PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General Conditions, [Division 01 - GENERAL REQUIREMENTS] [Division 1 - GENERAL REQUIREMENTS], and other applicable specification sections in the Project Manual apply to the work specified in this Section.

1.2 SUMMARY

A. Scope: Provide design and engineering, labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for a standby power systems generator set as required for the complete performance of the work, and as shown on the Drawings and as herein specified.

B. Section Includes: The work specified in this Section includes, but shall not be limited to, a complete factory-assembled generator set equipment with digital (microprocessor-based) electronic generator set controls, digital governor, and digital voltage regulator.

1.3 REFERENCES

A. General: The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.

B. ASTM (ASTM):

C. Canadian Standards Association (CSA):
   2. CSA C.22.2 No. 14, "Industrial Control Equipment."
1.4 SYSTEM DESCRIPTION

A. Design Requirements:
1. Ratings:
   a. The generator set shall operate at 1800 rpm.
   b. The generator set shall operate at voltage of 208 volts AC or 480 volts AC, three-phase, 3 wires or 4 wires, 60 hertz.
   c. The generator set shall be rated at 80 kW, 125 kW, or 200 kW, at 1.0 PF.
      1) Standby rating shall be based on site conditions of altitude of 12,000 feet (3658 m), ambient temperatures up to 95 °F (35 °C).
2. Performance:
   a. Voltage regulation shall be ±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 ±0.5 percent.
   b. 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 ±0.5 percent.
c. The diesel engine generator set shall accept a step load of 100 percent nameplate kW and power factor, less applicable de-rating factors, with the engine generator set at operating temperature.

d. The generator set shall be capable of recovering to a minimum of 90 percent 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 percent.

e. The alternator shall produce an AC voltage waveform, with not more than 5 percent total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3 percent in any single harmonic, and no third order harmonics or their multiples. Telephone influence factor shall be less than 40.

f. 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 the generator is ordered.

3. Construction:
   a. 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.
   b. Switches, lamps, and meters in the control system shall be oil-tight and dust-tight. 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.

4. Connections:
   a. The generator set load connections shall be composed of saddle lugs terminations of the number and type as shown on the submittals. Sufficient lug space shall be provided for use with cables of the number and size as shown on the submittals.
   b. Power connections to auxiliary devices shall be made at the devices, with required protection located at a wall-mounted common distribution panel.
   c. 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.

1.5 SUBMITTALS

A. General: See [Section 01 33 00 - SUBMITTAL PROCEDURES] [Section 01300 - SUBMITTALS].

B. Product Data: Submit product data showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications. Product data shall include, but shall not be limited to, the following:
   1. A paragraph-by-paragraph specification compliance statement, describing the differences between the specified and the proposed equipment.
   2. Manufacturer's certification of prototype testing.
   3. Manufacturer's published warranty documents.
   4. Manufacturer's installation instructions.

C. Shop Drawings: Submit shop drawings for each product and accessory required. Include information not fully detailed in manufacturer’s standard product data, including, but not limited to, shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring interconnection details.

D. Wiring Diagrams: Submit wiring diagrams detailing power, signal, and control systems, clearly differentiating between manufacturer-installed wiring and field-installed wiring, and between components provided by the manufacturer and those provided by others.
   1. Submit interconnection wiring diagrams showing external connections required; with field wiring terminals marked in a consistent point-to-point manner.

E. Operation and Maintenance Data: Submit operation and maintenance data to include in operation and maintenance manuals specified in [Division 01 - GENERAL REQUIREMENTS] [Division 1 - GENERAL REQUIREMENTS].
1.6 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of standby power system generator set of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of 20 years.
   a. The manufacturer shall be ISO 9001 certified and shall be designed to internationally accepted standards.

2. Installer Qualifications: Installer shall be a firm that shall have a minimum of five years of successful installation experience with projects utilizing standby power system generator set similar in type and scope to that required for this Project.

B. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State, and local authorities having jurisdiction. Obtain necessary approvals from such authorities.

1. 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, but shall not be limited to, necessary features to meet the requirements of these standards.
   a. CSA 282.
   b. ANSI/IEEE 446.
   c. NFPA 37.
   d. NEC. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702. Note, manufacturer’s equipment recommended for use in systems shall be in compliance with Article 702 only.
   e. NFPA 99. Note, manufacturer’s equipment not recommended for use in NFPA 99 systems.
   f. NFPA 110. 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 shall not substitute for this requirement. Note, manufacturer’s equipment not recommended for use in NFPA 110 required systems.

