SECTION -1: GENERAL SPECIFICATIONS

1.1 Scope

These specifications cover the technical requirements for supply 80 X 15kVA of diesel Generating Sets Complete with all accessories like starting batteries, control panel, silencer, anti-vibration mountings, sound and weather proof canopy, etc.

Diesel engine drives electric alternators, 400/230V+10% – 15%, 3phase, 4 wires, 50HZ, 1500 rpm, prime output rating 15kVA, and 0.8 PF at an altitude of 2200m ASL and 30℃.

1.2 Applications

The generators will be used to supply the telecommunication services of Yemen Mobile Company. All units are expected to supply rectifiers, single-phase air conditioners, single-phase lights, etc. In addition, one or two sets of generators shall be installed in each site according to availability of main electricity.

The tenderer shall provide customer list where similar Gen-sets and their facilities have been supplied and giving satisfactory services. The list should indicate the places where such equipment is currently in service.

The most important specifications and main points are summarized in the attached tables to be filled by the tender just as a secondary part from the whole Gen-set specification and it is significant to be fulfilled clearly and perfectly based on detailed required specifications.

1.3 Sites conditions

The Gen-sets will be working at operation conditions as follows:

a) At 2200m above sea level and 30℃.

b) At sea level, 45℃ andHumidity up to90%

- ***De-rating tables and curves for electric power generator sets shall be supplied by the tender.***

1.4 Documentations supplied with offer:

Proposals for approval shall include with the tenderer offer:

- Generator set photographs (suitable size) of all sides.
- Gen-set Technical Data , design and performance, specifications (tabulated data that identifies make , model and country of origin as attachment) for the following:

1) **Engine** (Including its relevant components).
2) **Alternator** (Including its relevant components).
3) **Control panel**(Including its relevant components).
4) **Auxiliary components:**

a) Starter components.

b) Fuel Solenoid.

c) Dynamo charger.
d) Injection pump.
e) Exhaust system.
f) Gen-set circuit breaker etc.

- **Drawings:-** General dimensions drawings showing overall generator set measurements, mounting location, and interconnecting points for load leads, fuel, exhaust, cooling and drain lines.
- All Wiring and schematic drawing showing detailed circuits.
- **Standards Compliance**: Complying with requirements of the international and European Codes and standards applicable for diesel generator sets.

1.5 Warranty Statements

- All Gen-sets shall be under two years on-site comprehensive warranty support from the date of installation and operation at the site or 30 months from date of final acceptance for the tender equipment as a whole including spare parts which is certainly after the technical test in warehouse of Yemen Mobile Company. All Gen-sets components shall be covered by the warranty. All components of the Gen-sets are to be warranted against any damage or malfunctions may occur during the warranty period. And an approved quality assurance certificate should be provided.
- Service - Location and description of local spare parts suppliers and services center including parts inventory and number of qualified generator set service personnel.
- The manufacturer shall have a local authorized dealer who can provide factory-trained servicemen.

Notes: Any submitted offer without complete technical data for all units and parts will be ignored and rejected.

1.6 Training

- The supplier shall provide a complete training program in the country of manufacturing.
- Tow engineers shall attend the factory test before supplying the required system.
- Training shall be prepared for other Five Engineers in a period not less than two weeks of business days.

SECTION -2
TECHNICAL SPECIFICATION OF GENERATOR SET

2.1 General

The generating sets shall be robust in construction factory tested and assembled to ensure prefect alignment of engine and alternator on a common base frame.

2.2 Noise and Vibration

The engine/ alternator combination shall be arranged to run free from excessive vibration and noise under all conditions of load and speed.

2.3 Acoustic enclosure (Canopy Requirements)

The acoustic enclosure shall be meet the following requirements:

a) Type: weather and sound proof.

b) Nosie Level: The noise level generated by the set at full load should be less than 70 dB (A) at (1) meter.

c) Design:

- The enclosure shall be designed to be weather, water and sound proof.
- The enclosure should be designed to meet the total air requirement for the D.G. Set at full load at site conditions as recommended by the engine manufacturer
- A canopy shall be capable of anti-corrosion to withstand high humidity.
- The enclosure base frame should be designed with supports for easy transferred using forklift.

