

PACKAGED ENGINE GENERATORS

PART 1 GENERAL

1.1 SCOPE

- A. Provide and install a complete and operable, packaged, standby engine-generator system including all devices and appurtenances specified herein. Provision of system shall include delivery, all documentation, testing, reports, and training and start-up assistance for this system.
- B. All equipment and components shall be new, factory tested and approved, and delivered complete, assembled and ready-for-use.
- C. This work shall include all labor and materials associated with a concrete pad to support the engine generator unit, as indicated on the project drawings.
- D. All prospective Suppliers of equipment specified herein shall include a paragraph by paragraph statement clarifying any and all deviations from this specification. Submittals that deviate from this specification without the attached explanatory sheet will be rejected.
- E. The generator will be sized by the generator supplier for the appropriate loads at the pump station and supplied to BCWS with the submittals. **No Exceptions.**

1.2 SUBMITTALS FOR APPROVAL

- A. Submit two (2) complete sets of the following to BCWS for approval: (see paragraphs B through G below)
- B. Shop Drawings: Indicate electrical characteristics and connection requirements. Show plan and elevation views with overall and interconnection point dimensions, fuel consumption rate curves at various loads, ventilation and combustion air requirements, and electrical diagrams including schematic and interconnection diagrams. Indicate drawings of all appurtenances.
- C. Product Data: Provide shop drawings, complete materials list, data showing dimensions, weights, ratings, interconnection points, and internal wiring diagrams for engine, generator, control panel, battery, battery rack, battery charger, exhaust silencer, vibration isolators, fuel tank, and cooling system.

- D. Test Reports: Provide a copy of the factory prototype model test report and the production model test reports, indicating the results of performance testing. Performance testing shall include full power rating, stability, and voltage and frequency regulation. Provide a copy of independent testing laboratory results.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.
- F. Sizing report with calculated FLA in percent of generator capacity with all pumps and appropriate loads in operation will be performed and provided by the generator supplier-No Exceptions

1.3 SUMITTALS REQUIRED AT CLOSEOUT

- A. Submit (2) Hard Copy complete sets, and one Electronic Copy of the following information to BCWS at closeout: (paragraphs B and C below)
- B. O&M Manuals: Include instructions for normal operation, instructions for routine maintenance requirements, and service manuals for engine, alternator, fuel system components, fuel tank, and electrical components. Include oil sampling and analysis for engine wear, and emergency maintenance procedures.
- C. Manufacturer's Warranty or Certificate: Certify that Products meet or exceed specified requirements, and provide a 5-year warranty against defects in material and factory workmanship with a 1-year service contract. The warranty period will begin on the date of the issuance of Permit to Operate. If the Permit to operate for the system is not issued within twelve (12) months of the startup inspection, another startup inspection must be conducted and be found satisfactory for BCWS to accept and assume O&M responsibilities.
- D. Manufacturer's Field Reports and System Calculation: Indicate procedures and findings. Calculation shall be issued by manufacturer to demonstrate that this unit will suitably drive the connected loads, as specified on project design drawings.
- E. Contractor's Field Reports: Provide reports showing that all manufacturer recommended maintenance has been performed on the generator since delivery was taken, and provide documentation showing that the fuel in the generator has been replaced or cleaned within 30 days of the issuance of Permit to Operate.

