

TECHNICAL SPECIFICATIONS - PRIME RATED DIESEL GENERATOR
150 kVA to 500 kVA

1. GENERAL AND SCOPE OF SUPPLY

This section specifies the design, manufacture, supply to the site, install, testing and commissioning of one three phase, low voltage silenced type Prime rated diesel generator with auto start feature and enclosed in a factory fitted canopy at the generator manufactures work (Note-1). The generator set should be provided with main failure automatic starter, automatic change over switch which will start on failure of CEB supply (Note-2).

The Work should be carried out by a firm specialised in this kind of work and having an accredited agency in Sri Lanka. The generator set shall be new, using approved and reliable known makes of diesel engine and alternator. They shall also be a make already operation in Sri Lanka for which maintenance facilities are already available during last five years.

The diesel generator set shall be supplied complete with all ancillary equipment necessary for starting and running of the set, including cooling systems, fuel storage and supply system, instrumentation, control and protection arrangements, spares and special tools. The generator set and the ancillary equipment shall be installed in the generator room as indicated in the drawings. Diesel generator metal part shall be earthed. Generator Neutral shall be solidly earthed.

The set is to be reasonably self-contained to minimize the work of installation at site. The engine, alternator and cooling radiator should be mounted on a combined underbase of stress relieved fabricated steel and engine accessories shall also be mounted on the under base where appropriate, provided that this does not result in difficulty of access for maintenance.

The set is to be mounted on suitable arrangement of antivibration mounting designed to minimize the transmission of vibration but without resulting in excessive amplitudes of movement of any parts of the set. If rubber is employed in the mounts, their design should incorporate means of preventing deterioration due oil leakages.

The generator set shall be provided with sound attenuated canopy fitted at the generators manufactures work, so that the noise level shall not exceed 80dB at 1m distance and 60 dB at 10m distance from the machine at full load operating condition at any direction.

Flexible connection shall be provided to all exhaust, water, air, fuel and oil piping that leaves the engine to prevent the transmission of vibration and the fracture of the piping due to movement of the set. The choice of connections and their installation is to be such as to give long life under normal operating condition of the set.

2. STANDARDS

The following Standards apply:

- BS 5000 Part 3 - Generators to be driven by Reciprocating Internal Combustion Engines
- BS 5514 (ISO3046) - Specification for Reciprocating Internal Combustion Engines Part 1-6
- BS 5486 (IEC 439) - Factory Built assemblies of Low Voltage Switchgear and Control Gear

Note-1 : The Purchaser may decide whether he requires a silenced type generator depends on site condition.

Note-2 : The Purchaser may decide whether he requires the ATS/AMF facilities with the generator set.

3. DESIGN DATA

3.1 ENGINE

Rated continuous output - As specified by the designer at 0.8 pf at generator output terminals. (Based on 35°C ambient temperature and a relative humidity of 90%).

The unit should be capable of delivering the rated output for continuous period of not less than 12 hours at a time. Overload capacity of 110% for one hour during a period of 12 hours.

Number of strokes	- 4
Speed	- 1500 rpm
Cooling	- fan-cooled closed cooling water circuit
Loading	- Asynchronous motor loads of upto 100% may be switched on with a maximum admissible speed droop of twelve (12) percent.

3.2 GENERATOR

Rated Output	- To be specified by the designer
Power Factor	- 0.8
Frequency	- $50 \pm 2\%$ Hz
Voltage	- 400/230 V $\pm 5\%$ 3 phase & neutral
Speed	- 1500 rpm
Deviation Factor of voltage wave form	- 5%
Insulation Class for rotor and stator windings	- H
Protection class of enclosure	- IP 23

3.3 ENGINE

Diesel engine shall be of a well-proven make, complying with the requirements of BS 5514 (ISO 3046). The engine shall meet all the performance requirements of the set under the specified operating conditions and shall be suitable for operation on light distillate fuel oil marketed by the Ceylon Petroleum Corporation as 'Lanka Super Diesel Oil'.

A sturdy elastic coupling shall connect the engine and the generator, and both shall be mounted on a common base plate forming part of the supply. Proven and highly effective antivibrating mountings shall be provided between base plate and concrete foundation.

