

GENERATORS

PART 1 - NERAL

1.1 RELATED DOCUMENTS

- A. Generator and pump station layout (Appendix C)
- B. Generator electrical connections to pump station (Appendix C)

1.2 SUMMARY

- A. It is the intent of this specification to secure generator systems for standby power supply needs that have been factory built, production tested, site tested, of the latest commercial design, together with all accessories necessary for a complete installation as detailed in the specifications herein. The equipment supplied shall meet the current requirements of NFPA 70 National Electrical Code, latest edition. The generator shall be listed to UL 2200. Where a relevant GVN standard is available for a specified testing or material standard, the GVN standard shall apply.
- B. The work includes furnishing all required labor, materials, tools apparatus and equipment for the complete installation and commissioning of the generator system as shown on the drawings and described in the Specifications including all miscellaneous items incidental to the work.

1.3 MEASUREMENT AND PAYMENT

- A. Generator installation shall be paid upon successful completion of each BOQ line item.

1.4 RELATED WORK

- A. Construction of concrete pad for generator installation.
- B. Furnish and install external fuel tank.
- C. Emergency communication system, and/or operation monitoring system to alert issues related to generator such as but not limited to:
 - 1. Status of operation
 - 2. Output rate and operational parameters
 - 3. Fuel consumption rate and level of fuel in fuel tank
 - 4. Operation history record

1.5 REFERENCES

- A. The generator set shall conform to the following current codes and standards:
 - 1. IEC 8528 Part 4: Control Systems for Generator Sets
 - 2. NFPA 70 – National Electric Code. Equipment shall be suitable for use in systems in compliance with Article 700, 701, and 702.
 - 3. UL 2200 – The genset shall be listed to UL 2200.

4. TCVN 9729-1 to 10:2013 Reciprocating internal combustion engine driven alternating current generating sets.
5. TCVN 4255:2008 Degrees of protection provided by enclosures (IP Code).

1.6 SUBMITTALS

- A. Six sets of submittal data shall include prototype test certification and specification sheets showing all standard and optional accessories to be supplied; schematic wiring diagrams; dimension drawings; and interconnection diagrams identifying by terminal number, each required interconnection between the generator set and an automatic transfer switch for all permanent mounted gensets. Submittal drawings for permanently installed units shall clearly show pad dimensions required and mounting details.
- B. A mark-up copy of this specification with notations clearly showing all deviations and/or exceptions to these Specifications.
- C. Voltage drop calculations under worst case motor starting for loads on the plan. When motor loads are not specified in the bid documents, the bidder shall provide available SKVA @ 25% instantaneous voltage dip.
- D. Testing results.
- E. Manufacturer's Instructions:
 1. Four sets of operating and maintenance instruction manuals specific to the equipment shall be supplied for the engine, generator, governor, voltage regulator, and auxiliary system components as specified herein. No generic manuals will be accepted. Each manual must be clearly marked to identify the site where the generator set is installed.
- F. Qualification Statements:
 1. Submit letter of verification for Manufacturer's Qualifications.
 2. Submit letter of verification for Installer's Qualifications.
- G. Warranty:
 1. The generator systems shall be warranted individually for 1 year or 2,000 hours, whichever occurs first, from the date of the site start-up to be free from defects in material and workmanship in accordance with the manufacturers published warranty. Replacement parts and labor must be furnished at no additional cost to the Owner. Optional 2-year and 5-year warranties shall be available upon request.

PART 2 - MATERIALS

2.1 EQUIPMENT

- A. Generator set shall be factory assembled and tested.
- B. Each standby generator set shall be rated continuous standby (defined as average power output of 70% of the standby power rating) for the duration of any interruption of the normal source power). Each generator shall output at 380V, 3 phase, 4 wire, 50 Hz, 80% power factor at a maximum altitude of 50 feet altitude and 100 degrees F (38 degrees C).
 - 1. Oversized alternators shall be provided as required for motor starting capability.
 - 2. Each generator set shall be capable of starting motor loads as specified in the plans or within the contract documents, with a maximum voltage dip of 25%. Generator will power lift station components with all pumps sequentially started with some miscellaneous loads. Maximum voltage dip shall be determined for Rev worst case scenario (full load demand).
 - 3. Vibration isolators shall be provided between the engine-generators and heavy duty steel bases.
 - 4. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

2.2 CAPACITY

- A. 100kW generator (100 kVA)
 - 1. Quantity: one
 - 2. Fuel tank (built-in): 225 liters- 250 liters
 - 3. Fuel Consumption: shall be no greater than 20 liters/hr at full load.

