SECTION 16600 - STANDBY EMERGENCY POWER GENERATION

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1.0 SCOPE

This section covers standards for power generating equipment for the City of Portland (COP), Bureau of Environmental Services (BES), Wastewater Group (WG), including the Columbia Blvd. Wastewater Treatment Plant, Tryon Creek Wastewater Treatment Plant and the Wastewater Pump Stations.

The requirements of Sections 16010, 16050 and 16400 apply to this section. If there is a conflict between those sections and the requirements of this section, the requirements of this section shall prevail.

2.0 MATERIALS PROVIDED

2.1 WARRANTY

Equipment furnished under this section shall be guaranteed against defective parts or workmanship for a period of at least one (1) year from date of acceptance by the City.

2.2 SPECIFIED UNIT

The engine-generator set shall be Kohler, Onan or equal as modified herein.

2.3 MATERIALS

The engine generator shall be manufactured in the U.S. by manufacturers currently engaged in the production of such equipment. The manufacturer shall have an authorized distributor or representative who maintains a stock of spare parts and a service facility within a radius of 50 miles of installation site. The generator must be provided with a charging system for the batteries used to start the engine.

2.3.1 EXHAUST SILENCER

Provide a residential-type silencer, including flexible exhaust fitting properly sized and installed according to the manufacturer's recommendation. Exhaust pipe shall be

sufficient to insure that the measured exhaust back-pressure does not exceed the manufacturer's maximum limitation. Silencer shall be mounted horizontally over engine.

2.3.2 INSTRUMENT PANEL

A set mounted instrument shall include:

- Voltmeter 3-1/2-inch, (+/-) 2 percent accuracy.
- Ammeter 3-1/2-inch, (+/-) 2 percent accuracy.
- Voltmeter / ammeter phase selector switch.
- Panel illuminating lights
- Battery charging voltmeter.
- Coolant temperature gauge.
- Oil pressure gauge.
- Running-time meter with auxiliary contact closure to be wired to logic controller.
- Voltage adjust rheostat.
- Fuel gauge.
- Frequency meter, 3-1/2-inch, (+/-) 2 percent accuracy.

2.3.3 GENERATOR

The insulation shall meet the NEMA Standard (MGI-22-40 and 16.40) for Class F and be vacuum impregnated with epoxy varnish and be fungus resistant per MIL E-4970A. The excitation system shall be of brush-less construction controlled by a solid-state voltage regulator capable of maintaining voltage within 2 percent at any constant load from 1 to 100 percent of rating. The regulator must be protected from the environment by conformable coating.

On application of any load up to 90 percent of the rated load, the instantaneous voltage dip shall not exceed 20 percent and shall recover to 2 percent of rated voltage within one second.

The generator shall be capable of sustaining at least 250 percent of rated current for at least 10 seconds under a 3-phase symmetrical short by inherent design or by the addition of an optional current boost system.

2.3.4 CONTROLLER

Unit shall be **all solid state** components and the enclosure shall be vibration isolated. All printed circuit boards shall be uniformly coated. Use of relays will only be acceptable in high current circuits.
Circuitry shall be of plug-in design for quick replacement. Controller shall be equipped to accept a plug-in device capable of allowing maintenance personnel to test controller performance without operating the engine.

The Controller shall include:

- Fused DC circuits.
- Complete two-wire START/STOP control, which shall operate on closure of a remote contact.
- Speed sensing and a second independent starter motor disengagement system, which shall protect against the starter engaging with a moving flywheel. Battery charging Generator voltage will not be acceptable for this purpose.
- Cranking cycler with 10-second ON and OFF cranking periods.
- Over-crank protection designed to open the cranking circuit after 60 seconds if the engine fails to start.
- Circuitry to shut down the engine when: signal for high coolant temperature, low oil pressure, or over speed are received, along with two sets of auxiliary contacts to monitor the shut down occurrence.
- Engine cool down timer, factory set at 5 minutes to permit unloaded running of the standby set after transfer of the load to the normal power source.
- Three-position AUTOMATIC/OFF/TEST selector switch with two complete sets of spare NO contacts for the AUTO and TEST positions. In the TEST position the engine shall start and run regardless of the position of the remote starting contacts. In the AUTOMATIC position the engine shall start when contacts in the remote control circuit close and stop 5 minutes after those contacts open. In the OFF position the engine shall not start even though the remote start contacts close. This position shall also provide for immediate shutdown in case of emergency.