The engine shall be started by 24 V starter motor engaging with the fly wheel ring gear and disengaging automatically when the engine starts. The equipment shall include an adequately rated lead/acid battery together with an automatic mains energized battery charger. The

charger shall have a continuous output rating sufficient to recharge the battery from 1.8 V/cell to a fully charged condition in a period of 8 hours. The battery shall be capable of providing at least six starting cycles within a period of 5 minutes.

The engine shall be water cooled. A sectional radiator shall be provided and mounted on the combined underbase and arranged to cool the engine jacket water, lubricating oil and charge air as appropriate. Circulation of cooling water through the engine and radiator shall be by means of engine driven pump. The water circuits shall be fitted with an easily accessible drain point. The cooling fan shall be arranged to drive directly by the engine and the hot air shall ducted to suitable openings in the generator room wall. The duct shall be incorporated with a suitable flexible section to prevent the transmission of vibration from the engine and the discharge end shall be provided with louvers and an insect screen.

Lubrication of the engine shall be by means of an engine driven integral pump. The pump shall have on the suction side a coarse strainer and on the delivery side a duplex 'full flow' fine filter complete with changeover cock incorporating pressure by-passes to facilitate oil flow to the engine should the filter become blocked. The lubricating oil system capacity shall be sufficient to enable the engine to run continuously for 12 hours at any load without replenishment.

The governor of the engine shall be electronic type and be capable of fine governing of speed to Class A2 of BSS 5514/1977, ISO 3046/IV.

The engine shall be efficiently silenced with suitable noise attenuators provided at cooling/combustion air inlets and outlets and exhaust silencers complete with interconnecting pipe and fittings. Supports for each complete system shall be of the anti-vibration type and due allowance for expansion of the exhaust system shall be made by the inclusion of expansion bellows.

Exhaust pipe shall be lagged with a removable Aluminium cladding. Exhaust pipe outlet point shall be 4m above ground level and path oh the exhaust pipe as indicated in the drawing DEC/EL/T/002.

The engine shall be provided with following protection devices for alarm and shutting down the engine automatically.

- Low lubricating oil pressure - two stage
- Engine overspeed
- High cooling water temperature - two stage
- Over crank

3.4 **GENERATOR**

Generator shall comply with BS 5000 (IEC 34-1) and shall be brushless, self-exciting and self-regulating type. The exciter shall be with rotating silicon rectifiers, auxiliary exciter of permanent magnet type, damper cage, static voltage regulator and compounding equipment. The voltage regulator shall maintain its setting for long periods without adjustment. Means shall be provided for a limited degree of manual adjustment of the output voltage setting.

Generator shall be directly coupled to and share a common high bedplate with the prime mover. The degree of protection for the generator and exciter shall be not less than IP 23.

Cooling of the generator shall be by a radial-flow fan. Generator bearings shall be of the ball or roller type, rated for long life and prepacked with sufficient grease for operating over long periods without replenishment.

The stator and field windings shall consist of electrolytic copper conductors insulated throughout with Class H materials as defined in IEC 85. A generator winding temperature detector (thermistor) installed at the hottest spot and wired to give alarm and shutdown.

Thermostatically controlled tubular low-temperature heaters of sufficient rating to maintain the windings in dry condition during long periods of standstill shall be fitted in the stator casing and wired out to a terminal box on the bed plate, which in-turn shall be connected to the 230-volt single-phase supply.

Voltage regulation should be maintained within $\pm 2\frac{1}{2}\%$ from no load to full load including cold to hot variation at any power factor from 0.8 to unity.

Neutral shall be solidly earthed.

3.5 FUEL STORAGE AND TRANSFER

The following shall be supplied with the unit.

