neat workmanlike appearance shall be removed and replaced when so directed by the Engineer, at the Contractors expense.

F. Coordinate the work of all equipment manufacturers and suppliers.

G. Arrange conduit, wiring, equipment, and other work generally as shown, providing proper clearances and access. Carefully examine all contract drawings and fit the work in each location without substantial alteration. Where departures are proposed because of field conditions or other causes, prepare and submit detailed drawings for acceptance. The right is reserved to make reasonable changes in location of equipment, conduit and wiring up to the time of rough-in or fabrication.

H. The contract drawings are generally diagrammatic and all offsets, bends, fittings and accessories are not necessarily shown. Provide all such items as may be required to fit the work to the conditions.

1.02 PERMITS AND FEES

A. Obtain, pay for and deliver all permits, certificates of inspection, etc., required by the authorities having jurisdiction. Deliver certificates to the Owner prior to final acceptance of the work.

1.03 ELECTRICAL WORK UNDER OTHER DIVISIONS

A. In general, power wiring and motor starting equipment for systems and equipment are included under this Division. However, the Contractor shall carefully review the contract documents and be responsible for the coordination of the electrical work under all of the various Divisions.

1.04 UTILITY CONNECTIONS

A. The Owner shall pay for all permanent electrical service charges.

B. The Contractor shall make all arrangements for permanent electrical service installation.

C. The Contractor shall obtain and pay for temporary electrical service for construction power.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

A. Material and equipment installed as a part of the permanent installation shall be new, unless otherwise indicated or specified, and shall be approved by the Underwriters' Laboratories, Inc., for installation in each particular case where standards have been established.

B. Where material or equipment is identified by proprietary name, model number, and/or manufacturer, furnish the named item or equivalent thereof, subject to acceptance.

C. Substituted items or items other than those named shall be equal or better in quality and performance and must be suitable for the available space, required arrangement and application. Submit any and all data necessary to determine the suitability of substituted items.

D. Substitutions will not be permitted for specific items of material or equipment where specifically indicated.

E. Material submissions shall conform to requirements outlined in "Submittals, Review and Acceptance".

2.02 SUBMITTALS, REVIEW AND ACCEPTANCE

A. General

1. The equipment, material, installation, workmanship, arrangement of work, final instruction and final documentation is subject to review and acceptance. Submit for review in clear and legible form the following documents as hereinafter specified.
   a. Descriptive Data
   b. Shop Drawings
   c. Contractor Record Drawings
2. Prepare all submittals specifically for this project and stamp each submittal in a form indicating that the documents have been contractor reviewed, are complete and are in compliance with the requirements of the plans and specifications.
3. Coordinate the installation requirements and any mechanical requirements for the equipment submitted. Submittals will be reviewed for general compliance with design concept in accordance with the contract documents. The Contractor is responsible for the correctness of all submittals. Reviews will not verify dimensions, quantities, or other details.
4. Identify all submittals, indicating the intended application, location, or service of the submitted item. Refer to specification sections or paragraphs where applicable. Clearly indicate the exact type, model number, size and special features of the proposed item. Submittals of a general nature will not be acceptable.
5. Submit actual operating conditions or characteristics for all equipment where required capacities are indicated. Factory order forms showing only required capacities will not be acceptable.
6. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted.
7. Documents of general form indicating options shall be clearly marked to show what is specifically proposed for this project.
8. Submittals NOT IN COMPLIANCE with the requirements of this section will be RETURNED WITHOUT REVIEW.

B. Descriptive Data

1. Submit DESCRIPTIVE DATA for all items. Data shall consist of specifications, data sheets, samples, capacity ratings, performance curves, operating characteristics, catalog cuts, dimensional drawings, installation instructions and any other information necessary to indicate complete compliance with the contract documents.

C. Shop Drawings

1. Prepare and submit SHOP DRAWINGS AND/OR DIAGRAMS for all specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the contract drawings or where the proposed installation differs from that shown on the contract drawings.
2. Shop drawings shall include plans, elevations, sections, mounting details of component parts, point to point interconnection diagrams, elementary diagrams, single line diagrams, and any other drawings necessary to show the fabrication and connection of the complete item or system.

D. Contractor Record Drawings

1. As the work progresses, record on a set of white prints, the installed locations, sizes of electric feeders, equipment, etc. Upon completion of the work, submit one (1) complete set of white prints with "Record" information neatly recorded thereon in red ink.

PART 3 - EXECUTION

3.01 EXAMINATION OF SITE

A. Examine the site, determine all conditions and circumstances under which the work must be done, and make all necessary allowances.

3.02 SUPERVISION AND COORDINATION

A. Provide complete supervision, direction, scheduling and coordination of all work under the contract, including that of subcontractors, manufacturers and suppliers, using full attention and the best skill. Be responsible for all work and make all sub-contractors, suppliers and manufacturers fully aware of all requirements of the contract.

B. Coordinate the rough-in of all electrical work performed under the various Divisions.

C. Coordinate the installation of all necessary sleeves, anchors and supports for conduit, wiring and other work performed under the various Divisions.

3.03 GUARANTEE

A. Guarantee obligations shall be as hereinbefore specified in the GENERAL CONDITIONS of these specifications, and as follows:

1. Guarantee the complete electrical system free from all mechanical and electrical defects for the period of one (1) year beginning from the day of final acceptance of the work by the Owner.
2. Also, during the guarantee period, be responsible for the proper adjustments of all systems, equipment and apparatus installed by him and do all work necessary to ensure efficient and proper functioning of the systems and equipment.
3. Upon receipt of notice from the Owner of failure of any part of the electrical installation during the guarantee period, new replacement parts shall be furnished and installed promptly at no cost.

*** END OF SECTION ***

DIVISION 16 - ELECTRICAL

SECTION 16100

BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.01 STORAGE AND PROTECTION OF EQUIPMENT

A. All electrical equipment to be used in the construction shall be properly stored and protected against the elements. All equipment shall be stored under cover, and shall not be stored at the construction site on the ground, in mud, water, snow, rain, sleet or dust.

B. Any equipment subject to damage or corrosion from excessive moisture shall be stored in dry, heated areas. Any equipment containing plastic or material subject to damage caused by excessive heat or sunlight shall be stored to prevent such damage. This includes plastic ducts and lenses.

C. Equipment damaged as a result of improper storage or handling shall be properly repaired at the Contractor's expense or shall be replaced at the Contractor's expense, if, in the opinion of the Engineer the equipment has been damaged to such an extent it cannot operate properly after repairs are made.

D. All electrical enclosures exposed to construction damages such as paint spots, spackling or plaster spatter, grout splashes, waterproofing compound, tar spots or runs and pipe covering compound splashes, shall be completely covered and protected against damage.

E. After connections to electrical equipment are complete and the equipment is ready for operation, all construction debris shall be removed from all enclosures. Such debris includes dust, dirt, wire clippings, tape and insulation removed in order to make the connection.

1.02 PENETRATION OF WATERPROOF CONSTRUCTION

A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls and interior waterproof construction. Where such penetrations are necessary, provide all necessary curbs, sleeves, shields, flashings, fittings and caulking to make the penetrations absolutely watertight.

1.03 TESTING AND ADJUSTMENT

A. Perform all tests which are specified or required to demonstrate that the work is installed and operating properly. Where formal tests are required, give proper notices and perform all necessary preliminary tests to assure that the work is complete and ready for final test.

B. Adjust all systems, equipment and controls to operate in a safe, efficient and stable manner.

C. Provide circuits that are free from ground faults, short circuits and open circuits.

D. Other tests of a specific nature for special equipment shall be as specified under the respective equipment.

1.04 IDENTIFICATION

A. Mark and permanently identify all motor starters, disconnect switches controls, panelboards, terminal boards, and other equipment in accordance with the project nomenclature. Identification plates shall be laminated plastic, white with black engraved 1/4 inch high lettering. Attach identification plates with 316 grade stainless steel screws approved for the purpose.

B. Identification by means of marking pens, embossed plastic tape markers or other temporary methods will not be acceptable.

PART 2 - PRODUCTS

2.01 CONDUIT AND FITTINGS

A. General

1. Install all wiring in conduit.
2. Minimum conduit size shall be 3/4 inch.
3. Install all conduit concealed where possible.
4. Support all conduit not embedded in concrete or masonry so that strain is not transmitted to outlet boxes and pull boxes, etc. Supports to be sufficiently rigid to prevent distortion of conduits during wire pulling.

B. Conduit

1. All conduit shall be hot-dip galvanized, rigid steel except as hereinafter specified.
2. Provide flexible metal conduit (Greenfield) in short lengths for the connection of lighting fixtures, dry type transformers and any vibrating

equipment.

3. Provide liquid tight flexible metal conduit with neoprene jacket in short lengths for the connection of exterior equipment and motors.
4. Provide hot-dip galvanized, rigid steel conduit with bonded on 40 mil thick PVC exterior jacket and 2 mil thick polyurethane interior coating and on threads; Robroy Industries "Plastic-Bond Red", or equal, for exposed exterior work, work not completely encased in concrete but laid directly in/or in contact with ground, and for exposed work installed in interior spaces which are considered damp and/or corrosive.
5. Aluminum conduit is prohibited.

C. Fittings

1. All fittings to match conduit material and be suitable for the purpose intended.
2. Provide compound filled sealing fittings for all conduits entering or leaving hazardous locations.
3. Provide expansion fittings with bonding jumpers where conduits cross expansion joints or where otherwise required to compensate for thermal expansion and contraction.
4. Fasten rigid steel conduit with threaded galvanized steel fittings, double locknuts, and insulated bushings. Insulated bushings shall be "OZ" Type "B", or equal.
5. Fasten liquid-tight conduit with fittings incorporating a threaded ferrule, nylon sealing ring, and steel or malleable iron compression nut and body. Furnish Crouse Hinds metallic liquid-tight fittings, or equal.
6. Fasten flexible metallic conduit with T&B "Tite-Bite" insulated connectors, or equal.
7. All fittings used in PVC coated conduit installations shall likewise have PVC bonded on coating.
8. Conduit seal fittings shall be as manufactured by Crouse–Hinds, Appleton, or equivalent.

