



United Nations Office for Project Services
Yemen Integrated Urban Services Emergency Project –II
Subcomponent 1.4: Energy for Critical Services

**Supply, Installation, Test, and Commission of One Diesel
Generator for 22 MAY HOSPITAL**

Aden City -Yemen.

SCOPE OF WORK AND TECHNICAL SPECIFICATIONS

OCT. 2022

1. General Site Conditions:

The de-rating for electric power generator sets shall be provide at following conditions:

- Ambient temperature Max. 50°C. Min -10°C.
- Relative Humidity Max. 90°C Min 50°C.
- Pollution type: Desert Dust and Sand Storm.
- Altitude: 100 meter ASL

2. Scope of Work:

Supply, Install, Test, and Commission new soundproof (Canopy) (Prime) Power Diesel Generators for 22 MAY HOSPITAL in Aden city in Yemen. including, Electrical reticulation/ cabling and Automatic transfer switch panel between the new diesel generator and grid include all devices and equipment specified herein or required for the service:

NO	City	Facility Name	Location	Capacity KVA	Qty.
1	ADEN	22 MAY HOSPITAL	12°51.38.28"N, 44°59.25.48"E.	990-1000	1

The scope of the work shall include any other works required to ensure a well-functioning Diesel Generators but not explicitly mentioned shall be the responsibility of the bidder:

- Supply of adequately rated cables, lugs, connectors, screws, nut bolts etc. required for retrofitting and other accessories, which are necessary for satisfactory operation of the DGs though not individually or specifically mentioned herein.
- The unit shall be automatically and manually start and stop. The power supply system shall be complete in all respect for supply, installation and should be deliver ready for operation.
- The work including dismantling and moving the old diesel generator to the beneficiary's stores or as per UNOPS engineer directions.

2.1 Inspection And Testing

2.1.1 Inspection

The generating set shall be subject to inspection by the owner, or owner's appointed representative.

Approval by any of the above inspectors shall not relieve the manufacturer of his commitments under the terms of the purchase order and this specification.

Purchaser shall be give fifteen (15) days' notice before shipment to arrange for formal inspection

2.1.2 Testing

The generating set shall be subject to witness tests in accordance with the current Standards referenced herein and manufacturer's standards carried out at the manufacturer's works.

The owner or its appointed representative at the Vendor's works shall witness these tests, either during site installation or during erection. The Vendor shall give the owner a' notice before the start of any test.

The tests shall include the following:

- ✓ Full functional testing to ensure proper operation of all components.
- ✓ Full load heat run for a period of 1-hour test to determine temperature rise, and to demonstrate engine and generator performance. Heating effects based on maximum design ambient shall be simulate to confirm the adequacy of the cooling system. Engine generator controls shall be use during testing. The heat run test shall be carried out in accordance with the following:
Test Program
 - Generator control tests to demonstrate all generator trips, alarms, and changeovers from duty to standby equipment.
 - Rejection of full load current at the design power factor. Voltage, frequency and load current should be record on chart recorders.
 - Trip of main auxiliaries from generator fully loaded condition to demonstrate ability of emergency run down equipment.
 - One hour running at 110% load Cool down

- oil temperature test and emergency test
- After acceptance, the engine water-cooling system shall be drain prior to packing for shipment.
- The test certificates shall be approve by the owner before the machines are dispatch from the manufacturer's works.

2.2 Materials and Equipment

- Materials and equipment to be supply shall be as per standards, and the manufacturer also well-known and equipment is commonly used.

2.3 Safety Protection for Personnel

- Belts, pulleys, chains, flywheels, couplings, projecting set screws, shaft keys, and other rotating parts, so located that any person can come in close proximity thereto, shall be fully enclosed or otherwise properly guarded. Engine local control panels shall be "dead format" and shall have suitable barriers or screens, wherever necessary, to protect personnel from contacting live electrical.
- Parts during normal routine use. Removable panels that, when removed will expose live electrical parts, shall have warning declare thereto.