2. The generator set and supplied accessories shall meet the requirements of the following standards:
   a. NEMA MG 1, Part 32. Alternator shall comply with the requirements of this standard.
   b. UL 142.
   c. UL 1236.
   d. UL 2200. The generator set shall be listed to UL 2200.

3. The control system for the generator set shall comply with the following requirements.
   b. EN 50082-2.
   c. EN 55011.
   d. FCC Part 15, Subpart B.
   e. IEC 8528-4.
   f. IEC 801.2, IEC 801.3, and IEC 801.5 for susceptibility, conducted, and radiated electromagnetic emissions.
   g. UL 508. The entire control system of the generator set shall be UL 508-listed and labeled.
   h. UL 1236.

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

C. Factory Testing:

1. 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.

2. Factory testing may be witnessed by the Owner and consulting engineer. Costs for travel expenses will be the responsibility of the Owner and consulting engineer. Supplier shall be responsible to provide two weeks notice for testing.
3. Generator set factory tests on the equipment shall be performed at rated load and rated power factor. Generator sets that have not been factory-tested at rated power factor will not be acceptable. Tests shall include, but shall not be limited to, run at full load, maximum power, voltage regulation, transient and steady-state governing, single step load pickup, and function of safety shutdowns.

D. **Pre-Installation Conference:** Conduct pre-installation conference in accordance with [Section 01 31 19 - PROJECT MEETINGS] [Section 01200 - PROJECT MEETINGS]. Prior to commencing the installation, meet at the Project site to review the material selections, installation procedures, and coordination with other trades. Pre-installation conference shall include, but shall not be limited to, the Contractor, the Installer, and any trade that requires coordination with the work. Date and time of the pre-installation conference shall be acceptable to the Owner and the Architect/Engineer.

1.7 **DELIVERY, STORAGE, AND HANDLING**

A. Deliver materials to the Project site in supplier’s or manufacturer’s original wrappings and containers, labeled with supplier’s or manufacturer’s name, material or product brand name, and lot number, if any.

B. Store materials in their original, undamaged packages and containers, inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.8 **PROJECT CONDITIONS**

A. **Environmental Requirements:** Do not install standby power system generator set until space is enclosed and weatherproof, wet work in space is completed and nominally dry, work above ceilings is complete, and ambient temperature and humidity conditions are and will be continuously maintained at values near those indicated for final occupancy.

1.9 **WARRANTY**

A. **General:** See [Section 01 77 00 - CLOSEOUT PROCEDURES] [Section 01770 - CLOSEOUT PROCEDURES].

B. **Special Warranty:** The Contractor shall warrant the work of this Section to be in accordance with the Contract Documents and free from faults and defects in materials and workmanship for period indicated below. This special warranty shall extend the one year period of limitations contained in the General Conditions. The special warranty shall be countersigned by the Installer and the manufacturer.

1. The generator set and associated equipment shall be warranted for a period of not less than two years from the date of commissioning against defects in materials and workmanship. If assembly services are included in the original purchase and are also performed by supplier authorized service personnel, supplier shall offer an additional year of parts warranty and the first year of on-site coverage at no additional charge.

2. The generator set manufacturer shall warrant equipment provided under this Section so that there is one source for warranty and product service.

C. **Additional Owner Rights:** The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

1.10 **MAINTENANCE**

A. Technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier shall service the generator sets.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Product specified is “Standby Power Systems Generator Set” as manufactured by APC by Schneider Electric. Items specified are to establish a standard of quality for design, function, materials, and appearance. Equivalent products by other manufacturers are acceptable. The Architect/Engineer will be the sole judge of the basis of what is equivalent.

1. Equipment specifications for this project are based on generator sets specified by APC and manufactured by Cummins Power Generation with microprocessor-based controls.

2.2 ENGINE AND ENGINE EQUIPMENT

A. The engine shall be diesel, four cycle, radiator and fan-cooled. Minimum displacement shall be either 275 cubic inches (4.5 l) four cylinders (80 kW) or 549 cubic inches (9.0 l) six cylinders (125 kW or 200 kW). 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, but shall not be limited to, the following:

1. 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 a function of starting, accelerating to start disconnect speed, accelerating to rated speed. The governing system shall include, but shall not be limited to, a programmable warm-up at idle and cool-down at idle function. While operating in idle state, the control system shall disable the alternator excitation system.

