SECTION 26 32 13
ENGINE GENERATOR SYSTEM

PART 1 - **GENERAL**

1.1 DESCRIPTION

A. Provide engine generator system in accordance with the Contract Documents.

B. It shall be the responsibility of the Contractor to complete the Local Air Quality Management District permits. The generator-set supplier shall provide the required engine manufacturer's data sheet and assist with other technical data requirements required to complete the permit submission application.

C. Related work specified in other divisions of these specifications:
1. Main fuel oil sub-base tank.
2. Fuel oil pumping and transfer pump system.
3. Exhaust system piping.
4. Insulation of exhaust piping.
5. Installation of exhaust silencer.
6. Ducting between radiator and exhaust outlet.
7. Cooling water piping between remote radiator and engine.

1.2 QUALITY ASSURANCE

A. The engine shall be diesel fueled, four (4) cycle, water cooled, while operating with nominal speed not exceeding 1,800 rpm. The engine will utilize in-cylinder combustion technology, as required, to meet applicable EPA non-road mobile regulations and/or the EPA NSPS rule for stationary reciprocating compression ignition engines. The in-cylinder engine technology must not permit unfiltered exhaust gas to be introduced into the combustion cylinder. Emissions requirements / certifications of this package: EPA Tier 2. Engines not certified EPA Tier 2 may trip the requirement for particulate filters early and are not allowed.

B. Equipment supplier shall have local representation and shall have been actively engaged in installation and service of generator sets and automatic transfer switches for a period of not less than 10 years.

C. Equipment suppliers shall have full parts back-up and 24 hour-per-day service availability for this equipment.

D. The generator-set supplier shall review the fuel system design and certify that the installation meets the engine manufacturer's requirements and will allow for proper operation of the generator set at full rated load.

E. The generator-set supplier shall review the cooling system design and certify that the installation meets the engine manufacturer's requirements and will allow for proper operation of the generator set at full rated load.

1.3 REFERENCE STANDARDS

A. Published specifications standards, tests or recommended methods of trade, industry or governmental organizations apply to work in this Section where cited below:

B. ASTM

1. ASTM D396 Standard Specification for Fuel Oils

C. NEMA – National Electrical Manufacturers Association

2.	NEMA MG 1-2016	Motors and Generators

D. UL – Underwriters Laboratories Inc.

3.	UL 1236	Standard for Battery Chargers for Charging Engine-Starter Batteries
4.	UL 508	Standard for Industrial Control Equipment
5.	UL 1008	Transfer Switch Equipment
6.	UL 2200	Standard for Stationary Engine Generator Assemblies
7.	UL 142	Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids

E. NFPA – National Fire Protection Association

8.	NFPA 70	National Electrical Code
9.	NFPA 99	Health Care Facilities Code
10.	NFPA 101	Life Safety Code Handbook
11.	NFPA 37	Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
12.	NFPA 110	Standard for Emergency and Standby Power Systems

F. CEI

13.	CEI EN 55011	Industrial, Scientific and Medical Equipment – Radio-Frequency Disturbance Characteristics – Limits and Methods of Measurement

G. IEC – International Electrotechnical Commission

14.	CEI EN 61000-4-2	Electromagnetic Compatibility (EMC) Part 4-2: Testing and Measurement Techniques – Electrostatic Discharge Immunity
15.	CEI EN 61000-4-3	Electromagnetic Compatibility (EMC) Part 4-4: Testing and Measurement Techniques – Radiated, Radio-Frequency, Electromagnetic Field Immunity Test
16.	CEI EN 61000-4-4	Electromagnetic Compatibility (EMC) Part 4-4: Testing and Measurement Techniques – Electrical Fast Transient/Burst Immunity Test
17.	CEI EN 61000-4-5	Electromagnetic Compatibility (EMC) Part 4-4: Testing and Measurement Techniques – Surge Immunity Test
18.	CEI EN 61000-4-6	Electromagnetic Compatibility (EMC) Part 4-4: Testing and Measurement Techniques –Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields
19.	CEI EN 61000-4-11	Electromagnetic Compatibility (EMC) Part 4-4: Testing and Measurement Techniques – Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests
20.	CEI EN 55011	Industrial, Scientific and Medical Equipment – Radio-Frequency Disturbance Characteristics – Limits and Methods of Measurement
21.	CEI EN 61000-6-2	Electromagnetic Compatibility (EMC) – Part 6-2: Generic Standards – Immunity for Industrial Environments