3.5.1 Base Tank

- The machine shall have one integral metal fuel tank (capacity sufficient for 08 hours operation at full load but not less than 900 litres) and shall be installed in a position where any fuel leakage cannot impinge on exhaust pipe or other hot engine surfaces. The tank shall be provided with all necessary fittings including fill, vent, drain and overflow line, level indication and access for inspection and maintenance. Level switches shall be provided for the following services.
 - (a) Low level alarm
 - (b) High level alarm
 - (c) Low level start of transfer pump
 - (d) High level stop of transfer pump

3.5.2 Fuel Transfer Pumps

- One electric motor-driven fuel transfer pump and one standby manual pump shall be provided to enable the integral fuel tank to be filled from the main storage tank. The capacity of the pump shall be such that the service tank can be completely filled in not more than one hour. All necessary check valves, by-pass valves, float valves and maintenance valves on piping system are to be provided. The pump motor starter control panel shall be provided with following features.
 - (a) Thermal overload protection and earth leakage protection
 - (b) A selector switch so that a pump may be either started and stopped by manually or automatically on receipt of signal from the level switches in the base tank.
 - (c) Pump stop when low level at main storage tank
 - (d) Indicator lamps for - Common alarm
 - Run - Stop
 - R,Y,B Phase indicator lamps
 - Fuel low level at main storage tank
 - (e) Audible Alarm and mute push button for fuel low level at main storage tank

3.5.3 Main Storage Tank

- The main storage fuel tank shall consist of one underground tank of capacity 9000 litres, including piping and valves. The tank shall be cylindrical, fabricated from 6mm thick high quality black steel plate welded on internal and external seams, hydro-statically tested at factory to a pressure of one atmosphere for 24 hours with welds proven sound and supplied complete with inspection manhole (600mm diameter) with hermetical sealing cover, lifting lugs and reinforcements for supporting the concrete access hatch. The cover shall be provided with necessary connection for tank filling, fuel transfer, fuel return, tank emptying and de-sliming, venting and dipstick level control. The fill pipe couplings shall suit to the Ceylon Petroleum Corporation bowser inlet sizes which is in line with the BS 799(Part 5). The main tank shall be provided with low-level alarm and an overfilling safety device.

The concrete tank of 3300mm x 4300mm x 3600mm(height) will be constructed near the generator room as indicated in the drawings to install the main storage fuel tank. The design, construction and erection of the tank shall be carried out by a specialist tank supplier in accordance with the relevant international and local codes and regulations.

3.5.4 Fuel Lines

Fuel lines shall be heavy gauge, black seamless steel, treated internally with corrosion resistant paint and with joints sealed with PTEE tape. The piping installation shall be complete with all necessary valves, strainers, supporters and such to provide a complete installation.

All piping connections to the tank shall be standard flanged connections. Piping connection to the generator shall be provided with flexible couplings.

3.6 CONTROL EQUIPMENT

A control cubicle fabricated with welded steel panels supported by structural steel frame, shall be provided and installed for the stand-by plant, together with all necessary inter-connections, anti-condensation heaters etc. The primary function of the control equipment shall be

- Automatic starting and stopping of the generator on receipt of signal from main panel board
- Fault indicating and appropriate action
- Manual start and stop operations in remote and local positions.

Terminal for cable connection shall be made in upstream of the MCCB to connect the power supply cables for fire fighting lift and fire pumps.

The operation of the diesel generator set shall be as follows. When a power failure occurs, this information is available to control panel via main distribution board. The relays in the control panels will start the generator and power will fed to the main distribution board. Automatic changeover from CEB supply to diesel generator supply is done by auto transfer switch (Note-2). When in a similar manner when the CEB power returns the machine should be taken off the system and stopped.

When the mains power is restored, a time delay between 5 to 10 sec. should be introduced before the removal of generator power and the reintroduction of mains power.

Note-2: The Purchaser may decide whether he requires the ATS/AMF facilities with the generator set.

Adjustable timer to protect generator against repeated transient power failures should also be provided.

The starting period for the machine should not exceed 15 sec. should this period be exceeded without speed sense switch cancelling the starting cycle all starting circuits shall be switched out and an indication shall be displayed on generator control panel.

Automatic shutdown of the set and lockout of the starting system shall result from any of the following:

- Low lubricating oil pressure
- High cooling water temperature
- Failed to start
- Engine over speed (if speed exceed 20% above normal)
- High stator temperature

The control system shall include the following:

- Overload protection
 - Restricted Earth fault protection
 - Visual & Audible Fault indication and alarm accept/reset
 - All necessary controls needed to prevent starting of machines on momentary fluctuations of main voltage
 - A selector switch for operation of the equipment in automatic and manual mode and off position
 - A selector switch for operation of the equipment in local and remote position
- Automatic start sequence control.