2. Skid-mounted radiator and cooling system rated for full load operation in 115 °F (46 °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 shall be 20 degrees F 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.

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

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

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

6. An engine driven, mechanical, positive displacement fuel pump. Provide 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.

7. Replaceable dry element air cleaner with restriction indicator.

8. Flexible supply and return fuel lines.

9. Engine-mounted battery charging alternator, 40 amperes minimum and solid state voltage regulator.

10. Coolant heater.
   a. Engine-mounted, thermostatically controlled, coolant heater for each engine. Heater voltage shall be as shown on the Drawings. The coolant heater shall be UL 499-listed and labeled.
   b. 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 (305 mm). The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall provide 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.

c. 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.

d. The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 104 °F (40 °C) in a 40 °F (4 °C) ambient, in compliance with NFPA 110 requirements, or the temperature required for starting and load pickup requirements of this Section.

11. Vibration isolators, spring/pad type, quantity as recommended by the generator set manufacturer. Isolators shall include, but shall not be limited to, seismic restraints if required by site location.

12. Starting and control batteries shall be calcium/lead antimony type, 12 volts 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 40 °F (4 °C) ambient temperature when fully charged.

13. 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.

14. An UL-listed/CSA certified 15 ampere voltage regulated battery charger shall be provided for each engine generator set. The charger shall be located in the generator enclosure. Input AC voltage and DC output voltage shall be as required. Chargers shall be equipped with float, taper, and equalize charge settings. Monitors shall provide visual output for:
   a. Loss of AC power, red light.
   b. Low battery voltage, red light.
   c. High battery voltage, red light.
   d. Power on, green light.

15. Charger to be monitored by engine controls and cause alarm condition at ATS when used in conjunction with compatible ATS.

16. A dual-wall sub-base fuel storage tank with 70 gallon (265 l) (80 kW) or 173 gallon (655 l) (125 kW and 200 kW) capacity. The tank shall be constructed of corrosion-resistant steel and shall be UL-listed. The equipment, as installed, shall meet local and regional requirements for above ground tanks.

2.3 **AC GENERATOR**

A. The AC generator shall be; synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single pre-lubricated sealed bearing, air-cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. Insulation system components shall meet NEMA MG 1 temperature limits for Class H insulation system and shall be UL 1446-listed. Actual temperature rise measured by resistance method at full load shall not exceed 257 °F (125 °C).

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 percent of rated current for not more than 10 seconds.

D. The subtransient reactance of the alternator shall not exceed 15 percent, based on the standby rating of the generator set.

2.4 **GENERATOR SET CONTROL**

A. The generator set shall be provided with a microprocessor-based control system that shall be 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 Section.

B. 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.

C. The generator set mounted control shall include, but shall not be limited to, the following features and functions:

1. **Control Switches:**
   a. Provide 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. A separate pushbutton to initiate starting shall be 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.
   b. Provide an emergency stop switch. Switch shall be red mushroom-head pushbutton. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and to be locked out from automatic restarting.
   c. Provide a 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. Provide a 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, but not limited to, the following features and functions:
   a. Digital metering set, 1 percent 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. Digital 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 percent at rated output.
   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 percent to 110 percent of rated load, in 10 percent increments. The control shall display hours of operation at less than 30 percent load and total hours of operation at more than 90 percent 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.

3. **Generator Set Alarm and Status Display:** The generator set control shall include, but shall not be limited to, 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, but shall not be limited to, the following:
   a. The control shall include, but shall not be limited to, 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.
      1) The control shall include, but shall not be limited to, a flashing red lamp to indicate that the control is not in automatic state, and red common shutdown lamp.
      2) The control shall include, but shall not be limited to, an amber common warning indication lamp.
   b. The generator set control shall indicate the existence of the warning and shutdown conditions on the control panel. Conditions indicated below for warning shall be field-configurable for shutdown. Conditions required to be annunciated shall include, but shall not be limited to, the following:
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) High AC voltage (shutdown).
q) Low AC voltage (shutdown).
r) Under frequency (shutdown).
s) Overcurrent (warning).
t) Overcurrent (shutdown).
u) Short circuit (shutdown).
v) Ground fault (warning) (optional when required by code or specified).
w) Over load (warning).
x) Emergency stop (shutdown).