***d)* Service Accessibility**

I. The enclosure shall be provided with suitable size and number of hinged type doors along the length of enclosure on each side for easy access inside the acoustic enclosure for inspection, operation and maintenance purpose.

II. Routine/ Periodical check on engine/ alternator and control cubicle (filter replacement, oil change, and tappet setting, etc.) should be possible without dismantling acoustic enclosure.

III. Generator control panel should be visible from outside the enclosure.

IV. The battery should be accommodated in enclosure in battery rack and easy access to it.

2.4 Guards

a) All moving and rotating parts such as belts, couplings and fans shall be protected by suitable guards to prevent accidental injury to personnel.

b) Guards shall be fitted to all engines with side-mounted exhaust manifolds.

2.5 Standard

- The generating set shall be designed, manufactured and tested in accordance with the latest revision of international and European standard.

2.6 Wiring And Conduits

Engine Control wiring shall be multi-strand annealed copper conductor encased by cross-linked Polyethylene insulation resistant to heat, abrasion, oil, water, antifreeze, and diesel fuel. Wiring shall be suitable for continuous use at 120 ℃ (250℉) with insulation not brittle at -50C° (-60℉). Cables shall be enclosed in nylon flexible conduit which is slotted to allow easy access and moisture to escape.

2.7 Labeling And Fixtures:

- Each part shall be labeled similar to the drawings.
- All wires and terminals shall be labeled according to the drawings.
- All wire terminals and lugs should be tightly fixed.
- The labels shall include all information required by IEC standards.

2.8 Finish

- The engine color shall remain the original color as supplied by the manufacturer.
- Rubber material, which is not fire or fuel proof, is not acceptable.

SECTION -3

TECHNICAL SPECIFICATIONS OF DIESEL ENGINE

Scope: This Section Covers engine diesel specification, Engine rating, Standard Components of diesel engine including systems of engine

3.1 Engine type:

The engine shall be diesel fuelled, inline type, multi-cylinder, four stroke, cold starting, water cooled, 1500 R.P.M, compression ignition, direct injection and naturally Aspirated.

3.2 Engine Rating: Sizing

- An engine of reputed make, suitable for 15kVA/12kW Gen -Set.
- **Prime Power:** The engine prime power duty shall be de-rated capable of developing sufficient output HP not less than required by the alternator (15kVA/12kW prime power) at the following site conditions:
  a) Altitude: up to 2200 meter Above Sea Level (A.S.L)
  b) Ambient Temperature:30℃
- **Overload Capacity**
  The engine should be capable of providing 10% overload for 1 hour for every 12 hour continuous running at full load

3.3 Cooling System

The Water cooled system of the engine shall be equipped with built in expansion tank.

- **Cooling Type:** Water-cooled with fan and radiator, Thermostat and self- contained piping
- **Radiator:** The radiator shall be Heavy duty with fan and corrosion resistance
- **Radiator Fan:** the capacity of the fan shall be sufficient to provide the required engine radiator cooling.
- **Water Pump:** the engine shall be equipped with engine mounted cooling pump.
- **Water heater:** The Gen-Set shall be equipped with heater for the coolant water to pass through and has the following features
  a) Adjustable heating level screw.
  b) Supplied from 220V AC when the gen-Set in standby condition.

➢ ***Provide technical details for radiator, water pump, water heater, etc.***

3.4 Lubrication System

- Full pressure lubricating oil system including an oil cooler is to be fitted.
- Oil pre-heating is required only before starting.
- The Oil shall be drained through external hose-pipe – plug type is preferred.

➢ ***The tender shall indicate the frequent of changing oil and oil Filter.***

3.5 Engine Starting System and Dc System

The engine shall be suitable for electric starting, as described below.

Electric Starting System:-

The system shall comprise a set of starter battery, battery charger and starter moter with requisite instruments.

I) Starter Motor:

- 12VDC electrical starter motor shall be supplied and shall have clutch for normal and abnormal operation.
- ***Electromagnetic solenoid switch*** it shall supply the required current to the starter motor and pull in and pull out pinion drive.

II) Starter Battery:

- The battery shall be dry type, maintenance free, of known manufacture, sufficient to supply starting and control circuit.
- The ampere – hour capacity of battery shall be adequately sized to ensure at least (6) Six attempts in one hour.
- The battery shall be adequately charged either from mains supply and / or from the Gen-set supply through the unit control panel.

