SUPPLY & INSTALLATION OF 800 KVA

3-PHASE DIESEL GENERATOR FOR DIGANA MILK FACTORY

Tender No: M/PUR/TEN/2025/09

Specification

Supply and installation of Standby Diesel Generator System

1. General

1.1 Scope of Work

The Contractor shall carry out design, supply, delivery erection, connection, testing, commissioning and maintaining for a specific period of complete standby/emergency Electrical power Supply System which includes 01 no of 800 kVA prime rated brand new diesel generator (Open Type) units and all the ancillary equipment and material required, for the Digana Milk Factory of MILCO (Pvt) Ltd at Digana. The engine generator system shall be fully automatic and shall constitute a unified and coordinated system ready for operation.

New generator shall be installed in the existing generator room. Therefore, contractor shall visit the site and submit modifications/comments if any and basic shop drawings of equipment layout for the existing generator room along with their bid.

Contractor shall carry out their installation work without disturbing the factory activities. All measures to be taken to maintain power supply to the factory during installations.

The installation shall include but not be limited to the following:

1. Diesel Engine (01 no.) complete with;
    - Lubrication oil system
    - Fuel tank and pumping System
    - Cooling system
    - Speed governing system
    - Intake and exhaust air systems
    - Starting system

2. Alternator (01 no.) coupled to diesel engine, complete with;
    - Control panel incorporating control, protection, monitoring/supervision systems.
    - Automatic voltage regulating system
    - Set Mounted Generator circuit breaker

3. Fuel Day tank (Minimum 1500 L capacity), pipes, valves and filling arrangement.
4. Supply, installation and termination of Power & control cables between Generator set, existing Generator Distribution Board and existing ATS panel.
5. Spare Parts

1.2 General Requirements

Under this contract, existing 500 kVA generator shall be removed with its accessories and 01 no. of 800 kVA brand new diesel Generators (open Type) and accessories shall be installed as an alternative (stand-by) power supply for the Digana Milk Factory of MILCO (Pvt) Ltd.

Removing of the existing Generator, its accessories and termination of cables shall be done with utmost care as those are intended to use later. Removal of cable termination shall be done carefully.

The Diesel Generator shall be capable of automatic quick start upon receiving, 'start' signal from relevant existing ATS and to switch on the full load. Since the ATS panel has already been installed, compatibility with new generator shall be checked and modifications shall be provided to the existing ATS panel as required.

The diesel generator set shall be supplied complete with all ancillary equipment necessary for starting and running of the set, including cooling system, fuel supply system, instrumentation, connection with existing ATS panel, control and protection arrangements & cables, spares and special tools.

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

Flexible connections shall be provided to all exhaust, water, air, fuel and oil piping that leave the engine to prevent the transmission of vibration and the fracture of the piping due to movement of the set.

Bidder shall confirm that space inside the existing generator room is sufficient for the new installation and proper functioning of the 800 kVA generator. Bidder may propose alternative arrangements based on existing generator room arrangement and availability of space at site.

1.3 Scope of work

Scope of work includes removal of existing 500 kVA generator and design, supply, install, testing and commissioning of 800 kVA prime rated brand new diesel generators (open type) and accessories as an alternative (stand-by) power supply for the Digana Milk Factory, of Milco (Pvt) Ltd.

Following works also shall be included in the scope of the work.

- Removal of 500 kVA generator, termination of power cables at generator side, control cables, exhaust pipes etc.
- Supply, installation, testing and commissioning of brand new 800 kVA prime rated diesel Generator (Open type) and accessories at the existing Generator room.
- Supply and installation of fuel day tank at the existing generator room.
- Supply and installation of fuel pumps and pump control panel at the existing Generator room.
- Supply and installation of fuel transfer pipes between new fuel day tank and existing main storage fuel tank.
- Supply, installation and termination of Power & control cables between Generator set, new Generator Distribution Board and existing ATS panel.

1.4 Site Conditions

All equipment and materials used shall be suitable for operation in the site conditions given below.

1.4.1 Site Environmental Conditions

All equipment shall be tropicalized and suitable for prolonged operation in tropical site environmental conditions. Prime rating of the diesel generator-shall be at site environmental conditions.