D. Installation

1. Install exposed conduits parallel and perpendicular to walls, install plumb.
2. Provide a nylon pull line in each conduit to be left empty.
3. Make angle bends in exposed runs of conduits with manufactured elbows, screw jointed conduit fittings or conduit bent to radius of manufactured elbows.
4. Use capped bushings or "push penny" plugs to prevent foreign matter from entering the conduit system during construction.
5. Clean and plug or cap all conduits left empty for future use.
6. Lubricants for pulling wires shall be approved for use with the wires and conduits installed.
7. All nicks, scrapes or gouges made in PVC coated conduit or fittings shall

be properly repaired as per the manufacturer's recommendations.

E. Supports

1. All parts and hardware used for support of equipment, conduits, and fittings shall be galvanized for dry locations and galvanized with PVC bonded (Plasti-Bond) jacket for exterior, damp, or wet locations. Provide galvanized fasteners for dry locations and stainless steel (316 grade or better) for exterior, damp, or wet locations.
2. Support surface runs of conduit using one hole pipe straps or two hole pipe straps. Strap spacing shall be maximum 6 feet on centers.
3. Fasten pipe straps and hangers to concrete using inserts or expansion bolts and to hollow masonry using toggle bolts. Wooden plugs and shields will not be permitted.
4. Supports for PVC coated conduits to have PVC bonded coating, matching the color of the conduit.

2.02 OUTLET BOXES

A. Boxes and conduit fittings for outdoor and exposed work shall be NEMA 4 cast-metal type with threaded hubs for conduit entrance. Boxes and conduit fittings for outdoor work shall have gasketed cover plates. Plastic boxes and cast "white metal" boxes classified as NEMA 4 will not be acceptable.

B. All boxes, whether outlet, junction, pull, or equipment, shall be furnished with appropriate covers.

C. Outlet boxes used in PVC coated conduit installations shall likewise have factory bonded on PVC coating.

D. No sectionalized boxes shall be used.

2.03 JUNCTION AND PULL BOXES

A. Junction and pull boxes shall be furnished and installed as shown or where required to facilitate pulling of wires or cables. Such boxes shall be installed in accessible locations. All boxes for interior work shall be constructed of 12 gauge USS galvanized sheet steel minimum, unless otherwise specified or indicated and provided with mounting brackets and flat screw covers secured in position by round head brass or stainless steel 300 grade, or better, machine screws. Boxes for exterior recessed work (in grade or concrete) shall be cast aluminum or galvanized cast iron type with threaded hubs unless otherwise directed. Boxes for exterior surface work shall be type 304, or better, grade stainless steel. Gasketed cover plates shall be furnished for outdoor installation.

2.04 WIRING DUCT

A. Wiring duct shall be slotted wall type of rigid PVC for interior RTU/Pump Control Cabinet use. Duct shall be suitable for continuous use in temperatures up to 50°C (122°F) and shall meet U.L. Flammability Rating of V-O.

B. Wiring duct shall be light gray finish.

C. Wiring duct shall be provided with all required fittings and snap on cover.

D. Wiring duct shall be Panduit Panduct Type F, or equivalent.

2.05 WIRES AND CABLES

A. All wire, unless otherwise indicated shall be 600 volt, Type THWN for number 8 wire and smaller, and Type THW for No. 6 wire and larger. Conductors shall be sized and run as indicated. Conductors shall be soft drawn copper of not less than 98% conductivity.

B. No branch circuit wires smaller than number twelve (12) AWG shall be used unless otherwise indicated. Conductors shall be continuous from outlet to outlet and from terminal board to point of final connection, and no splice shall be made except within outlet or junction boxes. All conductors shall be of the size indicated. All wires number eight (8) AWG and larger shall be stranded. Wires and cables shall be as manufactured by Plastic Wire and Cable Corporation, Okonite Company, or equal.

C. Control wiring shall not be less than number fourteen (14) AWG and shall be color-coded using colors impregnated into the insulation. All wiring, contacts, and terminal blocks shall be suitably tagged for ease in identification and tracing of circuits. Identification tags shall be engraved fiber or plastic type, subject to acceptance. Wires shall be numbered and coded, using Brady "Quicklabels", or equal.

D. Instrumentation wiring shall be two conductor number 16 AWG shielded cable with 600 volt polyethylene insulation, aluminum-polyester shield (100% shield coverage), No. 18 AWG copper drain wire and PVC jacket. Furnish Belden No. 8719, or equal. Three conductor cable shall be similar to above, Belden No. 8618, or equal.

E. A color coding system shall be used throughout the facilities' network of feeders and circuits and used as a basis of balancing the load. Selection shall be based on applicable work covered by this contract.

F. Joints of 10 AWG and smaller shall be made with properly insulated solderless type pressure connectors. Where stranded conductors or multiple solid conductors are connected to terminals, solderless lugs manufactured by Thomas and Betts Company, or equal, shall be used.

G. Joints of No. 8 AWG and larger in power and lighting circuits shall be of the type indented into the conductor by means of a hand or hydraulic pressure tool. Connectors shall be Burndy "Hy-dent", T&B "Sta-Kon", or equal. Connectors for control wiring shall be Burndy "Hy-Lug", or equal.

2.06 WIRING DEVICES

A. The following wiring devices shall be furnished and installed where called for on the drawings. Miscellaneous items not included below shall be Underwriter's Laboratories Standard conforming to the NEC. All devices shall be of the same manufacture. Devices shall be Arrow-Hart, Leviton, Hubbell, or equal, to the following Arrow-Hart Catalog Numbers:

B. Wall Switches

1. Toggle switches shall be of the silent mechanical type rated 20 ampere, 120/277 volt A.C. Single Pole switches shall be Arrow-Hart #1991-1 for 20 amp. Use Arrow-Hart #1991 Series, or equal.

C. Receptacles

1. 20 Ampere, 120 volt, Duplex Receptacles, NEMA 5-20R:
   Duplex receptacles shall be 3 wire, U-ground. Receptacles shall be Arrow-Hart #5352, or equal.
2. 20 Ampere, 120 volt, Single Receptacles, NEMA 5-20R:
   Single receptacles, 20 ampere, 3 wire, U-ground. Receptacles shall be Arrow-Hart #5361, or equal.
3. 20 Ampere, 120 volt, Duplex Receptacles, NEMA 5-20R:
   Ground fault circuit interrupter type. Arrow-Hart #GF5342, or equal.

D. Cover Plates

1. Exposed: Where devices are installed exposed in "FS" or "FD" cast metal boxes, they shall be furnished with cast aluminum "DS" type cover plates.
2. Wiring devices designated to be weatherproof shall be provided with a cover suitable for use in wet locations whether or not the attachment plug cap is inserted. (NEC 406.8 (B)(1)..

E. Special wiring devices shall be provided as called for on the drawings.

2.07 GROUNDING

A. Grounding shall be in accordance with the requirements of the National Electrical Code and as hereinafter specified and/or indicated on the Drawings.

B. Provide ground for secondary service, secondary neutral of all dry type

transformers and all raceways, devices and utilization equipment permanently and effectively. Continuity of rigid steel raceways shall be ensured by double locknuts. All grounded neutral conductors shall be continuously identified. All grounding and bonding connections shall be solderless.

C. Provide insulated grounding conductors for feeder and branch circuit wiring as called for on the plans. Provide grounding blocks, terminals, etc., for connection for grounding wires in all distribution equipment, outlets, junction boxes, and utilization equipment.

D. Ground rods shall be copper-clad steel as manufactured by Copperweld Steel Company, or equivalent, 3/4-inch minimum diameter and 10-foot minimum length in one piece, ITT Blackburn, Catalog No. 7510, or equal. Additional rods shall be driven to obtain a ground resistance of 5 Ohms or less as measured by a Biddle "Groundmeter". Rods shall be driven in soil and resistance measured between grounding point and grounding electrodes.

E. Wire between Ground Grid and other points of the system shall be uninsulated copper with conductor properties, as required, by the National Electrical Code. The minimum size wire for connection to a ground grid shall be #1/0. Above ground connections shall be made with approved grounding connections and fittings.

F. All cable to ground rod connections shall be stranded copper. All underground connections or shown on the drawings shall be accomplished by the exothermic welding process. Furnish all materials and molds necessary to properly perform all required exothermic welds. Furnish exothermic welding systems from the Cadweld Division of Erico Products, Inc., or Burndy Corporation.

2.08 SAFETY DISCONNECT SWITCHES

A. Provide safety disconnect switches as shown on the drawings and where required by the National Electrical Code. Switches shall be horsepower rated where applicable, and shall be of the sizes required.

B. Switches shall be heavy-duty type unfused, side-handle-operated, NEMA 1 for general interior work and NEMA 3R for exterior locations, Switches shall be equipped with a cover interlock to prevent operation with cover open.

C. Switches shall be visible blade, externally operated, with all current carrying parts silver or tin-plated. All switches shall have provisions for not less than two external padlocks.

D. Switches shall be as manufactured by Square D Company.

2.09 TRANSIENT VOLTAGE SURGE SUPPRESSOR

A. Transient Voltage Surge Suppressor shall be in a NEMA 1 enclosure, have a

short circuit current rating of 200 KAIC, surge capacity of 160 KA/phase and be complete with a sure counter/monitor and dry contacts for surge count monitoring. Unit shall be Advanced Protection Technologies, Inc. model TE/4XGA, or equal.

2.10 PANELBOARDS

A. Panelboards shall be constructed in accordance with the latest editions and revisions of N.E.M.A. Standard PB1-1977, Federal Specification W-P-115A(3), and Underwriters' Standard 67 and UL50. Panelboards used for service entrance shall be service entrance rated and bear the U.L. service entrance label.

B. Panelboards shall be dead-front, safety type and shall contain main circuit breakers, main lug ratings, branch circuit breakers and bussed spaces as indicated on the drawings.

C. Panelboard mains and busses shall be copper.

D. Panelboards shall be suitable for surface mounted installation as indicated on the drawings.

E. Main and Distribution panelboards for 277/480 volts service shall be bolt-in circuit breaker type equipped with quick-make, quick-break, trip indicating, thermal-magnetic molded case circuit breakers.

1. Branch breakers shall have a minimum interrupting capacity of 25,000 R.M.S. symmetrical amperes.
2. Main breakers shall have same minimum interrupting capacity as branch breakers.
3. Main busses shall be braced for fault current of the same magnitude as the minimum interrupting rating of the branch breakers. Panelboards shall be manufactured by Square D I-Line type, Cutler-Hammer, GE or equal.

F. Lighting and appliance branch circuit panel boards shall be bolt-in circuit breaker type equipped with quick-make, quick-break, trip indicating, molded case, thermal-magnetic circuit breakers.

