

**Section 16620B - NATURAL GAS ENGINE GENERATOR SET**

PART I-GENERAL

1.1 GENERAL

PROJECT NO.

- A. The requirements specified in GENERAL - general requirements of this project shall apply to and govern the work under CSI Division I except where indicated in the following articles.

1.2 WORK INCLUDED

- A. Provide all labor, materials and equipment to furnish, install and place in operation a natural gas power generation system in accordance with the contract documents and manufacturer's drawings and installation instructions. These specifications also describe requirements for the design, fabrication and testing of the power system. The total installation shall conform to manufacturer's recommendations.
- B. The installation of the power generation system shall include the following:
  - Engine-driven generator set
  - Control system
  - Cooling system
  - Connection to natural gas system
  - Generator set accessories
  - Mounting system
  - System control and switchgear
  - Base slab and vibration isolation
  - Weatherproof housing, sound attenuated

1.3 RELATED WORK

Refer to the following specifications for related mechanical and electrical considerations:

- Section 16000 - Electrical Work
- Section 16260 - Automatic Transfer Switch

1.4 SYSTEM DESCRIPTION

- A. The electric power generating system shall have a site capability of xxx kw, xxx kva, under continuous standby operation.
- B. The system shall consist of a natural gas generator set which includes all controls, protection, output circuit breaker, wiring, and accessories for automatic start-stop operation.
- C. The overload capability shall be in excess of this rating, at extreme limits of parameters specified, for not less than 1 hour.

Where air temperature extremes are not the case, test results will be extrapolated. The results shall be as interpreted by the University of Arizona Electrical Engineer.

- D. The generator set shall include the capability of automatically controlling generator set operation. After starting, the unit will attain rated speed and voltage, and accept rated load. Generator set speed shall be controlled by the engine governor, while generating output voltage regulation shall be a function of the generator automatic voltage regulator. Manual adjustment of generator

speed and voltage shall be provided.

- E. The generator set start-stop sequence shall be initiated manually or automatically by closing or opening of a contact. The control system shall automatically engage the cranking motor, sense engine starting speed, disengage the motor and arm the engine protection circuit.
- F. The set shall immediately shut down in the event of overspeed, low oil pressure, high water temperature and overcrank. Cause of shutdown shall be indicated by a light annunciator. System logic shall prevent restart until fault is cleared.

There shall be a provision for manual shutdown in the event of an emergency.

1.5 SITE CONDITIONS

The operating environment of the power generating system shall be:

Altitude	2400 ft.
Engine room temperature, max	125 F
Outside temperature, min	20 F
Outside Temperature max	115 F
Fuel type	Natural Gas
Fuel pressure (gas)	Verify pressure for specific site by contacting PDC

1.6 SYSTEM PERFORMANCE, GENERAL

- A. The power generating system shall conform to the following performance criteria:
  - 1 Rating - Engine brake horsepower shall be sufficient to deliver full rated generator set KW/KVA at the installation site when operated at rated rpm and equipped with all engine-mounted parasitic and external loads such as radiator fans and power generators.
  - 2. The Gas engine shall be able to deliver rated power when operating on dry natural gas having a low heating value (LHV) of 905 Btu/cu ft (33.74 kJ/L).
  - 3. Gas Engine fuel rates shall be based on fuel having a low heating value (LHV) of 905 Btu/cu ft. (33.74 kJ/L).
  - 4. Start Time and Load Acceptance - Engines shall start, achieve rated voltage and frequency, and be capable of accepting load within 10 seconds when properly equipped and maintained.
  - 5. Block Load Acceptance - Transient response shall conform to ISO 8528 requirements.
- B. The power generating system shall satisfy the following performance criteria at site conditions:
 

Total Power Capability	xxx Kw
Frequency	60 Hz
Voltage	480/277/1/3 phase 4 wire
Voltage Dip starting Largest Motor sequence	20%
Power Factor	0.8
Overload for 1 Hour	10%
- C. The individual generator set shall exhibit the following performance capability: Caterpillar xxx model. Other manufacturer's are Waukesha, Cummings, Onan, Generc, prior approved. Contact Robert Cousy, P.E., (621-9252) for approval prior to bid due date.

