33 32 50 EMERGENCY GENERATORS & BACKUP PUMPING SYSTEMS

SECTION 1 - GENERAL

1.1 SUMMARY

A. The contractor shall provide complete factory assembled backup generator set and/or backup pumping systems equipment with digital (microprocessor-based) electronic generator set controls, digital governor, and digital voltage regulator. Also included for LP gas generators and diesel generators is the fuel supply tank and fuel piping system for the generators, and connection to the natural gas piping system for natural gas generators.

B. The contractor shall provide complete factory assembled automatic 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.

C. 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.

D. All materials to be installed shall be purchased in accordance with all applicable provisions of the Buy American Act.

1.2 QUALITY ASSURANCE

A. Codes and Standards

1. Generator Set

a. The generator set installation and on-site testing shall conform to the requirements of the following codes and standards, as applicable. The generator set shall include necessary features to meet the requirements of these standards.

1) CSA 282, 1989 Emergency Electrical Power Supply for Buildings

2) IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

3) NFPA37 –
4) **NFPA70** – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.

5) **NFPA99** – Essential Electrical Systems for Health Care Facilities

6) **NFPA110** – Emergency and Standby Power Systems. The generator set shall meet all requirements for Level 1 systems. Level 1 prototype 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.

b. The generator set and supplied accessories shall meet the requirements of the following standards:

1) **NEMA MG1.** Alternator shall comply with the requirements of the current version this standard as they apply to AC alternators.

2) **UL142 – Sub-base Tanks**

3) **UL1236 – Battery Chargers**

4) **UL2200.** The generator set shall be listed to UL2200 or submit to an independent third party certification process to verify compliance as installed.

c. The control system for the generator set shall comply with the following requirements.

1) **CSA C22.2, No. 14 – M91 Industrial Control Equipment.**

2) **EN50082-2, Electromagnetic Compatibility – Generic Immunity Requirements, Part 2: Industrial.**

3) **EN55011, Limits and Methods of Measurement of Radio Interference Characteristics of Industrial, Scientific and Medical Equipment.**

4) **FCC Part 15, Subpart B.**

5) **IEC8528 part 4. Control Systems for Generator Sets**

6) **IEC Standard 801.2, 801.3, and 801.5 for susceptibility, conducted, and radiated electromagnetic emissions.**
7) UL508. The entire control system of the generator set shall be UL508 listed and labeled.

8) UL1236 – Battery Chargers.

d. 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.

2. Automatic Transfer Switch

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

1) CSA 282, Emergency Electrical Power Supply for Buildings

2) NFPA70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.

3) NFPA99 – Essential Electrical Systems for Health Care Facilities

4) NFPA110 – Emergency and Standby Power Systems. The transfer switch shall meet all requirements for Level 1 systems.

5) IEEE446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications.


b. The transfer switch assembly shall comply with the following standards:

1) CSA C22.2, No. 14 – M91 Industrial Control Equipment.

2) EN55011, Class B Radiated Emissions

3) EN55011, Class B Conducted Emissions

4) IEC 1000-4-5 (EN 61000-4-5); AC Surge Immunity.

5) IEC 1000-4-4 (EN 61000-4-4) Fast Transients Immunity

6) IEC 1000-4-2 (EN 61000-4-2) Electrostatic Discharge Immunity
7) IEC 1000-4-3 (EN 61000-4-3) Radiated Field Immunity
8) IEC 1000-4-6 Conducted Field Immunity
9) IEC 1000-4-11 Voltage Dip Immunity.
10) IEEE 62.41, AC Voltage Surge Immunity.
11) IEEE 62.45, AC Voltage Surge.
12) UL1008 – Transfer Switches. Transfer switches shall be UL1008 listed. UL1008 transfer switches may be supplied in UL891 enclosures if necessary to meet the physical requirements of the project.

c. 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.

B. Factory Testing

1. The manufacturer of the generator set and automatic transfer switch shall perform a complete operational test on the generator set and automatic transfer prior to shipping from the factory. Equipment supplied shall be fully tested at the factory for function and performance.