2.4 General Requirements

- The diesel engine shall be directly couple to the alternator. The diesel engine, alternator, lubrication Oil filters, fuel oil filters, lubrication Oil strainers, fuel oil strainers, and lubrication Oil coolers and other accessories deemed necessary by the manufacturer shall be mounted on a common steel fabricated base plate of sufficient strength to adequately support all equipment mounted on it, without distortion, either during operation or shipment.
- The steel base plate shall be support on steel springs, working as vibration isolators specifically designed for the weights involved. The isolators shall be furnished as a part of the equipment. All pipes connections between the engine and accessories such as air intake and exhaust: shall be flexible connections. These flexible shall be furnished as a part of the equipment. Owing to elastic suspension, the set should always have the possibility to move freely surrounding structures.
- The diesel engine exhaust pipe shall be complete with silencer to eliminate noise and flexible joints to eliminate transport of vibration.

2.5 Submittals

Submittals for approval shall be include but not be limited following:

- Component List - A breakdown of all components and options.
- 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.
- Auxiliary Equipment - Specification or data sheets, including, transfer switch, battery charger, jacket water heater, main circuit breaker etc.
- Drawings - General dimensions drawings showing overall generator set measurements, mounting location, and interconnect points for load leads, fuel, exhaust, cooling and drain lines.
- Warranty Statements - Warranty verification published by the manufacturer.
- Service - Location and description of supplier's parts and service facility including parts inventory and number of qualified generator set service personnel.

2.6 Warranty

The manufacturer shall have a local authorized dealer who can provide factory-trained service members, the required stock of replacement parts, technical assistance, and warranty administration. **(One YEAR FACTORY WARRANTY SHALL BE PROVIDED).**

2.7 Technical support

2.7.1 Training

- The supplier shall detail their capacity for delivering training courses in installation, commissioning, operation and maintenance of al equipment across their local service centers and/or requested locations. (the provision of these training courses is not to be included in this offer).
- The supplier shall also outline the content, and various levels, of their training courses.

2.7.2 Guarantee

The Supplier shall state and guarantee of following:

- Fuel usage rates at 110%, 100%, 75% and 50% prime rated output (g/kWe) and corrected values as noted.
- Maximum net output (kWe) of each diesel generator
- prime net output (kWe) of each diesel generator.

2.7.3 Manuals, Catalogues and Electrical Drawings

Manuals, catalogues and drawings and any other documentation supplied shall be available in English, the following manuals and catalogues shall be supplied with each generating set:

- Engine and alternator Manuals.
- Generating set operation Manual.
- Control installation and operation manual
- Maintenance Manual.
- Troubleshooting Manual.
- Workshop and Spare Parts Manuals and catalogues. g) Electric diagram.

In particular, the appended manuals should contain the following information:

2.7.3.1 Operating Instructions:

The Instruction Manual shall include detailed Operating Instructions and, as a minimum, should cover starting, stopping, protection of circuits, automatic controls, battery charging, safety considerations, method of adjustment of speed, output voltage, control timers, etc.

Performance parameters of the generator set shall be detailed for the operator's guidance and as a minimum should cover output voltage, frequency, load, engine temperature and oil pressure nominal values and acceptable limits. Circuit drawings with component identifications shall be included for reference purposes.

2.7.3.2 Maintenance Recommendations:

The supplier shall provide complete maintenance procedures for all the equipment supplied. Schedules for maintenance to be effected on a daily, weekly, monthly, etc. or on hourly run basis should be included.

Guidelines for the selection of fuel oil, lubricating oil, use of water treatment additives and anti-freeze if applicable.

2.7.3.3 Troubleshooting:

Troubleshooting procedures shall be available to enable the timely diagnosis of a defect considered likely to occur in service. Reference outputs and conditions shall be quoted to facilitate diagnosis.

Note: It is mandatory that one set of above manuals, catalogues, and electrical drawing/diagram for each category of the offered generating sets is supplied with the bid (electronic versions). Bids shall not be acceptable unless the offer includes these items.

3. Technical Specifications

3.1 Generator Unit (Set):

3.1.1 Diesel Engine:

3.1.1.1 General

- The diesel engine shall be of the turbocharger, after cooled type with the following characteristics:
- The engine shall be of the vertical, four strokes, cold starting.
- The engine shall be capable of running satisfactorily with fuel oil and lubricating oil of grades and standards used in ADEN city – Yemen.
- The engine speed regulation shall not exceed $\pm 10\%$ for the momentary and $\pm 6\%$ for the permanent change when the full load on the engine is suddenly thrown off or put on, respectively.