1.7 QUALITY ASSURANCE

- A. The complete power generation system, including engine, generator, and switchgear shall be the

product of one manufacturer who has been regularly engaged in the production of complete generating systems for at least 10 years. All components shall have been designed to achieve optimum physical and performance compatibility and prototype tested to prove integrated design capability. The complete system shall have been factory fabricated, assembled, and production tested as performed by Caterpillar, or prior approved systems.

#### 1.8 RESPONSIBILITY

- A. The responsibility for performance to this specification shall not be divided among individual component manufacturers, but must be assumed solely by the primary manufacturer. This includes generating system design, manufacture, test, and having a local supplier responsible for service, parts, and warranty for the total system.

#### 1.9 SUBASSEMBLY AND PACKAGING

- A. Generator set mounted subassemblies such as cooling system, base, air intake system, exhaust outlet fittings, and generator set mounted controls and switchgear shall also be designed, built, and assembled as a complete unit by the engine - generator manufacturer.

#### 1.10 PRODUCTION TESTS

- A. The system manufacturer shall perform post production tests on the generator set supplied. A certified report of these tests shall be available when requested at the time of the generator set order.

#### 1.11 DRAWINGS/SCHEMATICS

- A. All installation drawings and wiring diagrams for the generator set, controls, and switchgear must conform to a common format of 8 ½" x 11", 11" x 17" and 24" x 36".

#### 1.12 SUBMITTALS

- A. Submittals shall include but not be limited to:
  1. Component List - A breakdown of all components and options including switch gear.
  2. Technical Data - Manufacturer produced generator set specification or data sheet identifying make and model of engine and generator, and including relevant component design and performance data.
    - a. Engine:
      - Type, aspiration, compression ratio, and combustion cycle.
      - Bore, stroke, displacement, and number of cylinders.
      - Engine lubricating oil capacity.
      - Engine coolant capacity without radiator.
      - Engine coolant capacity with radiator.
      - Coolant pump external resistance (maximum). Where remote radiator is specified
  3. Generator: Model
    - Model
    - Frame
    - Insulation class
    - Number of Leads
    - Weight, total
    - Weight, rotor
    - Air Flow

At rated voltage:

Efficiency at 0.8 power factor for: 50% load, 75% load, 100% load  
 Fault current, 3 phase symmetrical  
 Decrement curve

- 4. Radiator: (High Ambient, Brass)  
 Model  
 Type  
 Coolant capacity, radiator  
 Coolant capacity, radiator and engine  
 Weight: Dry, Wet
- 5. System:  
 Dimensions: Length, Width, Height  
 Weight: Dry, Wet

Performance in 115°F air, 2400 MSL.

Continuous power rating at 0.8 power factor (KW) kVA rating  
 Fuel consumption at standard conditions for:  
 50%, 75% and 100% load Heat rejection to:  
 coolant, after-cooler, exhaust, atmosphere from engine, and atmosphere from  
 generator  
 Exhaust gas stack temperature  
 Exhaust gas components; % NOX, % SO  
 Tons particulate/yr/mo at 50%, 100% load  
 Verification of 10% overload capability

- B. Transient response of frequency and voltage for the generator set:
- C. Auxiliary Equipment - Specification or data sheets, including switchgear, spring type vibration isolators.
- D. Drawings - General dimensions drawings showing overall generator set measurements, mounting location, and interconnect points for load leads, fuel, exhaust, cooling and drain lines.
- E. Wiring Diagrams - Wiring diagrams, schematics and control panel outline drawings published by the manufacturer in Joint Industrial Council (JIC) format for controls and switchgear showing interconnected points and logic diagrams for use by contractor and owner.
- F. Warranty Statements - Warranty verification published by the manufacturer.
- G. Service - Location and description of supplier's parts and service facility including parts inventory and number of qualified generator set service personnel.

1.13 SERVICE AND WARRANTY

- A. The manufacturer shall have a local authorized dealer who can provide factory trained servicemen, the required stock of replacement parts, technical assistance, and warranty administration.
- B. The manufacturer's authorized dealer shall have a parts and service facility within 130 miles of the jobsite.
- C. The generator set supplier shall have factory trained service representatives and tooling

necessary to install, test, maintain, and repair all provided equipment.