- Altitude of site above sea level: Around 520m
- Average Ambient temperature: 35 degC (Max. 40 degC)
- Average relative humidity: 90%

1.5 Electrical System

- Nominal system voltage : between phases 400V
  : between phases & neutral 230V
- Wiring system : Three phase, four wire,
- Earthing of system : Solid earthing, TT system
- System frequency : 50 Hz
- Symmetrical short-circuit RMS current : 50 kA (Minimum)

2. Standards and Quality

2.1 Standards

Diesel Generator set and the control Panel shall comply with the applicable requirements of the standards/publications or equivalent other national/international standards.

Engine:

- ISO 3046
- BS 5514, BS 5000 Part III

Generator:

- BS 5000, BS 4999 (IEC 34-1)
- IEC 60034

Instruments:

- BS 89
- IEC 60051

Switchgear:

- IEC 60947

Power Cables shall meet the requirements of the following standards:

- BS 5467
- IEC 60502

2.2 Qualifications

2.2.1 Engine Manufacturer: Shall be a renowned company specialized in manufacture of diesel engines with minimum 15 years documented experience, and whose product (proposed type and size) has been satisfactorily used in similar services for not less than five years, document evidence required at submission. Manufacturing plant where the proposed engine would be built shall have minimum 5 years documented experience in the production of diesel engines. Quality assurance system of the manufacturer shall have ISO 9001 certificate.

2.2.2 Alternator Manufacturer: Shall be a renowned company specialized in manufacture of alternators with minimum 15 years documented experience, and whose product (proposed type and size) has been satisfactorily used in similar services for not less than five years, document evidence required at submission. Manufacturing plant where the proposed alternator would be built shall have minimum 5 years documented experience in the production of alternators for diesel gen sets. Quality assurance system of the manufacturer shall have ISO 9001 certificate.

2.2.3 Assembly of Generator Set: lf the assembly of engine-alternator set is carried out neither by engine manufacturer nor alternator manufacturer, then the assembling party shall be a reputable company with a minimum of 10 years documented experience in the assembly of generating sets. The quality assurance system of the assembling company shall have ISO 9001 and/or ISO 9002 certification.

2.2.4 Local Agent: There shall be an accredited agency in Sri Lanka for the make of generator set offered and also the agent shall have proven record of providing after sales services including maintenance services at least during last 10 years (preferably including the proposed model & closer capacity of gen set). The local agent shall have adequate stock of spare parts at all the time, qualified maintenance staff and repair facilities. Also Bidder should submit the Manufacturer's authorization especially for this project along with the bid documents.

- Bidder and manufacturer should have valid ISO certification for past 5 years and present year, and submit certification.
- The proposed Engine & Alternator brands shall be well-known in Sri Lanka with a local experience of 10 years.
- The proposed engine and alternator brand also need to have more than 15 years of experience in manufacturing engines and alternators for diesel power generators, and well-known brands in Sri Lanka with maintenance facilities are already available for a local experience of 10 years.

2.2.5 Local Agent's Experience:

- Bidder should have been appointed and functioned as the Exclusive Representative/Sole agent **for the proposed Product** for minimum of last 5 years. Bidder should have at least 10 years' experiences of supply & installation & commissioning of generators for same offered brand, document evidence required for submission. Non Compliance to this condition would disqualify Bidder.
- Experience in the successfully completion of at least 10 diesel generator installations of 500kVA or larger within last 5 years. The bidder should submit documentary evidence with the bid.
- Preferred, Experience in the successfully completion of at least one installation which included two or more diesel generators of 500 kVA or larger synchronized together, within the last 5 years.

3. Engine Generator Set

3.1 General

The Generator set shall consist of a diesel engine complete with radiator, exhaust system, electronic governing one alternator with exciter and a flywheel with flywheel housing, mounted on a steel base. The automatic voltage regulator may be mounted on the alternator. Generator control, protection, monitoring systems and accessories shall be mounted on a control panel. The complete generator shall be origin in USA, UK, Japanese or within European Union. Each generator set shall be factory assembled and aligned accurately on the steel base which shall be strong and rigid enough to ensure permanent alignment of all rotating units and prevent vibration build up and shall permit skidding in any direction during installation.

3.2 Engine-Generator Set-Ratings

- Prime power : Not less than the 800 kVA at 0.8 power factor
- Rated speed : 1500 rpm
- Overload capacity : 110% for 1 hour in any 12 continuous hours operation
- Block load 70% may be switched ON with a maximum admissible speed drop of Fifteen (15) percent. Relevant document (test certificates) to prove shall be submitted with the documents.
- Engine's emission shall be compliance with EU stage II or better (or equivalent). Relevant document (test certificates) to prove shall be submitted with the documents.