2.3 ENGINE

- A. Each engine shall operate at a governed speed of 1500 rpm.
- B. Engine-driven or electric fuel transfer pump capable of lifting fuel 1.4 meters, fuel filters, and a fuel distribution system with an electronic isochronous governor capable of +/-0.25% steady-state frequency regulation over an operating temperature range of -40 degree C to +85 degree C.
- C. Cast iron sleeved cylinders.
- D. 2 flexible fuel lines rated 300 degree F (149 degrees C) and 100 psi (6.9 bar) ending in pipe thread.
- E. 12-Volt positive engagement solenoid shift-starting motor.
- F. Automatic battery charging alternator with solid-state voltage regulation, 25 ampere minimum.
- G. Batteries capable of delivering the manufacturer's recommended minimum cold cranking amps required at -20 degrees C, per SAE standard J-537 shall be supplied along with the required battery rack(s) and battery cables mounted within the generator weather protective housing.

- H. 10-Ampere automatic float and equalize battery charger mounted inside the weather protective housing with +/-1% constant voltage regulation from no load over +/-10% AC input line variation, current limited during engine cranking and short circuit conditions, temperature compensated for ambiens from -40 degrees C to 60 degrees C, 5% accurate voltmeter and ammeter, fused, reverse polarity and transient protected. Alarm circuit board to meet the requirements of NFPA- 110 for low battery voltage, high battery voltage, and battery charger malfunction shall be provided and wired to provide annunciation on the control panel. Battery charge shall be 3rd party listed.
- I. Positive displacement, full pressure lubrication oil pump, cartridge oil filters, dipstick, and oil drain.
- J. The generator set supplier shall furnish lubricating oil to fill the crankcase as recommended by the manufacturer.
- K. Dry-type replaceable air cleaner elements for heavy duty application. Each naturally aspirated or turbo charged engine shall be fueled with No. 2 diesel, liquid-cooled by a unit-mounted radiator. Blower fan, water pump, thermostat, and radiator duct flange shall properly cool the engines in 40 degrees C ambient with up to 12.7 mm H2O static pressure on the fan. Radiator shall include a duct flange adapter for connection to the discharge air vent.
- L. The generator set supplier shall furnish 50% ethylene glycol antifreeze solution to fill the engines cooling system.
- M. Block heater, minimum 1500-watts, 220 volt. Thermostatically controlled to maintain engine coolant at not less than 32 degree C in 0 degrees C ambient. Block heater(s) shall be 3rd party listed.
- N. Gas proof, stainless steel, flexible exhaust bellows with threaded NPT or flanged connections shall be supplied.
- O. Super critical grade exhaust silencer(s) shall be coated to be temperature and rust resistant with integral condensate drain. Exhaust silencers shall limit noise to 75 dBA @ 7 meter radius from the genset.
- P. Each engine shall be equipped with prealarm switches and safety shutdown switches to protect the engines from the following:
 - 1. Oil pressure prealarm.
 - 2. High coolant temperature prealarm.
 - 3. Low coolant temperature prealarm.
 - 4. High coolant temperature shutdown.
 - 5. Low coolant level shutdown.
 - 6. Low oil pressure shutdown.
 - 7. High/Low Voltage shutdown.
 - 8. High/Low Frequency shutdown.

2.4 GENERATOR

- 1. The alternator shall be salient-pole, brushless, 12-lead reconnectable, of 2/3 pitch to eliminate the third harmonic, self-ventilated of drip-proof construction with amortisseur rotor windings and skewed for smooth voltage waveform. The insulation shall meet the NEMA standard (MG1-22.40)/ or TCVN 4255:2008 Degrees of protection provided by enclosures (IP Code) for Class H and be vacuum impregnated with epoxy varnish to be fungus resistant per MIL 1-24092. Temperature rise of the

rotor and stator shall be limited to NEMA Class F, 40 degrees C. The excitation system shall be of brushless construction controlled by a solid-state voltage regulator located in the controller.