#### 1.15 WARRANTY ADMINISTRATION

- A. The manufacturer's authorized dealer shall be capable of administering the manufacturer's and dealer's warranty for all components supplied by the selling dealer (who may or may not be the same as the servicing dealer).

#### 1.16 WARRANTY TERMS

- A. The manufacturer's and dealer's standard warranty shall in no event be for a period of less than two (2) years from date of initial start-up of the system and shall include repair parts, labor, reasonable travel expense necessary for repairs at the jobsite, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Running hours shall not be a limiting factor for the system warranty by either the manufacturer or servicing dealer. Submittals received without written warranties as specified will be rejected in their entirety.
- B. The manufacturer's and dealer's extended warranty shall in no event be for a period of less than five (5) years from date of initial start-up of the system or 2500 operating hours, whichever comes first. It shall include repair parts, labor, reasonable travel expense necessary for repairs at the jobsite, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair. Applicable deductible costs shall be specified in the manufacturer's warranty. Submittals received without written warranties as specified will be rejected in their entirety.

#### 1.21 WARRANTY NAMEPLATE

- A. A warranty nameplate of not less than 152 mm x 203 mm (6 in x 8 in) must be affixed to the generator set with the following data:

Warranty Period:  
Start-up Date:  
Termination Date:  
Supplier Name:  
Supplier Address:  
24-Hour Emergency Number:  
Preventive maintenance to be performed by:

#### 1.22 MAINTENANCE CONTRACT

- A. The generator set supplier shall offer a maintenance and repair contract which guarantees all support costs of the specified system. It shall include routine and 24 hour emergency access to a factory account manager to expedite emergency repairs. This shall be priced during the bid process as an additive bid item.
- B. The contract shall protect the user from parts and labor price increases, and shall provide a refund of residual funds at any time of user dissatisfaction. Optional payment schedules shall include fixed rate throughout the life of the contract.

#### 1.23 PARTS AVAILABILITY

- A. The generator set supplier shall have sufficient parts inventory to maintain over the counter availability of at least 90% of any normal wear and tear parts. (Belts, hoses, filters, turbines, pumps, safeties, regulators, injectors, gaskets)

- B. The generator set supplier shall guarantee overnight 100% parts from the time an order is entered with the dealer.

#### 1.24 OIL SAMPLING SERVICE

- A. The generator set supplier shall provide a scheduled oil sampling service to monitor engine condition on an ongoing basis. The sampling method shall be of the atomic absorption spectrophotometry method.

Immediate notification of critical results shall be provided to the owner's representative.

### PART 2- PRODUCTS

#### 2.1 PRODUCTS

- A. The following articles and paragraphs are intended to define a power generation system of proven type and design, of current production, and with all components commercially available.
- B. Approved systems, subject to conforming to the Specifications are Caterpillar, Generac and Cummins/Onan.
- C. These products shall be from vendors with factory approval as stocking dealer – distributors with evidence of having supplied and serviced units of equal size and performance for at least 5 years.
- D. Generators shall be designed to provide not less than 110% output, based on specified capacity, for a period of 2 hours at temperature extremes.

#### 2.2 ENGINE

- A. The engine shall be a stationary, liquid cooled, 1800 rpm, four-cycle design, vertical inline or V-type, with Dry exhaust manifolds. It shall have cylinders with minimum displacement of xx liters and be manufactured in the United States.

#### 2.3 ENGINE EQUIPMENT

- A. The engine shall be equipped with air filters, fuel filters and pressure gauge, lubricating oil cooler, filters, and pressure gauge, water pump and temperature gauge, service hour meter, flywheel, and flywheel housing.

#### 2.4 LUBRICATION SYSTEM

- A. The lubrication oil pump shall be a positive displacement type that is integral with the engine and gear driven from the engine gear train. The system shall incorporate full flow filtration with bypass valve to continue lubrication in the event of filter clogging.
- B. The bypass valve must be integral with the engine filter base or receptacle. Systems where bypass valves are located in the replaceable oil filter are not acceptable. Pistons shall be oil cooled by continuous jet spray to the underside or inside of the crown and piston pin.
- C. System shall utilize synthetic lubricants with compatible filtration, and compatible engine seals, approved by the engine manufacturer.