4. **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 degrees C).
      3) Engine oil temperature (degrees F or degrees 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.

5. **Engine Control Functions:**
   a. The control system provided shall include, but shall not be limited to, a cycle cranking system, which shall allow for Owner-selected crank time, rest time, and number of cycles. Initial settings shall be for three cranking periods of 15 seconds each, with 15 second rest period between cranking periods.
   b. The control system shall include, but shall not be limited to, an idle mode control, which shall allow 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, but shall not be limited to, an engine governor control, which shall function to provide steady state frequency regulation as noted elsewhere in this Section. The governor control shall include, but shall not be limited to, 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, but shall not be limited to, time delay start (adjustable 0 second to 300 seconds) and time delay stop (adjustable 0 second to 600 seconds) functions.
   e. The control system shall include, but shall not be limited to, sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which shall be capable of discriminating between failed sender or wiring components, and an actual failure conditions.

6. **Alternator Control Functions:**
a. The generator set shall include, but shall not be limited to, a full-wave rectified automatic digital voltage regulation system that shall be matched and prototype-tested by the engine manufacturer with the governing system provided. It shall be immune from miss-operation due to load-induced voltage waveform distortion and shall 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, but shall not be limited to, 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 shall be capable of being curve-matched to the engine torque curve with adjustments in the field. The voltage regulator shall include, but shall not be limited to, adjustments for gain, damping, and frequency roll-off. Adjustments shall be broad range, and shall be made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level. Rotary potentiometers for system adjustments are not acceptable.

b. Controls shall be provided to monitor the output current of the generator set and initiate an alarm (overcurrent warning) when load current exceeds 110 percent 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 (overcurrent shutdown). The protective functions provided shall be in compliance to the requirements of NEC, 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 NEC, Article 445.

d. Controls shall be provided to monitor the kW load on the generator set, and shall initiate an alarm condition (overload) when total load on the generator set exceeds the generator set rating for in excess of 5 seconds. Controls shall include, but shall not be limited to, a load shed control, to operate a set of dry contacts (for use in shedding Owner 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 percent of the operator-set voltage level for more than 10 seconds, or with no intentional delay when voltage exceeds 130 percent. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85 percent for more than 10 seconds.

f. When required by NEC or as indicated on the Drawings, the control system shall include, but shall not be limited to, a ground fault monitoring relay. The relay shall be adjustable from 3.8 amperes to 1200 amperes, and shall include, but shall not be limited to, adjustable time delay of 0 second to 10.0 seconds. The relay shall be for indication only, and shall not trip or shut down the generator set. Note bonding and grounding requirements for the generator set, and provide relay that shall function correctly in system as installed.

g. The generator set control shall include, but shall not be limited to, a 120 volt AC control heater.

7. Other Control Function:

a. The generator set shall be provided with a network communication module to allow communication with the generator set control by remote devices. The control shall communicate engine and alternator data, and shall allow starting and stopping of the generator set via the network in both test and emergency modes.

b. A battery monitoring system shall be provided which shall initiate alarms when the DC control and starting voltage is less than 11 volts DC or more than 15 volts DC. 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.
c. The following information shall be communicated to the ATS when used with a Compatible ATS:

1) An ATS-designed and supplied by the same generator supplier shall be required to achieve all potential monitoring and control capabilities as detailed below:
   a) Generator status event.
   b) Low fuel level alarm.
   c) Low fuel level alarm cleared.
   d) Low runtime alarm.
   e) Low runtime alarm cleared.
   f) Very low fuel level alarm.
   g) Very low fuel level alarm cleared.
   h) Very low runtime alarm.
   i) Very low runtime alarm cleared.
   j) Service interval exceeded alarm.
   k) Service interval exceeded alarm cleared.
   l) Service record reset.
   m) Low coolant level.
   n) Low coolant level cleared.
   o) Very low coolant level.
   p) Very low coolant level cleared.
   q) High coolant temperature.
   r) High coolant temperature cleared.
   s) Very high coolant temperature.
   t) Very high coolant temperature cleared.
   u) Low coolant temperature.
   v) Low coolant temperature cleared.
   w) Low oil level.
   x) Low oil level cleared.
   y) Low battery voltage during crank.
   z) Low battery voltage during crank cleared.
   aa) Very low battery voltage during crank.
   bb) Very low battery voltage during crank cleared.
   cc) Local e-stop.
   dd) Local e-stop cleared.
   ee) Remote e-stop.
   ff) Remote e-stop cleared.
   gg) High battery voltage.
   hh) High battery voltage cleared.
   ii) Low battery voltage.
   jj) Low battery voltage cleared.
   kk) Control switch not in auto.
   ll) Control switch not in auto cleared.
   mm) Low oil pressure.
   nn) Low oil pressure cleared.
   oo) Very low oil pressure.
   pp) Very low oil pressure cleared.
   qq) Overload.
   rr) Overload cleared.
   ss) Low AC voltage.
   tt) Low AC voltage cleared.
   uu) Ready for load.
   vv) Ready for load cleared.
   ww) Common fault.
   xx) Common fault cleared.
   yy) High AC voltage.
   zz) High AC voltage cleared.
   aaa) Overspeed.
   bbb) Overspeed cleared.
ccc) Engine cold, may not start.
ddd) Engine cold, may not start cleared.
eee) Output breaker off.
fff) Output breaker off cleared.
ggg) Generator shutdown, will not start.
hhh) Generator shutdown, will not start cleared.
iii) Generator battery charger voltage low.
jjj) Generator battery charger voltage low cleared.
kkk) Generator fuel level.
lll) Generator runtime with and without generator running.
mmm) Genset hardware data.
nnn) Software version level.
 oo o) Fault history.
ppp) Event log.
qqq) Generator output breaker position status.
rrr) Engine starting battery voltage.
sss) Engine starting battery weak warning.
ttt) Engine oil lube pressure.
uuu) Engine lube oil level.
vvv) Engine coolant temperature.
www) Engine coolant level.
xxx) Engine operating hours.
yyy) Number of starts.
zzz) Engine rpm.
aaaa) Output power, kW and PF.
bbb) Generator total kWh.
ccc) Generator total kWh.
ddd) Percent governing and percent voltage regulation.
eeee) Overspeed.
fff) Overcrank.

8. Control Interfaces for Remote Monitoring:
   a. A fused 10 ampere switched 12 volt DC power supply circuit shall be provided for the
      Owner's use. DC power shall be available from this circuit at all times from the engine
      starting/control batteries.
   b. The control shall be provided with a direct serial communication link for the communication
      network interface with a compatible ATS as described elsewhere in this Section and as
      shown on the Drawings.

2.5 OTHER EQUIPMENT TO BE PROVIDED WITH THE GENERATOR SET

A. 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 shall 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.

B. Provide outdoor weather-protective enclosure as follows:
   1. The generator set shall be provided with an outdoor enclosure, with the entire package listed
      under UL 2200. The package shall comply with the requirements of NEC for wiring materials
      and component spacing. The total assembly of generator set, enclosure, and sub-base fuel
      tank (when used) shall be designed to be lifted into place using spreader bars. Housing shall
      provide ample airflow for generator set operation at rated load in an ambient temperature of
      100 °F (38 °C). The housing shall have hinged access doors as required to maintain easy
      access for operating and service functions. Doors shall be lockable. Enclosure roof shall be
      cambered to prevent rainwater accumulation. Openings shall be screened to limit access of
      rodents into the enclosure. Electrical power and control interconnections shall be made within
      the perimeter of the enclosure.
2. Sheet metal shall be primed for corrosion protection and finish-painted with the manufacturers standard color using a two-step electro-coating paint process, or equal, meeting the performance requirements specified below. Surfaces of metal parts shall be primed and painted. The painting process shall result in a coating that meets the following requirements:
   a. Primer thickness shall be 0.5 mil (0.13 mm) to 2.0 mils (0.51 mm). Top coat thickness shall be 0.8 mil (0.20 mm) to 1.2 mils (0.30 mm).
   b. Gloss, per ASTM D 523 shall be 80 percent, ±5 percent. Gloss retention after one year shall exceed 50 percent.
   c. Crosshatch adhesion, per ASTM D 3359, shall be 4B to 5B.
   d. Impact resistance, per ASTM D 2794, shall be 160 inch pounds (13.56 N·m) to 160 inch pounds (18.08 N·m).
   e. Salt spray, per ASTM B 117, shall be 1000+ hours.
   f. Humidity, per ASTM D 2247, shall be 1000+ hours.
   g. Water soak, per ASTM D 2247, 1000+ hours.
3. Painting of hoses, clamps, wiring harnesses, and other non-metallic service parts shall not be acceptable. Fasteners used shall be corrosion-resistant, and designed to minimize marring of the painted surface when removed for normal installation or service work.
4. Enclosure shall be constructed of minimum 12 gage steel for framework and 14 gage steel for panels. Hardware and hinges shall be stainless steel.
5. 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.
6. The enclosure shall include, but shall not be limited to, the following maintenance provisions:
   a. Flexible coolant and lubricating oil drain lines, that shall extend to the exterior of the enclosure, with internal drain valves.
7. Provide external radiator fill provision.
8. The generator set shall be provided with a sound-attenuated housing which shall allow the generator set to operate at full rated load in an ambient temperature of up to 100 °F (38 °C). The enclosure shall reduce the sound level of the generator set while operating at full rated load to a maximum of 72 dBA at any location 23 feet (7 m) from the generator set in a free field environment.
9. The enclosure shall be insulated with non-hygroscopic materials.