3.3 Engine-Generator Set Features

Generator set shall have the following features:

- Factory-mounted on a common, rigid, welded, structural steel base.
- Automatic start, accelerate to the rated speed and deliver the specified kW/kVA output at 50 Hz within 10 seconds.
- Recover rapidly from instantaneous changes between no load and the specified kW/kVA rating, and the reverse changes of load, without damage.
- Engine-generator set shall be statically and dynamically balanced at the factory.
- Shall complete with base mounted fuel tank with a capacity adequate for 8 hrs full load operation.

3.4 Vibration Reduction

The engine-generator set shall be provided with proper vibration dampers fitted to the base mounting and a proper exhaust silencer so that the noise level will be minimized.

Flexible connection shall be provided to all exhaust, water, air, fuel and oil piping that leave 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.

4. Diesel Engine

4.1 General

Engine shall be a general purpose continuous service heavy duty diesel engine for stationary application. The engine shall be the standard product of manufacturer, a current production model complete with all auxiliaries normally furnished and shall provide sufficient power to drive the coupled alternator. The engine shall be origin in USA, UK, Japanese or within European Union and it need to comply the EU Stage II or above emission class (or equivalent). The engine shall be compression ignition type, liquid-cooled turbo-charged with intercooler, direct injection, multi cylinder designed for industrial use.

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 anti-vibrating mountings shall be provided between base plate and concrete foundation.

4.2 Engine Parameters

Engine prime power: Shall be adequate to deliver generator output (net of radiator fan power) of 800 kVA at 0.8 power factor

- Rated speed :1500 rpm
- No. of cylinders :Not less than 6
- Cycle :4 stroke

4.3 Engine Cooling System

The engine shall be closed loop liquid cooled. The capacity of the radiator shall be suitable for tropical conditions for maximum ambient temperature of 40℃. The radiator core shall be fabricated with seam welded copper tubes and copper fins, as appropriate. A radiator shall be provided and mounted on the combined under base and arranged to cool the engine jacket coolant, lubricating oil and charge air as appropriate. Circulation of cooling liquid through the engine and radiator shall be by means of engine driven pump. The coolant circuits shall be fitted with an easily accessible drain point. The cooling fan shall be arranged to drive directly by the engine.

Cooling capacity shall not be less than the cooling requirements of the engine-generator set and its lubricating oil while operating continuously at 110 percent (110%) of its specified rating.

The preferred setup for cooling air shall be to arrange the air inlets such that relatively clean, cool, dry air is drawn across the generator to the engine. The air shall be then drawn into the radiator fan, and shall be blown through the radiator.

4.4 Exhaust System

Engine exhaust system shall be complete with a flexible section, a muffler and exhaust piping graded away from the engine to the outside. Exhaust system shall include heavy duty industrial capacity critical type exhaust silencer and stainless steel exhaust bellows. The exhaust silencer and the exhaust piping shall be fully heat insulated with environmentally friendly lagging material. To release exhaust gases at appropriate elevation, additional exhaust pipes shall be supplied and installed, cladded with Aluminium sheet having thickness not less than 1 mm. Aluminium cladding shall be of easily removable type.

Material and diameter of the additional pipes shall be stainless steel, with same diameter as the engine manufacture's standard exhaust pipes.

4.5 Starting System

The engine shall be equipped with an electronic starting system which is arranged for fully automatic starting upon receiving the signal from existing ATS on failure of any phase of the main power supply. The engine shall be started by 24V/12V starter motor engaging with the flywheel ring gear and disengaging automatically when the engine starts. Engine starting system shall start the engine at any position of the flywheel.

The equipment shall include an adequately rated battery bank together with a battery charging alternator.

Electric cranking motor: Rating shall be adequate for cranking the cold engine at the voltage provided by the battery system, and at the required speed during five consecutive starting attempts of 10 seconds cranking each at 10 second intervals, for a total of 50 seconds of actual cranking without damage.