III) Alternator for battery charging (Dynamo charger)

- The engine shall be equipped with a charging alternator of suitable voltage with a current rating of not less than 30 Amps to charge the starter battery.
- The alternator shall be readily replaceable.

IV) All cables required to make the starting system complete shall be supplied.

➢ ***Provide complete technical details for starter motor, starter battery and dynamo charger.***

3.6 Fuel System

I. **Fuel injection Pump:** Fuel injection pump with fuel lift hand pump.

II. **Fuel Filter:** fuel flow paper replaceable filter.

III. **Separate preliminary fuel filter (water separator)**: A water and fuel separator shall be fitted before the supply pump to filter the input fuel to the engine

IV. **Fuel Control (Fuel solenoid Valve)**

- Electric fuel solenoid preferred energized to run type) should be provided.
- A Solenoid Valve shall be fitted to engine fuel line and shall be rated for continuous operation.

V. **Fuel hoses:** Flexible hoses shall be provided for the connections to the input and output.

- The tenderer shall furnish details of fuel injection pump, fuel consumption at full load and at varying loads.

3.7 Governing System:

Type of Governor: Mechanical Governor

- Under steady state conditions, whatever the load might be, the rotational speed shall remain between N and 1.04 N, where N is the normal speed in the event of a sudden load variation of 0.25L nominal, but with the load remaining between 0.5 L and L nominal, Where L nominal is the rated load, the instantaneous change in speed should not exceed 4% of N. The rotational speed then should be returned within offset limits is less than 3 seconds and stabilize in less than 8 seconds.

- The tender shall enclose graphic diagrams showing the de-rating of his units depending on altitudes, temperature and humidity varying.

3.8 Intake Air System

I. **Air Filter:** Dry Type Replaceable paper element Air cleaner.

II. **Air intake manifold:** Air intake manifold with necessary connections shall be provided.

3.9 Exhaust System and Silencer

The following exhaust system shall be provided:

I. **Exhaust manifold:** Residential type with exhaust piping with vibration isolators, thermal insulation for exhaust line with glass wool, aluminum sheet.

II. An efficient exhaust silencer with external insulation and stainless steel cladding within the enclosure.

III. Stainless steel exhaust flexible coupling.

IV. Silencer: Silencer suitably optimized to meet stringent sound emission shall be provided.

V. Adequate brackets and clamps to support the silencer and exhaust system.

- ***Provide technical details for exhaust system and silencer.***

3.10 Coupling Arrangement:

a) **Flexible Coupling:** A heavy-duty flexible block coupling shall be fitted between the engine and the alternator to absorb the transmission of shock loads.

b) **Flywheel:** Flywheel housing and flywheel to suit single bearing alternator.

c) **Anti-vibration pads:** to reduce vibrations and eliminate misalignment of engine and alternator.

- ***Details of coupling arrangements should be offered by the tender.***

3.11 Engine Protective Devices

The engine shall be equipped with protective devices to provide warning and automatic shut-down under the following conditions:-

1	Low Lubricating Oil Pressure	*W+SD*
2	High Water Temperature	*W+SD*
3	Low Radiator Water Level	*W*
4	Fail To Start	*W+SD*
5	Over Speed/Under Speed	*W+SD*
6	Low and high Battery Voltage	*W*
7	Dynamo Charger Fail	*W*

8 The engine shall be equipped with an oil pressure and temperature detectors.

9 The engine shall be fitted with an oil pressure and Temperature sensors that shall be extended to the controller.

3.12 Engine conformances Standards

The engine shall be complying with an international standard.

3.13 Accessories

- All fuel-lines before the cut off valve shall be fireproof.
- The engine color shall remain the original color as supplied by the manufacturer.
- Rubber hose pipes used on the water, lubricating oil or fuel systems and rubber belts shall not be painted.
- All cables that connect the engine auxiliary components such as sensors, dynamo charger, starter motor, and fuel solenoid shall be extended through high quality conduit to be protected from engine heating.