The starting system shall be designed for restarting, in event of a false engine start, by permitting the engine to completely stop and then re-engage the starter.

2.3.5 AUTOMATIC TRANSFER SWITCH

Standard switch control features and accessories shall include the following:

- Differential voltage sensing on all phases of <u>normal source</u> with adjustable pickup and dropout settings - use factory settings.

- Differential voltage sensing on all phases of <u>emergency source</u> with adjustable pickup and dropout settings - use factory settings.

- Frequency sensing on both emergency and normal source with adjustable pickup and dropout settings - use factory settings.

- TDNE (Time Delay Normal to Emergency) adjustable 0 to 60 seconds.

- TDES (Time Delay on Engine Start) adjustable 0 to 5 minutes.

- TDEN (Time Delay Emergency to Normal) adjustable 0 to 10 minutes.

- TDEC (Time Delay for Engine Cool-Off) adjustable 0 to 30 minutes.

- Manual controls consisting of 4-position TEST/AUTO/OFF/ENGINE START selector switch. Each switch position shall be provided with two normally open (NO) contacts for system controls. The NO contacts shall close when the switch is in their switch position.

- The TEST position shall simulate a power failure, start the engine, and transfer the load to the engine-generator set. The AUTO position shall be the normal mode of operation. The Engine-START position shall start the engine, but not transfer the load to the engine-generator set.

- Red/green transformer push-to-test type indication lights for emergency/normal switch positions, respectively. Provide in the switch enclosure, in a visible location, two dummy lamp sockets mounted to the enclosure with two spare indicating light lamps.

- Two auxiliary contacts (four total) to sense each major shaft position (emergency and normal).

Transfer mechanism shall be energized only momentarily during transfer.

Components of the operating mechanism shall be insulated or electrically dead.

Components of linkages and handles in operating mechanisms shall be ruggedly constructed and not subject to deterioration. Medium or light-duty plastic components **will not** be accepted. Mount on the enclosure door interior, a metal paper holder, and **provide an approved as-built copy of the control diagram** in the holder.

Provide the Load disconnect control circuit with two sets of single-pole, double throw (SPDT) contacts that operate a nominal 3 seconds before transfer in either direction.

The transfer switch shall, when in the AUTO mode, have a provision to:

1. Transfer the load to the generator when a contact closes at the generator control panel (monthly engine-generator exercise run).
2. Transfer the load to the normal power supply when the contact opens at the generator control panel.

The transfer switch shall be suitable for connection to normal and standby sources: 480Y/277 volts, 3-phase, four wire, 60 Hz. The transfer switch shall have a rating that is capable of handling the computed load in accordance with the NEC. Provide a switch with solid neutral with fully rated terminals - AL/CU, UL listed. Closing and withstand short circuit rating shall be at least 22,000 amps RMS symmetrical. The switch shall be UL listed and housed in the MCC space provided for the automatic transfer switch.

Transfer switch shall be mechanically held and electrically operated with operating current drawn from the source to which the load is being transferred. Switch shall be so designed in order to prevent a neutral position and shall be provided with electrical and mechanical interlocking to prevent load being fed from both normal and emergency sources simultaneously. Switch shall not be circuit breaker type.

2.3.6 BATTERY CHARGER

Engine generator battery trickle charger (Katolight CI series, or approved equal) with 120-volt, single-phase fused input, circuit breaker protected output, adjustable charge rate, and charging current ammeter. Battery trickle charger shall be powered by the automatic transfer switch.

Provide a removable Plexiglas plate mounted on stand-offs (length as required) on the enclosure door interior to cover door-mounted device terminal connections.