1. Branch breakers shall have a minimum interrupting capacity of 10,000 R.M.S. symmetrical amperes.
2. All single pole 15 and 20 amp circuit breakers shall be UL listed as switching duty breakers.
3. Branch Panel boards shall be Square D type NQOD, or equal.

G. Two or three pole circuit breakers shall be common trip type. Single pole breakers with tie handles will not be permitted.

H. Tandem breakers will not be permitted.

I. Provide ground buses in all panelboards. Ground bus shall be similar in all respects to neutral bus.

J. Panelboards shall contain a typed directory of circuits, adequately protected, indicating type and location of device connected on each circuit.

K. Circuit numbers as shown on the drawings for branch circuit indicate groupings of loads on circuits and are not necessarily to be intended as actual circuit numbers in panelboards. Circuits shall be so arranged as to balance the loads over the phases as evenly as practical.

L. All Branch panelboards and distribution panels shall be installed on galvanized formed steel channels designed to distribute the weight on the supporting wall.

2.11 MANUAL MOTOR STARTERS

A. Manual Motor Starters shall be toggle switch type with integral thermal overload relay and NEMA 1 enclosure an shall be Square D Class 2510, or equal.

2.12 POWER RELAYS

A. Power Relays shall be horsepower rated, suitable for operation on 120 volts AC, complete with 30 ampere rated contacts and shall be Square D Type C – Class 8501, or equal.

2.13 CONTROL RELAYS

A. Control Relays shall be NEMA Type Industrial Relays with 600 volt AC rating, contacts rated at 20 amperes, NEMA 1 enclosure and shall be Square D Type X, Class 8501, or equal.

2.14 DRY TYPE TRANSFORMER

A. Dry type Transformer: Furnish and install a floor mounted dry type, three phase, transformer of voltage and kva ratings indicated. Transformer shall have six 2.5% full capacity taps and shall be Square D, Class 7400, Type EE, (NEMA standard TP-1), or equal.

2.15 VARIABLE FREQUENCY DRIVE CONTROLLERS

A. Scope of Work: AC Inverter type adjustable frequency, variable speed drives or herein identified as AC drives for use with NEMA B design, 75 horsepower vertical turbine pump AC motors.

B. Quality Assurance:

1. The AC drive and all options shall be UL listed according to Underwriters Laboratories and be provided in a NEMA 12 enclosure.
2. The AC drive shall be designed, constructed, and tested in accordance with NEMA, ICS, NFPA, IEC Standards and CSA certified.
3. The manufacturer of the AC drive shall be a certified ISO 9002 facility.
4. The AC drive manufacturer shall offer 24-hour, 7-day product and application response via a nationwide network of factory certified technical support personnel.
5. The AC drive shall be an ALTIVAR 61, E-Flex enclosed drive as manufactured by the Schneider Electric Square D Company, or equal.

C. General Description: The AC drive shall convert the input AC mains power to an adjustable frequency and voltage as defined in the following sections.

1. The input section shall contain a common mode choke and/or an internal line reactor.
2. The rectifier section shall convert fixed voltage, fixed frequency, AC line power to fixed DC voltage. The rectifier section shall utilize a full wave bridge design incorporating diode rectifiers. The rectifier shall be insensitive to phase rotation of the AC line. The DC voltage shall be filtered.
3. The inverter section shall change fixed DC voltage to variable frequency AC. The inverter section shall utilize only intelligent power modules (IPM's) as required by the current rating of the motor.

D. Motor Date: The AC drive shall be sized to operate a NEMA Design B, AC motor with a nameplate rating as defined in the National Electric code, Table 430-149, for the applicable horsepower.

E. Application Data

1. The AC drive shall operate a variable torque load and be complete with Modbus Plus communications.
2. The speed range shall be form a minimum speed of 0.1 Hz @ 100% breakaway torque to a maximum speed of 500 Hz. The speed range shall be selectable at 50 Hz, 60 Hz, 200 Hz, 500 Hz. Speed shall be capable of being manually selected.

F. Environmental Ratings:

1. The AC drive construction shall meet Type 1 Pollution Degree 3 according to IEC 60664-1, EN50718, and NEMA ICS-1 Annex A.
2. The AC drive will be designed to operate in an ambient temperature of 0 to 40 degrees C (32 to 104 degrees F).
3. The storage temperature range shall be -25 to +70 degrees C (-13 to 158

degrees Fahrenheit.

4. The maximum relative humidity shall be 95% at 40° degrees C (104 degrees F), non-condensing.
5. The AC drive will be rated to operate at altitudes less than or equal to 1000 m (3,300 feet). For altitudes above 1000m, derate the AC drive by 1.2% for every 1000m (330 feet).
6. The AC drive will meet the IEC 68-2-6 vibration specification.
7. The AC drive shall be designed and constructed to be of touch-safe construction with the enclosure open to operator access according to IP20 Standards.

G. Ratings:

1. The AC drive shall be designed to operate from an input voltage of 400/460 +/- 15% Vac.
2. The AC drive shall operate from an input voltage frequency range from 47.5 to 63 Hz.
3. The displacement power factor shall not be less than 0.95 lagging under any speed or load condition.
4. The efficiency of the AC drive at 100% speed and load shall not be less than 96%.
5. The constant torque overtorque capacity will be 150% for 1 minutes.
6. The output switching frequency of the drive will be randomly modulated and selectable at 2 kHz, 4 kHZ, 8 kHz, 12 kHz, or 16 kHz depending on drive rating for low noise operation.
7. The output frequency shall be from 0.1 to 500 Hz (selectable at 50 Hz, 60 Hz, 200 Hz, 500 Hz).
8. The AC drive will be able to provide rated motor torque at 0.5 Hz in a Sensorless Flux Vector mode using a standard motor and no tachometer feedback.

H. Protection:

1. The AC drive design and all hardware options will meet IP20 Standards and allow for touch-safe access with the front cover open for all AC drives.
2. Upon power-up, the AC drive shall automatically test for valid operation of memory, option module, loss of analog reference input, loss of communication, dynamic brake failure, DC to DC power supply, control power, and the pre-charge circuit.
3. The AC drive shall be protected against short circuits between output phases; between output phases and ground; on the control terminal outputs; and the internal supplies. The logic and analog outputs shall also be optically isolated.
4. The AC drive shall have a minimum of power loss ride-through of 200 ms. The AC drive shall have the user-defined option of frequency fold-back to increase the duration of the power-loss ride-through.

5. The AC drive will have a selectable ride-through function which will allow the logic to maintain control for a minimum of one second without faulting.
6. For a fault condition other than a ground fault, short circuit or internal fault, an auto restart function will provide restart.
7. The deceleration mode of the AC drive shall be programmable for normal and fault conditions. The stop modes shall include free-wheel stop, fast stop, and DC injection braking.
8. A synchronized restart shall be provided that will catch a spinning motor by sensing the motor frequency and rotational direction and synchronize the AC drive's output prior to restarting.
9. Upon loss of the analog process flow reference signal, the AC drive shall fault and/or operate at a user-defined speed set between software programmed low speed and high speed settings.
10. The AC drive shall have solid state 12t protection that is UL listed and meets UL 508 C as a Class 20 overload protection and meets IEC 947. The adjustment shall be from 0.45 to 1.05 percent of the current output of the AC drive.
11. The AC drive shall have a thermal switch with a user-selectable pre-alarm that will provide a minimum of 60 seconds delay before overtemperature fault.
12. The AC drive may utilize bonded fin heatsink construction for maximum heat transfer.
13. The AC drive shall have a programmable fold-back the frequency to avoid a fault condition.
14. The output frequency shall be software enabled to fold back when the motor is overloaded.
15. There shall be a skip frequency that can each be programmed with a selectable bandwidth of +/-2.5Hz, selectable anywhere in the speed range.

I. Adjustments and Configurations:

1. The AC drive shall have a user-selectable Auto Tune feature. The Auto Tune will automatically send a signal to the connected motor and store the resulting resistance data into memory. The inductance data will be measured during no-load operation. The AC drive will automatically optimize the operating characteristics according to the stored date.
2. The AC drive will contain factory pre-set Macros in order to speed configuration of I/O for the most common applications. The Macro menu shall contain configurations for material handling, general use and variable torque.
3. A choice of three types of acceleration and deceleration ramps will be available in the AC Drive software: Linear, S Curve and U Curve.
4. The acceleration and deceleration ramp times shall be adjustable from 0.1 to 999.9 seconds.
5. The volts per frequency ratios shall be user-selectable to meet quadratic

torque loads, normal and high torque machine applications.

6. The memory shall retain and record run status and fault type of the past 8 faults.
7. Slip compensation shall be a software-enabled function.
8. The software shall have a selectable energy savings function *nLd* (energy Eco) function that will reduce the voltage to the motor when selected for variable torque loads. A constant volts/Hz ratio will be maintained during acceleration. The output voltage will then automatically adjust to meet the torque requirement of the load.
9. The AC drive shall offer programmable DC injection braking that will brake the AC motor by injecting DC current and creating a stationary magnetic pole in the stator. The level of current will be adjustable between 50 and 150% of rated current and available from 0.0 to 30 seconds continuously. For continuous operation after 30 seconds, the current shall be automatically reduced to 50% of the nameplate current of the motor.
10. Sequencing logic will coordinate the engage and release thresholds and time delays for the sequencing of the AC drive output, mechanical actuation, and DC injection braking in order to accomplish smooth starting and stopping of a mechanical process.

J. Operator Interface

1. The operator interface terminal will offer the modification of AC drive adjustments via a touch keypad. All electrical values, configuration parameters, drive menu parameters, application and activity function access, faults, local control, adjustment storage, self-test, and diagnostics will be shown. There will be a standard selection of four additional languages built in to the operating software as standard.
2. The display will be high resolution, LED screen capable of displaying four (4) 7- segment LED's for display of numerical values and codes in combination with a 16-character LCD display for messages.
3. The AC drive keypad will announce horsepower and voltage.
4. The display shall be capable to be configured to display multiple parameters with numeric data that is selectable and scalable by the operator. A user-defined display value proportional to output frequency shall be available. As a minimum, the display values shall consist of speed reference, output frequency, output current, motor torque and output power. Output voltage, line voltage, DC voltage, motor thermal state, drive thermal state and motor speed.
5. The keypad must allow dynamic switching between display variables.
6. The terminal keypad will provide the means of holding four different sets of drives parameters. The functions will allow both operating commands and programming options to be preset by the operator.
7. A hardware selector switch wil allow the terminal keypad to be locked out from unauthorized personnel.
8. The keypad display will offer a general menu consisting of parameter

setting, fault display, and drive configuration. A software lock will limit access to the main menu. The main menu will consist of keypad configuration, drive configuration, general configuration, diagnostic mode and AC drive initialization screens.