Batteries: 12 volt or 24 volt with the following features:

- Batteries shall be lead-acid type.
- Each battery cell shall have minimum and maximum electrolyte level indicators.
- Batteries shall have connector covers for protection against external short circuits.
- With the charger disconnected, the batteries shall have sufficient capacity so that the total system voltage does not fall below 85 percent of the nominal system voltage with the following demands: Five consecutive starting attempts of 10 seconds cranking at 10 second intervals for a total of 50 seconds of actual cranking.
- Battery racks shall be metal with an acid resistant finish and thermal insulation, and secured to the floor/unit.
- Battery shall operate continuously for 12 hours and be able to provide the cranking power described in above without charging.

Battery charger: Charger shall be provided with both AC and DC transient protection. Charger shall be able to recharge a fully discharged battery without tripping AC protective devices. AC circuit breaker shall not trip under any DC load condition including short circuit on output terminals. The charger shall be capable of recharging the fully discharged battery in less than 12 hours and simultaneously power the Supervisory and Control panel. The charger shall have fused AC input and DC output protection, and shall not discharge the batteries when AC power fails.

4.6 Engine Filtration System

Engine filtration system shall consist of sealed paper mesh type dry air filter, cartridge type fuel filters and full blow lube oil filters. All filters shall have replaceable elements.

4.7 Governor

The Governor shall be of electronic type. Steady-state speed band at 50 Hz shall not exceed plus or minus 1/3 of one percent. At 50 Hz, when load changes equal to 25 percent of the specified kW/kVA rating, frequency change shall not exceed two percent and it shall recover to 50 Hz within three seconds. At 50 Hz, when load changes equal to 100 percent of the specified kW/kVA rating, frequency change shall not exceed 8% and it shall recover to 50 Hz within five seconds. While the engine is running, manual speed adjustments may be made.

4.8 Lubricating System

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 bypass to facilitate oil flow to the engine should the filter become blocked. A permanently installed manual feed pump with necessary connection shall be provided to remove the lubricating oil from the engine sump during servicing.

Engine generator Starting and Stopping Controls:

The following controls shall be provided.

a. A three-position selector switch with positions marked "AUTOMATIC", "OFF", and "MANUAL".
b. A momentary contact pushbutton switch with positions marked ""MANUAL START" and "MANUAL STOP"
c. Selector switch in "AUTOMATIC" position shall cause the engine to start automatically when a signal from the existing ATS panel arrives.
d. Selector switch in "OFF" position shall prevent the engine from starting either automatically OR manually, selector switch in "MANUAL" position shall be cause the engine to start when the manual start push button is also depressed momentarily.
e. With selector switch in "MANUAL" position, depressing the "MANUAL STOP" pushbutton momentarily shall stop the engine after a cool down period.
f. A red mushroom head pushbutton switch marked "EMERGENCY STOP" will cause the engine to stop without a cool down period independent of the position of the selector switch.

Engine Protections:

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

a. Low lubricating oil pressure
b. High cooling water temperature
c. Engine over speed
d. Over crank
e. Low Coolant level

5. Alternator

5.1 Alternator Parameters

Rated Output	Not less than 800 kVA
Rated Power Factor	0.8
Frequency	50 Hz
Rated Voltage	400/230 V, 3 phase & neutral
Connection	Three phases & neutral star connected
Voltage wave-form Deviation factor	5%
Protection class of enclosure	IP 23
Insulation	Class H (on class F temperatures)
Short time (10 sec) overload capacity	Up to 300%

5.2 Alternator – General

The alternator shall be synchronous, brushless type with fully interconnected damper windings; and possess PMG or auxiliary winding. The alternator shall be origin in USA, UK, Japanese or within European Union. The alternator and the excitation windings shall be tropicalized and be capable of satisfactory operation at an ambient temperature and relative humidity stated. The alternator shall have low waveform distortion with non-linear loads and shall have been designed for sustained short circuit currents. The PMG or auxiliary winding exciting and self-regulating characteristics may be obtained from solid state electronic equipment, but such equipment shall be fully tropicalized and certified to be sufficiently aged to prevent correct parameters being altered due to ageing, humidity, temperature etc. The alternator frame shall be of screen protected and drip-proof type.

Nameplates attached to the alternator and exciter shall show the manufacturer's name, equipment identification, serial number, voltage ratings, field current ratings, kW/kVA output ratings, power factor rating, temperature rise ratings, RPM rating, full load current rating, number of phases and frequency, and year of manufacture.

The neutral shall be electrically isolated from equipment ground and terminated in same terminal box as the phase conductors. Neutral shall be solidly earthed.

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 pre-packed with sufficient grease for operating over long periods without replenishment.