H. FCC – Federal Communications Commission

22.	Part 15 Subpart B	

I. CSA – Canadian Standard Association

23.	CSA C22.2 No. 14	Industrial Control Equipment
24.	CSA C22.2 No. 100	Motors and Generators
25.	CSA C282	Emergency Electrical Power Supply for Buildings

J. ISO – International Organization for Standardization

26.	ISO 8528-9	Reciprocating Internal Combustion Engine Driven Alternating Current Generating Sets – Part 9: Measurement and Evaluation of Mechanical Vibrations

K. Local Air Quality Management District

L. NETA – InterNational Electrical Testing Association

1.4 LOCATION CRITERIA

A. Altitude: **7000** feet above sea level.

B. Maximum ambient temperature: **45** degrees C **110 degrees F**.

C. Minimum ambient temperature: **minus 12** degrees C **10 degrees F**.

D. Seismic: D. Seismic: In accordance with CBC Chapter 17, Seismic Design Category D.

1.5 SUBMITTALS

A. Detailed drawing of the engine generator set with dimensioned locations of components and external connections and attachments. Indicate position of radiator and direction of air movement.

B. Engine manufacturer's specifications, performance data, certified power outlet curves, and certified fuel consumption curves.

C. Provide a statement or show calculations that confirm that the brake horsepower of the engine with all attached accessories as described within is not less than that which is required by the full load rating of the generator, taking into consideration efficiency losses, plus a reserve factor of at least five (5) percent under environmental conditions as set herein.

D. Exhaust system back pressure calculations certifying that the engine exhaust system with proposed silencer (and/or particulate filter) and piping as indicated on the mechanical drawings for this installation is within the manufacturer's criteria.

E. Starting battery sizing calculations showing compliance with specifications at ambient conditions.

F. Drawing showing battery cell and jar connections.

G. Certified vibration isolation details and product data showing the number and location of each support and the exact number, size, and type of each anchor. Submit for engine generator set, exhaust silencer, day tank, and battery rack.

H. Manufacturer's product data sheets, specifications, and wiring diagrams for each engine generator system component.

I. Detailed point-to-point wiring diagrams.

J. Manufacturer's statement that the overall system design and specification has been reviewed and is satisfactory for system performance or list of exceptions.

K. After the engine generator system is accepted, submit a completed permit application for the local Air Quality Management District, ready for submission by the Owner.

L. Manufacturer's product data sheets, performance data, detailed layout drawings, and control and

wiring diagrams for the automatic transfer switches.

M. Name and location of factory-authorized service agency to approve and start up installation.

N. Name and location of factory-authorized service agency to perform warranty and service work.

O. Name and location of certified testing agency to perform field testing.

P. Certified prototype, factory, and field test reports.

1.6 BID ALTERNATE

A. Provide as an add-alternate a price for a “Certified Particulate Filter” with a minimum PM reduction of 85 percent. The HSRA in the Air Quality Management District’s permits will determine the PM requirements and notice to supply or not will occur after the permit is complete.

B. Contractor shall complete permit application for the local Air Quality Management District using the Base Bid exhaust air cleaner/silencer as recommended by the engine manufacturer.

C. If approval is not (or cannot) be achieved with the Base Bid silencer, the Contractor shall resubmit a revised completed permit application form with a Diesel Particulate Filter (DPF), as specified within.

1.7 SYSTEM TESTING

A. Factory Tests:
   1. Factory tests shall be conducted by the manufacturer.
   2. 4-hour 100-percent resistive and reactive load test at full rated load and power factor.
      a. Monitor voltage stability
      b. Monitor frequency stability
   3. Oscillograph chart recordings of voltage and frequency of generator-set transient performance for 100-percent step load addition and subtraction indicating compliance with specifications.
   4. Equipment shall be Prototype Test Supported certified.

B. Field Tests:
   1. Field tests shall be conducted by factory-certified technicians.
   2. Field inspection and testing shall occur after installation is complete and the room is secure.
   3. Test transfer switches, engine start circuits, time delay circuits, status points, and system control points.
   4. Perform 4-hour 100-percent full resistive load test using a temporary load bank. Unsuccessful tests shall be fully documented, submitted, and re-tested until successful.
   5. Conduct field tests in accordance with NFPA 110.
   6. The Contractor shall provide a full tank of diesel fuel upon completion of all testing.