The following equipment shall be included in the control panel

- Voltmeter and selector switch to indicate individual phase and line voltage
- Ammeter and selector switch to indicate the line current
- Frequency meter
- Hour run counter
- Engine 'start' & 'stop' push button and lock switch
- 'Remote' & 'Local' selector switch with provision for start & stop at main panel board
- 'Auto', 'Manual' & 'Off' selector switch
- 'Emergency Stop' push button
- Mains operated battery charger of the constant potential type with MCCB, ammeter, incorporating mains failure relay
- Run indicator lamp
- Fault indicator lamp
- Audible Alarm
- Lamp test push buttons, Alarm accept and reset buttons
- Tachometer and Speed indicator
- 3 Pole MCCB with neutral link

The following engine related items shall be mounted separate from the control cubicle.

- Battery charge indicator
- Lubrication oil pressure indicator
- Cooling water temperature indicator
- Engine speed adjustment (speed droop between 0 and 6 %)
- Fuel level in integral fuel tank low
- Fuel level in integral fuel tank high
- Fuel level in main storage fuel tank low

Microprocessor Control Panel with Alphaneumerical character digital display is acceptable alternative to hardwired equipments. Microprocessor Control Panel shall incorporate all above mentioned facilities.

The Microprocessor Control Panel shall be able to connect to Standard Personal Computer to download data and information from module and to programme the Module. The tenderer shall tabulate all parameters, signals, safety devices and other facilities available in the Microprocessor Control Panel.

It should be noted that control equipments should be suitable for tropical climatic conditions so that their parameters shall not vary due to ambient temperature or aging.

3.7 **TESTS**

3.7.1 **SHOP TESTS**

The following tests and checks shall be carried out in the manufacturer's shops. Test reports shall be submitted for Engineer's approval.

- All tests as required by the manufacturer's practice or by applicable standards during the manufacture stage.
- Performance tests on the assembled diesel generating set with sound proof canopy (with voltage regulator)
- Check of fuel consumption at different loads
- Functional tests on the fuel transfer pump
- Dielectric and insulation tests
- Routine tests on voltage regulator
- Hydrostatic pressure test on fuel tank (at 2 bars)

3.7.2 **SITE TESTS**

The following tests shall be carried out after installation at the Site:

- Load tests
 - 50% load 15 minutes
 - 100% load 15 minutes
 - 110% load 15 minutes
- Measurement of vibration
- All necessary resistive loads shall be provided by the contractor at his own expense.
- Functional testing of all alarm devices
- Checking of the starting time and time up to taking-over full load.
- Testing of noise levels at 1m & 10m distances.
- Load rejection test

3.8 **FREE MAINTENANCE AND DEFECTS LIABILITY PERIOD**

Following are the works shall be carried out during the free maintenance period.

- Emergency call back service
- Inspect, clean, oil and grease where necessary
- Adjustment of machinery
- Replacement of any defective parts

TECHNICAL SCHEDULE – PRIME RATED DIESEL GENERATOR
150 kVA to 500 kVA

REF.		UNITS	PARTICULARS	
			As Specified	As Offered
1	<u>Diesel Engine</u>		Clause 3.3	
1.1	Manufacturer's Name			
1.2	Country of Origin			
1.3	ISO rating	kW brake		
1.4	Site rating at 35°C	kW brake	400kW	
1.5	Brake mean effective pressure at site rating	Bar		
1.6	Number of cylinders			
1.7	Bore	mm		
1.8	Stroke	mm		
1.9	Speed	rpm		
	Type of Aspiration			
1.10	Year this type was put in service			
1.11	Drop in frequency/speed when engine response to 100% load injection			
	Fuel consumption of 100% Prime Rated load is less than	l/hrs.		
1.12	Turbocharger			
	Applicable standard		BS or Eq.	
	Manufacturer's Name			
	Manufacturer's type No.			
	Pressure ratio (site rating)			
	Mass Airflow (site rating)	kg/s		
1.13	Radiator			
	Applicable standard		BS or Eq.	
	Manufacturer's Name			
	Manufacturer's type No.			
	Fan tip speed	m/s		
	Fan power required	kW		
	Cooling airflow	m ³ /min		
	Cooling surface area - water	m ²		
	Cooling surface area - oil	m ²		
1.14	Cooling water system			
	Applicable standard			
	Water temperature	°C		
	Water pressure	Bar		
	System capacity	litre		
	Thermostat bypass valve type			
	Low water level switch type			
1.15	Lubricating oil system			
	Applicable standard			
	Oil pressure	Bar		
	Oil temperature	°C		