2. Test process shall include calibration of voltage sensors for the automatic transfer switch.

3. A certified factory test report shall be provided to the Utility.

1.3 SUBMITTALS

A. Within 30 days after award of contract, provide six sets of the following information for review:

1. Manufacturer’s product literature and performance data, sufficient to verify compliance to specification requirements.

2. A paragraph by paragraph specification compliance statement, describing the differences between the specified and the proposed equipment.

3. Manufacturer’s certification of prototype testing.

4. Manufacturer’s published warranty documents.

5. Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.
6. Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.

7. Manufacturer's installation instructions.

B. If applicable, LP Fuel Tank and Instrumentation Submittal
   1. Manufacturer's product literature and performance data, sufficient to verify compliance to specification requirements.
   2. Manufacturer's published warranty documents.
   3. Shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.
   4. Manufacturer's installation instructions.

C. If applicable, natural gas regulator manufacturer's data sheet and warranty information.

D. A certified factory test report shall be provided to the Utility before shipping the equipment to the site.

E. Operating and Maintenance Manuals
   1. Provide one paper copy and one digital copy (on a flash drive) for the backup generator set, automatic power transfer equipment and/or backup pumping systems.
   2. All manufacturers’ O&M Manuals shall be combined into one project O&M Manual. Individual manufacturer’s O&M Manuals are unacceptable.
   3. The O&M Manual copies provided shall both be fully indexed for easy reference.

SECTION 2 – MATERIALS

2.1 GENERATOR SET

A. Ratings
   1. The generator set shall operate at 1800 rpm and at the voltage shown in the contract documents, and shall be 3-phase, 4-wire, 60 hertz.
   2. The generator set shall be rated per the contract documents and based on altitude at the site location and ambient temperatures as noted in the contract documents.
3. The generator set rating shall be based on 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. 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 0.5%.

3. The engine generator set shall accept a single step load 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 the minimum as shown in the contract documents. The generator set shall be capable of recovering to a minimum of 90% of rated no load voltage following the application of the specified kVA load at near zero power factor applied to the generator set. Maximum voltage dip on application of this load, considering both alternator performance and engine speed changes shall not exceed 25%.

5. 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, and no 3\(^{rd}\) order harmonics or their multiples. Telephone influence factor shall be less than 40.

6. The generator set shall be certified by the engine manufacturer to be suitable for use at the installed location and rating, and shall meet all applicable exhaust emission requirements at the time of commissioning.

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. All active control components shall be installed within a UL/NEMA 3R enclosure. There shall be no exposed points in the control (with the door open) that operate in excess of 50 volts.

D. Electrical and Control 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 permanently labeled terminal block assembly. Labels describing connection point functions shall be provided.

E. Engine And Engine Equipment

1. The engine shall be a 4-cycle, radiator and fan cooled engine. 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. Engine accessories and features shall include:

   a. An electronic governor system shall provide automatic isochronous frequency regulation. 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 a function of starting, accelerating to start disconnect speed, accelerating to rated speed. The governing system shall include a programmable warm up at idle and cooldown at idle function. While operating in idle state, the control system shall disable the alternator excitation system.

   b. Skid-mounted radiator and cooling system rated for full load operation in 122 degrees F (50 degrees C) ambient as measured at the alternator air inlet. Radiator fan shall be suitable for use in a system with 0.5 in H2O restriction. Radiator shall be sized based on a core temperature that 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 equipment manufacturer shall fill the cooling system with a 50/50 ethylene glycol/water mixture prior to shipping. Rotating parts shall be guarded against accidental contact.

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

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

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

g. Replaceable dry element air cleaner with restriction indicator.

h. Flexible supply and return fuel lines.

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

j. Coolant heater

1) Engine mounted, thermostatically controlled, coolant heater(s) for each engine. Heater voltage shall be as shown on the project drawings. 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 provisions to isolate the heater for replacement of the heater element without draining the coolant from the generator set. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.

3) The coolant heater shall be provided with a DC 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 104F (40C) in a 40F (4C) ambient, in compliance with NFPA110 requirements, or the temperature required for starting and load pickup requirements of this specification.

k. Starting and Control Batteries shall be calcium/lead antimony type, 24 volt DC, sized as recommended by the engine manufacturer, complete with battery cables and connectors. The batteries shall be capable of a minimum of three complete 15-second cranking cycles at 40F ambient temperature when fully charged.
I. Provide exhaust silencer(s) for each engine of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer. Exhaust system shall be installed according to the engine manufacturer’s recommendations and applicable codes and standards.