#### 2.5 GASEOUS FUEL SYSTEM

- A. The gaseous fuel system shall consist of gas pressure regulators and carburetors. The carburetor shall be a diaphragm type which includes a load screw for air-fuel ratio adjustment, and throttle body to control the air-fuel mixture to the engine.

## 2.6 IGNITION SYSTEM

- A. The ignition system shall be the low tension type and consist of magneto, transformers, and spark plugs. The magneto shall be of solid state design and spark plugs will incorporate gold palladium electrodes for reliability and life.

## 2.7 GOVERNOR

- A. The engine governor shall control engine speed and transient load response within commercial and ISO 8528 tolerances. It will be selected, installed, and tested by the generator set manufacturer.

## 2.8 GOVERNOR, ELECTRONIC-SPEED CONTROL

- A. The engine governor shall be a Woodward 2301 Electronic Speed Control with EG Electro-Hydraulic Actuator or Barber Coleman Equal. Speed drop shall be externally adjustable from 0 (isochronous) to 10% from no load to full rated load. Steady state frequency regulation shall be  $\pm 0.25$  percent.

## 2.9 COOLING SYSTEM

- A. The engine jacket water cooling system shall be a closed circuit design with provision for filling, expansion, and de-aeration. The cooling pump shall be driven by the engine. Auxiliary coolant pumps required for heat exchangers or separate circuit after cooling shall also be engine driven. Coolant temperature shall be internally regulated to disconnect external cooling systems until operating temperature is achieved.

## 2.10 RADIATOR, ENGINE-MOUNTED

- A. Heat rejected to the engine jacket water shall be discharged to the atmosphere through a close coupled radiator. The radiator shall be sized to cool the engine continuously while operating at full rated load and at site conditions of 115°F ambient.

## 2.11 FAN AND BELT GUARDING

- A. The fan, fan drive, and fan belts shall be covered with punched steel mesh guarding for personnel protection. The guarding shall conform to UL 2200.

## 2.12 BLOWERFAN

- A. The radiator cooling fan shall be a blower type driven from the engine. Air shall be drawn from the engine side and exhausted through the radiator core with no more than 12.7 mm (0.5 in) of water external restriction in addition to core restrictions.

## 2.13 INLET AIR SYSTEM

- A. The engine air cleaner shall be engine mounted with dry element requiring replacement no more frequently than 250 operating hours or once each year.

## 2.14 TURBOCHARGING

- A. Only single stage turbo charging shall be allowed.

## 2.15 AFTERCOOLING

- A. After-cooler core air surfaces shall be coated with a corrosion inhibitor to minimize oxidation.

## 2.16 EXHAUST SYSTEM

- A. The engine exhaust system shall be installed to discharge combustion gases quickly and silently with minimum restriction. System including silencer shall be designed for minimum restriction, and in no case shall back pressure exceed 6.7 kPa.
- B. Heavy walled piping such as Schedule 40 is preferred, with radii of 90 bends at least 1-1/2 times the pipe diameter. Piping shall be installed with 229 mm (9 in) minimum clearance from combustible material or incorporate appropriate insulation and shielding.
- C. Piping shall be supported and braced to prevent weight or thermal growth being transferred to the engine and flexible expansion fittings provided to accommodate thermal growth. Support dampers and springs shall be included where necessary to isolate vibration. Install in accord with manufacturer's recommendations.
- D. Long runs of pipe shall be pitched away from the engine and water traps installed at the lowest point. Exhaust stacks shall be extended to avoid nuisance fumes and odors. And outlets cut at 45° to minimize noise. Aim outlet to northwest as directed.

## 2.17 SILENCER-CRITICAL

- A. Provide critical silencer in accordance with Paragraph 2.32 E.
- B. The silencer shall have an end inlet and end outlet.

## 2.18 PACKAGED SYSTEMS

- A. Submit for individual approval in lieu of Paragraph 2.16.

## 2.18 ELECTRIC STARTING SYSTEM

- A. The engine starting system shall include 24 volt DC starting motor(s), starter relay, and automatic reset circuit breaker to protect against butt engagement. Batteries shall be maintenance free, lead acid type mounted near the starting motor. A corrosion resistant or coated steel battery rack shall be provided for mounting. Required cables will be furnished and sized to satisfy circuit requirements. The system shall be capable of starting engine within 10 seconds. 12 v systems will be considered for 75 kw or less units by prior approval.