2.3.7 DESIGN AND INSTALLATION OF LOAD BANK

Load bank shall be designed to load the generator at 75% of full load, and be rated for 480 V, 3-phase, 60 Hz, continuous duty. Nominal maximum temperature rise shall be 100 degrees Fahrenheit. Provide loading resistors assembled into a resistor load bank. Loading resistors will operate through a magnetic contactor. Individual loading resistors shall be isolated from the metal structure by appropriate insulating material. Individual resistors shall be either, an edgewise ribbon type or a wire wound on a ceramic body. Control power shall be derived internally from the load bank power.

An engine radiator, air flow cooled, resistive load bank is required as a permanent, integral component of the engine generator system. During all running periods the load bank and /or the station load will provide at least 50% load.

2.3.7.1 CONTROLS

The load bank shall be operable from a local panel (mounted on the load bank), and shall be labeled "LOAD BANK CONTROL PANEL". A switch, labeled "HAND/OFF/AUTO", shall operate the load bank. Included will be switches and lights that operate individual functions of the load bank as is necessary. When the switch is in the HAND position, it allows manual operation of the load bank where the load can be applied in equal steps (usually 12.5 kW). When the switch is in the OFF position, no part of the load bank is allowed to function. When the switch is in the AUTO position, the load bank is automatically brought on line after warm up of generator and is dropped off line before cool down of generator.

During operation, load is adjusted to maintain proper load parameters. The load bank shall have automatic over-temperature protection.

DISCUSSION: The reason for maintaining a load on the generator during all operating periods is that the performance of the generator will be enhanced by better fuel economy, less wear on the engine, injectors will need less maintenance and for higher reliability.

2.3.8 IDENTIFICATION

Provide a plasticized sheet or nameplate, permanently mounted, on the front of the enclosure door. The sheet or nameplate shall provide simplified operating instructions. These instructions shall include an explanation of each of the four selector switch positions. Use text and graphics as required.

2.3.9 MANUFACTURER

Automatic Switch Company (ASCO 940 with Group 7 microprocessor control panel), or approved equal.

2.3.10 GENERATOR REMOTE ANNUNCIATOR PANEL

Within the space provided for the generator, there shall be mounted on an adjacent wall, a remote annunciator panel that is compatible with the generator that is supplied, that shall operate all damper motors and annunciate all generator functions and alarms.

2.3.11 BLOCK HEATER

The engine block heater shall be a KIM HOTSTART P.S. 252, 120 VAC. It shall be controlled with a pressure switch that is connected to the lube oil system. The pressure switch shall be a SQUARE D class 9013 type "G" code J20 or equal. All connections are to utilize standard plug and receptacle cord caps NEMA 5-15P AND 5-15R, and shall be a HUBBLE HBL5266C and HBL5269C or equal.

3.0 INSTALLATION REQUIREMENTS

3.1 INSTALLATION LOCATION
All electrical generators shall be installed within a building for weather protection.

3.2 DUPLEX OUTLET
Install a duplex outlet (2-pole, 20A, 125V grounding receptacle) on diesel generator unit so as to be in a convenient / accessible location for plugging in the engine block heater. Duplex outlet shall be furnished with outdoor weatherproof cover plate with two individual lift covers.

3.3 FINAL TESTING
Test fuel, lubricating oil, and antifreeze for conformity to the manufacturer's recommendations.

Accessories that normally function while the generator set is standing by shall be checked prior to cranking the engine. These shall include: battery charger, annunciator, etc.

Start up the generator under test mode to check for exhaust leaks, cooling airflow, movement during starting and stopping, vibration during running, normal and emergency line-to-line voltage and phase rotation.

Test automatic startup by means of simulated power outage to test remote automatic starting, transfer of the load, and automatic shutdown. In addition, demonstrate automatic exercise of the generator set using the full rating of the load bank.

During checkout and startup of the various plant systems, provide a crew of skilled craftsmen to be available for checkout and troubleshooting activities, as required by the Engineer and Contractor.

Calibrate meters and transducers per manufacturers' instructions.

To assure that the equipment has been designed and built to the highest reliability and quality standards, the manufacturer and local representative shall be responsible for three separate tests: design prototype tests, final production tests, and field tests.