F. Emissions Certificate

1.4 QUALITY ASSURANCE

- A. Perform work in accordance with NFPA 110.
- B. The performance of the generating set / system shall be certified by a testing laboratory as to the unit's full power rating, stability, and voltage and frequency regulation.
- C. Maintain one copy of document on site.
- D. Factory Prototype Model Test:
 - 1. The power system consisting of prime mover, generator and all necessary controls must be tested as a complete system on representative engineering prototype models. The tests, being potentially damaging to the equipment tested, must not be performed on equipment sold, but on separate prototype models. A certificate certifying that this prototype testing has been accomplished shall be submitted along with submittal data for approval. These tests shall include:
 - a. Maximum power level (maximum KW).
 - b. Maximum motor starting capacity (maximum KVA).
 - c. Structural Soundness.
 - d. Torsigraph analysis per MIL-STD 705B, method 504.2 A torsional analysis shall be calculated using data from actual tests by the generator set manufacturer to verify freedom from torsional stresses within $\pm 10\%$ of rated speed. Results torsional fatigue test must be performed on the complete prototype generator set. Calculations based on engine and generator data separately are not acceptable.
 - e. Engine-alternator cooling air flow.
 - f. Transient response and steady state governing.
 - g. Alternator temperature rise by embedded thermocouples and by resistance method per NEMA MG1-22.40.
 - h. Harmonic analysis and voltage wave form deviation per MIL-STD-705B, method 601.4.
 - i. Three-phase, short-circuit test for mechanical and electrical strength. With system operating at rated volts, amps, power factor, and speed the generator terminals must be short circuited ten times on all three phases for duration of thirty seconds. Generator set must build up and perform normally without manual interventions of any kind such as resetting of circuit breakers or other tripping devices when the short circuit is removed.

- j. Failure mode test for voltage regulator. With generator set operating at no load, rated speed and voltage, the AC sensing circuit to the regulator must be disconnected for a period of at least an hour. The generator set must be fully operative after test, and without evidence of any kind of damage.
 - k. Endurance testing at rated load and speed is required without significant damage or failures of electrical or mechanical components occurring.
- E. Factory Production Model Test:
- 1. Before shipment of the equipment, the generator set, and system components shall be tested under rated load and power factor for performance and proper functioning of control and interfacing circuits. Testing at unity power factor only (resistive banks only) is not acceptable, since KW output is affected by the higher generator efficiency at unity power factor and the KVAR for motor starting and regulation is not correctable between unity and rated power factor. Other tests shall include:
 - a. Single step load pickup per NFPA-110.
 - b. Transient response and steady state governing.
 - c. Alternator temperature rise by resistance method.
 - d. Functional compatibility between generator set controls and transfer switch controls (start, transfer, retransfer and stop, with all time delays).
 - e. Fuel Consumption.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section. Evidence of a satisfactory installation of similar equipment within a reasonable distance shall be furnished on request. The system shall be built, tested and shipped by the manufacturer of the Generator Set which has been regularly engaged in the production of such equipment for the past ten years, so that performance of the electric plant series and solid state automatic transfer switch (covered in Section 11312) shall have been certified by a laboratory as to the plant's full power rating, voltage and frequency regulation and shall be warranted per paragraph 1.3 C, above.
- B. The Supplier shall have available complete parts and service departments employing full time, factory authorized and factory trained personnel, devoted exclusively to this service, all located within a reasonable distance of the installation site. A factory trained service representative shall also instruct BCWS' representatives in operation and

service of the system. A copy of the factory test shall be furnished with the unit.

- C. Manufacturer, or manufacturer's authorized representative, shall assemble and test the system, using manufacturer's own engine or generator – without exception. The system shall have one source of supply and responsibility.

1.6 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 110.
- B. Furnish Products listed and classified by testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.
- C. Obtain all operating permits required by local and state laws.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Caterpillar
- B. Cummins / Onan.
- C. Kohler
- D. No Substitutions

2.2 PACKAGED, ENGINE-GENERATOR SYSTEM

- A. The Supplier shall furnish one (1) standby electric generating set consisting of water-cooled, diesel fueled unit as follows:

<u>LOCATION</u>	<u>KW</u>	<u>KVA</u>	<u>PF</u>	<u>VOLTS</u>	<u>PH</u>	<u>W</u>	<u>HZ</u>	<u>RPM</u>	<u>BHP</u>
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- B. The alternator shall be a broad range, 12 lead re-connectible revolving field type with rotating exciter and solid state voltage regulator. No commutator or commutator brushes shall be allowed. It shall be directly connected to ensure permanent alignment.