Thermostatically controlled 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.

5.3 Automatic Voltage Regulator

A fully sealed automatic voltage regulator shall maintain the voltage within the limits of +/-1.5% of rated voltage from no load to full load at any power factor between 0.8 lagging and unity. It shall correct voltage fluctuations rapidly and restore the output voltage to the predetermined level with a minimum amount of hunting.

5.4 Alternator Protections

The following protections shall be provided for the alternator, to trip off the main breaker and shut down the engine.

a. Over current protection
b. Over / Under voltage protection
c. Earth Fault protection
d. Over / Under Frequency protection

5.5 Generator Circuit Breaker

Power switching and over-current/short-circuit current protection shall be accomplished with a moulded case circuit breaker. Circuit Breaker shall meet the following requirements.

1) Shall be in accordance with IEC 60947-2
2) Shall be provided with solid state adjustable trip type control module.
3) Trip unit shall have field adjustable tripping characteristics as follows:
    a) Long-time current setting (continuous).
    b) Long-time delay
    c) Short-time trip point.
    d) Short-time time delay.
    e) Instantaneous trip point.
4) Electrically and mechanically trip free.
5) Manual operating handle with lock-open padlocking provisions, and position indicators on the front of the breaker.

6. Generator Control panel

6.1 General

A set mounted generator control panel shall be provided for the generator which incorporates complete controls for all the functions of the set and protection, monitoring and metering functions. The generator control cubicle shall be of sheet steel vermin and dust proof with lockable hinged front doors complying with IP23. The circuit breaker shall have adjustable shunt tripping facility for electrical protections and thermal overload. The control panel and module shall be origin and manufacturing in USA, UK, Japanese or within European Union.

A control system shall comprise as described in 6.2.

Microprocessor control Panel with Alpha numerical character digital display (or advance version) is preferred. Microprocessor control panel shall incorporate all the specified facilities. There shall be free access available to all internal components and wiring within the switch board. All internal wiring including control cables shall be marked properly.

6.2 Controls

A control system comprising of a microprocessor incorporated with relays, switching and other devices and necessary wiring shall be provided for fully automatic and manual operation of the generator set. It shall provide total generating set system integration, including automatic remote starting/stopping,

automatic load transfer, precise frequency and voltage regulation, alarm and status message display, protections, output metering, auto-shutdown at fault detection. An emergency stop button shall be provided. All devices shall be mounted on the generator control board.

The essential controls shall include but not be limited to the following.

a. 'Auto', 'Manual' & 'Off" selector switch
b. Engine 'start' & 'stop' push button and lock switch
c. Emergency stop button with a transparent cover to prevent inadvertent operation (pressed locked and turned released type)
d. Lamp test button

6.3 Protection

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 protection system shall also include the following:

- Over current protection
- Over / under voltage protection
- Earth Fault protection
- Over / Under Frequency protection

6.4 Alarms & indications

The alarms and indications shall include but not be limited to the following.

(a) Low Lubricant oil pressure alarm and shut down indication
(b) High water temperature alarm and shut down indication
(c) Over speed alarm and shut down indication
(d) Over current trip indication
(e) Over voltage trip indication
(f) Fail to start indication
(g) Mains available indication
(h) Mains on load indication
(i) Generator on load indication
(j) Indication Reset Button

All protection, alarm indicators shall be of audio visual resetting type. Audio alarm shall automatically switch off after three minutes.

6.5 Meters shall be solid state type multi-function power meters. The following measurements shall be possible with the multifunction power meter.

Instantaneous RMS values

- Active power (kW) and reactive power (kVar) - total and per phase.
- Current (A) -3 phases and neutral
- Voltage (V) - phase to phase and phase to neutral.
- Frequency (Hz).
- Apparent power (kVA).
- Power factor – total
- Engine R.P.M
- Hour run recorder

Energy values

- Active energy (kWh).
- Reactive energy (kVar)

Demand values

- Active power (kW) - present and maximum values
- Apparent power (kVA) - present and maximum values

Accuracy of multi-function power meter shall be not less than the following.

- Energy and power accuracy -2%
- Current and voltage accuracy – 0.5%

6.6 Miscellaneous

The generators shall have its own static battery charger (Boost & Trickle) to charge battery bank by means of main power sources of single phase 230V AC when the plant is shut down.