2. The voltage regulator must be capable of maintaining voltage within $\pm 2\%$ at any constant load from 0 to 100% of rating. The regulator must be isolated to prevent tracking when connected to SCR loads, and provide individual adjustments for voltage range, stability, and volts-per-hertz operation, and be protected from the environment by conformal coating.
 3. Voltage level adjusting rheostat shall be furnished external to the automatic voltage regulator. Minimum adjustment range shall be $\pm 10\%$.
- B. Upon 1-step application of any load up to 100% of the rated load at 0.8 power factor, the voltage dip shall not exceed 30% and shall recover to $\pm 2\%$ of rated voltage within 1 second.
 - C. The generator shall be capable of sustaining at least 250% 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.
 - D. The generator shall be capable of sustaining at least 110% of rated output for at least one hour in a 24 hour period.
 - E. A resettable line current sensing circuit breaker with inverse time versus current response shall be furnished which protects the generator from damage due to its own high current capability. This breaker shall not trip within the 10 seconds specified above to allow selective tripping of downstream fuses or circuit breakers under a fault condition. This breaker shall not automatically reset, preventing restoration of voltage if maintenance is being performed. Field current-sensing breaker will not be acceptable.
 - F. Line circuit breaker, 3 pole, amperes rating as specified on plans, shall be mounted in the generator set outlet box.
 - G. The generator, having a single maintenance-free bearing, shall be directly connected to the flywheel housing with a semi-flexible coupling between the rotor and the flywheel.

2.5 FUEL SYSTEM

- A. No additional fuel system required.

2.6 ENCLOSURE

- A. Sound attenuated drip-proof, weather protective enclosure shall be constructed of 0.063" (1.6mm) (14 gauge equivalent) marine grade 5052 aluminum alloy. The enclosure shall be primed and finish coated with powder baked paint. The paint color shall be machinery gray. The enclosure shall be fabricated and mounted to the sub-base fuel tank by the generator manufacturer. The enclosure roof shall be peaked to direct water runoff away from all components.
- B. Two doors per side and one rear door shall be provided for operator and service access. Hinges shall allow the doors to swing open or be removed easily for access and service. Access to the controller and main line circuit breaker must meet the requirements of the National Electric Code (current edition). All door locks shall be stainless steel and shall be keyed alike to match the existing county equipment, manufacturer A.L. Hansen, Key #1250.

- C. Exhaust piping and internally insulated super critical grade silencer shall be mounted inside the enclosure.
- D. Cooling and combustion air shall enter the enclosure through wire screened panels. Engine exhaust gases and cooling air shall discharge vertically through a screened opening.
- E. Sound shall be reduced by UL approved polyether acoustic material with protective facing film which is securely attached to the enclosure interior. Sound shall not exceed 75 dBA, 7 meters from the enclosure center with the generator set operating at full load.

2.7 CONTROLLER/GAUGE PANEL

- A. Set-mounted and vibration isolated on the generator enclosure. Gauge panel shall include:
 - 1. Panel illuminating lights.
 - 2. Battery charging voltmeter.
 - 3. Coolant temperature gauge.
 - 4. Oil pressure gauge.
 - 5. Running time meter.
 - 6. Local emergency stop button.
- B. The controller shall include:
 - 1. Fused DC circuit.
 - 2. Complete 2-wire start/stop control, which shall operate on closure of a remote contact.
 - 3. Speed sensing and a second independent starter motor disengagement systems shall protect against starter engagement with a moving flywheel. Battery charging alternator voltage will not be acceptable for this purpose.
 - 4. The starting system shall be designed for restarting in the event of a false engine start, by permitting the engine to completely stop and then re-engage the starter.
 - 5. Cranking cycler with 15 second ON and OFF cranking periods.
 - 6. Overcrank protection designed to open the cranking circuit after 75 seconds if the engine fails to start.
 - 7. Circuitry to shut down the engine when signal for high coolant temperature, low coolant level, low oil pressure, low fuel level, or overspeed are received.
 - 8. Engine cooldown timer factory set at 5 minutes to permit unloaded running of the standby set after transfer of the load to normal.
 - 9. 3-position (Automatic-OFF-TEST) selector switch. 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 an emergency. Reset of any fault shall also be accomplished by putting the switch to the OFF position.
 - 10. Indicating lights to signal:
 - a. Not-in-Auto (flashing red)
 - b. Overcrank (red)
 - c. Emergency Stop (red)
 - d. High Engine Temperature (red)
 - e. Overspeed (red)
 - f. Low Oil Pressure (red)
 - g. Air Damper (red)
 - h. Battery Charger Malfunction (red)
 - i. Low Battery Voltage (red)
 - j. Low Fuel (red)

- k. Auxiliary Prealarm (yellow)
- l. Auxiliary Fault (red)
- m. System Ready (green)
- n. Prealarm High Engine Temp. (yellow)
- o. Prealarm Low Oil Pressure (yellow)
- 11. Test button for indicating lights.
- 12. Alarm horn with silencer switch per NFPA 110.
- 13. Dual element electronic speed switch with crank disconnect contact and overspeed contact shall be controlled by a magnetic pickup mounted radially to the flywheel ring gear.
- 14. Terminal blocks shall be provided for all engine/generator prealarms safety shutdowns, plus auxiliary functions. Each terminal shall be permanently marked to match the point-to-point wiring diagrams.
- 15. The controller shall be provided with a RS 485 Modbus port to provide industry standard open communications protocol.
- 16. Dry contact kit w/10 relays to provide normally open and normally closed contacts in a form C configuration to activate warning devices and other customer provided accessories allowing remote monitoring of the generator set as indicated above.