9. There will be arrow keys that will provide the ability to scroll through menus and screens, select or activate functions or increase the value of a selected parameter.
10. A data entry key will allow the user to confirm a selected menu, numeric value or allow selection between multiple choices.
11. An escape key will allow a parameter to return the existing value if adjustment is not required and the value is displayed. The escape function will also return to a previous menu display.
12. A RUN key and a STOP key will command a normal starting and stopping as programmed when the AC drive is in keypad control mode.
13. The AC drive shall have 2 LED's mounted on the front panel to indicate functional status. A green LED will verify that the AC drive power supply is on. A red LED indicator will indicate an AC drive fault.

K. Control

1. External pilot devices shall be able to be connected to a terminal strip for starting/stopping the AC drive, speed control, and displaying operating status. Control inputs and outputs will be software assignable.
2. Two-wire or three-wire control strategy shall be defined within the software. External relays or logic devices will not be needed to implement 3-wire control.
3. The control power for the digital inputs and outputs shall be 24 Vdc.
4. The internal power supply incorporates an automatic current fold-back that protects the internal power supply if incorrectly connected or shorted. The transistor logic outputs will be current-limited and not be damaged if shorted or excess current is pulled.
5. All logic connections shall be furnished on pull-apart terminal strips.
6. There will be two (2) analog inputs, one (1) analog input will be software selectable and shall consist of the following configurations: 0-20 mA, 4-20mA, 20-4 mA, x-20 mA (where x is user-defined). The other analog input shall be 0-10 volt.
7. Provide one (1) analog output card.
8. There will be four (4) isolated logic inputs, three (3) shall be user-assignable in the software. The selection of assignments shall consist of RUN, REVERSE, JOG, RAMP SWITCHING, PLUS/MINUS SPEED (2 inputs required), SETPOINT MEMORY, PRESET SPEEDS (Up to 4 Inputs), AUTO/MANUAL CONTROL FAST STOP, FORECED LOCAL, MOTOR SWITCHING, and FAULT RESET.
9. One voltage-free Form C relay output contact will be provided to indicate AC drive fault status. An additional NO relay contact will be user-assignable.

10. There shall be available an additional hardware input/output extension card which also provides interlocking and sequencing capabilities. The card shall be fully isolated with pull-apart terminal strips. The analog output assignments shall be proportional to the following motor characteristics: frequency, current, power, torque, voltage and thermal state. The ouput signal will be selectable from 0-20 mA or 4-20 mA. All of the I/O will be user-assignable in the software as previously defined.

L. Line Reactor: Line reactors shall have 5 percent impedance, NEMA 1 enclosed and shall be Square D Company (MTE Corporation), or equal, sized for compatibility with the drive unit.

M. Installation:

1. Installation shall be in compliance with manufacturer's instructions, drawings and recommendations.
2. The AC drive manufacturer shall provide a factory-certified technical representative to supervise the Contractor's installation, testing, and start-up of the AC drive(s) furnished under this specification for a maximum total of two (2) days. The start-up service shall be quoted as a separate line item.

N. provide full 3-year warranty on each VFD, provided by Square D Company.

2.16 ANTENNA AND COAXIAL CABLE

A. Radio antenna for spread spectrum radio transmission shall be furnished by the System Integrator to be installed by the Contractor. Antenna shall be 6 dBd gain, 890-960 MHz, 50 ohms impedance and shall be an omni SCALA OGB6 as manufactured by Kathrein, Inc. – Scala Division, or equal. Antenna shall be provided complete with mounting bracket.

B. A radio path study has been performed and identified the new antenna location to be on top of the existing Water Tank.

C. Coaxial cable shall be furnished by the System Integrator to be installed by the Contractor. Coaxial cable shall be Andrew Catalog #LDF4-50A, or equal and of a length required based on the radio path test results. Cable shall be furnished with Type N connectors, and shall be grounded at the TRU using Andrew Catalog #204989 grounding kit. Kit shall be furnished by the System Integrator. Grounding shall be completed by the contractor. Cable Hangers and hardware shall be stainless steel. Mounting pole shall be furnished and installed by the Contractor and shall be round straight aluminum. Pole shall be a minimum of 16 feet high by minimum of 2 – ½ inches in diameter with anodic natural aluminum finish, and shall be secured to the building chimney with stainless steel hardware.

PART 3 - EXECUTION

3.01 SUPPORTS, HANGERS AND FOUNDATIONS

A. Provide all supports, hangers, braces, attachments and foundations required for the work. Contractor shall make use of existing tower stand-offs located beneath the tank for routing of all cabling.

B. Supports, hangers, braces and attachments shall be stainless steel.

C. Concrete equipment pads and foundations shall be not less than 4 inches high, unless otherwise noted, and in general shall extend at least 4 inches beyond the equipment base on all sides. Provide wire-mesh reinforcement, chamfer exposed edges and corners and finish all exposed surfaces smooth. Concrete shall be minimum 3,000 psi test at 28 days.

3.02 CUTTING AND PATCHING

A. Provide all cutting and patching necessary for the installation of the electrical work. Any damage done to the work already in place by reason of this work shall be repaired at the Contractor's expense by a qualified mechanic experienced in such work. Patching shall be uniform in appearance and shall match with the surrounding surface.

B. Do not cut structural members without approval by Structural Engineer.

3.03 CLEANING, PAINTING AND FINISHES

A. Provide protective finishes on all materials and equipment. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint all bare untreated ferrous surfaces prior to installation, using rust-inhibiting paint.

B. Clean all surfaces prior to application of adhesives, coatings, paint, or other finishes.

C. Provide factory-applied finishes where specified. Unless otherwise indicated, factory-applied paints shall be baked enamel with proper pre-treatment.

D. Protect all finishes and restore any damaged finishes to their original condition.

E. The above requirements apply to all work, whether exposed or concealed.

F. Remove all construction markings and writing from exposed equipment, conduit and building surfaces.

*** END OF SECTION ***

DIVISION 16 - ELECTRICAL

SECTION 16200

POWER GENERATION

PART 1 - GENERAL

1.01 SCOPE

A. Provide complete factory assembled diesel generator set equipment with digital electronic controls.

B. Provide factory test, startup by a supplier authorized by the manufacturer, and on-site testing of the system.

C. The generator set manufacturer shall warrant all equipment provided under this section, whether or not it is manufactured by the generator set manufacturer, so that there is one source for warranty and product service. Technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier shall service the generator sets.

1.02 CODES AND STANDARDS

A. The generator set and its installation and on-site testing shall conform to the requirements of the following codes and standards:

1. CSA C22.2, No. 14 – M91 Industrial Control Equipment.
2. CSA 282, 1989 Emergency Electrical Power Supply for Buildings
3. EN50082-2, Electromagnetic Compatibility – Generic Immunity Requirements, Part 2: Industrial.
4. EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.
5. FCC Part 15, Subpart B.
6. IEC8528 part 4. Control Systems for Generator Sets
7. IEC Std 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions.
8. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
9. IEEE587 for voltage surge resistance.
10. Mil Std 461D – 1993. Military Standard, Electromagnectic Interference Characteristics.

11. Mil Std 462D – 1993. Military Standard, Measurement of Electromagnetic Interference Characteristics.

12. NEMA ICS10 – 1993 – AC Generator sets.
13. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
14. NFPA110 – Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1prototype tests required by this standard shall have been performed on a complete and functional unit, component level type tests will not substitute for this requirement.
15. UL508. The entire control system of the generator set shall be UL508 listed and labeled.
16. UL2200. The genset shall be listed to UL2200 or submit to an independent third party certification process to verify compliance as installed.

B. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.03 ACCEPTABLE MANUFACTURERS

A. Equipment specifications for this project are based on microprocessor-based generator sets manufactured by Cummins Onan. Equipment by other manufacturers that meet the requirement of this specification are acceptable. Substitute submittals must include a listing of any non-compliance referenced to applicable specification paragraph, and a sizing program calculation confirming the submitted generator size based on the load steps included at the back of this section.

PART 2 - PRODUCTS

2.01 GENERATOR SET

A. Ratings.

1. The generator set shall operate at 1800 rpm and at a voltage of: 277/480 volts AC, Three phase, Four-wire, 60 hertz.
2. The generator set shall be rated at 100 kW, 125 KVA at 0.8 PF, Standby rating, based on site conditions of : Altitude 500ft. (152 meters), ambient temperatures up to 122 degrees F (50 degrees C)
3. The generator set rating shall be based on emergency/standby service.

B. Performance

1. Voltage regulation shall be plus or minus 0.5 percent for any constant load between no load and rated load for both parallel and non-parallel applications. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.
2. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.25%.
3. The diesel engine-generator set shall be capable of single step load pick up of 100% nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.
4. Motor starting capability shall be a minimum of 563 kVA. The generator set shall be capable of sustaining a minimum of 90% of rated no load voltage with the specified kVA load at near zero power factor applied to the generator set.
5. The generator set shall be capable of accepting the block loads in the steps indicated in the sizing calculation included in the back of this section.
6. The alternator shall produce a clean AC voltage waveform, with not more than 5% total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3% in any single harmonic. Telephone influence factor shall be less than 40.

C. Construction

1. The engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold-down clamps within the rails.
2. All switches, lamps, and meters in the control system shall be oil-tight and dust-tight, and the enclosure door shall be gasketed. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts.

D. Connections

1. The generator set load connections shall be composed of silver or tin plated copper bus bars, drilled to accept mechanical or compression terminations of the number and type as shown on the drawings. Sufficient lug space shall be provided for use with cables of the number and size as shown on the drawings.
2. Power connections to auxiliary devices shall be made at the devices, with required protection located at a wall-mounted common distribution panel.
3. Generator set control interfaces to other system components shall be made on a common, permanently labeled terminal block assembly.

2.02 ENGINE AND ENGINE EQUIPMENT

A. The engine shall be diesel, 4 cycle, radiator and fan cooled. Minimum displacement shall be 359 cubic inches, with 6 cylinders. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories. Two cycle engines are not acceptable.

B. An electronic governor system shall provide automatic isochronous frequency regulation. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous or parallel states.