REF		UNITS	PARTICULARS	
			As Specified	As Offered
1.16	Grade of oil			
	Sump capacity	litre		
	Oil consumption/100 hr.	litre		
	Recommended oil change	hrs.		
	Engine alarms			
	Applicable standard			
	Low oil pressure setting	Bar		
	Low water level setting as % of total cooling water capacity	%		
	Overspeed setting	rpm		
1.17	High water temperature setting	°C		
	High oil pressure setting	Bar		
	Exhaust system			
1.18	Applicable standard			
	Silencer manufacturer's name			
	Type of silencer (residential or standard)			
	Exhaust temperature gauge range	°C		
1.19	Sound attenuation system			
	Whether sound attenuated canopy fitted at generator manufactures work	Yes/No		
	Country of origin			
1.20	Sound level	dBA at 1m	80 dB	
		dBA at 10m	60 dB	
	Materials used for sound attenuation			
	Engine governor			
1.21	Applicable standard		BS or Eq.	
	Manufacturer's name			
	Class of governing			
1.22	Fuel system		Clause 3.5.2	
	Pump manufacturer's name			
	Fuel injector manufacturer's name			
	Pump pressure	Bar		
	Fuel consumption at			
1.21	a) Full load	litre/hour		
	b) 3/4 load	litre/hour		
	c) 1/2 load	litre/hour		
	d) 1/4 load	litre/hour		
	Base Fuel tank		Clause 3.5.1	
	Mounted integrally with engine bed plate		Yes	
1.22	Capacity	litre	Not less than 900	
	Fitted with level gauge		Yes	
	Main Fuel Storage Tank		Clause 3.5.3	
	Length x Weight x Height	m x m x m		
	Capacity	litre	9000	
1.22	Gross weight (dry)	kg		
	Type of level gauge			

REF		UNITS	PARTICULARS	
			As Specified	As Offered
	Transfer pump manufacturer's name			
	Type of Transfer pump			
	Delivery rate of Transfer pumps	litre/min.		
1.23	Emission Standard			
	(a) HC (Hydro Carbon)	gr/kWH		
	(b) CO	gr/kWH		
	(c) NO _x	gr/kWH		
2	<u>A.C. Generator</u>		Clause 3.4	
2.1	Manufacturer's name			
2.2	Type			
2.3	Country of Origin			
2.4	Rated output	kVA	500 kVA At site rating	
2.5	Terminal voltage	V		
2.6	Power factor	Cosφ	0.8	
2.7	Frequency	Hz	50	
2.8	Connection		star	
2.9	Weight of complete alternator	kg		
2.10	Weight of name of heaviest single item for erection	kg		
2.11	Applicable standard		BS or Eq.	
2.12	Generator mechanical protection class		IP 23	
2.13	<u>Reactances :-</u>			
	a) On short circuit when running at normal speed and voltage			
	Sub-transient reactance	%		
	Transient reactance	%		
	b) Unsaturated synchronous reactance	%		
2.14	Short circuit ratio			
2.15	Stator insulation class			
2.16	Stator d.c. resistance per phase at 75°C	ohm		
2.17	Type of rotor bearings			
2.18	Number of rotor bearings			
2.19	Method of protection against shaft currents			
2.20	Rotor critical speed(s)	rpm		
2.21	Rotor inertia	kg m ²		
2.22	Weight of rotor	kg		
2.23	Rotor insulation class			
2.24	Rotor winding resistance at 75°C	ohm		
2.25	Generator response for 100% load change at a low Power factor :-			
	A. Instantaneous values when at :-			
	(i) Minimum excitation	%V		
		%A		
	(ii) Maximum excitation	%V		
		%A		
	B. After 10 Hz when initially at :-			
	(i) Minimum excitation	%V		
		%A		