## 2.19 JACKET WATER HEATER

- A. Jacket water heater(s) shall be provided to maintain coolant temperature of 32 C (90 F) while the engine is idle. Heaters shall accept 208 volt AC single phase power and include adjustable thermostats.

## 2.20 BATTERIES

- A. Batteries for starting and control shall be selected and supplied by the generator set manufacturer. They shall be a heavy duty SLI lead acid type with through-partition connectors, and housed in a hard rubber or polypropylene case with provision for venting.
- B. Battery warranty shall be the responsibility of the generator set manufacturer.



## 2.21 ALTERNATOR

- A. An engine mounted belt driven battery charging alternator shall be installed with an automatic voltage regulator. It shall be suitable for heavy duty applications with a rating of 24 volts.

## 2.22 INSTRUMENTATION-ENGINE

- A. The engine mounted instrument panel shall consist of a shock-mounted formed and welded enclosure primed for coastal environment. Provide Metric/English marked gauges. Gauges shall include: engine oil pressure, oil filter differential, fuel pressure, jacket water temperature, electric service meter and running time meter.

## 2.23 GENERATOR

- A. The generator shall be equivalent to caterpillar model xxx and shall be rated for standby service at xxx kw, xxx KVA, 0.8 PF, xxx V, three phase, wire, 60 Hz, 1800 rpm.
- B. The generator shall be capable of withstanding a three phase load of 300% rated current for 10 seconds, and sustaining 150% of continuous load current for 2 minutes with field set for normal rated load excitation.
- C. It shall exhibit less than 5% waveform deviation at no load.
- D. Generator efficiencies shall be calculated according to IEC 34-2 Section 4, with all current squared times R losses corrected to 115 F.

## 2.24 STRUCTURE

- A. The generator shall be close coupled, drip proof and guarded, constructed to NEMA I and IP 22 standards, single bearing, salient pole, revolving field, synchronous type with amortisseur windings in the pole faces of the rotating field.

## 2.25 MECHANICAL DESIGN - SINGLE BEARING

- A. The generator housing shall be one piece and mount directly to the engine flywheel housing without bolted adaptors.

## 2.26 WINDINGS

- A. Thermal Class 200 magnet wire as described by NEMA Magnet Wire Standard MW 1000, Section MW 35-C, shall be used for rotor and stator windings. The windings shall consist of copper magnet wire. All winding insulation materials shall be Class H in accordance with BS and IEEE standards.

## 2.27 OPERATING ENVIRONMENT

- A. The generator shall be designed to operate in a sheltered drip-proof environment.

## 2.28 EXCITER-PERMANENT MAGNET

- A. The permanent magnet excitation system shall derive excitation current from a pilot exciter mounted on the rotor shaft. It shall enable the generator to sustain 300% of rated current for ten seconds during a fault condition.

## 2.29 VOLTAGE REGULATOR - SEALED

- A. The automatic voltage regulator shall be manufactured by the manufacturer of the engine -

generator set. The volts/hertz regulator shall sense line-to-line three phases of generator output voltage and exhibit the following characteristics:

1. Generator output voltage maintained within +/- 1% of rated value for any load variation between no load and full load.
2. Generator output voltage drift no more than +/- 1/2% of rated value at constant temperature.
3. Generator output voltage drift no more than +1- 1% of rated value within a 40° change over ambient temperature range of -40° C to 70° C.
4. Generator frequency change not over ¼ cycle no load to full load and back.
5. Response time less than 20 milliseconds.
6. Telephone Influence Factor (TIF) of less than 50.
7. Electronic Interference/Radio Frequency Interference (EMI/RFI) suppressed to commercial standards.
8. The regulator shall include the following features:
  - a. Voltage level rheostat to provide generator output voltage adjustment of -25% to +10% of nominal.
  - b. Gain adjustment to provide output voltage compensation for changes in load or frequency.