Design prototype tests: Components of the standby system such as the engine/generator set, transfer switch, and accessories shall not be subjected to prototype tests since the tests are potentially damaging. Other units of similar design, **not to be sold**, shall be made for these tests. The following certified test records shall be provided:

- Maximum power (kW).
- Maximum starting (kVA) at 20% instantaneous voltage dip.
- Generator temperature rise by embedded thermocouple and resistance method per NEMA MG 1-22, 40, and 16.40.
- Governor speed regulation under steady state and transient conditions.
- Voltage regulation and generator transient -response.
- Fuel consumption at no load, 1/4, 1/2, 3/4, and full load.
- Harmonic analysis, voltage wave form deviation, and telephone influence factor.
- 3-phase line-to-line and line-to-ground short circuit current tests
- Generator cooling airflow
- Torsional analysis testing to verify that the generator is free of harmful Torsional stresses.

Final production tests: Generator set shall be tested under varying loads with guards and exhaust system in place. Tests and certified test reports shall be provided and shall include:

- Single step load pickup
- Transient and steady state governing

- Safety shutdown device testing
- Voltage regulation
- Rated power
- Maximum power

Field tests: An installation check, startup, and station load test shall be performed by the manufacturer's local representative. The Engineer *and* Maintenance staff shall be notified of the time and the date of *all* tests. Include all tests and inspections recommended by the equipment manufacturer, whether required by this guideline or not, unless specifically waived in writing by the Engineer. Include any additional tests issued by the Engineer that are deemed necessary because of field conditions to determine that equipment, material, and systems meet requirements of the Specifications. Maintain, in quadruplicate, a written record of all tests showing date, personnel making test, equipment or material tested, tests performed, manufacturer and serial number of testing equipment and results. Furnish at least two copies of test records to the Engineer. The tests shall include:

- Fuel, lubricating oil, and antifreeze shall be checked for conformity to the manufacturer's recommendations.

- Accessories that normally function while the set is standing-by shall be checked prior to cranking the engine. This shall include: battery charger, annunciator, etc.

- Startup under test mode to check for exhaust leaks, cooling airflow, movement during starting and stopping, vibration during running, normal and emergency line-to-line voltage and phase rotation.

- Automatic startup by means of simulated power outage to test remote-automatic starting, transfer of the load, and automatic shutdown. In addition, demonstrate automatic exercise of the generator set using the full KW rating of the load bank.

- Successful start of one pump with one pump and all facility loads already on.

Care and Precautions

Contractor shall be responsible for any damage to equipment or material due to improper test procedures or test apparatus handling, and shall replace or restore to original condition any damaged equipment or material. Contractor shall furnish <u>and use</u> safety devices such as rubber gloves and blankets, protective screens, barriers, and danger signs, to adequately protect and warn all personnel in the vicinity of the tests. Contractor shall be completely responsible for the adequacy of safety devices and procedures for conducting tests.

4.0.0 **REQUIRED DOCUMENTATION**

All test records shall be reviewed and certified by the Contractor and submitted to the Engineer for review. All applicable drawings shall be corrected and verified for correctness of in-field changes by the Contractor prior to submittal to the Engineer for final review.

Provide Certified Copies of factory test reports. Provide certified copies of design test reports as applicable on similar equipment of the same rating.

Provide copies of *all* field test reports. Include all test reports in the Operation and Maintenance Manuals

Provide Electrical schematics of:

- Generator control panel
- Battery charging system
- Main generator
- Voltage regulator
- Governing system

Provide Data sheets for the following:

- Engine make and model.
- Rated rpm.
- Number of cylinders, bore, stroke, and piston displacement.
- Generator make and model.
- Rating both standby and continuous.
- Generator insulation class and temperature rise.
- Generator transient (x'd) and sub-transient (x’d) reactance in per unit.
- Reports and curves.
- Parts and service support.
- Engine manufacturer's certified engine HP curve.
- Certified generator set fuel consumption curve.
- Factory certified test log.
- Generator motor starting capability curves.