REF		UNITS	PARTICULARS	
			As Specified	As Offered
	(ii) Maximum excitation	%V %A		
2.26	State whether stator windings are protected with embedded thermistor overloads		Yes	
2.27	State whether thermostatically controlled anti-condensation heaters are fitted in the generator		Yes	
2.28	Wattage of the heaters in item 2.27	W		
3	<u>Generator Exciter</u>			
3.1	Applicable standard		BS or Eq.	
3.2	Manufacturer's name			
3.3	Field winding insulation			
3.4	Field winding resistance at 75°C	ohm		
3.5	Exciter winding insulation class			
3.6	Exciter winding resistance per phase at 75°C	ohm		
3.7	Number of diodes			
3.8	Type of diodes			
3.9	Diode rated current	A		
3.10	Diode rated voltage	V		
3.11	Exciter full load current in d.c. amp	A		
3.12	State what provision has been made to suppress the field when the main circuit opens under fault conditions			
4	<u>Generator Automatic Voltage Regulator</u>			
4.1	Applicable standard		BS or Eq.	
4.2	Manufacturer's name			
4.3	Type			
4.4	Range of manual voltage control	V		
5	<u>800 Amp. Generator Circuit Breaker</u>			
5.1	Applicable standard		BS or Eq.	
5.2	Manufacturer's Name			
5.3	Type			
5.4	Country of origin			
5.5	Rated current	A	800	
5.6	Rated voltage	V	400	
5.7	Breaking capacity		(mini. 35kA)	
5.8	Inherent protections provided			
	Short circuit		Yes	
	Overcurrent		Yes	
	Range of adjustment of overcurrent	% to.....%	
6	<u>ATS/AMF Facility</u>			
	Manufacturer's Name			
	Type			

REF		UNITS	PARTICULARS	
			As Specified	As Offered
	Country of Origin			
	Details of Operation			
7	<u>Battery</u>			
7.1	Manufacturer's name			
7.2	Type			
7.3	Electrolyte			
7.4	Voltage	V		
7.5	Capacity at 10 hour rate	Ah		
7.6	Number of cells			
7.7	Voltage per cell	V		
7.8	Normal charging rate	A		
7.9	Maximum charging rate	A		
7.10	Ampere-hour efficiency at 10 hour rate	%		
7.11	Ampere-hour efficiency at 1 hour rate	%		
7.12	Dimensions of cells	mm		
7.13	Dimensions of battery complete	mm		
7.14	Weight of cell complete with electrolyte	kg		
7.15	Total weight of battery complete	kg		
7.16	Internal resistance per cell when fully charged	ohm		
7.17	Battery voltage at end of the duty cycle	V		
8	<u>Charger</u>			
8.1	Manufacturer's name			
8.2	Type			
8.3	AC input to charger	kVA		
8.4	DC output of charger	kW		
8.5	Type of d.c. voltage control			
8.6	Range of d.c. voltage control	V		
8.7	Regulation	%		
8.8	Overall dimensions	mm		
8.9	Total weight	kg		
9	<u>Control Panels</u>			
9.1	Manufacturer's Name			
9.2	Type			

BILL OF QUANTITIES

**SUPPLY, INSTALLATION, TESTING & COMMISSIONING OF 500KVA PRIME RATED
DIESEL GENERATOR - 150KVA TO 500 KVA**

Item No	Description	Unit	Qty	Amount Before VAT (Rs.)	Amount After VAT (Rs.)
1	Import, Supply, Delivery to site 01 No. of Sound proof 500 kVA Prime Powered Diesel Generator.	Item	1		
2	Supply and installation of ATS/AMF facilities with the generator sets.	Item	1		
3	Installation of Generator complete with Control Panel, Inter connecting cables, Exhaust pipes, Generator Earthing, Control Cabling and other accessories as per specification & drawings.	Item	1		
4	Supply and Installation 9000 litres capacity main storage fuel tank with electric & manual fuel transfer pumps, pipes, fittings motor starter control panel and all other necessary equipment as per specification.	Item	1		
5	Testing & Commissioning and Training of owner's staff assigned for generator operation at the site.	Item	1		
	Sub Total				
	Discount if any (.....%)				
	Sub Total after Discount				
	VAT				
	Total				

Tenderer's VAT No. (if any)

Tender Amount before VAT (in words) Rupees

Tenderer's Signature :

Tenderer's Seal :

Date :