#### 2.30 MOUNTING BASE-STANDBY PACKAGE

- A. The base shall be constructed of formed "C" section steel members with minimum 6 mm thickness. Corners shall be squared to provide rodent/bird proof joint when enclosure is added. Provision shall be made for four corner lifting. It shall incorporate flexible fuel lines, external oil and coolant drains and external crankcase fumes disposal hose. Support cross members shall add rigidity and allow installation of vibration isolators between base and generator set. Generous space for ground stub-ups between the members shall be provided. The base shall include bottom mounting holes.

#### 2.31 ISOLATOR-SPRING TYPE

- A. Steel spring isolators shall be installed between the generator set base and the mounting surface. The isolators shall bolt to the base, and have a waffled or ribbed pad on their bottom surface. The pads shall be resistant to heat and age, and impervious to oil, water, antifreeze, diesel fuel, and cleaning compounds

#### 2.32 ENCLOSURE - STANDBY PACKAGE, FULL

- A. The enclosure shall offer protection as specified by OSHA from all moving and hot parts of the engine, generator and radiator. It shall be constructed to allow full access to the engine for maintenance without exposing personnel to any moving machinery. Radiator and radiator fan assembly shall be totally enclosed with lockable door over the radiator cap. The radiator shall be sized to accommodate any resulting air flow restrictions. Provision shall be made for a duct flange or perforated metal grill to protect the radiator core. Doors shall be the lift off hingeless type with lockable stainless steel security latches.
- B. Louvers shall allow sufficient air flow to allow full load operation of the generator set. The louvers

shall be twisted to deflect water and direct noise downward. The enclosure shall satisfy IEC 1P22 requirements for drip proof construction acceptable for outside installation when doors are in place.

- C. The enclosure shall be fitted to the generator set base and isolated from engine vibration. Corners shall be formed and welded to assure strength and rigidity. Sheet metal with minimum thickness of 2.0 mm for enclosure and 1.2 mm for doors shall have no burrs or sharp edges. Inside and outside surfaces shall be finished with a baked high performance enamel. Exposed fasteners shall be minimized with all hardware stainless steel.
- D. Outdoor generator enclosures shall be sage green, Federal standard 595b, 14449.

### 2.32 CONTROLS, PROTECTION AND MONITORING

- A. The controls, protection and monitoring systems of the generator set and its operation shall be the responsibility of the generator set manufacturer. All subsystem components, interfaces, and logic shall be compatible with engine mounted devices.

### 2.33 AUTOMATIC START-STOP CONTROL

- A. The control panel shall be shock mounted on the generator and have the capability to face either side or the rear of the generator. The 24 volt DC system shall incorporate energize to run logic and include:
  - 1. Control:
    - a. Generator voltage level rheostat and ammeter/voltmeter phase selector switch shall be mounted on the panel door.
    - b. The engine start-stop switch shall be door mounted and include positions for off/reset, manual, automatic and stop.
  - 2. Shutdowns/Annunciation:

The generator set shall shut down and individual red lights shall signal operational faults of high water temperature, low oil pressure, overspeed and overcrank.
  - 3. Monitor:

Monitoring devices shall include AC voltmeter, AC ammeter, ammeter/voltmeter phase select switch, frequency meter, electric hourmeter, oil pressure gauge, and water temperature gauge.
  - 4. Safety Devices:

ISO red emergency stop pushbutton shall be provided, and all controls, annunciation, and monitors labeled with ISO symbols.
  - 5. Cycle Cranking

A cycle crank timer shall provide five 10 second cranking periods separated by 10 second rest periods.
  - 6. Engine Cool Down

A cool down timer shall provide an adjustable 0-30 minute engine running period before shutdown after removal of load set at 15 min.

7. Alarm Module

NFPA-99 requirements for the alarm panel shall be satisfied by a 24 volt DC alarm module mounted in the panel and including red indicating lights and silencable alarm horn to annunciate alarm conditions for high and low coolant temperature, low oil pressure, low DC voltage, and system not in automatic.

8. Battery Charger

The battery charger is to be a solid-state device with adjustable float voltage control. It is to be a constant voltage device with current limit, and it is to include an equalize switch which will allow the battery to be overcharged for maintenance purposes.