- Provision shall be made for varying the engine speed within 6% above or below the normal speed at all loads.
- The engine shall be provided with a control panel as mentioned hereafter.

3.1.1.2 Engine Rating

- The engine when running at 90% of its continuous rated output at site shall be capable of driving the alternator when delivering its full load output, i.e. the power of the engine shall be nearly 10% in excess of the power of the alternator.

3.1.1.3 Supercharging

- The supercharging of the diesel engine shall be achieved by means of charging blowers utilizing the energy of exhaust gases. An after cooler must be fitted in the air manifold for cooling air before entering the engine cylinders.

3.1.1.4 Cylinders, Liners and Cylinder Cover

- The engine shall be multi-cylinder type provided with removable cylinder covers and renewable liners, furnished with water jacket of ample size, avoiding any pockets, which may cause accumulation of deposits from the cooling water.

3.1.1.5 Duplex Fuel Oil Strainer and Filter

- Fuel-flow strainers shall be provided ahead of the engine fuel pump. The fuel-flow filters shall be provided after the engine fuel pump. Strainers shall be of the metal edge or screen type as recommended by the engine manufacturer. The filter case shall have inlet and outlet connections plainly marked. The case shall be mounted in an accessible location, which will permit changing strainers and filter elements without disconnecting the piping or other engine-mounted equipment.

3.1.1.6 Engine Fuel Pumps

- Engine fuel pumps shall be of the positive-displacement, engine-driven type and capable of supplying the necessary quantity of fuel under all conditions of operation. Relief valves shall be provided to prevent equipment damage due to buildup of excessive pressures, which might result from restrictions in the discharge lines. In addition, a hand-operated fuel oil priming pump shall be provided.

3.1.1.7 Fuel Oil Drip

- Nozzle drip lines, overflow, ... etc., shall not drain on the floor. Means shall be provided for collecting these lines, and return of excess fuel to the day tank automatically.

3.1.1.8 Fuel Oil Lines

- Fuel oil lines shall be provided with solid connections between fuel piping and engine.

3.1.1.9 Lubricating System

- The engine lubricating system shall operate and be maintained at a predetermined constant pressure by means of an engine-driven positive-displacement lubricating oil pump. Relief valves, a pressure gauge, and automatic safety feature, to sound an alarm and shut down the engine at a predetermined lubrication oil pressure by closing contact, shall be supplied. To maintain proper oil temperature, if deemed necessary, lubrication system shall be provided with water cooler.

3.1.1.10 Oil Cooler

- One shell type or plate type cooler arranged to utilize engine-cooling water as the oil-cooling medium, shall be furnished with the engine. The capacity and construction of the unit shall be as recommended by the engine manufacturer. Suitable connections shall be furnished for connections between the engine, radiator, and oil cooler as required.

3.1.1.11 Lubrication Oil Strainers and Filters

- Duplex full-flow filters shall be provide in the lubrication. Oil line. The filters shall be of the cartridge type.

3.1.1.12 Lubrication Oil Priming Pump

- An electrically operated priming pump shall be provide for priming the engine lubricating system prior to starting. The pump shall be of suitable capacity. The pump shall be mounted on the engine and shall be factory completed. A manual pump shall also be provide as stand-by. Starting of engine without priming can be accept if the engines' manufacturer recommends it.

3.1.1.13 Exhaust System

- The exhaust system shall include a flexible section, condensate drain, muffler-silencer, weather cap and all necessary accessories.
- Exhaust piping shall be of the diameter recommended by the diesel manufacturer. The flexible exhaust connection shall be stainless steel. The exhaust silencer shall be of heavy duty, side inlet and end outlet, designed for vertical installation. It shall be of size and design that will ensure durability, prevent backpressure and provide medium degree silencing. Flanged connections shall be provided at each end of the silencer. All companion flanges shall be furnished, installed and securely attached to the housing. Exhaust system components shall be painted with high temperature aluminized paint. Each flanged joint shall be provided with 1/16" asbestos, full-face gaskets.