F. AC Generator

1. 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.

2. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system and shall be UL1446 listed. Actual temperature rise measured by resistance method at full load shall not exceed 105 degrees Centigrade.

3. 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.

4. 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.

G. Generator Set Control

1. The generator set shall be natural gas fueled, liquefied petroleum (LP) gas fueled, or diesel fueled per the contract documents.

2. 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.

3. The control shall be mounted on the generator set, or may be mounted in a free-standing panel next to the generator set if adequate space and accessibility is available upon approval of the Utility. The control shall be vibration isolated and tested to verify the durability of all components in the system under the vibration conditions encountered.

4. The generator set mounted control shall include the following features and functions:
a. Control Switches:

b. 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. A separate push-button to initiate starting is acceptable. 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.

c. 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.

d. 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.

e. 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.

5. The generator set shall be provided with a metering set including the following features and functions:

a. Digital metering set, 1% 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.

b. Analog voltmeter, ammeter, frequency meter, power factor meter, and kilowatt (KW) meter. Voltmeter and ammeter shall display all three phases. Meter scales shall be color coded in the following fashion: green shall indicate normal operating condition, amber shall indicate operation in ranges that indicate potential failure, and red shall indicate failure impending. Metering accuracy shall be within 1% at rated output. Both analog and digital metering are required.

c. The control system shall monitor the total load on the generator set, and maintain data logs of total operating hours at specific load levels ranging from 0 to 110% of rated load, in 10% increments.
The control shall display hours of operation at less than 30% load and total hours of operation at more than 90% of rated load.

d. The control system shall log total number of operating hours, total kWh, and total control on hours, as well as total values since reset.

6. The generator set control shall include LED alarm and status indication lamps. The lamps shall be high-intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. Functions indicated by the lamps shall include:

a. The control shall include five configurable alarm-indicating lamps. The lamps shall be field adjustable for any status, warning, or shutdown function monitored by the genset. They shall also be configurable for color, and control action (status, warning, or shutdown).

b. The control shall include green lamps to indicate that the generator set is running at rated frequency and voltage, and that a remote start signal has been received at the generator set. The running signal shall be based on actual sensed voltage and frequency on the output terminals of the generator set.

c. The control shall include a flashing red lamp to indicate that the control is not in automatic state, and red common shutdown lamp.

d. The control shall include an amber common warning indication lamp.

7. The generator set control shall indicate the existence of the warning and shutdown conditions on the control panel. All conditions indicated below for warning shall be field-configurable for shutdown. Conditions required to be annunciated shall include:

a. low oil pressure (warning)

b. low oil pressure (shutdown)

c. oil pressure sender failure (warning)

d. low coolant temperature (warning)

e. high coolant temperature (warning)

f. high coolant temperature (shutdown)

g. high oil temperature (warning)
h. engine temperature sender failure (warning)
i. low coolant level (warning)
j. fail to crank (shutdown)
k. fail to start/overcrank (shutdown)
l. overspeed (shutdown)
m. low DC voltage (warning)
n. high DC voltage (warning)
o. weak battery (warning)
p. low fuel-daytank (warning)
q. high AC voltage (shutdown)
r. low AC voltage (shutdown)
s. under frequency (shutdown)
t. over current (warning)
u. over current (shutdown)
v. short circuit (shutdown)
w. over load (warning)
x. emergency stop (shutdown)
y. Four configurable conditions - 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.

8. Engine Status Monitoring.

a. The following information shall be available from a digital status panel on the generator set control:
   
   1) engine oil pressure (psi or kPA)
2) engine coolant temperature (degrees F or C)
3) engine oil temperature (degrees F or C)
4) engine speed (rpm)
5) number of hours of operation (hours)
6) number of start attempts
7) 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.

9. 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.