1.8 OPERATING INSTRUCTIONS

A. The engine generator-set supplier shall provide a minimum of four hours of operating instructions on maintenance and operation of the emergency power system. Classes shall be open for up to three representatives of the Owner’s maintenance staff. Instructions shall be administered by a full-time employee of the supplier.

PART 2 - **PRODUCTS**

2.1 ACCEPTABLE COMPONENT MANUFACTURERS

A. This entire engine generating system shall be completely built, factory tested and shipped by an assembler/manufacturer who has been regularly engaged in the production of such equipment for the past ten years and who has parts and service facilities locally or provides service and parts on

a national basis subject to approval by the Owner and Engineer. The performance of the electric plant shall be certified by an independent test laboratory acceptable to the Engineer as to the plant's full power rating, voltage and frequency regulation. The engine/alternator shop-assembled unit shall be assembled, calibrated and tested by Caterpillar, Cummins-Onan, Kohler, Generac or an Engineer-approved equal factory-authorized assembler of the engine and alternator manufacturers listed hereinafter.

B. If it complies with these Specifications, specific engine generator equipment components manufactured by one of the following manufacturers will be acceptable:
   1. Diesel Engine: Caterpillar, Cummins/Onan, or Detroit Diesel.
   2. Radiator: IEA, Modine, Young, or equal.
   3. Exhaust Silencer: Cowl, Maxim, GT Exhaust, or Nelson.
   4. Diesel Particulate Filter: Clean Air Systems, Cleaire, or Harco.
   5. Vibration Isolators: CalDyn, Mason Industries, or Vibration Eliminator.
   6. Batteries: C & D, Exide, Interstate, or Nife.
   7. Battery Charger: LaMarche, Sens, or equal.
   8. Generator: Caterpillar, Kato, Marathon, or Onan.
   9. Governor: Caterpillar, Woodward, or equal.
   10. Circuit Breakers: Cutler Hammer, General Electric, Siemens, or Square D.
   11. Load Bank: Avtron, Loadtec, or Simplex.
   12. Automatic Transfer Switches: Asco, Cummins/Onan, Kohler, Generac, Russelectric, or Zenith.
   13. Remote fuel fill station

2.2 ENGINE

A. The engine shall run on number 2 diesel fuel, 1,800 rpm, compression ignition type, four-stroke cycle, water cooled, solid injection, either vertical in-line or vee configuration.

B. The brake horsepower of the engine with all attached accessories as described within shall be not less than that which is required by the full load rating of the generator, taking into consideration efficiency losses, plus a reserve factor of at least eight (8) percent under environmental conditions as set herein.

C. Fuel consumption of the engine generator shall be substantiated by means of manufacturer's certified curves.

D. The engine shall be equipped with an electronic governor to maintain engine speed within specified limits. Governor shall be adjustable from isochronous to five (5) percent droop. Frequency shall be factory-set at rated frequency.

E. Engine safety devices, including high water temperature switch, overspeed sensing switch, low oil pressure switch, low water temperature switch, and other required devices to comply with NFPA110 Level 1, shall be mounted on the engine and connected to the control and status panel instruments and alarms as specified herein.

F. Engine wiring shall be industrial quality, heat resistant, insulated, copper conductors. Wiring shall be protected and shall be isolated from high temperature engine parts. Wiring for alternating current power circuits shall installed in conduit.

2.3 ELECTRIC STARTING SYSTEM

A. Provide an engine-mounted electric starting motor with solenoid and over-running clutch drive. The starting motor shall be of the required voltage and ampere rating.

B. Provide a system of lead acid batteries sized such that the engine generator set may complete three (3) complete cranking cycles as specified in NFPA110 at specified room temperature. Provide a seismic rack and cables of sufficient ampacity.

C. Provide a wall-mounted 120V AC battery charger which shall recharge battery to full capacity within twelve hours. Battery charger shall have both a high rate and float rate charging system. The battery charger shall be current limiting and shall not require cranking cutout contacts for charger protection when cranking. Accessories shall include: DC ammeter, fused input, DC voltmeter, high/low DC output voltage relay, and input voltage failure relay. Battery charger output shall be rated ten (10) amperes minimum at required voltage. Charger current level shall automatically drop to a sufficiently low level to eliminate overcharging of the batteries.