PART 3 - EXECUTION

3.1 FACTORY PRODUCTION TEST

- A. Perform the test according to TCVN 9729-6:2013:
 - 1. Item 6.7.4.1. Acceptance test with electrical load.
 - 2. Item 6.7.4.2. Acceptance test using test bench switchgear
 - 3. Item 6.7.4.3. Acceptance testing includes the generator set's switchgear
 - 4. Item 6.7.4.5. Acceptance test without electrical load.
- B. Submit 3 certified copies of report of production test results, and obtain approval before shipment to the site.

3.2 FIELD INSTALLATION

- A. Verify that equipment pads are dimensionally correct and ready to receive the equipment.
- B. Verify that required utilities are available, in proper location and ready for use.
- C. Install equipment in accordance with manufacturer's instructions.
- D. Install safety labels to NEMA 260 and labeling per Division 26 Section "Common Work Results for Electrical".

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.
- B. Connect fuel, cooling system, and exhaust system piping adjacent to packaged engine generator to allow service and maintenance.
- C. Ground equipment per TCVN 9358:2012 and manufacturers recommendations.

3.4 SITE TESTING

- A. Test the engine-generator set and ancillary systems at service load to demonstrate durability; verify that heat of extended operation does not adversely affect or cause failure in any part of the system; and check all parts of the system. If the engine load run test is interrupted for any reason, repeat the entire test. Perform the following tests in addition to any manufacture recommended testing. And the tests according TCVN 9729-6:2013 and TCVN 9729-10:2013.
 - 1. Perform and record engine manufacturer's recommended prestarting checks and inspections. Include as a minimum checking of coolant fluid, fuel, and lube-oil levels
 - 2. Start the engine, make and record engine manufacturer's after-starting checks and inspections during a reasonable warmup period.
 - 3. TCVN 9729-6:2013 Item 6.7.5 Acceptance testing at installation site, Group the test items and measurements to be performed according to Table 3.
 - 4. TCVN 9729-10:2013 Measurements of airborne noise by the enveloping surface methods.

3.5 OPERATION AND MAINTENANCE TRAINING

- A. Operating personnel shall be instructed (a minimum of two hours) by the representative in the proper operation and maintenance of the unit on the test day.
- B. Formal operation and maintenance training shall be conducted by the vendor or manufacturer's representatives within two weeks of activation of the equipment. An outline of the proposed program shall be submitted for approval at least two weeks before date of commencement of training.

3.6 FINAL SUBMITTALS

- A. Five sets of bound copies of text and illustrations, delineating maintenance and repair procedures for engine, generator, engine-generator control, radiator, fuel oil day tank assembly, fuel oil tank gage, and other equipment related to the engine-generator set installation. Assemble data on like equipment in clearly identified and indexed three-ring binders or equal. Include the following:
 - 1. Lubrication charts showing types of lubricant, locations of lubrication points, and recommended lubrication frequency for all equipment.
 - 2. Parts list of replaceable parts and any special tools required.
 - 3. Lists of component items not the product of the manufacturer of equipment on which used, with local source of supply, catalog cuts, and all necessary information for ordering replacements.
 - 4. Complete AS-BUILT electrical schematic and connection diagrams with all internal and external connection points identified to match identification on equipment.
- B. Furnish a written guarantee that the equipment will meet the specified performance. In addition, the guarantee shall cover the equipment against any defects in design, workmanship and material for one year from date of start-up. Also, a one-year labor and material guarantee shall be provided which will be twelve (12) months from date of start-up.
- C. Posted Operating Instructions: Submit proposed operating instructions which shall be laminated between matte-surface thermoplastic sheets and be suitable for placement adjacent to applicable equipment. After approval, operating instructions shall be returned to the Subcontractor for installation where directed by the Project Manager.

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- D. Test Reports: Submit certified test and inspection reports for all work performed in Paragraphs 3.2 & 3.4. A certified report verifying proper installation of all of the system shall be provided to the Project Manager and shall be approved prior to start-up of equipment.

END OF SECTION