C. Provide a sub-base fuel tank for the generator set, sized to allow for full load operation of the generator set for 12 hours. The sub-base fuel tank shall be UL 142-listed and labeled. Installation shall be in compliance to NFPA 37. The fuel tank shall be a double-walled, steel construction and shall include, but shall not be limited to, the following features:
   1. Emergency tank and basin vents.
   2. Mechanical level gauge.
   3. Fuel supply and return lines, connected to generator set with flexible fuel lines as recommended by the engine manufacturer and in compliance to UL 2200 and NFPA 37 requirements.
   4. Leak detection provisions, wired to the generator set control for local and remote alarm indication.
   5. Continuous float level gauge. Wire gauge to generator control to be remote indication of fuel level and runtime when used with compatible ATS.
   7. Integral lifting provisions
   8. Overfill catch basin with drain.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Architect/Engineer, of any
conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 INSTALLATION

A. General: Preparation and installation shall be in accordance with reviewed product data, final shop drawings, manufacturer’s written recommendations, and as indicated on the Drawings.

1. Equipment shall be installed in accordance with final submittals and the 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.

2. Installation of equipment shall include, but shall not be limited to, providing interconnecting wiring between major equipment provided for the on-site power system. Also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.

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

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

5. 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 dirt and construction debris prior to initial operation and final testing of the system.

B. Sequence of Operation:

1. 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 and a redundant signal over the required network connection.

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

3. The generator set control shall initiate the starting sequence for the generator set. The starting sequence shall include, but shall not be limited to, 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 Section. 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.

3.1 FIELD QUALITY CONTROL

A. See [Section 01 45 23 - INSPECTING AND TESTING SERVICES] [Section 01410 - INSPECTING AND TESTING SERVICES].
B. On-site acceptance test shall be as follows:
   1. The complete installation shall be tested for compliance with this Section following completion
      of all site work. Testing shall be conducted by representatives of the manufacturer, with
      required fuel supplied by the Contractor. The Owner shall be notified in advance and shall
      have the option to witness the tests.
   2. 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. Coordinate timing and obtain approval for start of test with site personnel.

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

D. The generator set shall be serviced by a local service organization that shall be 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.

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

3.2 DEMONSTRATION

A. Provide the services of a factory-authorized service representative of the manufacturer to provide
   start-up service and to demonstrate and train the Owner’s personnel.
   1. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and
      equipment.
   2. Train the Owner’s maintenance personnel on procedures and schedules related to start-up
      and shutdown, troubleshooting, servicing, and preventive maintenance.
   3. Review data in operation and maintenance manuals with the Owner’s personnel.
   4. Schedule training with the Owner, through the Architect/Engineer, with at least seven day’s
      advanced notice.

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

C. Contact equipment supplier if training is required for the facility operating personnel covering
   operation and maintenance of the equipment provided.

3.3 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer, that shall
   ensure that the standby power system generator set shall be without damage at time of Substantial
   Completion.

END OF SECTION