D. The entire electric starting system shall be rated for 12 or 24 VDC operation as recommended by the manufacturer.

2.4 ENGINE HEATING SYSTEM

A. Provide jacket water heaters sized to insure that engine will start within the specified time period and ambient conditions. Provide thermostats, engine running heater disconnect, and required connection boxes.

B. Provide branch circuit wiring in conduit from panelboard to jacket water heaters. Circuit breakers shall have the appropriate ampere and pole configuration to suit the selected jacket water heaters.

2.5 ENGINE COOLING SYSTEM

A. The engine shall be liquid-cooled by means of a remote fan radiator. The radiator shall be adequately sized to cool the engine on a continuous basis at the maximum ambient temperature and altitude specified. Radiator shall be suitable for outdoor application and include fan, fan guard, core guard, steel support legs, cooling coils, steel frame, filler neck and pressure cap. Fan motor shall be single speed, totally enclosed fan-cooled (TEFC) for 3 phase, 60 hertz, 480-volt operation. Radiators without integral surge space shall be supplied with a 20-gallon minimum expansion tank, complete with mounting angles, sight glass, fittings and filler neck with pressure cap. Engine coolant shall be a mixture of ethylene glycol based antifreeze and water as required to provide freeze protection at minimum ambient temperature.

A. The engine shall be equipped with a centrifugal type water circulating pump and thermostat valve to maintain the engine at recommended temperature level.

B. Charge cooler is to be mounted on the generator skid.

2.6 AIR INTAKE AND EXHUAST SYSTEM (BASE BID)

A. Provide an air cleaner/silencer as recommended by the engine manufacturer. Air cleaners shall be dry type with replaceable elements.

B. Engine exhaust outlets shall be coupled to the exhaust silencer(s) by means of an adequately sized section of stainless corrugated flex. Flex connector(s) shall be flanged at both ends for mating to the engine and exhaust system.

C. Exhaust silencer(s) shall be critical grade. Exhaust silencer(s) shall be sized to limit exhaust back pressure to acceptable values. Exhaust silencer(s) shall be suitable for horizontal mounting, equipped with flanged bottom inlet and flanged end outlet. The exhaust silencer(s) shall be double wall construction and shall have a high temperature anti-corrosion coating applied uniformly on the outside surface. Exhaust silencers that are mounted indoors shall be insulated to limit surface temperature to not more than 38 degrees C **100 degrees F**.

2.7 DIESEL PARTICULATE FILTER (ALTERNATE BID)

A. Contractor shall provide a diesel particulate filter if it is required to achieve local air quality management approvals as described in Paragraph 1.6 – Bid Alternate.

B. Ceramic device in a metal housing shall capture particulate matter; the particulate filters shall serve

as a replacement for a conventional critical grade silencer.

C. The filter shall have a catalytic coating that converts carbon monoxide and hydrocarbons into innocuous compounds.

D. Provide a monitor and connection to generator status and control panel to indicate that service or regeneration is needed.

E. The diesel particulate filter shall meet the following minimum requirements:
   1. PM reduction: 85 percent to 90 percent.
   2. HC reduction: 70 percent to 99 percent including some toxic air contaminants.
   3. CO reduction: 70 percent to 99 percent.

F. Engine exhaust outlets shall be coupled to diesel particulate filter(s) by means of an adequately sized section of stainless corrugated flex. Flex connector(s) shall be flanged at both ends for mating to the engine and exhaust system.

G. Diesel particulate filter (DPF) shall be critical grade, sized to limit exhaust back pressure to acceptable values. Diesel particulate filter(s) shall be suitable for horizontal mounting, equipped with flanged bottom inlet and flanged end outlet. The diesel particulate filter(s) shall have a high temperature anti-corrosion coating applied uniformly on the outside surface.
   1. The DPF's must be constructed to limit the clean back pressure to a maximum of 15 inches of water column. DPF must be equipped with two differential pressure switches to close dry contacts indicating a restricted element. The first contact shall be used as a pre-alarm warning to indicate that the filter is approaching a high level of back pressure. The second contact shall be used as a critical warning to indicate that it is no longer safe to run the engine. Pre-alarm shall be set to 75 percent of maximum.
   2. The DPF must be able to operate effectively within the acceptable back pressure range for a period of 20 hours of operation at no load on the engine. In addition, the DPF must be able to accommodate the high concentration of particulates associated with a minimum of 60 engine starts. The particulate filter controller must be capable of monitoring the amount of engine starts for verification purposes.
   3. DPF's that are mounted indoors shall be insulated to limit surface temperature to not more than 38 degrees C**, 100 degrees F**.