2.3 ENGINE

- B. Type: Diesel fueled, unit-mounted radiator- (water) cooled, four-cycle internal combustion engine. Cooling system design temperature is 122°F (50°C).
 - 1. Intake and exhaust valves shall be heat resisting alloy steel.
 - 2. Provide hard-faced, exhaust valves with rotators and heat inserts.
- C. Rating: Sufficient to operate under full load ratings, continuously, in a design ambient temperature condition.
- D. Fuel System: Diesel. Provide all required accessories for fuel injection system.
- E. Engine speed: A mechanical governor shall govern engine speed.
- F. Governor: Isochronous type to maintain engine speed within ½ percent from no load to full load, with recovery to steady state within 2 seconds following sudden load changes. Frequency output shall be maintained within 5% from no-load to full-load, or better.
- G. Safety Devices: Engine shutdown on high water temperature, low oil pressure, overspeed, and engine overcrank. Design limits shall be as selected by manufacturer.
- H. Engine Starting: 12 VDC, two wire, solenoid shift, starting system with positive engagement, number and voltage of starter motors in accordance with manufacturer's instructions. Include remote starting control circuit, with MANUAL-OFF-REMOTE selector switch on engine-generator control panel.
- I. Engine Jacket Heater: Receptacle wired plug in, thermal circulation type water heater with integral thermostatic control, sized to maintain engine jacket water at approximately 100°F. Heater turns off while engine is running.
- J. Radiator: Unit-mounted radiator, using glycol-water mixed coolant, with blower type fan, sized to maintain safe engine temperature at design temperature of 122°F (50°C).
- K. Engine Accessories: Replaceable fuel filter, replaceable lube oil filter, positive displacement lube oil pump, replaceable intake air filter, lube oil cooler, fuel transfer pump, fuel priming pump, gear-driven water pump. Include fuel pressure gauge, water temperature gauge, and lube oil pressure gauge on engine/generator control panel.

- L. Mounting: Provide unit with suitable vibration isolators.

2.4 GENERATOR

- A. Generator: NEMA MG1, three phase, four pole, revolving field, air cooled, broad range, 12-lead re-connectable brushless synchronous generator with permanent magnetic exciter, and full amortisseur windings.
- B. Rating: Generator one-step load acceptance shall be 100% of full rating. Stable alternator operation shall be established within 2 seconds following any sudden change in load between no-load and full-load, or between full load not exceeding $\pm 0.5\%$ and voltage variation $\pm 1\%$ of their mean value for constant loads from no-load to full-load.
- C. Insulation Class: F as defined by NEMA MG-1.65.
- D. Temperature Rise: Within limits defined by NEMA MG1-22.40.
- E. Enclosure: NEMA MG1, open drip proof. Include space heaters.
- F. Voltage Regulation: Solid state, temperature compensated. Include generator-mounted exciter-regulator, or other approved automatic exciter-controller, to match engine and generator characteristics, with voltage regulation $\pm 2\%$ from no-load to full-load. Include manual rheostat controls to adjust frequency droop, voltage droop, voltage level ($\pm 5\%$) and voltage gain.
- G. Unit shall produce a voltage waveform limiting line-to-neutral THD of less than 5%, with no single harmonic order exceeding 3% of fundamental.

2.5 ACCESSORIES

- A. The following accessories shall be furnished: diesel engine starting batteries which shall be gel or lead acid cell type, battery cables and battery rack, flexible, seamless exhaust connection, a critical grade engine muffler, and an engine block heater, with thermostat.

CIRCUIT BREAKERS BATTERIES FUEL TANK

LOCATION POLE AMPHERE QTY VOLT AMPHERE GALLONS

- B. Radiator: Radiator, selected and sized by engine generator manufacturer to match engine cooling capacity, and suitable for

operation at elevation of 100 feet in an ambient air temperature of 104°F.