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.
10. Alternator Control Functions:

a. The generator set shall include a full wave rectified automatic digital voltage regulation system that is matched and 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 line to neutral 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 an adjustable frequency threshold. Torque matching characteristic shall be adjustable for roll-off frequency and rate, and be capable of being curve-matched to the engine torque curve with adjustments in the field. 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. A microprocessor-based protection device shall be provided to individually monitor all phases of 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 device 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 NFPA70 article 445.

c. A microprocessor-based protection device shall be provided to monitor all 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. A microprocessor-based 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. The system shall monitor individual phases and be connected line to neutral on 3-phase 4-wire generator sets, and for systems that are solidly grounded.

11. Other Control Functions

a. 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 DC voltage shall be monitored as load is applied to the battery, to detect impending battery failure or deteriorated battery condition.

12. Control Interfaces for Remote Monitoring:

a. The control system shall provide four programmable output relays. These relay outputs shall be configurable for any alarm, shutdown, or status condition monitored by the control. The relays shall be configured to indicate: (1) generator set operating at rated voltage and frequency, (2) common warning, (3) common shutdown, (4) load shed command.

b. 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.

c. A fused 10 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.

H. Circuit Breaker

1. The generator set shall be provided with a mounted main line circuit breaker, sized to carry the rated output current of the generator set. The circuit breaker shall incorporate an electronic trip unit that operates to protect the alternator under all overcurrent conditions, or a thermal-magnetic 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.
I. Outdoor Weather-Protective Enclosure

1. The generator set shall be provided with an outdoor enclosure, with the entire package listed under UL2200. The package shall comply with the requirements of the National Electrical Code for all wiring materials and component spacing.

2. The total assembly of generator set, enclosure, and sub-base fuel tank (when required) shall be designed to be lifted into place using spreader bars.

3. Housing shall provide ample airflow for generator set operation at rated load in an ambient temperature of 100F. The housing shall have hinged access doors as required to maintain easy access for all operating and service functions.

4. All doors shall be lockable, and include retainers to hold the door open during service.

5. Enclosure roof shall be cambered to prevent rainwater accumulation.

6. Openings shall be screened to limit access of rodents into the enclosure. All electrical power and control interconnections shall be made within the perimeter of the enclosure.

7. All sheet metal shall be primed for corrosion protection and finish painted with the manufacturer’s standard color using a two step electrocoating paint process, or equal meeting the performance requirements specified below. All surfaces of all metal parts shall be primed and painted. The painting process shall result in a coating that meets the following requirements:

   a. Primer thickness, 0.5-2.0 mils. Top coat thickness, 0.8-1.2 mils.

   b. Gloss, per ASTM D523-89, 80% plus or minus 5%. Gloss retention after one year shall exceed 50%.

   c. Crosshatch adhesion, per ASTM D3359-93, 4B-5B.

   d. Impact resistance, per ASTM D2794-93, 120-160 inch-pounds.

   e. Salt Spray, per ASTM B117-90, 1000+ hours.

   f. Humidity, per ASTM D2247-92, 1000+ hours.

   g. Water Soak, per ASTM D2247-92, 1000+ hours.

8. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable.
9. Fasteners used shall be corrosion resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.

10. Enclosure shall be constructed of minimum 12-gauge steel for framework and 14-gauge steel for panels. All hardware and hinges shall be stainless steel.

11. A factory-mounted exhaust silencer shall be installed inside the enclosure. The exhaust shall exit the enclosure through a rain collar and terminate with a rain cap. Exhaust connections to the generator set shall be through seamless flexible connections.

12. The enclosure shall include the following maintenance provisions:
   a. Flexible coolant and lubricating oil drain lines, that extend to the exterior of the enclosure, with internal drain valves
   b. Provision for external radiator filling.

13. The generator set shall be provided with a sound-attenuated housing which allows the generator set to operate at full rated load in an ambient temperature of up to 100F. The enclosure shall reduce the sound level of the generator set while operating at full rated load to a maximum of 90 dBA at any location 7 meters from the generator set in a free field environment.

2.2 AUTOMATIC POWER TRANSFER SWITCH

A. Ratings

1. Refer to the contract drawings for specifications on the sizes and types of transfer switch equipment, withstand and closing ratings, voltage and ampere ratings, enclosure type, and accessories. Unless otherwise noted on the drawings, transfer switches operating at 150VAC (line to neutral) and lower, and transfer switches serving exclusively 3-wire loads shall be 3 pole with solid neutral. All other transfer switches shall be 4-pole.