2.8 FUEL SYSTEM

A. Fuel lines between injection pumps and valves shall be heavy seamless tubing.

B. Provide fuel filters with replaceable elements. Fuel filters shall be located in an accessible housing ahead of the injection pumps.

C. Provide an engine-driven fuel transfer pump.

D. Base-Mounted Fuel Oil Tank: Factory-installed and -piped, UL Listed and Labeled dual wall sub-base fuel oil day tank with **16 hour run time** capacity. Features include the following:
   1. Tank level indicator, and low fuel alarm switch for remote indication. Provide low, approach to high, and high fuel level sensors in skid tank and connect to generator control panel and remote panel.
   2. Capacity: Fuel for two hours of continuous operation at 100 percent rated power output.
   3. Vandal-resistant fill cap.
   4. Containment: Integral rupture basin with a capacity of 110 percent of nominal capacity of fuel tank.
   5. Leak Detector: Locate in rupture basin and connect to provide audible and visual alarm in the event of day-tank leak.
   6. Provide five-gallon catch basin at fuel fill port.

E. Remote fuel fill station to be supplied as part of the generator package and installed by Div 22.

F. Fuel Oil Piping: As specified in Division 22.

G. Vent pipes shall be located such that any field extension of the pipe does not interfere with access to serviceable parts to the generator.

2.9 ALTERNATOR

A. Engine generator set shall be rated 277/480V, wye connected, three phase, four wire, 60 hertz, 0.8 power factor, kilowatt capacity as indicated on the Drawings. The alternator shall be ⅔ pitch.

B. The alternator shall be four pole, synchronous brushless type. The alternator shall be single bearing type coupled directly to the engine flywheel by means of a flexible disc coupling.

C. The voltage regulator shall be digital, microprocessor based with fully programmable operating and protection characteristics. The regulator shall maintain generator output voltage within plus or minus 0.25 percent for any constant load between no load and full load. The regulator shall be capable of sensing true RMS in three phases of alternator output voltage, or operating in single phase sensing mode. The voltage regulator shall include a VAR/Pf control feature as standard. The regulator shall provide an adjustable dual slope regulation characteristic in order to optimize voltage and frequency response for site conditions. The voltage regulator shall include standard the capability to provide generator paralleling with reactive droop compensation and reactive differential compensation.

D. The alternator insulation system shall be NEMA Class F or H and shall be a combination of epoxy coating and varnish. The alternator shall be sized and properly derated according to NEMA MG1-22 to yield a maximum temperature rise of 105 degrees C by resistance above an ambient temperature of 40 degrees C at rated altitude and load.

E. Excitation shall be provided by a direct connected brushless permanent magnetic rotating exciter. The alternator shall be of the three-phase design and connected to a full wave three-phase rotating bridge. Diodes used shall be of the silicon type mounted on proper heat sinks with surge protector.

F. Exciter field power shall be provided by a separate permanent magnet generator directly connected to the brushless exciter. The PMG shall provide sufficient power to the excitation system to produce 300 percent current from the main operator armature during a three-phase fault with sufficient duration for protective devices to operate.

G. The alternator shall be protected from all types of short circuit conditions, based on the thermal damage capability of the machine under faulted conditions. The alternator shall include protection or other means to prevent overvoltage conditions on single-phase faults. This protection shall be in addition to circuit breakers that are shown on the Drawings and provided for feeder protection.

2.10 CONTROL AND STATUS PANELS

A. General:
   1. Provide an audible alarm signal, silence switch, and lamp test button on each control and status panel. Provide power for alarm system from generator battery system.
   2. Upon alarm activation, sound the audible alarm signal and indicate, by means of individual lights at annunciator panels, which particular malfunction is initiating the alarm.