7. Fuel Delivery System

7.1 General

Above ground fuel storage and delivery system already exists in the site and this shall be used to get diesel for the new generators also. Existing delivery system shall be replaced with new delivery system under this contract. New delivery system shall be consists of pipeline from main storage tank to new day tank, fuel transfer pumps for pumping diesel from main storage tank to day tank, and pipe lines from day tank to the diesel engine. Oil transfer from day tank to diesel engines shall be by gravity. The day tank shall be provided with low level alarm and overfilling safety devices.

7.2 Day Fuel Tank (Service Tank)

Minimum 1500 litres capacity Day tank shall be installed at the existing generator room. Day tank capacity shall be sufficient for 8 hour operation of the generator.

The tanks shall be provided with all necessary fittings including fill, vent, drain and overflow line, level indication, Level switches and access for inspection and maintenance.

7.3 Fuel Transfer pumps

Two electric motor-driven fuel transfer pumps, one running and the other stand-by, shall be provided to enable the day tank to be filled from the main storage tank. The capacity of the pumps shall be such that the service tank can be completely filled in not-more than half an hour. The pump motor starter control panel shall contain a selector switch so that a pump may be either started or stopped by hand or automatically on receipt of signal from the level switches in the service tank. A selector switch shall be provided to select the running pump and stand-by pump, out of the two pumps. For emergency use a semi- rotary hand pump shall be supplied and connected in parallel with the motor driven pump. There shall be a suitable strainer.

7.4 Pipes, Valves Etc.

All pipes, valves and other accessories required for the entire fuel transfer system;

- from existing main fuel storage tank to day fuel tank

- from day fuel tank to diesel generator

- and overflow return pipes etc. shall be provided.

Piping system shall be Black steel, standard weight, ASTM A-53 pipe and with necessary valves and pressure gages.

8. Tests

8.1 Shop Tests

The following tests and checks shall be carried out in the manufacturer's workshops and test certificates shall be submitted.

- All tests as required by the manufacturer's practice or by applicable standards during the manufacture stage. The manufacturer's factory test data shall be submitted with the variations in frequency, engine RPM, Voltage, etc., at load test.

1. Quick Start rest: Record time required for the engine generator set to develop specified voltage, frequency and kW load from a standstill condition.

2. Performance tests on the assembled diesel generating set (with voltage regulator)

- Check of fuel consumption at different loads

- Dielectric or insulation tests

- Functional tests on the fuel transfer pumps

3. Main skid storage tank against leakage (pressure test at 0.5 bar for 24 hours).

The test data shall be furnished to the purchaser before dispatch of the generator from the manufacture's factory and get the approval, agreement and concurrence of the purchaser for the testing data performed at the manufacture's factory. If the purchaser does not agree with the results, it may be informed to the manufacturer and manufacturer shall correct the errors of the plants and resubmit the fresh testing data for the approval of the purchaser. The factory test data shall be compatible with the site testing data substantially for the payment to be released after successful installation and commissioning of the generator.

8.2 Site Tests

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

1. Load Test: During this test record the following data at 5-minute intervals

Time	Engine RPM	Oil Temperature Out
kW	Water Temperature In	Fuel Pressure
Voltage	Water Temperature Out	Oil Pressure
Amperes	Oil Temperature In	Ambient Temperature

2. Operational tests (including instantaneous loading and load rejection)

3. Measurement of the output

4. Functional testing of all alarms, protections and control devices

5. Checking of the starting time and of the time up to taking-over full load.

Note: Manufacturer shall furnish load banks, testing instruments and all other equipment as necessary to perform these tests to be witnessed by representatives of Engineer and Employer at the site. During this test record the following data at 5-minute intervals by adding load from 0% up to 25%, 50%, 75%, 100% load using a resistive load bank arranged at the site. Finally, 110% of load shall be added and tested for 15 minutes.

Instantaneous load addition of 70% shall be tested with all protections enabled to measure the drop in RPM, frequency, recovery time of frequency etc.

All the costs of the witnessing representatives (traveling, lodging etc.) for witnessing the tests shall be borne by the Contractor.

NB: All testing measuring devices and equipment shall be calibrated within six months before the site testing as well for the factory testing dates.

9. LV Power Cables

9.1 General

The cables shall be sized to comply with the regulations for Electrical installations published by the institutions of Electrical Engineers, London, except where specified sizes of cables are shown on the drawing or detailed elsewhere in the specifications or schedules.