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 the available fault currents shown on the drawings and 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 equipped with permanently attached manual operating handles and quick-break, quick-make over-center contact mechanisms. Transfer switches over 1000 amperes shall be equipped with manual operators for service use only under de-energized conditions.

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 designated on the contract documents as 4-pole shall be provided with a switched neutral pole. The neutral pole shall be of the same construction and have the same ratings as the phase poles. All poles shall be switched simultaneously using a common crossbar. Substitute equipment using overlapping neutral contacts is not acceptable.

7. 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.

D. Transfer Switch Control

1. 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 4X 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.

   a. High intensity LED lamps to indicate the source that the load is connected to (source 1 or source 2); and which source(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.

   b. 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.

   c. “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.

   d. “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.

   e. “RESET/LAMP TEST” pushbuttons that will clear any faults present in the control, or simultaneously test all lamps on the panel by lighting them.

   f. 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 and an operator display panel.

   g. 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.

   h. 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.

i. 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:

1) 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. Line to neutral voltages shall be displayed for 4-wire systems.

2) Display source status, to indicate source is connected or not connected.

3) 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.

4) The display panel shall allow the operator to view and make the following adjustments in the control system, after entering an access code:

   a) Set nominal voltage and frequency for the transfer switch.

   b) Adjust voltage and frequency sensor operation set points.

   c) Set up time clock functions.

   d) Set up load sequence functions.

   e) Enable or disable control functions in the transfer switch, including program transition.

   f) Set up exercise and load test operation conditions, as well as normal system time delays for transfer time, time delay start, stop, transfer, and retransfer.
5) 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.

6) 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.

7) 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,
and network communications error.

2. Internal Controls

a. 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.

b. Transfer switch voltage sensors shall be close differential type,
providing source availability information to the control system
based on the following functions:

1) 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).

2) 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).

3) Monitoring all phases of the normal service (source 1) and
emergency service (source 2) for voltage imbalance.

4) Monitoring all phases of the normal service (source 1) and
emergency service (source 2) for loss of a single phase.
5) Monitoring all phases of the normal service (source 1) and emergency service (source 2) for phase rotation.

6) 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).

7) Monitoring all phases of the normal service (source 1) and emergency service (source 2) for over or under frequency conditions.

8) Monitoring the neutral current flow in the load side of the transfer switch. The control shall initiate an alarm when the neutral current exceeds a 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.

c. All transfer switch sensing shall be configurable from a Windows 7 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.

d. 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.

e. 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 (cool down) (adjustable in a range of 0-30 minutes).

f. 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.

g. 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.
h. 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.

i. 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 2 amps. The battery charger shall include an ammeter for display of charging current and shall have fused AC inputs and DC outputs.

3. Control Interface

a. 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.

b. Provide one set Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.

E. Enclosure

1. 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.

2. Transfer switch equipment shall be provided in a NEMA 4X (Stainless Steel) or better enclosure.

3. 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.

2.3 BACKUP PUMP SYSTEM (if specified)

A. Pump

1. Pump casting shall be cast iron. Pump design shall incorporate a direct suction flow path that is in axial alignment with the impeller eye. There shall be no turns, chambers, or valves between the suction line (or inlet) and the impeller. Discharge shall be side under underslug type.

2. The pump impeller shall be of open non-clog type with pump out vanes on the back shroud. The impeller shall be of hardened cast chromium steel construction (minimum Brinell Hardness 340 HB).
3. Wear plates shall be fully adjustable and replaceable, fabricated of a hardened cast iron (minimum Brinell Hardness 340 HB). Wearplate clearances shall have no relationship to the ability of the pump to achieve a prime.

4. Pump shall be fitted with a bearing bracket which contains the shaft, two sets of heavy duty angular contact ball bearings at the drive end and cylindrical roller bearings on the hydraulic end. Bearings shall be of adequate size to withstand imposed loads and up to 100 psi of suction pressure. Minimum I.S.O. L10 bearing life to be 100,000 hours. Impeller shafts shall be of one and a half percent (1½%) chromium alloy.