B. Control and Status Functions:
   1. Provide a main control and status panel for each engine generator set. Panel shall be hinged door, mounted on the engine generator set with vibration isolators.
   2. Main line circuit breaker: The breaker shall have a solid state trip unit with true RMS current sensing. Circuit breaker shall be 100 percent continuous rated. The circuit breaker shall be provided with a DPDT auxiliary contact to provide a supervisory indication should the breaker be in the off or tripped position. The breaker shall be UL/CSA Listed of IEC construction and connected to engine/generator safety shut-downs. Breaker shall be housed in an extension

terminal box which is isolated from vibrations induced by the generator set. Mechanical type lugs, sized for the circuit breaker feeders shown on Drawing, shall be supplied on the load side of breaker. When required by code or the Authority Having Jurisdiction, the generator set shall be provided with residual ground fault sensing equipment with an auxiliary contact wired to alarm light on remote control and status panels. The equipment shall be configurable for either tripping or alarm only, and defaulted to provide alarm only on a ground fault condition.

3. The generator set shall be provided with three-phase line-to-line and line-to-neutral displays for AC voltage and AC current. The control shall display all phases of data simultaneously, to allow viewing of load and voltage balance. The display shall include a frequency meter and kW meter. All metering shall be two (2) percent accuracy or better.
4. Engine data displayed shall include engine coolant temperature, oil pressure, oil temperature, and starting/control battery DC voltage.
5. Control and status points as specified under remote control and status panels.
   a. Provide Generator Run Status to Building Management System.

C. Remote Control and Status Panels:
   1. Provide two remote control and status panels per engine generator set. Locate one in the Engineer's Control Center and one in the Fire Control Center. Provide control and status points as required by NFPA 110 for Level 1 systems and as specified herein. Provide separate switch status points for each transfer switch.
   2. Provide control and status points as follows:

Condition	Engine Generator Control & Status Panel	Fire Control Center Remote Control & Status Panel	Engineer's Control Center Control & Status Panel	Engine Shut Down
High Coolant Temperature	Alarm	Alarm	Alarm	Yes
Approach to High Coolant Temperature	Alarm	Alarm	Alarm	No
Low Coolant Temperature	Alarm	Alarm	Alarm	No
Low Coolant Level	Alarm	Alarm	Alarm	No
Overspeed	Alarm	Alarm	Alarm	Yes
Approach to Low Oil Pressure	Alarm	Alarm	Alarm	No
Low Oil Pressure	Alarm	Alarm	Alarm	Yes
Over Crank	Alarm	Alarm	Alarm	Yes
High Battery Voltage	Alarm	No	No	No
Low Battery Voltage	Alarm	No	No	No
Low Cranking Voltage	Alarm	Alarm	Alarm	No
Battery Charger AC Failure	Alarm	No	No	No
Low Fuel Day Tank	NA	NA	NA	NA
Low Fuel Main Tank	Alarm	Alarm	Alarm	No
Main Circuit Breaker Open or Tripped	Alarm	Alarm	Alarm	No
Main Circuit Breaker Ground Fault	Alarm	Alarm	Alarm	No
Load Bank Cooling Failure	Alarm	Alarm	Alarm	No
Generator Running Indication	NA	Yes	Yes	NA
Not In Auto	Yes	Yes	Yes	NA
Generator Start/Stop Switch	Yes	No	No	NA
Generator Online	Yes	Yes	Yes	No
Generator Derangement	Yes	Yes	Yes	No
Remote Emergency Stop (Located outside of room)	No	No	No	Yes
Lamp Test	Yes	NA	NA	NA

Condition	Engine Generator Control & Status Panel	Fire Control Center Remote Control & Status Panel	Engineer's Control Center Control & Status Panel	Engine Shut Down
Audible Alarm Silencing Switch	NA	Yes	Yes	NA

D. Provide a remote manual stop station located outside the room housing the generator.

E. Load Shedding Control:
   1. Provide load sensing (voltage sensing) control panel at the generator.
   2. When generator reaches 95 percent of capacity, or voltage dips below 90 percent due to loading, the control panel shall send a signal to automatically re-transfer the "optional standby" transfer switches back to utility power.