9. Overvoltage, Undervoltage and Underfrequency Protection

The controls will include devices to protect against overvoltage, undervoltage, underfrequency and overfrequency output from the generator. This protection must sense voltage and frequency directly and controls which attempt to measure these values by measuring excitation current will not be acceptable.

10. Emergency Stop Switch

The engine controls will be arranged to stop the engine if a remote maintained contact emergency stop switch is depressed. Once the switch has been operated, it should not be possible to start the engine until the stop switch is released. The "Switch Off Normal" indicating lamp on the front of the panel and the remote engine fail alarm must both be activated if the stop switch has been operated.

#### 2.34 CIRCUIT BREAKER-GENERATOR SET MOUNTED

- A. The circuit breaker shall be mounted and connected in a guarded drip-proof enclosure. Cable lugs shall be provided for customer connections.
- B. One molded case electronic circuit breaker, three pole, single-throw, stationary-mounted with manual operating handle, overload and short circuit trips, complete with cable lugs. Overcurrent trip shall be 100% rated and sized to provide enclosed and ambient temperature compensation. The breaker shall be qualified for 600 volt operation and tested in accordance with UL Standard 489, LSI / LSIG. Breaker shall be adjustable to allow for 110% output test.
- C. One shunt trip, 24 volt DC, on circuit breaker wired to terminal board.
- D. Three current transformers, 5 ampere secondaries.
- E. One ground connection point.

#### 2.35 REMOTE ANNUNCIATOR PANEL

- A. NFPA-99 requirements for remote annunciation shall be satisfied by a remote mounted electro-mechanical panel which includes red and yellow indicating lights and silenceable alarm horn for low oil pressure shutdown, low coolant temperature alarm, high coolant temperature, shutdown, overcrank, overspeed shutdown, battery charger malfunction (via charger switch), generator on load (via Customer switch). Install where directed by the University.

## 2.36 AUTOMATIC TRANSFER SWITCH

- A. The automatic transfer switch shall be as specified in the specification.

## 2.37 WEATHERPROOF SOUND ATTENUATING ENCLOSURE

- A. Enclosure shall be sound attenuating enclosure: the engine-generator set shall be factory enclosed in not less than a 12 gauge steel enclosure constructed with corner posts, uprights and headers. The roof shall aid in the runoff of water and include a drip edge. The enclosure shall be coated with electrostatically applied paint, baked and finished to manufacturers specifications. The enclosure shall be completely lined with not less than 1" thick, UL 94 HF-1 listed, sound deadening material. This material must be of a self extinguishing design. The critical silencer shall be included to further reduce the unit sound level. The overall design must be such that sound level is 75dbA at 7 meters (23 feet) or less.
- B. Exhaust silencer(s) shall be provided of the size as recommended by the manufacturer and shall be of critical grade to attenuate the sound to the level noted above. It shall be supplied with a flexible, seamless, stainless steel exhaust connection. A rain cap will be supplied to terminate the exhaust pipe. These components must be properly sized to assure operation without excessive back pressure when installed.

**PART 3- EXECUTION**

## 3.1 EXECUTION

- A. The following articles and paragraphs are intended to define acceptable procedures and practices of inspecting, installing, and testing the generator set and associated equipment.

## 3.2 PREDELIVERY INSPECTION

- A. A pre-delivery inspection must be performed by the system manufacturers' local dealer at the dealer's facility to insure no damage occurred in transit and all genset components, controls, and switchgear are included as specified herein.

## 3.3 PREDELIVERY TESTING

- A. Prior to delivery and acceptance, the generator set shall be tested to show it is free of any defects and will start automatically and carry full load. This testing shall be performed at the facility of the system manufacturer's authorized local dealer.
- B. The testing shall be done on dry type, resistive load banks.
- C. The load banks shall not be dependent on the generator control instruments to read amperage and voltage on each phase. Rather, the test instrumentation will serve as a check of the generator set meters.
- D. Load bank testing shall be done in the presence of the owner's engineer or his appointed representative. After manufacturers approved break-in procedure, sample oil, change oil and performance testing, forward oil test results to U of A Engineer. Testing shall be for a minimum of 1 hour at 80% load, 1 hr. at 100% load, 2 hrs. at 110% load, 1.0 pf. Demonstrate voltage dips and frequency dips with block loading. If breaker trips, record time run at 110°
- E. All consumables necessary for testing shall be furnished by the bidder. Any defects which become evident during the test shall be corrected by the bidder at his own expense prior to shipment to the jobsite.