C. Skid-mounted radiator and cooling system rated for full load operation in 122 degrees F (50 degrees C) ambient as measured at the generator air inlet, based on 0.5 in H^2O external static head. Radiator shall be sized based on a core temperature which is 20F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The cooling system shall be filled with a 50/50-ethylene glycol/water mixture by the equipment manufacturer. Rotating parts shall be guarded against accidental contact.

D. Electric starter(s) capable of three complete cranking cycles without overheating.

E. Positive displacement, mechanical, full pressure, lubrication oil pump.

F. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.

G. An engine driven, mechanical, positive displacement fuel pump. Fuel filter with replaceable spin-on canister element. Fuel cooler, suitable for operation of the generator set at full rated load in the ambient temperature specified shall be provided if required for operation due to the design of the engine and the installation.

H. Replaceable dry element air cleaner with restriction indicator.

I. Flexible supply and return fuel lines.

J. Engine mounted battery charging alternator, 40-ampere minimum, and solid-state voltage regulator.

K. Coolant heater.

1. Engine mounted, thermostatically controlled, coolant heater(s) for each engine. Heater voltage shall be 120 volts, AC. The coolant heater shall be UL499 listed and labeled.
2. The coolant heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall be installed using quick disconnect couplers to isolate the heater for replacement of the heater element. The quick disconnect/automatic sealing couplers shall allow the water element to be replaced without draining the engine cooling system or significant coolant loss.
3. The coolant heater shall be provided with a 24VDC thermostat, installed at the engine thermostat housing. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.
4. The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 100F (40C) in a 40F ambient, in compliance with NFPA110 requirements, or the temperature required for starting and load pickup requirements of this specification.

L. Provide vibration isolators, spring/pad type, quantity as recommended by the generator set manufacturer.

M. Starting and Control Batteries shall be calcium/lead antimony type, 12 volt DC, sized as recommended by the engine manufacturer, complete with battery cables and connectors.

N. Provide exhaust silencer(s) for each engine of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer. The mufflers shall be critical grade. Exhaust system shall be installed according to the engine manufacturer's recommendations and applicable codes and standards.

O. Provide a dual wall sub-base fuel storage tank sized to support 24 hours of operation of the generator at 80% load. The tank shall be constructed of corrosion resistant steel and shall be UL listed. The equipment, as installed, shall meet all local and regional requirements for above ground tanks.

2.03 AC GENERATOR

A. The AC generator shall be; synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet NEMA MG1 temperature limits for Class H

insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 80 degrees Centigrade.

B. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5 percent above or below rated voltage.

C. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of rated current for not more than 10 seconds.

D. The subtransient reactance of the alternator shall not exceed 12 percent, based on the standby rating of the generator set.

2.04 GENERATOR SET CONTROL.

A. The Generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this specification. The control shall be mounted on the generator set. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.

B. The generator set mounted control shall include the following features and functions:

1. Control Switches
   a. Mode Select Switch. The mode select switch shall initiate the following control modes. When in the RUN or Manual position the generator set shall start, and accelerate to rated speed and voltage as directed by the operator. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
   b. EMERGENCY STOP switch. Switch shall be Red "mushroom-head" push-button. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting.
   c. RESET switch. The RESET switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.

d. PANEL LAMP switch. Depressing the panel lamp switch shall cause the entire panel to be lighted with DC control power. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.

2. Generator Set AC Output Metering. The generator set shall be provided with a metering set including the following features and functions:
   a. Analog voltmeter, ammeter, frequency meter, and kilowatt (KW)meter voltmeter and ammeter shall display all three phases. Ammeter and KW meter scales shall be color coded in the following fashion: readings from 0 -90% of generator set standby rating: green; readings from 90-100% of standby rating: amber; readings in excess of 100%: red.
   b. Digital metering set, 0.5% accuracy, to indicate generator RMS voltage and current, frequency, output current, output KW, KW-hours, and power factor. Generator output voltage shall be available in line-to line and line-to-neutral voltages, and shall display all three phase voltages (line-to-neutral or line to line) simultaneously.
   c. Both analog and digital metering are required. The analog and digital metering equipment shall be driven by a single microprocessor, to provide consistent readings and performance.
3. Generator Set Alarm and Status Display.
   a. The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing warning and shutdown conditions. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. The generator set control shall indicate the existence of the following alarm and shutdown conditions on an alphanumeric digital display panel:
      low oil pressure (alarm)
      low oil pressure (shutdown)
      oil pressure sender failure (alarm)
      low coolant temperature (alarm)
      high coolant temperature (alarm)
      high coolant temperature (shutdown)
      engine temperature sender failure (alarm)
      low coolant level (alarm or shutdown—selectable)
      fail to crank (shutdown)
      fail to start/overcrank (shutdown)
      overspeed (shutdown)
      low DC voltage (alarm)
      high DC voltage (alarm)
      weak battery (alarm)
      low fuel-daytank (alarm)
      high AC voltage (shutdown)

low AC voltage (shutdown)
under frequency (shutdown)
over current (warning)
over current (shutdown)
short circuit (shutdown)
over load (alarm)
emergency stop (shutdown)

b. Provisions shall be made for indication of four customer-specified alarm or shutdown conditions. Labeling of the customer-specified alarm or shutdown conditions shall be of the same type and quality as the above specified conditions. The non-automatic indicating lamp shall be red, and shall flash to indicate that the generator set is not able to automatically respond to a command to start from a remote location.

4. Engine Status Monitoring

a. The following information shall be available from a digital status panel on the generator set control:

engine oil pressure (psi or kPA)
engine coolant temperature (degrees F or C)
engine oil temperature (degrees F or C)
engine speed (rpm)
number of hours of operation (hours)
number of start attempts
battery voltage (DC volts)

b. The control system shall also incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.

5. Engine Control Functions

a. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and # of cycles. Initial settings shall be for 3 cranking periods of 15 seconds each, with 15-second rest period between cranking periods.

b. The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the alternator excitation system shall be disabled.

c. The control system shall include an engine governor control, which functions to provide steady state frequency regulation as noted elsewhere in this specification. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.

d. The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds) functions.

e. The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.

6. Alternator Control Functions:

a. The generator set shall include an automatic digital voltage regulation system that is matched and prototype tested by the engine manufacturer with the governing system provided. It shall be immune from misoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter. The voltage regulation system shall be equipped with three-phase RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot. The system shall include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of [58-59] HZ. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off, Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level. Rotary potentiometers for system adjustments are not acceptable.

b. Control shall be provided to monitor the output current of the generator set and initiate an alarm (over current warning) when load current exceeds 110% of the rated current of the generator set on any phase for more than 60 seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (over current shutdown). The protective functions provided shall be in compliance to the requirements of NEPA70 article 445.

c. Controls shall be provided to individually monitor all three phases of the output current for short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown). The protective functions provided shall be in compliance to the requirements of NFPA70 article 445.

d. Controls shall be provided to monitor the KW load on the generator set, and initiate an alarm condition (over load) when total load on the generator set exceeds the generator set rating for in excess of 5 seconds. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.

e. An AC over/under voltage monitoring system that responds only to true RMS voltage conditions shall be provided. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110% of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130%. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85% for more than 10 seconds.

f. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25VDC or more than 32 VDC. During engine cranking (starter engaged), the low voltage limit shall be disabled, and if DC voltage drops to less than 14.4 volts for more than two seconds a "weak battery" alarm shall be initiated.

7. The generator set shall be provided with a 250 A, mounted main line circuit breaker, sized to carry the rated output current of the generator set on a continuous basis. The circuit breaker shall incorporate an electronic trip unit that operates to protect the alternator under all overcurrent conditions, or a thermalmagnetic trip with other overcurrent protection devices that positively protect the alternator under overcurrent conditions. The supplier shall submit time overcurrent characteristic curves and thermal damage curve for the alternator, demonstrating the effectiveness of the protection provided.

8. Control Interfaces for Remote Monitoring:

a. All control and interconnection points from the generator set to remote components shall be brought to a separate connection box. No field connections shall be made in the control enclosure or in the AC power output enclosure. Provide the following features in the control system:

b. Form "C" dry common alarm contact set rated 2A @ 30VDC to indicate existence of any alarm or shutdown condition on the generator set.

c. One set of contacts rated 2A @ 30VDC to indicate generator set is ready to load. The contacts shall operate when voltage and frequency are greater than 90% of rated condition.

d. A fused 10 amp switched 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.

e. A fused 20 amp 24VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.

f. The control shall be provided with a direct serial communication link for the LonWorks communication network interface as described elsewhere in this specification and shown on the drawings.

2.05 OUTDOOR WEATHER-PROTECTIVE SOUND ATTENUATED HOUSING

A. The generator set shall be housed in a ruggedly constructed, heavy gauge, steel or aluminum, pre-painted (Dark Green), sound attenuating, weatherproof and vermin-proof enclosure. A critical grade exhaust silencer as specified above shall be housed within the enclosure. The enclosure shall have inspection doors located for easy access to control equipment and maintenance points. Doors shall be complete with continuous piano hinge and latching type key locking handles. Expanded metal louvers shall be provided for air tank and radiator discharge. The enclosure shall be sized to house the various control components herein specified. Mounting of components shall be accomplished in such a way that vibration effect is not an inherent problem. Enclosure shall be Onan Quiet Site II, Second Stage, or equal.

PART 3 - OPERATION

3.01 SEQUENCE OF OPERATION

A. Generator set shall start on receipt of a start signal from remote equipment. The start signal shall be via hardwired connection to the generator set control.

B. The generator set shall complete a time delay start period as programmed into the control.

C. The generator set control shall initiate the starting sequence for the generator set. The starting sequence shall include the following functions:

1. The control system shall verify that the engine is rotating when the starter is signaled to operate. If the engine does not rotate after two attempts, the control system shall shut down and lock out the generator set, and indicate "fail to crank" shutdown.
2. The engine shall fire and accelerate as quickly as practical to start disconnect speed. If the engine does not start, it shall complete a cycle cranking process as described elsewhere in this specification. If the engine has not started by the completion of the cycle cranking sequence, it shall be shut down and locked out, and the control system shall indicate "fail to start".
3. The engine shall accelerate to rated speed and the alternator to rated voltage.
   Excitation shall be disabled until the engine has exceeded programmed idle speed, and regulated to prevent over voltage conditions and oscillation as the engine accelerates and the alternator builds to rated voltage.

D. On reaching rated speed and voltage, the generator set shall operate as dictated by the control system in isochronous, synchronize, load share, load demand, or load govern state.