3.1.1.14 Air Intake System

- The engine shall be equipped with heavy-duty oil bath or dry type air cleaner (S) of sufficient capacity to protect working parts of the engine from dirt or grit. The air-cleaner shall be equipped with a pre-cleaner and a restriction indication. A crankcase breather shall be included. In-line air inlet silencer shall be provided between the turbocharger and air inlet.

3.1.1.15 Speed Control Governor

- The engine shall be equipped with a full hydraulic isochroous governor, which shall be mechanically driven by the engine, and which shall hold engine speed to within $\pm 5\%$ of any selected speed at any constant load form no-load to full-load.
- The governor shall control speed smoothly but positively and shall be fitted with stabilizing or compensating device to preclude hunting or over travel. The governor shall prevent variation in speed of the sustained periodic type (Hunting) and shall limit variation in speed of

3.1.1.16 Flywheel

- The flywheel shall be adequately protect by means of removable guards. An appropriate means shall be provided for barring.

3.1.1.17 Emissions standers

- The engine shall be meet Tire 4 final emission standers.

3.2 Alternator

3.2.1 Design Data

- The alternator shall be directly connect to the engine flywheel through a coupling designed and supplied in accordance with alternator manufacturer requirements.
- The alternator shall be of three phase, synchronous, drip proof, self-excited with built in exciter machine and voltage setting rheostat, provided with special windings for reduced harmonics and arranged for parallel operation with similar unit.
- Insulation shall be of tropical and moisture proof type, class (F).
- The alternator shall be of the following technical data:

Power	As mentioned in B.O.Q
Power factor	0.8 – 0.85

Efficiency	Minimum 92%
Voltage	400 V
Frequency	50 Hz
Speed not exceed	1500 r.p.m
Voltage dip at starting not exceed	15%
Overload rating	10% for two hours
Short circuit rating	300% of alternator capacity symmetrical for 10 seconds.
Temperature rise over ambient temperature.	65°C
Maximum harmonic content	1.10
Ambient temperature	50°C

3.2.2 Exciter

- The exciter shall be brush less and its armature shall be directly connected to the alternator shaft. It shall be of the alternator type and have a solid-state, hermetically sealed rectifiers mounted directly on its armature. The rectified exciter output shall be directly connected to the revolving alternator field windings without brushes, slip ring or communicators. The excitation system shall be equipped with a series of boots transformers or permanent magnet generator for field forcing capabilities.

3.2.3 Automatic Voltage Regulator

- The AVR shall be of a solid state electronic . The AVR shall be manufactured such that it will maintain electrical properties, even under severe overload, under/over voltage and under/over frequency conditions. Input correction range shall be -30% to +20% of nominal input voltage. The system design shall be capable of operating at an input frequency range of -15% to +10% of nominal, without clearing protective devices or causing component failure within the AVR. When generator or utility power is restored, the AVR shall automatically restart. Upon turn on or restart, the output of the AVR shall not exceed the specified output regulation limits.

3.3 Main Line Circuit Breaker, Control and Instrument Panel:

- **The main line circuit breaker shall be mounted and connected in a guarded drip-proof enclosure meeting IP 22 and IEC 144.**
- For generating unit, a main line circuit breaker with shunt trip to protect generator set from accidental faults and to disconnect it from its load shall be supplied. **(It shall be with min. rating Amps as specified at BOQs).**
- The control and instrument panel shall be provided. This panel shall be mounted on to the alternator and shall be provided with vibration isolators of adequate size to protect the instruments and control from vibrations. The following minimum instruments and control shall be provided.

3.4 Alarm

- Lubrication Oil from engine.
- Engine water temperature, high-shut down of the engine.
- Engine, over speed and visual alarm.