SECTION -4:
TECHNICAL SPECIFICATION OF ALTERNATOR

4.1 Scope:

This Section covers technical requirement of alternator

4.2 Type:

1) Self-Excited, screen protected, self-regulated, drip-proof, brushless alternator, directly coupled to engine and horizontal foot mounted in single bearing constructions.
2) The alternator shall be three phases, 0.8 PF (lagging), four wires, 400/230V +10% -15%with a frequency of 50 Hz, star connected.

4.3 Rating

Synchronous alternator shall be have suitable capacity to generate 15kVA/12kW output at alternator terminal or shall be determined in accordance to the engine output rating at sea level.

4.4 Construction

1) ***Design:*** the alternator shall be design of welded steel construction.
2) ***Degree of protection*****:** an International Protection Code (IP) not less than "IP 23".
3) ***Insulation Level:*** The alternator shall be to class 'H' insulation.
4) ***Bearing:*** Only single bearing for alternator shall be supplied.
5) ***Frame:*** Engine and alternator shall be coupled and mounted on strudy, fabricated, welded construction base frame.
6) ***Ventilation:*** Self-Ventilated balanced.
7) ***Centrifugal fan:*** High velocity cooling air circuit shall maintain internal winding and rotor free of dust particles.

4.5 Excitation System

- Permanent magnet (PMG) in exciter field is preferred (for fast voltage build up both after a short circuit and after a long time of inactivity).
- Self-excitation is acceptable, *if it gives* fast voltage build up both after a short circuit and also after a long time of inactivity. The main exciter shall be protected against surge voltage.
    - The auxiliary exciter technique shall be described in full details by the tenderer.

4.6 Automatic Voltage Regulation (AVR)

1) AVR Type: Electronic 3 Phase Sensing type and shall be mounted in the relevant control cubicle.
2) Voltage Regulation: Accuracy Voltage regulation not more than ±1%.

3) Voltage Variation: The voltage shall be maintained within ±5% of nominal range from no-load to full-load, at unity and 0.8 P.F lag whatever the alternator temperature is..
4) The AVR shall be protected against failure due to low speed operation, over excitation, overvoltage and any abnormal conditions.

The full technical data with schematic diagram for A.V.R shall be provided.

4.7 Wave Shape

The output waveform should be pure sine. The residual harmonic percentage between full load and no load should not exceed +5%.

4.8 Overload And Short Circuits

1. The overload characteristic should be able to handle 110% of rated power continuously for at least one hour every 12 hours.
2. The design of the alternator and regulator system shall be able to maintain machine excitation for a period of 10 seconds at a rating of 300% before fault clearing.
3. Alternator shall be provided with full protection against abnormal conditions in order to withstand all types of short circuits without any damage.
4. The alternator and voltage regulator components shall be protected against voltage transients induced by switching or lightning surges.

- ***All protections shall be stated in details by the tender.***

4.9 Efficiency*:*

The efficiency of alternator shall preferable not be less than 87% at full load, nominal voltage and 50Hz at a load power factor of 0.8 lagging.

4.10 Sensing Abnormal Conditions

- Sensing electrical conditions which might cause damages to the generator e.g. high and low output voltages and frequency and sudden severe phase unbalance.
- In such circumstances and any fault electric problem the control equipment shall immediately isolate the generator from the load, stop the diesel engine and raise an alarm.

SECTION -5

TECHNICAL SPECIFICATIONS OF GENERATOR CONTROL PANEL

5.1 General

The control panel shall be fitted on the generator set and shall be able to function as follows:-

a) Automatically starts up the generator set when receiving the remote start signal from (A.T.S) and stop after cooling the generator when removing the signal.

b) Supervise and monitor all Gen-set devices and parameters and react for any abnormal conditions.

c) All operation modes, monitoring, measurements, and protections processes should be functioned by using its control and display unit (electronic card).

5.2 Control and Display Unit (Electronic card)

- The control module shall stand the dip in voltage during starting processes, and it shall be isolated by external switch.
- The control module shall perform the following:

I. Operation mode selection :

The Controller shall contain the following operation modes and shall be selected via soft pressing key:

1) **Auto** operation mode
2) **Manual** operation mode
3) **Test** operation mode
4) **Off** Mode

II. Digital Display:

- The controller should have Multifunction liquid crystal display (LCD) with Soft keys for Configuration and system monitoring.
- Warning and Fault messages appear on the LCD when the fault conditions are detected.