E. When all start signals have been removed from the generator set, it shall complete a time delay stop sequence. The duration of the time delay stop period shall be adjustable by the operator.

F. On completion of the time delay stop period, the generator set control shall switch off the excitation system and shall shut down.

1. Any start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.

3.02 FACTORY TESTING

A. The generator set manufacturer shall perform a complete operational test on the generator set prior to shipping from the factory. A certified test report shall be provided. Equipment supplied shall be fully tested at the factory for function and performance. Test shall be conducted at 0.8 PF and run for 2 Hours at full load. Tests shall include: run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and function of safety shutdowns.

3.03 INSTALLATION

A. Equipment shall be off loaded and installed by the Contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.

B. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.

C. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions.

D. Equipment shall be initially started and operated by representatives of the manufacturer.

E. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be

thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.

3.04 ON-SITE ACCEPTANCE TEST:

A. The complete installation shall be tested for compliance with the specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests.

B. Installation acceptance tests to be conducted on-site shall include a "cold start" test, a four hour full load test, and a one step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test.

3.05 TRAINING

A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance of the equipment provided. The training program shall be not less than 4 hours in duration and the class size shall be limited to 5 persons. Training date shall be coordinated with the facility owner.

3.06 SERVICE AND SUPPORT

A. The manufacturer of the generator set shall maintain service parts inventory at a central location which is accessible to the service location 24 hours per day, 365 days per year.

B. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.

C. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

3.07 WARRANTY

A. The generator set and associated equipment shall be warranted for a period of not less than 5 years from the date of commissioning against defects in materials and workmanship.

B. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

END OF SECTION *

GENERATOR LOAD STEPS

STEP 1

LIGHTING LOAD	-	0.6 KVA, 120V, 1Ø
ELECTRIC ROOM RECEPTABLE LOAD		0.6 KVA, 120V, 1Ø
CHLOR. ROOM RECEPTABLE LOAD	-	0.8 KVA, 120V, 1Ø
CHEM PUMP RECEPTABLE LOAD		0.5 KVA, 120V, 1Ø
SUMP PUMP RECEPTABLE LOAD		0.5 KVA, 120V, 1Ø
MOTOR LOAD	-	0.2 KVA, 120V, 1Ø
PTAC - 1	-	2.1 KVA, 208V, 1Ø
HEATING LOAD		10.0 KVA, 480V, 3Ø
MISCELLANOUS LOAD		2.5 KVA, 120V, 1Ø
SPARE LOAD		3.0 KVA, 120V, 1Ø

STEP 2

PRODUCTION WELL PUMP	75 HP, 408V, 3 Ø on VFD

DIVISION 16 - ELECTRICAL

SECTION 16210

AUTOMATIC TRANSFER SWITCH

PART 1 - GENERAL

1.01 SCOPE

A. Provide complete factory assembled power transfer equipment with field programmable digital electronic controls designed for fully automatic operation and including: surge voltage isolation, voltage sensors on all phases of both sources, linear operator, permanently attached manual handles, positive mechanical and electrical interlocking, and mechanically held contacts for both sources.

B. The generator set manufacturer shall warrant transfer switches to provide a single source of responsibility for all the products provided. Technicians specifically trained to support the product and employed by the generator set supplier shall service the transfer switches.

1.02 CODES AND STANDARDS

A. The automatic transfer switch shall conform to the requirements of the following codes and standards:

1. CSA C22.2, No. 14 – M91 Industrial Control Equipment.
2. CSA 282, 1989 Emergency Electrical Power Supply for Buildings
3. EN55011, Class B Radiated Emissions
4. EN55011, Class B Conducted Emissions
5. IEC 1000-4-5 (EN 61000-4-5); AC Surge Immunity. Similar waveforms are described in ANSI/IEEE 62.41-1991
6. IEC 1000-4-4 (EN 61000-4-4) Fast Transients Immunity
7. IEC 1000-4-2 (EN 61000-4-2) Electrostatic Discharge Immunity
8. IEC 1000-4-3 (EN 61000-4-3) Radiated Field Immunity
9. IEC 1000-4-6 conducted Field Immunity
10. IEC 1000-4-11 Voltage Dip Immunity
11. NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
12. NFPA110 – Emergency and Standby Power Systems. The transfer switch shall meet all requirements for Level 1 systems.
13. IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.
14. NEMA ICS10-1993 – AC Automatic Transfer Switches.

15. UL1008. The transfer switch shall be UL listed and labeled.

B. The transfer switch manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/ development, production, installation, and service, in accordance with ISO 9001.

1.03 ACCEPTABLE MANUFACTURERS

A. Equipment specifications for this project are based on microprocessor-based transfer switches manufactured by Cummins Onan. Substitutions which satisfy specification requirements are acceptable. Substitute submissions must include a listing of all items of non-compliance referenced to applicable specification paragraph.

PART 2 - PRODUCTS

2.01 POWER TRANSFER SWITCH

A. Ratings.

1. Provide a heavy duty, 260A, 3P, 480 VAC, 3 Phase, 4 Wire, Cummins Model OTPC, or equal.
2. Main contacts shall be rated for 600 Volts AC minimum.
3. Transfer switches shall be rated to carry 100 percent of rated current continuously in the enclosure supplied, in ambient temperatures of –40 to +60 degrees C, relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000M).
4. Transfer switch equipment shall have withstand and closing ratings (WCR) in RMS symmetrical amperes greater than 25,000 amperes at the specified voltage. The transfer switch and its upstream protection shall be coordinated. The transfer switch shall be third party listed and labeled for use with the specific protective device(s) installed in the application.

B. Construction

1. Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in the source 1 and source 2 positions. The transfer switch shall be specifically designed to transfer to the best available source if it inadvertently stops in a neutral position.
2. Transfer switches rated through 1000 amperes shall be quipped with permanently attached manual operating handles and quick-break, quick-make over-center contact mechanisms.
3. Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.

4. Transfer switch internal wiring shall be composed of pre-manufactured harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plug(s), to allow the control system to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism.
5. Power transfer switch shall be provided with flame retardant transparent covers to allow viewing of switch contact operation but prevent direct contact with components that could be operating at line voltage levels.
6. Transfer switches that are designated on the drawings as 3-pole shall be provided with a neutral bus and lugs. The neutral bus shall be sized to carry 100% of the current designated on the switch rating.

C. Connections

1. Field control connections shall be made on a common terminal block that is clearly and permanently labeled.
2. Transfer switch shall be provided with AL/CU mechanical lugs sized to accept the full output rating of the switch. Lugs shall be suitable for the number and size of conductors shown on the drawings.

2.02 TRANSFER SWITCH CONTROL

A. Operator Panel. Each transfer switch shall be provided with a control panel to allow the operator to view the status and control operation of the transfer switch. The operator panel shall be a sealed membrane panel rated NEMA 3R/IP53 or better (regardless of enclosure rating) that is permanently labeled for switch and control functions. The operator panel shall be provided with the following features and capabilities.

1. High intensity LED lamps to indicate the source that the load is connected to (source 1 or 2); and which sources(s) are available. Source available LED indicators shall operate from the control microprocessor to indicate the true condition of the sources as sensed by the control. High intensity LED lamps to indicate that the transfer switch is "not in auto" (due to control being disabled or due to bypass switch (when used) enabled or in operation) and "Test/Exercise Active" to indicate that the control system is testing or exercising the generator set.
2. "OVERRIDE" pushbutton to cause the transfer switch to bypass any active time delays for start, transfer, and retransfer and immediately proceed with its next logical operation.
3. "TEST" pushbutton to initiate a preprogrammed test sequence for the generator set and transfer switch. The transfer switch shall be programmable for test with load or test without load.
4. "RESET/LAMP TEST" pushbutton that will clear any faults present in the control, or simultaneously test all lamps on the panel by lighting them.

5. The control system shall continuously log information on the number of hours each source has been connected to the load, the number of times transferred, and the total number of times each source has failed. This information shall be available via a PC-based service tool or an operator display panel.
6. Security Key Switch to allow the user to inhibit adjustments, manual operation or testing of the transfer switch unless key is in place and operated. Analog AC meter display panel, to display 3-phase AC Amps, 3-phase AC Volts, Hz, KW load level, and load power factor. The display shall be color-coded, with green scale indicating normal or acceptable operating level, yellow indicating conditions nearing a fault, and red indicating operation in excess of rated conditions for the transfer switch.
7. Vacuum fluorescent alphanumeric display panel with push-button navigation switches. The display shall be clearly visible in both bright (sunlight) and no light conditions. It shall be visible over an angle of at least 120 degrees. The Alphanumeric display panel shall be capable of providing the following functions and capabilities:
    a. Display source condition information, including AC voltage for each phase of normal and emergency source, frequency of each source. Voltage for all three phases shall be displayed on a single screen for easy viewing of voltage balance.
    b. Display source status, to indicate source is connected or not connected.
    c. Display load data, including 3-phase AC voltage, 3-phase AC current, frequency, KW, KVA, and power factor. Voltage and current data for all phases shall be displayed on a single screen.
    d. The display panel shall allow the operator to view and make the following adjustments in the control system, after entering an access code:
        (1) Set nominal voltage and frequency for the transfer switch.
        (2) Adjust voltage and frequency sensor operation set points.
        (3) Set up time clock functions.
        (4) Set up load sequence functions.
        (5) Enable or disable control functions in the transfer switch, including program transition.
        (6) Set up exercise and load test operation conditions, as well abnormal system time delays for transfer time, time delay start, stop, transfer, and retransfer.
    e. Display Real time Clock data, including date, and time in hours, minutes, and seconds. The real time clock shall incorporate provisions for automatic daylight savings time and leap year adjustments. The control shall also log total operating hours for the control system.
    f. Display service history for the transfer switch. Display source connected hours, to indicate the total number of hours connected to

each source. Display number of times transferred, and total number of times each source has failed.

g. Display fault history on the transfer switch, including condition, and date and time of fault. Faults to include controller checksum error, low controller DC voltage, ATS fail to close on transfer, ATS fail to close on retransfer, battery charger malfunction, network battery voltage low, network communications error.