- C. Exhaust Silencer: Critical-grade silencer, with stainless steel muffler companion flanges and flexible, seamless, stainless steel exhaust fitting and end cap, all sized in accordance with engine manufacturer's specifications.
- D. Batteries: Heavy duty, 12 or 24 Volt DC, diesel starting type lead-acid storage batteries, 700 CCA, minimum capacity. Match battery voltage to starting system. Include necessary cables and clamps.
- E. Battery Tray: Treated for electrolyte resistance, constructed to contain spillage.
- F. Battery Charger: Trickle-charging, float-type, sized by manufacturer to suit batteries. Include overload protection and fused input. Provide suitable, unit-mounted enclosure for environmental conditions as required.
- G. Line Circuit Breaker: NEMA AB 1, molded case circuit breaker on generator output with integral thermal and instantaneous magnetic trip in each pole, sized in accordance with NFPA 70. Include battery-voltage operated shunt trip, connected to open circuit breaker on engine failure. Mount circuit breaker in enclosure to meet NEMA 250, requirements.
- H. Engine-Generator Control Panel: NEMA 250, generator shock-mounted control panel enclosure with engine and generator controls and indicators. Include the following equipment and features:
 - 1. Remote starting relay, engine stops when relay opens.
 - 2. Frequency Meter: 45-65 Hz. Range.
 - 3. AC Output Voltmeter: 2% accuracy min, with phase selector switch and "off" position.
 - 4. AC Output Ammeter: 2% accuracy min, with phase selector switch and "off" position.
 - 5. Output voltage adjustment.
 - 6. Fuel level gauge.
 - 7. 60 – 75 second cranking limiter.
 - 8. Push-to-test indicator lamps, one each for low oil pressure, high water temperature, overspeed, overcrank, and low engine temperature.
 - 9. Control panel general illumination lamps for instrument gauges.
 - 10. Engine Mode Select Switch: RUN-STOP-REMOTE.
 - 11. System Emergency Shutdown, red, mushroom-head, maintained-contact pushbutton.

12. Engine running time meter.
 13. Oil pressure gauge.
 14. Engine Coolant temperature gauge.
 15. Battery charge rate ammeter.
 16. Auxiliary Relay: 3PDT, operates when engine runs, with contact terminals prewired to terminal strip.
 17. Additional visual indicators and alarms as required by NFPA 110.
 18. Remote Alarm Contacts: Pre-wire SPDT contacts to terminal strip for remote alarm functions as required by NFPA 110.
 19. Solid state engine start controls and terminals.
 20. Voltmeter-ammeter selector switch.
 21. Manual reset overload protection (field circuit breaker). A field circuit breaker shall be utilized to protect the factors that would cause high field current. Furnish mainline circuit breakers installed in the output box.
 22. Common failure alarm relay kit, to provide an external normally open dry contact, to close upon any alarm condition with three pairs of No. 12 wires pulled from the generator to the pump control panel for SCADA use.
- I. Local Annunciator Panel: Generator unit-mounted panel with painted finish. The alarms or indications below may be provided in the control panel, nor requiring a separate enclosure. Provide audible alarm horn, reset button and visual indicators and alarms as follows:
1. High battery voltage (alarm).
 2. Low battery voltage (alarm).
 3. Low fuel (alarm).
 4. System ready.
 5. Anticipatory-high water temperature.
 6. Anticipatory-low oil pressure.
 7. Low coolant temperature.
 8. Low coolant level.
 9. Overcrank (alarm).
 10. Emergency stop (alarm).
 11. High coolant temperature (alarm).
 12. Overspeed (alarm).
 13. Low oil pressure (alarm).
 14. Generator power available.
 15. Lamp test and horn silence switch.
 16. Short Circuit (alarm)
 17. Under/Over Frequency (alarm)
 18. Overcurrent (alarm)
- J. Weather-protective and Sound-Attenuating Enclosure:

1. The generator set shall be provided with a factory-installed sound-attenuated housing which allows the generator set to operate at full rated load in the ambient conditions previously specified.
2. The enclosure shall reduce the sound level of the generator set while operating at full rated load to a maximum of 79 dBA at any location 7 meters from the generator set in a free field environment. Housing configuration and materials used may be of any suitable design which meets application needs, except that acoustical materials used shall be oil and water resistant. No foam materials shall be used unless they can be demonstrated to have the same durability and life as fiberglass.
3. The enclosure shall include hinged doors for access to both sides of the engine and alternator, and the control equipment. Key-locking and pad lockable door latches shall be provided for all doors. Door hinges shall be stainless steel.
4. The enclosure shall be provided with an exhaust silencer that is mounted inside of the enclosure, and allows the generator set package to meet specified sound level requirements. Silencer and exhaust shall include a rain cap and rain shield. All sheet metal shall be primed for corrosion protection and finish painted with the manufacturer's standard color using a two step electro coating 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 B 117-90, 1000 + hours.
 - f. Humidity, per ASTM D2247-92, 1000 + hours.
 - g. Water Soak, per ASTM D2247-92, 1000 + hours.
5. 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.