## 3.4 SHIPMENT TO JOBSITE

- A. Delivery shall be FOB to the jobsite by the system manufacturer's authorized dealer.

## 3.5 INSTALLATION

- A. The installation shall be performed in accordance with shop drawings, specifications, and the manufacturer's instructions.

## 3.6 FIELD QUALITY CONTROL

- A. The complete installation shall be checked for procedural and operational compliance by a representative of the system manufacturer's authorized local dealer. The engine lubricating oil and antifreeze, as recommended by the system manufacturer, shall be provided by the generator set dealer. If switchgear and generator sets are furnished by different manufacturers, technical representatives of both manufacturers' authorized dealers shall verify the installation meets requirements. Any deficiencies shall be noted and corrected by the Contractor.
- B. The system manufacturer's dealer representative shall be present to assist the Contractor during start-up, systems check, adjusting, and site testing required after the installation is complete. Re run the pre delivery test and then test the oil. (Do not change the oil.)

## 3.7 POST-INSTALLATION TESTING

- A. Following installation, the following tests shall be performed by the system manufacturer's local dealer representative(s) in the presence of the owner's engineer or designated appointee.

## 3.8 PRESTART CHECKS

- Oil level
- Water level
- Day tank fuel level
- Battery connection and charge condition
- Air start supply pressure (if so equipped)
- Engine to control interconnects
- Engine generator intake/exhaust obstructions
- Removal of all packing materials

## 3.9 OPERATION

- A. Load - two hours operation at 80% of full load rating. One hour operation at 100% of full load rating and one hour at 110°C. After the first half-hour stabilization period at full load, the following shall be recorded at fifteen minute intervals (starting at time equals "zero"):
  - 1. Voltage, amperage, frequency
  - 2. Fuel pressure, oil pressure and water temperature
  - 3. Exhaust gas temperature at engine exhaust outlet
  - 4. Ambient temperature
- B. If equipped with appropriate instrumentation:
  - 1. Kilowatts
  - 2. Power Factor

3. KVARs
4. Generator Temperature

C. Proper operation of controls, engine shutdown, and safety devices shall be demonstrated.

### 3.10 ORIENTATION

A. The system manufacturer's authorized dealer shall provide a complete orientation for the owner's engineering and maintenance personnel. Orientation shall include both classroom and hands-on instruction. Topics covered shall include control operation, schematics, wiring and diagrams, meters, indicators, warning lights, shutdown system and routine maintenance.

### 3.11 SERVICE MANUALS AND PARTS BOOKS

A. The system manufacturer's authorized local dealer shall furnish one copy each of the manuals and books listed below for each unit under this contract:

1. OPERATING INSTRUCTIONS - with description and illustration of all switchgear controls and indicators and engine and generator controls.
2. PARTS BOOKS - that illustrate and list all assemblies, subassemblies and components, except standard fastening hardware (nuts, bolts, washers, etc.).
3. PREVENTATIVE MAINTENANCE INSTRUCTIONS - on the complete system that cover daily, weekly, monthly, biannual, and annual maintenance requirements and include a complete lubrication chart.
4. ROUTINE TEST PROCEDURES - for all electronic and electrical circuits and for the main AC generator.
5. TROUBLESHOOTING CHART - covering the complete generator set showing description of trouble, probable cause and suggested remedy.
6. RECOMMENDED SPARE PARTS LIST - showing all consumables anticipated to be required during routine maintenance and test.
7. WIRING DIAGRAMS AND SCHEMATICS - showing function of all electrical components.

B. All manuals and books described above shall be contained in rigid plastic pouches.

### 3.12 CONTRACT MAINTENANCE

A. The system manufacturer's authorized dealer shall furnish the owner's engineer with a copy of any contract maintenance agreement negotiated relative to the equipment specified in this section. The contract information shall detail agreed maintenance intervals, work to be performed at each interval, reimbursement schedule for maintenance work, and owner's responsibilities versus dealer's responsibilities.

**End of Appendix Section 16620B**