2.11 ENGINE GENERATOR-SET PERFORMANCE

A. The engine generator set shall meet or exceed the following performance criteria:
   1. Voltage regulation: plus or minus 1 percent from 0- to 100-percent load.
   2. Steady-state voltage stability: plus or minus 0.5 percent rated voltage.
   3. Balanced telephone interference factor (TIF): not to exceed 50.
   4. Frequency regulation from no load to full load: plus or minus 0.00 percent.
   5. Steady-state frequency stability: plus or minus 0.33 percent.
   6. Generator set: capable of start-up and accepting rated load within 10 seconds.
   7. Maximum frequency change on application change on application or removal of 100-percent rated load resistive and reactive load shall not exceed plus or minus 15.0 percent.
   8. Maximum recovery time to return to frequency stability bandwidth shall not exceed 8.0 seconds.
   9. Maximum voltage dip with step application of load up to 100-percent rated capacity at 0.8 power factor shall not exceed 35 percent.
   10. Voltage recovery time with step application of load up to 100-percent rated capacity at 0.8 power factor shall not exceed plus or minus 1 percent voltage within 8.0 seconds.

2.12 VIBRATION ISOLATION AND SEISMIC RESTRAINTS

A. Installation shall be in accordance with approved vibration isolation and seismic restraint submittal.

B. Flexible fuel oil and oil lines shall be stainless steel reinforced synthetic rubber hoses. Flexible coolant lines shall be fabric-reinforced rubber rated 150 degrees C minimum.

C. Raceway connections to unit shall be in liquid-tight flexible metal conduit.

2.13 AUTOMATIC TRANSFER SWITCHES

A. Automatic transfer switches shall be capable of switching all classes of load and shall be fully rated for continuous duty when installed in a non-ventilated enclosure.

B. Transfer switches on 3-wire systems or 120/208 volts AC systems shall be 3-pole with solid neutral. Transfer switches operating at greater than 150 volts (line to neutral) shall be 4-pole, with switched neutral.

C. 4-pole switches shall have all four poles connected to a common shaft, or may be provided with overlapping neutral contacts.

D. The transfer switch shall not chatter or fail to transfer in any way on any switching operation within acceptable operating voltage range.

E. The transfer switch shall be electrically operated and mechanically held. The electrical operator shall be a single solenoid mechanism, momentarily energized to minimize power consumption and heat generation. The transfer switch shall be capable of opening or closing to or from any source in not less than three electrical cycles from initiation of a signal to operate. Operation time of the transfer switch from source to source shall be configurable in a range of no intentional delay to ten seconds, with a default of 0.5 seconds.

F. The use of molded case circuit breakers, contactors, or other components not rated for continuous duty, repetitive switching, or transfer between two active power sources is not acceptable.

G. Transfer switches shall be switchboard-mounted or mounted in NEMA 1 enclosures as indicated on the Drawings. Switchboard mounted automatic transfer switches shall be furnished without enclosure to the switchboard manufacturer. Enclosure shall be an integral part of the switchboard and fabricated by the switchboard manufacturer. Connections to other switchboard components shall be bus connected.

H. The entire transfer switch and relay plate assembly shall be capable of withstanding a 2,500-volt crest transient per IEEE Standard 472-1974. The transient voltage test shall be conducted across the normal source terminals, the emergency source terminals, and between adjacent normal and emergency source terminals. Minimum withstand and close-in ratings shall be as follows (ratings shall be higher where indicated on the Drawings):

Automatic Transfer Switch Ampere Rating	Circuit Breaker Rating	Current Limiting Fuse Rating
Up to 30	22,000	100,000
70, 100, 150	22,000	200,000
250, 260, 400	42,000	200,000
600, 800	65,000	200,000
1,000, 1,200	85,000	200,000
1,600 to 4,000	100,000	200,000

I. Provide in-line current limiting fuse protection within transfer switch where required to meet short circuit withstanding ratings.

J. Transfer switch shall have a field-adjustable programmed delay in the neutral position when transferring between live sources. In-phase monitor system is not permitted.

2.14 AUTOMATIC TRANSFER SWITCH FEATURES AND ACCESSORIES

A. Close differential solid-state adjustable voltage sensing on all phases (line to neutral) of normal source:
   1. Set pick-up at 90 percent rated voltage.
   2. Set drop-out at 80 percent rated voltage.

B. Three-phase voltage sensing (line-to-line and line-to-neutral) of emergency source:
   1. Set pick-up at 90 percent rated voltage.
   2. Set drop-out at 80 percent rated voltage.

C. Frequency sensing of emergency source:
   1. Pick-up field-adjustable from 90 to 100 percent. Factory-set at 95 percent.