K. Fuel Storage Tank:

1. Provide a sub-base double wall fuel storage tank, including a "fuel in rupture basin" alarm, to be installed in the generator set control panel. The tank shall be for diesel fuel and include all necessary fitting and accessories. The diesel engine generator supporting system shall be a secondary containment generator base tank that is the combination of a sub-base, fuel storage and secondary containment devices. It shall be of double walled construction having a primary tank to contain diesel fuel, held within another tank that is intended to collect and contain any accidental leakage from the primary fuel tank. Devices shall be included for monitoring the annular space for leakage. Appropriate generator mounting locations shall be provided.
2. The primary tank, as well as the secondary containment tank shall be structured to withstand normal and emergency internal pressures and external loads. They shall be capable of withstanding internal air pressures of 5 PSIG without showing signs of excessive or permanent distortion and 25 PSIG hydrostatic pressure without evidence of rupture or leakage. The load bearing capability of the system shall be four times the actual imposed load. The containment tank top shall be capped to allow water run off.
3. The primary and secondary containment tanks shall have venting provisions to prevent the development of vacuum or pressure capable of distorting them as a result of atmospheric temperature changes or while emptying or filling. The vents shall also permit the relief of internal pressures caused by exposure to fires. The vent sizes shall be determined by using the calculated wetted surface area in square feet (the top is excluded) in conjunction with venting capacity table 10.1 of UL 142. The vents shall also be equipped with coupling devices and shall be located to facilitate connection to a vent piping system.
4. All components of these tanks shall be made from 7 gauge ASTM A569 or an A-36 hot rolled steel. Internal baffles or reinforcement plates shall be located on maximum 24 inch centers in tanks up to 60 inch width and on maximum 19 inch centers in tanks over 60 inch width. At least one baffle shall separate the fuel suction pipe from the fuel return line. Vertical reinforcement shall be welded to the outer side of the secondary containment tank at maximum 45-inch spacing on tanks up to 30 inches high and on 24 inch spacing on tanks greater than 30-inch height. At least one vertical reinforcement shall be positioned adjacent to each mounting hole/location.
5. The fill neck may be welded directly into the top of the primary tank and be equipped with a lockable fuel cap. All other ports shall be equipped with welded pipefittings to accommodate the required accessories. The exterior surface shall be cleaned appropriately

- for painting. The coats (one primer and one finish enamel) of paint shall be applied by accepted commercial painting methods.
6. Manufacturing and testing of this system shall be done within the scope of Underwriters Laboratories, Inc. "Standard For Safety UL 142". A UL label shall be permanently attached to the system showing the following information:
 - a. The registered UL mark and the name: Underwriters Laboratories, Inc.
 - b. A control number and the word "Listed"
 - c. The products name as identified by Underwriters Laboratories, Inc.
 - d. The serial number assigned by Underwriters Laboratories, Inc.
 - e. Other manufacturer's information may also be included
 7. A drawing or facsimile of the information plate illustrating exactly how it will appear on the final product shall be included with the submittal data.
 8. A label stating the primary tank's fuel capacity in U.S. gallons shall be permanently attached to the system.
 9. Should the size of the fuel storage tank require platform type access to reach generator panels, it shall be provided by developer/contractor when installed for safe operation and maintenance of the generator. Platform or multiple platforms to be rated for full access to panels on both sides of generator without blocking fuel fill access.
- L. Unit shall be equipped with a structural steel skid base with suitable vibration isolation that provides suitable mounting to any level surface.

2.6 ENGINE GENERATOR CONCRETE PAD

- A. Provide all materials and labor to complete a concrete pad to support the engine generator. Concrete pad shall be suitably reinforced and of adequate thickness to support unit.
- B. Install concrete pad in accordance with the project design drawings.
- C. Stub-up conduits in concrete pad in location underneath ATS and/or control panel as required. Refer to manufacturer's installation drawings for exact location.