B. Internal Controls

1. The transfer switch control system shall be configurable in the field for any operating voltage level up to 600VAC. Provide RMS voltage sensing and metering that is accurate to within plus or minus 1% of nominal voltage level. Frequency sensing shall be accurate to within plus or minus 0.2%. Voltage sensing shall be monitored based on the normal voltage at the site. Systems that utilize voltage monitoring based on standard voltage conditions that are not field configurable are not acceptable.
2. Transfer switch voltage sensors shall be close differential type, providing source availability information to the control system based on the following functions:
   a. Monitoring all phases of the normal service (source 1) for under voltage Conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of normal voltage level).
   b. Monitoring all phases of the emergency service (source 2) for under voltage Conditions (adjustable for pickup in a range of 85 to 98% of the normal voltage level and dropout in a range of 75 to 98% of pickup voltage level).
   c. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for voltage imbalance.
   d. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for loss of a single phase.
   e. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for phase rotation.
   f. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over voltage conditions (adjustable for dropout over a range of 105 to 135% of normal voltage, and pickup at 95-99% of dropout voltage level).
   g. Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over or under frequency conditions.
   h. Monitoring the neutral current flow in the load side of the transfer switch. The control shall initiate an alarm when the neutral current exceeds preset adjustable value in the range of 100-150% of rated phase current for more than an adjustable time period of 10 to 60 seconds.

3. All transfer switch sensing shall be configurable from a Windows 95, 98, or NT PC-based service tool, to allow setting of levels, and enabling or disabling of features and functions. Selected functions including voltage sensing levels and time delays shall be configurable using the operator panel. Designs utilizing DIP switches or other electromechanical devices are not acceptable. The transfer control shall incorporate a series of diagnostic LED lamps.
4. The transfer switch shall be configurable to control the operation time from source to source (program transition operation). The control system shall be capable of enabling or disabling this feature, and adjusting the time period to a specific value. A phase band monitor or similar device is not an acceptable alternate for this feature.
5. The transfer switch shall incorporate adjustable time delays for generator set start (adjustable in a range from 0-15 seconds); transfer (adjustable in a range from 0-120 seconds); retransfer (adjustable in a range from 0-30 minutes); and generator stop (cooldown) (adjustable in a range of 0-30 minutes).
6. The transfer switch shall be configurable to accept a relay contact signal and a network signal from an external device to prevent transfer to the generator service.
7. The control system shall be designed and prototype tested for operation in ambient temperatures from –40C to +70C. It shall be designed and tested to comply with the requirements of the noted voltage and RFI/EMI standards.
8. The control shall have optically isolated logic inputs, high isolation transformers for AC inputs, and relays on all outputs, to provide optimum protection from line voltage surges, RFI and EMI.
9. The transfer switch shall be provided with a battery charger for the generator set starting batteries. The battery charger shall be a float type charger rated 10 amps. The battery charger shall include an ammeter for display of charging current and shall have fused AC inputs and DC outputs. The charger shall also include fault indications for high and low dc voltage, and supply power failed, and dry contacts for external indication of these fault conditions. Supply power failed indication shall be displayed on the ATS control panel.

C. Control Interface

1. The transfer switch will provide an isolated relay contact for starting of a generator Set. The relay shall be normally held open, and close to start the generator set. Output contacts shall be form C, for compatibility with any generator set.
2. Provide one set Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.

3. The transfer switch shall provide relay contacts to indicate the following conditions: Source 1 available, load connected to source 1, source 2 available, source 2 connected to load.

2.03 ENCLOSURE

A. Enclosures shall be UL listed. The enclosure shall provide wire bend space in compliance to the latest version of NFPA70. The cabinet door shall include permanently mounted key type latches.

B. Transfer switch equipment shall be provided in a NEMA 12 enclosure.

C. Enclosures shall be the NEMA type specified. The cabinet shall provide code-required wire bend space at point of entry as shown on the drawings. Manual operating handles and all control switches (other than key-operated switches) shall be accessible to authorized personnel only by opening the key-locking cabinet door. Transfer switches with manual operating handles and/or non key-operated control switches located on outside of cabinet do not meet this specification and are not acceptable.

PART 3 - EXECUTION

3.01 OPEN TRANSITION SEQUENCE OF OPERATION

A. Transfer switch normally connects an energized utility power source (source 1) to loads and a generator set (source 2) to the loads when normal source fails. The normal position of the transfer switch is source 1 (connected to the utility), and no start signal is supplied to the genset.

B. Generator Set Exercise (Test) With Load Mode. The control system shall be configurable to test the generator set under load. In this mode, the transfer switch shall control the generator set in the following sequence:

1. Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
2. When the control systems senses the generator set at rated voltage and frequency, it shall operate to connect the loads to the generator set by opening the normal source contacts, and closing the alternate source contacts a predetermined time period later. The timing sequence for the contact operation shall be programmable in the controller.
3. The generator set shall operate connected to the load for the duration of the exercise period. If the genera tor set fails during this period, the transfer switch shall automatically reconnect the generator set to the normal service.
4. On completion of the exercise period, the transfer switch shall operate to connect the loads to the normal source by opening the alternate source contacts, and closing the normal source contacts a predetermined time

period later. The timing sequence for the contact operation shall be programmable in the controller.

5. The transfer switch shall operate the generator set unloaded for a cool down period, and then remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

C. Generator Set Exercise (Test) Without Load Mode. The control system shall be configurable to test the generator set without transfer switch load connected. In this mode, the transfer switch shall control the generator set in the following sequence:

1. Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.
2. When the control systems senses the generator set at rated voltage and frequency, it shall operate the generator set unloaded for the duration of the exercise period.
3. At the completion of the exercise period, the transfer switch shall remove the start signal from the generator set. If the normal power fails at any time when the generator set is running, the transfer switch shall immediately connect the system loads to the generator set.

3.02 FACTORY TESTING

A. The transfer switch manufacturer shall perform a complete operational test on the transfer switch prior to shipping from the factory. A certified test report shall be available on request. Test process shall include calibration of voltage sensors.

3.03 SERVICE AND SUPORT

A. The manufacturer of the transfer switch shall maintain service parts inventory at a central location which is accessible to the service location 24 hours per day, 365 days per year.

B. The transfer switch shall be serviced by a local service organization that is trained and factory certified in both generator set and transfer switch service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.

C. The manufacturer shall maintain model and serial number records of each transfer switch provided for at least 20 years.

3.04 WARRANTY

A. The Automatic Transfer Switch and associated equipment shall be warranted for a period of not less than 5 years from the date of commissioning against defects in materials and workmanship.

B. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

*** END OF SECTION ***

DIVISION 16 - ELECTRICAL

SECTION 16400

SERVICE AND DISTRIBUTION

PART 1 - GENERAL

1.01 ELECTRICAL SERVICE

A. Electrical service will be provided for Well No. 6 by the Power Company as shown on the Drawings and as hereinafter specified.

1. Electrical Service Level will be 480/277 volt, three phase, four wire, 60 Hertz.
2. The incoming primary service, service transformer, and all associated raceways, concrete work, cable and earthwork will be the responsibility of the Power Company.
3. Service meter socket shall be furnished and installed by the Contractor. Coordinate with the Power Company for exact meter type and its installation.

B. All work shall be fully coordinated with the Power Company by the Contractor.

C. All service installation charges levied by the Power Company shall be paid by the Contractor. If the cost exceeds the given allowance, the difference shall be paid for by change order during construction. All power usage charges during construction and up until final acceptance of the facilities by the Owner shall be paid by the Contractor.

D. Temporary power for and during construction shall be obtained and paid for by the Contractor.

PART 3 - EXECUTION

This part not used.

*** END OF SECTION ***

DIVISION 16 – ELECTRICAL

SECTION 16900

PUMP CONTROL AND SCADA SYSTEM

PART 1 – GENERAL

1.01 GENERAL

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. The work includes all labor, materials, equipment and services necessary for the upgrade of the Denton Well System Pump Control and SCADA system.

1.02 SYSTEM INTEGRATOR

A. The contractor shall engage the services of an approved system integrator to furnish, calibrate, start-up/ test and demonstrate a new PLC based pumping station SCADA and control system and provide modifications and additions to the existing SCADA system at the Denton Waste Water Treatment Plant. The new pumping station SCADA/control system shall be compatible with the existing SCADA system.

B. All components used in the new Remote Terminal Units (RTU) shall be new and of the most current design. The components shall be assembled to provide a complete and functional system.

C. The RTU's and supervisory PLC's shall be assembled and tested as a system at the system integrators facility prior to shipment to the jobsite. The owner and engineer shall have the option to view the operation of the system at the integrators facility to verify compliance to the sequence of operation. Two weeks advance notice of the test shall be given to owner and engineer.

D. The RTU's shall be UL listed as a complete assemblies in accordance with UL-508.

E. System Integrator shall be:

Micro-Tech Designs, Inc.
Hampstead, MD
Phone (410) 239-2885
Fax (410) 239-3736

F. The contractor may propose a substitute system integrator provided the following qualifications are met and submitted with the bid along with cost saving, proposed system block diagram, proposed PLC manufacturer, proposed I/O list, and proposed I/O cabinet layout:

1. The system integrator shall meet or exceed the following insurance requirements:

General Liability	$ 1,000,000.00 per Occurrence
Prod/Comp Ops Aggregate	$ 2,000,000.00
Automobile Liability	$ 1,000,000.00 combined single limit
Workers Compensation	$ 500,000.00 each employee

2. The system integrator shall maintain a place of business within 100 miles of the job site.
3. List of engineers and service techs on staff with resume of projects completed and experience.
4. List of 5 similar projects with references, date completed and system description
5. UL-508 file number.
6. Years in business doing this type of work – minimum of 5 years required.

All of the above information will be reviewed to determine equality of the proposed substitution with the named supplier.

1.03 SYSTEM INTEGRATOR RESPONSIBILITIES

A. The system integrator shall fulfill the following project responsibilities:

1. Furnish the RTU as specified herein after. The RTU shall house the PLC, UPS, I/O Rack, Terminal Strips, relays, circuit breakers, power supplies, Operator Interface Unit, Spread Spectrum Radio and associated Lightning Arrestor. The RTU's shall be installed by the Contractor.
2. Furnish Variable Frequency Drive (1) as specified in specification section 16100 to be installed by Contractor.
3. Provide modification and additions to the SCADA system at the Denton Wastewater Treatment Plant as follows:
   a. Program HMI PC for new Well House screens.
   b. Program Matrix Control System as defined herein.
   c. Provide meetings, testing, site support and training as defined in PART 3 of this Section.
4. Furnish OMNI antenna and coaxial cable specified in Section 16100 to be installed by Contractor.
5. Furnish and install new OIT at Well No.3 location.