5. Seals shall be high pressure, capable of withstanding suction pressures to 50-psi. The pump seal will be a mechanical seal arrangement. The inboard mechanical seal shall be a mechanical self-adjusting type with silicon carbide faces. The mechanical seal shall be cooled and lubricated in its own cooling reservoir, requiring no maintenance or adjustment. Pump shall be capable of running dry, with no damage, for periods up to twenty-four hours. All metal parts shall be of stainless steel. Elastomers shall be Viton.

6. Pump suction and discharge flanges shall be cast iron ANSI (B16.1) Class 150, flat faced.

7. Pump gaskets shall be compressed fiber.

8. Pump O-rings shall be Buna-N.

9. Pump shall be supplied with an integral flap type check valve mounted on the discharge flange of the pump, allowing unrestricted flow into the impeller. The check valve shall prevent in-line return of flow when the pump is shut off. Non-return valve elastomers shall be Nitrile Rubber, and shall be field replaceable.

10. Each pump shall be supplied with an air release valve upstream of the check valve and shall have its own isolation valve to facilitate maintenance. The air release valve shall be constructed of stainless steel and suitable for wastewater pumping applications.

11. Units shall be supplied with a vacuum rated flanged expansion joint for mounting on the suction side (Proco Series 240-AV/NP, Neoprene Cover-AV, Buna-N Tube-NP). Units shall be supplied with a pressure rated flanged expansion joint for mounting on the discharge side (Proco Series 240-AV/NP, Neoprene Cover-AV, Buna-N Tube-NP).
B. Pump Priming

1. Pump shall be fitted with a fully automatic priming system capable of repeated priming from a completely dry pump casing. Priming static suction lift shall be provided for as noted in the contract drawings.

2. The pump must be capable of running totally dry for periods up to twenty four (24) hours, then re-priming and returning to normal pumping volumes.

3. Supplemental Static Suction Lift System

   a. If pump requires additional static suction lift to meet the project requirements for static suction lift, manufacturer shall obtain specific approval of the vacuum lift system form the Utility prior to manufacture of the equipment.

   b. If approved by the Utility, manufacturer shall provide as part of the scope of supply all required supplemental vacuum suction lift required to provide priming of the system at startup of the diesel backup pump system. Delay in system priming after pump startup is not acceptable.

4. Equipment acceptance shall be contingent upon the pump’s ability to run continuously at full speed in a completely dry condition. The engineer may require a demonstration.

A. Pump Drive Unit

1. Pump drive unit, unless otherwise specified, shall be a diesel water-cooled engine. Engine shall drive pump by use of direct connected intermediate drive plate. Starter shall be 12 volt electric. Low oil pressure safety shutdown, high temperature shutdown, tachometer, and hour-meter shall be integrated into engine control panel. Battery shall have 180 Amp hour rating. Unit shall be a Caterpillar C7 or equal, rated at a minimum of 225 HP (continuous) at 2,200 RPM. A certified continuous duty engine curve shall be supplied to the owner/engineer.

2. Governor shall be electronic type. Engine speed shall be adjustable to operate the pump between maximum and minimum design operation speeds.

3. The engine shall be capable of operating satisfactorily on a commercial grade of distilled No. 2 fuel oil.

4. Integral structural steel skid type fuel tank shall be sized with sufficient capacity to provide at least twenty four (24) hours of operating time at full load.
5. Exhaust system shall include muffler and silencer of suitable size.

B. Enclosure

1. The engine and pump shall be completely enclosed with 12 gauge sheet metal panels and 14 gauge sheet metal doors with 1-inch and 2-inch layers of polydamp acoustical sound deadening material. The acoustical enclosure shall reduce pump and engine noise to 70 dbA or less at a distance of thirty (30) feet. The panels shall be removable for easy access to the engine / pump for maintenance and repair. The engine control panel shall have a locking door with a plexiglass cover for visual inspection. For maintenance and service needs, the pump discharge side of the trailer shall have a hinged door for quick access to the engine oil fill, fuel fill port, oil dipstick and filters.

2. Pump, engine, and base shall be shop primed and finish painted at the place of manufacturer. Materials and thickness for priming shall be in accordance with manufacturer's standards.

3. The unit shall include a single switch operated 12 VDC interior dome light mounted within the enclosure.

B. Electrical Connections and Battery Charger

1. The unit shall include a single GFCI 110VAC duplex outlet to be connected to Pump Station electrical circuit to power the automatic trickle charger and engine coolant heater. It shall be rated for 20-amps.