III. Digital Instruments(Measuring, Monitoring and Display):

NO	Engine	NO.	Alternator
1	R.P.M "Speed Value	**1**	AC Voltage Values (Line-Line)
2	Battery DC voltage	**2**	AC Voltage Values (Line-Neutral)
3	Battery charging DC ampere	**3**	AC current per phase values
4	Oil pressure value (bar, Pascal)	**4**	Frequency Hz
5	Coolant Temp value (℃)	**5**	kVA, kVAR, kW/phase and total, kWh
6	Running hours	**6**	Power factor (P.F)

IV. Indictors ,Alarms Lights and Protection for :

Engine			Alternator		
No.	**Item**	**Event**	**No.**	**Item**	**Event**
1	Fail to Start	LED	**1**	Over Frequency	W +SD
2	Gen-set normal running	LED	**2**	Under Frequency	W +SD
3	High Engine Temp.	W +SD	**3**	Over voltage	W +SD
4	Low Oil Pressure	W +SD	**4**	Under voltage	W +SD
5	Low Coolant Level.	W	**5**	Over load and S.C	Trip +SD
6	Battery charger fail	W	**6**	Missing protections	
7	Over/Under speed	W +SD	**7**	Phase sequence	
8	Dynamo charge fail	W			
9	High/low Battery Volts	W			
10	Emergency Stop	SD		.	
Warning (W), Shutdown (SD)					

- Any alarms (warning and shutdown) occur shall be interpreted as an alphabetic comprehensive text massage in display.

V. Configuration and Communication

a) Configuration:

- The controller shall be configured using front panel or by PC through USB Connections.
- The controller shall have the features of configurable timers as the Crank on timer, crank off timer, crank delay time and preheat (glow) timer.

VI. Alarm Retransmission

- Gen-set running (shall be free contact)
- Gen-set failure (shall be free contact)

5.3 Battery charger (Automatic Battery Charger)

- The battery charger shall be of the static type arranged to draw power either from the mains supply (240V, 1 Phase, 50Hz) or from the D.G supply through the unit control panel.
- Output rated: 12V DC, 5A, and it shall be adjustable charge current and voltage.

5.4 Protections Devices

1) Gen-set output circuit breaker 4 poles (MCCB), 25A, level protection at least IP 22, breaking capacity current at least 10kA.
2) 4-pole Gen-set output surge protection device (SPD) level-1 or level-2.
3) Rated of MCB shall be suitable of Gen-set working at sea level.
4) Suitable MCBs protection for all input and output (AC /DC) circuits.

5.5 Terminals

a) Power Terminals :

- Power terminal contacts 4 terminals for output, each terminal shall suit a cross section area 16mm^2.

b) Control and alarm Terminals:

1) Control and alarm terminals cross-section area 4mm^2, blade screwdriver.
2) Suitable terminal for remote start/Stop Gen-Set.
3) Alarm Terminal (+B) For Generator Running.
4) Alarm Terminal (+B) For Generator Failure.
5) Auxiliary Terminals for Heater (Line- Neutral) AC.
6) Suitable terminals for Gen-set's battery (Positive / Negative) and an automatic battery charger (L-N) so that the Gen-set's battery can be easily connected to the automatic battery charger installed in the ATS.

SECTION-6

DOCUMENTS AND DRAWINGS

The contractor shall supply the following manual and drawings:

6.1 Gen-set

1) Wiring and schematic drawing showing detailed circuits.
2) Each wire, component, terminal, etc. shall be clearly annotated on the drawing for identification and maintenance purposes.
3) Hardcopy of every handbook, manual and every drawing per unit (for each).
4) In case of handbooks, manual and drawings are not available at the time of final inspection the bidder will not be acceptable.

6.2 Engine and Alternator

1) Original test factory certificate
2) Service and Maintenance Manuals
3) Workshop Manual.
4) Spare Parts Manual
5) Spare part list - indicating make, model, rating etc.

6.3 Control Panel

1) Description (operating) manual.
2) Control module manual.
3) Fault-finding manual.
4) Single line Diagram.
5) Component lists – indicating country of origin, make, etc.
6) One original Software program for control panel and three soft copies.
7) Software cable link (three).
8) Spare part list - indicating make, model, rating etc.