Applicable colour coding shall be as follows:

Function	Colour
Phase L1	Brown
Phase L2	Black
Phase L3	Grey
Neutral N	Blue
Earthing	Yellow/Green

9.2 Cables

LV power cables required for connection of the diesel generator to the existing Generator Distribution Board. LV power cables shall be of copper conductor, unless otherwise specified, XLPE insulated, PVC sheathed armoured or non-armoured four-core or single-core cables, and shall be of 600/1000 volt grade complying with BS 5467 or IEC 60502.

Conductor size of the cable shall be decided by considering the total allowable voltage drop in the cable and current rating.

9.3 Cable Laying

The cables from existing 500 kVA generator set to the existing Generator Distribution Board have already being laid. Removal of them from the existing generator and replace them with new cables for the new generator has to be done under this contract. Supply, installation and termination of cables to the new Generator Distribution Board is under this contract.

LV power cables from the new Diesel Generator and the existing Generator Distribution Board shall be laid inside the existing cable trench route. In case the existing cable trench not sufficient, a new trench shall be installed.

10. Miscellaneous

10.1 Spares and Tools

Essential tools and spares shall be supplied with the engine-generator set, which shall include the following.

A. For the engine-generator set:

1. Three lubricating oil filters.
2. Three primary fuel oil filters.
3. Three secondary fuel oil filters.
4. Three intake air filters.

B. For battery charger:

1. Three complete sets of fuses.
2. One complete set of indicating lamps

C. For control and supervisory panel:

1. Three complete sets of fuses.
2. One complete set of indicating lamp

10.2 Fire Extinguishers

01 No.3 kg carbon dioxide and 01 No. 3 kg dry powder type fire extinguishers shall be supplied and installed at the suitable location in the generator room.

10.3 Submittals

The following documents shall be submitted by the contractor at the appropriate time

A. Shop Drawings:

1. Sufficient information, clearly presented, shall be included to determine compliance with specifications.
2. Prior to fabrication, submit for approval the following data for the engine-generator set, transfer device and control and supervisory equipment;

    a. Engine generator set

    b. Engine jacket water heaters

    c. Muffler assembly

    d. Day tank and pumps

    e. Batteries, racks and charger

    g. Control and Supervisory Equipment

    f. Performance:

        1) Voltage regulating equipment

        2l Frequency regulating equipment

        3) Voltage and frequency dips and recovery times due to motor loading

        4) Ambient derating

    g. Fuel oil system

    h. Cooling system

B. Manuals:

1. Submit, simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals of the engine generator set and auxiliaries including technical data sheets, wiring diagrams, and information, such as telephone number, fax number, and web sites, for ordering-replacement parts.

2. Two weeks prior to the final inspection, submit four copies of the updated maintenance and operating manual to the Factory Engineer:

    a. Include complete "As installed" diagrams, which indicate all items of equipment and their interconnecting wiring, including generator, control panels etc.
    b. Include complete diagrams of the internal wiring for each of the items of equipment, including “As installed” revisions of the diagrams.
    c. The wiring diagrams shall identify the terminals to facility installation, maintenance, operation and testing.

d. Complete lists of spare parts and special tools recommended for two years of normal operation of the complete system.
e. Layout plan and as-built drawings

C. Spare Parts Confirmation:

The contractor shall provide the Spare parts catalogue of engine & alternator, and a written confirmation mentioning the ability of supplying spare parts for **minimum ten years** after commissioning.

D. Certification

a) Name and Address of the Manufacturer, country of Manufacturing of the generator.
b) Variations and/ or deviations from specifications if any
c) Manufacturer's technical literature for engine
d) Load acceptance capability of the engine
e) CE or equivalent certification
f) Emission test report
g) Manufacturer's technical literature for alternator
h) Manufacturer's technical literature for control module
i) Sketch of generators
j) FAT certificate for the generator
k) ISO 9001 certificate of complete generator manufacture
l) Complete material list for the local work
m) Complete list of tools
n) Manufacturer authorization letter

11. Warranty

Warranty period of the Diesel Generator and all the equipment supplied under this contract shall be 365 days from the date of commissioning of the set at site. Contractor shall be attended necessary servicing of the generators (as recommended by the manufacturer), free of charge, during the warranty period. The servicing and maintenance shall include the supply of necessary oil, grease, cleaning material, etc. and labour.