2. The unit shall include a fully automatic trickle charger powered by 6-amps, 115 VAC. It shall be hard-wired into the junction box within the enclosure.

3. The drive unit shall be supplier with an integral thermostatically and pressure controlled engine block heater (9-amp, 115 VAC required) hard-wired to the junction box within the enclosure.

C. Controls

1. The unit shall be supplied with one (1) float assembly including two (2) normally open floats which shall integrate with the engine control panel via a single multi-pin.

2. The unit shall be supplied with one (1) sewage compatible level transducer assembly including a single 4-20 Ma level transducer (0-5 psig), 50-foot conductor, and shall integrate into the engine control panel via a single multi-pin connector. Level transducer to be supplied with either a desiccant filter or aneroid bellows option and mounting bracket.
3. The unit shall include a multi-pin connector for integration into the engine control panel. The connector shall include 50-foot shielded conductor cable (OMNI AWG 16, 3-cond, P/N DS11602).

4. The units shall be supplied with a NEMA 4X enclosure including a 3-circuit terminal block and mounting for desiccant filter or aneroid bellows.

5. The units shall be supplied with Murphy Fuel level sender (P/N ES2F) integrated into the engine control panel.

D. Vibration Isolation

1. The units shall be supplied with 1-inch thick Unisorb Red-Line FB-1 (or approved equal) vibration isolation pads cut to size per pump manufacturer's recommendations. Isolation pads are to be installed between the bottom of the unit and concrete slab. Resilient washers are also to be included for installation between the anchor bolt heads and anchor bolt holes of the units.

E. Acceptable Manufacturers

1. Diesel powered back-up pumps acceptable manufacturers shall be Thompson Pumps Godwin Pumps, or approved equal.

2.3 FUEL SYSTEM AND TANKS

A. Natural-Gas Piping

1. Natural gas piping shall comply of NFPA 37 and 54.

2. Natural gas piping to the site will be installed by the local Natural Gas Utility. Contractor shall be responsible to extend piping from the local Natural Gas Utility termination point to the generator set including installation of a gas regulator.

3. Natural gas piping shall be sized to provide adequate fuel to the engine while allowing for no greater than 1 inch water column pressure drop from no load to full load.

4. Natural gas piping will supply pressure to the generator set inlet per manufacturer's recommendations.

5. Natural gas regulator provided by the Contractor shall be sized to provide 125 percent of full-load generator set capacity.

B. LP Fuel Tank (required for generator sets specified to be LP fuel only)

1. A separate aboveground LP fuel tank shall be provided for LP fueled generators per the size shown in the contract documents.
2. The fuel tank shall be steel construction and meet the following requirements:
   a. Tank shall conform to the latest edition of ASME Rules for Construction of Pressure Vessels, Section VIII, Division 1.
   b. Tank shall comply with NFPA 58.
   c. Tank shall be rated at 250 psig from -20° F to 125° F.
   d. Tank shall be UL listed (UL 644 - Container Assemblies for LP-Gas).
   e. Tank shall be primed with liquid epoxy and coated with a liquid urethane top coat.
   f. Tank shall be shipped vacuum purged.
   g. Tank shall have integral lifting provisions.

3. Tank shall include the following features:
   a. Emergency tank and basin vents.
   b. Pressure relieving devices.
   c. Mechanical level gauge.
   d. Fuel supply and return lines, in accordance with NFPA 37 and 58 requirements.
   e. Liquid level transmitter to indicate fuel level. Wire level transmitter to generator control for local and remote indication of fuel level.

C. Diesel Fuel Tank (required for diesel generator sets only)

1. A sub-base fuel tank integral to the generator shall be provided for all diesel generator sets, sized to allow for full load operation of the generator set for 25 hours. The sub-base fuel tank shall be UL142 listed and labeled.