PART 3 EXECUTION

3.1 INSTALLATION

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- A. Install packaged engine generator in accordance with manufacturer's instructions, mounted on spring vibration isolators as per manufacturer's outline dimension drawing.

3.2 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed. Notify BCWS 72 hours prior to testing to schedule on-site witnessing of tests.
- B. Provide full load test for four hours minimum. Cold start test shall be performed. Existing system loads shall be run at the discretion of BCWS. Note overall system stability.
- C. Record in 20 minute intervals during four hour test:
 - 1. Kilowatts.
 - 2. Amperes.
 - 3. Voltage.
 - 4. Coolant temperature.
 - 5. Room temperature.
 - 6. Frequency.
 - 7. Oil pressure.
- D. Test alarm and shutdown circuits by simulating conditions.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Prepare and start systems. A direct employee of the manufacturer shall be on-site to commission the unit. Sales representatives and vendors shall not be permitted to perform this work.
- B. Adjust generator output voltage, engine speed, and make all other adjustments required.
- C. Provide written report of all startup activities to BCWS subsequent to completion.

3.4 DEMONSTRATION

- A. Provide systems demonstration as per manufacturers' recommendations to BCWS.
- B. Describe loads connected to standby system and restrictions for future load additions. Submit report and provide a copy of manufacturer's calculations in writing.

- D. Upon completion of work, thoroughly clean all exposed portions of the system removing soil, grease, oil and any other foreign material, using only cleaners or solvents recognized by the manufacturer.

PART 4 SOLID STATE AUTOMATIC TRANSFER CONTROL

- 4.1 Automatic transfer control shall be provided to automatically start the engine generator set and transfer the load circuits to standby power when *the normal line voltage fails*. It must also automatically retransfer the load circuits back to their normal power supply when live voltage is restored and then secure the engine/generator set.
- 4.2 The Solid State Automatic Transfer Control shall be rated as follows:

<u>LOCATION</u>	<u>AMPERE</u>
_____	_____

Four-pole transfer switch with switched neutral contactors shall be of the 600-volt type for all classes of loads and Installed as a separately derived system.

- 4.3 Each pole shall be of high-pressure contact design, with a bi-directional linear actuator operator that shall operate in either direction in 6 seconds or less. Contacts shall be solid silver cadmium oxide (stationary) and silver tungsten (movable), capable of switching both inductive and resistive loads. Thermal capacity of each contact shall allow for inrush currents at least 20 times the continuous rating. Contact pressure chambers must have arc chutes to provide quenching by the Deion principle and to prevent cross arcing between poles.
- 4.4 Transfer switch shall have a non-electric manual operator designed and tested for safe transfer and retransfer of the load with either or both the normal and alternate power source terminals energized as required by 1977 NFPA 76A 3-2.4.9.
- 4.5 Transfer switches shall be the quick-break, quick-make type so that the speed of opening and closing is not controlled by the operator during manual operation. Transfer switches shall provide a center “programmed transition” position. Transfer switches shall be approved for manual operation under full load.
- 4.6 Both the line and the generator side of the transfer switch shall be mechanically held and electrically interlocked with auxiliary 10-amp rated

contacts on both sides. A mechanical interlock mechanism shall prevent both sources from supplying the load simultaneously.

- 4.7 The transfer switch shall be tested and listed under Underwriter's Laboratory Standard 1008.
- 4.8 Control modules in transfer switches must be solid state plug-in modules for high reliability and easy service.
- 4.9 The transfer switch controls shall have a built-in diagnostic signal system showing that the following functions are in progress:

Light On	Indicates
Source 2 OK	Source 2 voltage (emergency) is available and within the voltage and frequency settings of the voltage/frequency sensor.
Timing for Stop	Control is timing out for generator stop signal. At the end of the timing period, the 2-Wire Run Lamp and the Timing for Stop Lamp will go out.
Transfer Command	Control is signaling for transfer to emergency power source. The Source 2 O.K. Lamp and the 2 Wire Run Lamp will also be on.
Timing for Over-voltage of Source 2	Control is timing out the over-voltage condition on Source 2. Over-voltage time delay is Adjustable from 0 to 120 seconds; factory setting is 5 seconds. Source 2 OK light will stay on during the timing out period. Do not operate if no over-voltage sensor.
Retransfer Command	Control is signaling for retransfer to normal power source. The Source 1 OK Lamp also will be on.
2 Wire Run	Control is signaling for the generator to run.
Timing for Over-voltage of Source 1	Control is timing out for over-voltage condition on Source 1. Over-voltage time delay is Adjustable from 0 to 120 seconds; factory setting is 5 seconds. Source 1 OK Lamp will stay on during timing out period. Do not operate if no over-voltage sensor.

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| Source 1 OK | Source 1 voltage (Normal) is available and within the voltage/frequency sensor. |
| Timing for Retransfer | Control is timing out for retransfer to normal power source. At the end of timing period, lamp will go out. Delay is adjustable from 0 to 30 minutes factory setting is 2 seconds. |
| Timing for Transfer | Control is timing out transfer to emergency power source. At the end of the timing period, lamp will go out. Delay is adjustable from 0 to 120 seconds; factory setting is 2 seconds. |
- 4.10 Should the system malfunction during any other time sequences above, a maintained signal shall show the sequence step in which the system malfunctioned.
- 4.11 The control shall contain a fused 2-amp automatic SCR voltage regulated, current limiting float type charging circuit with ammeter to maintain starting batteries at full charge.
- 4.12 The automatic transfer control, along with the engine/generator and starting control, shall be built and supplied as a complete package by one manufacturer. Cat, Kohler, or Onan. The enclosure will be coated by manufacturer and have a three-point lockable latching system. Enclosure shall be NEMA 4X stainless steel. Bolted dogs and latches are **not acceptable**. This manufacturer shall accept responsibility for performance and service of the complete standby package. The transfer switch and generator set shall be warranted for FIVE years against defects in material and factory workmanship. Basis of design is OTPC style switch from Cummins/Onan.
- 4.13 Transfer switches are to be prewired and rack mounted. Installation of transfer switch shall not reduce effectiveness or sound attenuating enclosure. All transfer switches shall be provided with a sunshield for the controls from davidsonsaleshop.com or approved equal. In the event a specific sunshield is not for the manufacturer model the closest appropriate size will be selected.
- 4.14 The solid state control shall contain the following:
- A. Solid state adjustable low voltage and full phase failure sensitive relays. Dropout is 5 to 20% below the pickup of 75 to 100 % of the normal line voltage. Duplicate sensors shall also be supplied for the generator output voltage.

- B. Solid state adjustable over-voltage sensors with dropout time delay. Dropout is 5% of normal voltage above pickup setting: Pickup is adjustable from 100% to 130% of nominal voltage setting. Time delay for dropout is to be adjustable from .5 seconds to 2.2 minutes. Duplicate sensors for both sources of power.
- C. Adjustable frequency sensors with dropout time delay. Dropout is 5% of nominal wider than pickup frequency bandwidth, pickup is $\pm 4\%$ of nominal frequency minimum to $\pm 20\%$ of nominal frequency maximum.
- D. Solid state adjustable 0 to 6 seconds, time delay on starting.
- E. Solid state adjustable 0 to 120 seconds, time delay on transfer.
- F. Solid state adjustable 0 to 8 minutes, time delay on unload running.
- G. Adjustable 0 seconds to 32 minutes time delay retransfer to normal.
- H. Test Load switch, test engine and automatic transfer switch with or without load.
- I. Automatic system exercise, with or without assuming the load.
- J. Pilot contact to initiate starting controls on engine.
- K. Control circuit disconnected plug, to allow service on de-energized transfer switch without interrupting normal service.
- L. Normal lamp (white), Emergency lamp (amber), lights indicating switch position.
- M. Programmed transition (adjustable dwell in the neutral (Open) position shall be provided to permit decay of regenerative power from motors when transferring to or back from emergency to normal power.)
- N. Alarm contacts for SCADA will be voltage free and cover Generator Run, Generator Fail, and Utility Voltage failure at a minimum

END OF SECTION