D. Time delay on engine start:
   1. Field-adjustable from 0.5 to 3 seconds. Factory-set at 1 second.

E. Time delay on re-transfer to normal:
   1. Field-adjustable from 0 to 30 minutes. Factory-set at 10 minutes.
   2. Immediate bypass of time delay and transfer to normal source if emergency source fails.

F. Time delay on transfer to emergency:
   1. Field-adjustable from 0 to 60 seconds. Factory-set at 0 seconds.

G. Time delay between live sources adjustable from 0.4 to 2.0 seconds. Factory-set at 1 second.

H. Unload engine run cool-down time delay:
   1. Field-adjustable from 0 to 5 minutes. Factory-set at 5 minutes.

I. Engine start contacts:
   1. SPDT to operate upon failure of normal source.

J. Test switch:
   1. Mounted on enclosure door.
   2. Simulates failure/return of normal source.

K. Auxiliary contacts:
   1. Provide two sets of SPDT contacts to operate with switch in normal position.
   2. Provide two sets of SPDT contacts to operate with switch in emergency position.
   3. Contacts shall be exclusive customer use and not utilized for any other ATS or generator system functions.
   4. Contacts shall be 120V AC, 10 amp rated minimum wired to a terminal strip.
   5. Provide additional contacts or other provisions as required to display information on remote annunciators described elsewhere in this specification.

L. Indicating lights:
   1. Mounted on enclosure door.
   2. Red to indicate switch in emergency position.
   3. Green to indicate switch in normal position.
   4. **[White]** to indicate **[normal]** source available.
   5. **[White]** to indicate **[emergency]** source available.

M. Pre-transfer contacts:
   1. Provide a contact closure for elevator controls prior to transfer between live sources in either direction. Interval shall be adjustable from 0 to 30 seconds. Contacts shall be rated SPDT 120V AC, 10 amps.

N. Exerciser clock: Programmable cycle timer that starts and runs the generator for a pre-determined time. The timer shall use 14 user-programmable sequences that are repeated in a 7-day cycle. Each sequence shall have the following programmable set points:
   1. Day of week
   2. Time of day to start
   3. Duration of cycle

O. Annunciator panel located at Engineer's Control Center with the following indicators

Transfer Switch	Not in Automatic Mode	(one per transfer switch)
Transfer Switch	Connected to Normal Source	(one per transfer switch)
Transfer Switch	Connected to Emergency Source	(one per transfer switch)
Transfer Switch	Emergency Source Available	(one per transfer switch)
Transfer Switch	Normal Source Available	(one per transfer switch)

P. Service manual and wiring diagram shall be supplied inside of enclosure when shipped. Control wiring shall be labeled to correspond with wiring diagram.

PART 3 - **EXECUTION**

3.1 GENERAL

A. Provide all necessary wiring and conduit to each remote alarm panel and automatic transfer switch.

B. Position the generator to allow adequate ventilation over engine block and through the radiator and to prevent short circuiting of radiator discharge air back to engine and radiator intake.

C. Provide 120V branch circuit and circuit breaker and connection to battery charger and day tank. Connect to emergency power supply.

D. Provide 220V branch circuit and circuit breaker and connection to jacket water heater. Connect to normal power supply.

3.2 SEQUENCE OF OPERATION

A. Engine start contacts shall signal generator to start when the voltage of the normal source drops below 80 percent on any phase, after a time delay of one second to allow for momentary dips. The voltage-sensing relays shall be field-adjustable while energized.

B. The transfer switch shall transfer to emergency when 90 percent of rated voltage, and frequency of the emergency source have been reached. The maximum time interval from onset of power failure and transfer to emergency shall not exceed ten seconds.

C. After restoration of normal power on all phases to 90 percent of rated voltage, an adjustable time delay period shall delay re-transfer to allow stabilization of normal power. If the emergency power source should fail during this time delay period, the switch shall bypass the timing relay and transfer to the normal source.

D. After re-transfer to normal, the engine generator shall be allowed to operate at no load for five minutes.

E. A test on the transfer switch shall simulate normal power failure.

3.3 HOUSEKEEPING PADS

A. Provide a 6-inch high concrete housekeeping pad beneath each generator.

B. Provide a concrete curb under each door of the generator room to prevent migration of spilled liquids out of the room.

end of SECTION 26 32 13

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