2. Installation shall be in compliance to NFPA 37.

3. The fuel tank shall be a double-walled, steel construction and include the following features:
   a. Emergency tank and basin vents.
   b. Mechanical level gauge.
c. Fuel supply and return lines, connected to generator set with flexible fuel lines as recommended by the engine manufacturer and in compliance to UL2200 and NFPA 37 requirements.
d. Leak detection provisions, wired to the generator set control for local and remote alarm indication.
e. High and low level float switches to indicate fuel level. Wire switches to generator control for local and remote indication of fuel level.
f. Basin drain.
g. Integral lifting provisions.

2.4 SCADA INTEGRATION

A. Generator/ATS System SCADA Integration

1. The unit/s shall include necessary dry contacts to be integrated into Utility’s SCADA system for the following I/O:
   a. Generator Call to Run
   b. Generator Running
   c. Generator Common Alarm
   d. Fuel Level Low
   e. Run Time Hours
   f. ATS Status
   g. Power Fail

B. Backup Pump System SCADA Integration

1. The unit/s shall include necessary dry contacts to be integrated into Utility’s SCADA system.
   a. Engine Running
   b. Engine Failure
   c. Fuel Level Low
   d. Run Time Hours
2.5 CONCRETE

A. Concrete shall meet the requirements of section 03 30 53 Miscellaneous Cast-in-Place Concrete.

SECTION 3 - EXECUTION

3.1 SEQUENCE OF OPERATION

A. Normal Operation

1. Automatic 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.

2. Generator set shall start on receipt of a start signal from the automatic transfer switch. The start signal shall be via hardwired connection to the generator set control.

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

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

   a. 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.

   b. 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”.

   c. 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 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.

g. 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

B. Generator Set Exercise

1. 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:

a. Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.

b. 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.

c. The generator set shall operate connected to the load for the duration of the exercise period. If the generator set fails during this period, the transfer switch shall automatically reconnect the generator set to the normal service.

d. 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.

e. 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.

2. 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:
a. Transfer switch shall initiate the exercise sequence at a time indicated in the exercise timer program, or when manually initiated by the operator.

b. 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.

c. 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.

3.2 INSTALLATION

A. Equipment shall be 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.

B. Installation of equipment shall be in accordance with manufacturer’s instructions and instructions included in the listing or labeling of UL listed products.

C. 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.

D. Equipment shall be installed on concrete housekeeping pads as detailed in the contract documents. Equipment shall be permanently fastened to the pad in accordance with manufacturer’s instructions and seismic requirements of the site.

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

F. 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.

G. LP Fuel Tank (required for generator sets specified to be LP fuel only)

1. Installation shall be in compliance to NFPA 30, 37 and 58.

2. Installation shall be on a concrete base of size and capacity to support fully loaded LP fuel tank. Tank shall be anchored to the concrete base with anchor bolts cast or anchored into the concrete base.
3. All LP gas piping shall be installed in accordance with NFPA 58.

H. SCADA integration including programming and required wiring and hardware shall be completed by the Contractor, and shall be compatible with the Utility’s existing SCADA system.

### 3.3 ON-SITE STARTUP AND ACCEPTANCE

A. Manufacturer shall provide startup and on-site testing of the system by a supplier authorized by the equipment manufacturer.

B. 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 Utility shall be notified in advance and shall have the option to witness the tests.

C. Installation acceptance tests to be conducted on-site shall include a "cold start" test, a 2-hour full load test, and a one step rated load pickup test in accordance with NFPA 110. Contractor shall provide a resistive load bank and make temporary connections for full load test, if necessary.

D. The Contractor shall perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Timing of the testing shall be coordinated with the Utility.

### 3.4 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 ONUS.

### 3.5 SERVICE AND SUPPORT

A. The manufacturer of the generator set, automatic transfer switch and backup pumping system 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, automatic transfer switch and backup pumping system shall be serviced by a local service organization that is trained and factory certified in for service of the equipment. 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 the generator set, automatic transfer switch and backup pumping system provided for at least 20 years.
3.6 WARRANTY

A. Generator / Automatic Transfer Switch

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

B. Backup Pimping System

1. The emergency backup pumping system shall be warranted for a period of one (1) year Parts and Labor Warranty issued by the manufacturer on the emergency backup pump system. This warranty must cover all pump parts including the mechanical seal, all engine components, all control components, and all sensors.

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

D. The generator set manufacturer shall warrant all equipment provided under this section, whether or not 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.

END OF SECTION 33 32 50