1.04 SCADA PROJECT SCOPE

A. Sequence of System Operation.

The Town of Denton, Maryland Well Control System shall be programmed such that any well pump (3) can be selected to respond to any (2) tank levels for lead lag operation. Programming will be required at new Well #6 (for Pump control and settings for existing Tank) and at the Wastewater Treatment Plant (for HMI screens and lead and lag control matrix). The HMI screen at the WWTP shall be modified to duplicate for Well #6 all features presently programmed for Well #3 and Well #5. The OIT to be installed at Well #6 shall display the same status and alarm information presently available on Well #3 and Well #5 OIT's. All elevated tank (2) levels shall be dynamically displayed on the HMI.

B. Well No.3

Furnish and install new OIT at Well No.3 location.

C. Well #6.

The new Well #6 Well House shall be provided with a new NEMA 12 RTU complete with PLC, OIT, UPS, spread spectrum radio and lightning arrestor. The radio shall be connected, via coaxial cable, to a tank mounted Omni antenna. The existing valve vault shall be provided with a new pressure transducer, flood sensor and low temperature thermostat.

The following status and alarms shall be indicated on the local OIT and on the HMI at the WWTP:

Elevated Tank Level (Real Time)
Well #6 Required
Valve Open
Well #6 Running
Well Flow (Real Time)
Chemical Feed Required
Well House Door Alarm
Vault Low Temperature
Vault Flooding
ATS on Emergency
Utility Power Failure

PART 2 – PRODUCTS

2.01 REMOTE TERMINAL UNIT – WELL #6

A. The RTU shall be a NEMA 12 enclosure sized to accommodate all PLC I/O racks and associated components required to provide a complete and operational system. The enclosure exterior shall be painted ANSI 61 gray over phosphatized surfaces. The

enclosure doors shall be held shut with quarter turn latches and hinged. All interior components shall be securely mounted on white painted steel or aluminum mounting pans. The enclosure and accessories shall be Bulletin CWI as manufactured by Hoffman Engineering Company, or equal.

B. Unit-mounted circuit breakers shall be provided in the RTU to disconnect control power and protect internal components. The breaker shall have 10,000 Amp interrupting capacity at 120/240V AC and be sized for the connected load. Separate breakers shall be provided for main disconnect and individual protection for the PLC.

C. All field control and signal wiring terminations shall be made on terminal boards located in the RTU. A minimum of 20% spare terminals shall be provided in each terminal board. Terminal blocks shall be box lug type rated 600V, 30A identified with a permanent marking that matches the wire number terminated in the block.

D. All PLC outputs controlling devices outside of the RTU shall be wired to interposing relays. The relays shall be blade base plug-in type with coils rated to match the PLC output modules and contacts rated 7A @ 120V AC. Relays shall have the number of poles required to perform the necessary functions. Where more than 4 poles are required, a multi-pole machine tool relay with field convertible contacts shall be provided.

E. All pilot devices shall be heavy duty oil-tight NEMA 13. Pilot lights shall be push-to-test transformer type. Emergency stop push buttons shall be maintained type with red mushroom type button. Each pilot device shall be provided with an engraved legend plate indicating its function.

F. Analog signal isolators shall be provided for all analog signals where required. The signal isolators shall have isolated inputs with a maximum input impedance that is compatible with the existing equipment.

G. A power supply shall be furnished to provide power for analog loops as required. The power supply shall be rated a minimum of 1 Amp minimum @ 24V DC. The power supply shall have internal automatic current limit short circuit protection. Minimum load regulation shall be $\pm$1.5% and maximum output ripple shall be 2% peak-to-peak. The power supply output shall be protected with a DC rated circuit breaker sized at 80% of the output rating of the power supply. The power supply shall be UL listed.

H. A UPS shall be supplied for the RTU and OIT. The UPS shall be sized to provide back-up power to the connected load for a 15 minute duration minimum during a power failure. The UPS shall be a true on-line unit with a sine wave output. The UPS shall also include input and output noise suppression; input power factor correction; PWM inverter; integral sealed, Flame Retardant, non-spillable, user replaceable battery; battery fuses; automatic and manual battery test feature with push button and indicator; microprocessor-based control and monitoring package; automatic restart. The UPS shall be UL listed and carry a two year warranty covering parts and labor.

I. The RTU shall be supplied with an internally fused surge suppressor connected to the incoming power terminals. The surge suppressor shall be rated for use on 120V, 1 phase, 2 wire circuits with minimum energy absorption of 560 joules. The suppressor shall have LEDS to indicate the presence of power and protection. If there is a loss of protection due to suppressor damage, an audible alarm shall be activated.

J. Programmable Logic Controller

1. The PLC shall be a microprocessor based programmable device designed for industrial control applications. It shall be capable of operating mixed I/O points.
2. The CPU shall be an adaptor module with built-in executive memory, application memory and communications ports.
3. There shall be a minimum of (2) communications ports on the CPU. One port shall be RS-232 compatible for communicating with the spread spectrum radio. The second port shall communicate via I/O bus to local I/O modules.
4. The PLC shall be provided with an option adapter. The option adapter shall have a Modbus Plus communications port, TOD clock and battery backup.
5. Communications adapter shall be provided as necessary for communications to local I/O modules.
6. The PLC shall be provided with all necessary cables, power supplies, memory and communications modules to form a complete and operational system.
7. There is an existing base of Modicon Momentum PLCs at SCADA system sites. Where possible, the System Integrator shall use identical component models in the interest of spare parts compatibility.

K. Digital input modules shall be 16 point, 120 Vac. Digital input modules shall be software configurable; configuration setting shall reside in the CPU so that replacement modules will automatically be configured. Each point shall be optically isolated from the PLC data bus to prevent surges from damaging other modules. Inputs shall be either individually isolated or grouped in groups of 8 as required to interface to the existing field equipment. Each digital input module shall have LED's to indicate the status of each input point and module health.

L. Digital output modules shall be 16 point 120 Vac. Digital output modules shall be software configurable; configuration setting shall reside in the CPU so that replacement modules will automatically be configured. Each point shall be optically isolated from the PLC data bus to prevent surges from damaging other modules. Outputs shall be fused and grouped in groups of 4. Each digital output module shall have LED's to indicate the status of each output point. Output points shall be capable of being configured to turn-off, go to a predefined safe state or stay in last state on a CPU service failure.

M. Analog input modules shall be 8 channel 4 – 20 mA or 1 -5 V as required to interface to the existing equipment. Analog input modules shall be software configurable; configuration setting shall reside in the CPU so that replacement modules will automatically be configured. Each channel shall be optically isolated from the PLC data bus to prevent surges from damaging other modules. Each analog input module shall have a LED to indicate module status. Open wire indication shall be available to the CPU for use in the PLC program.

N. Analog output modules shall be 4 channel 4 – 20 mA. Analog output modules shall be software configurable; configuration setting shall reside in the CPU so that replacement modules will automatically be configured. Each channel shall be optically isolated from the PLC data bus to prevent surges from damaging other modules. Each analog output module shall have an LED to indicate module status.

O. All interconnecting communications cables shall be supplied to provide a complete and operational system.

P. This PLC shall be capable of communicating with other PLC's via radio, for SCADA operation.

2.02 REMOTE TERMINAL UNIT FABRICATION

A. Instrumentation signal cables shall be twisted shield pairs with polyvinyl jacket and foil shield with drain wire. Shields shall be grounded at one point only on each instrumentation loop as shown on the drawings. The shielded cable shall be rated 300V 90°C. Minimum conductor size shall be not less than #20 AWG.

B. All control wiring shall be #16 AWG with MTW insulation rated 90°C minimum. Control wiring shall be color coded as follows:

Black	- Unfused 120V Control Power
Red	- Fused 120 VAC Control
Blue	- D-C Circuits
Yellow	- Power fed from a remote device
White	- Grounded current carrying conductor – neutral
Green	- Grounded non-current carrying conductor

C. Each signal and control wire shall have a unique number assigned to it and marked at each end of the wire. Wire markers shall be white PVC tubing with machine printed black markings and shall match the number shown on the wiring diagrams and loop drawings.

D. Each terminal board shall have one side reserved for "FIELD" wiring with wire duct provided of sufficient size to accommodate all field wiring plus 50% spare.

E. Each device within the RTU shall be assigned a unique device designation. This designation shall be used to identify the device on all wiring diagrams and within the RTU bill of material. All RTU devices shall be provided with a printed label adjacent to the device on the interior of the enclosure that matches these designations.

F. An engraved panel nameplate shall be provided on the RTU. The nameplate shall be white with black engraved letters that are at least ½"high. Stainless steel screws shall be used to secure the nameplate to the door of the RTU.

G. All components installed within the RTU shall be securely mounted on an interior mounting pan in accordance with the manufacturers instructions, paying special attention to spacing and grounding requirements.

H. Wiring within the RTU shall be run in wire duct or harnessed to provided a neat appearance. AC and DC circuits shall be separated wherever possible and shall not be harnessed together or run in the same wire duct.

2.03 SPREAD SPECTRUM RADIO AND LIGHTNING ARRESTOR

A. The spread spectrum radio shall be a 900 MHz transceiver with a license free frequency range from 902 to 928 MHz, 240 channels, channel spacing of 100 kHz, input voltage of 6-30 VDC, SMA antenna connector with SMA to N coaxial jumper and shall be a Cellnet Series 3 or latest compatible version, T/A UTILINET S3 IWR radio. In the interest of existing system component compatibility no substitutions are acceptable.

B. Lightning arrestor shall be Polyphasor IS-B50 or equal, compatible with frequency range of 890-960 MHz, suitable for bulkhead mounting and complete with Type N connectors.

2.04 OPERATOR INTERFACE UNIT

A. Operator Interface Unit shall be Magellis XBTGT 10.4 (Part No. XBTGT 5330) as manufactured by Magellis.

2.05 SPARE PARTS

A. Fuses – five of each type used

B. Plug-in relays – two of each type used

C. System DC Power Supply – one of each type used

D. Signal Isolator – one of each type used

E. Discrete Input Module – one of each type used

F. Discrete Output Module – one of each type used

G. Analog Input Module – one of each type used

H. Analog Output Module – one of each type used

I. Communications Module – one of each type used

J. PLC Processor – one of each type used

K. VFD Drive – one of each type used

All parts shall be furnished in their original sealed packages with part numbers clearly marked on the outside of the boxes.

PART 3 – EXECUTION – Not Used.

*** END OF SECTION ***