3.5 Starting of the Generating Units

3.5.1 Electric Starting System

- The engine shall be equipped with a 12/24 VDC solenoid shift electric starter capable of withstanding four, 30 second consecutive cranking periods.
- The starting battery shall be Lead Acid, especially designed for diesel engine cranking service and of a capacity as recommended by the battery manufacturer for cranking the engine being furnished, for the necessary break-away current as required and spinning current for four consecutive starts of thirty seconds of cranking on each start, or for 60 seconds of continuous cranking without being recharged and with the ambient temperature of both the engine and battery of 45°C. Steel battery rack shall be secured to the mounting skid and the battery shall be secured to this rack.
- A complete automatic battery charger shall be furnished for charging the lead acid battery being supplied. The charger shall be the static type, magnetic amplifier control with direct current voltmeter, direct current ammeter and potentiometer for voltage adjustment and shall have float and high charge

rate, with a 0 to 24 hour high rate charge timer. Charge rate shall be automatically determined by the state of the battery and reducing to milliamp. Current to fully charged battery. Charger shall be for 220 volt, single phase, and 50 Hz alternating current input, with an output of not less than 6 percent of the nominal ampere-hour rating of the battery. A time delay under voltage relay shall be provided within the charger for remote alarms. The charger shall be for the correct voltage for the battery. The charger shall be mounted inside the pump housing.

- Required battery cables shall be installed for connecting the battery to electric starter.

3.6 Cooling System

- The engine shall be water-cooled of a closed type system, with liquid to air radiator supplied with blower fan(s) to maintain desired operation conditions. The radiator unit shall be of the indoor or outdoor type designed for operating 10% continuous overload at 50°C ambient temperature.
- All connections to the engine and its mounted accessories shall be solid. The radiator shall have an engine driven fan of adequate size.
- The system shall not be susceptible to the formation of deposit of rust and scale within the engine, and shall circulate the coolant through the engine at a regulated temperature and flow rate as recommended by the manufacturer.
- A jacket water temperature control valve shall be provided. It shall be of thermostatic type with 3-way body and flanged connections. The thermostatic element shall be designed to maintain the jacket water temperature within the requirements at stated by the engine manufacturer.
- The system shall also include a separate path of lubrication Oil cooling.
- Similar approved type can be taken into consideration.
- Gen sets shall be equipped with a cooling system having sufficient capacity to effectively cool the engine when delivering full rated horsepower at the conditions stated above. A radiator and engine-driven fan of a type and capacity recommended by the engine manufacturer shall be included.
- The radiator shall be sized in accordance with the engine manufacturer's recommendation for use with 50 percent aqueous ethylene glycol. Air flow shall be controlled by a power inlet damper and a gravity discharge damper, Design ambient air temperature shall be 50 degrees C at sea level.
- Gen sets shall have an engine-driven, gear driven centrifugal type water circulating pump for circulating water through the cooling system.

3.7 Automatic Transfer Switchboard & Control Panel

For generation unit, an automatic transfer switchboard, control & instrument panel (with digital indication) shall be provided. This panel shall be mounted on (at substaion room) The panel size to be suitable to cables entry and shall be provided with control cables from generating unit to control panel at substaion room the length of power at control cables not less L = 150 meters (the automatic transfer switchboard, control & instrument panel must be supply with power and control cables). The following minimum instruments and control shall be provide for the generating unit power supply in the two substation.

- AC automatic transfer switch suitable for Existing public grid & New DG will be install in two substations
- AC voltage 3 phase (L – L & L – N).
- AC amps 3 PH & total.
- KW total & per phase.
- KVA total.
- K VAR total.
- KWh total.
- KVARh total.
- Power factor average & total.
- Percentage of rated (total).
- Frequency.
- DC voltage.
- Coolant temperature.
- Oil pressure.
- RPM.
- Hours run.

- System diagnostic.

➤ **CONTROLS**

- Automatic transfer switch.
- Auto start / stop and Emergency stop.
- Lamp test.
- Cycle crank.
- Voltage control.
- Cool down timer.
- Phase selector switch.
- Load demand relay.

➤ **INDICATING LIGHTS**

- Low oil pressure.
- High coolant temperature.
- Over speed.
- Emergency stop.
- Fault shutdown and Fault alarms.
- 3 spare lights / 4 spare inputs, customer programmable (shutdown or alarm) to spare alarm or fault Leeds and Over crank.

➤ **PROTECTIVE RELAYING**

- Programmable relays.
- Over / under voltage.
- Reverse power relay.
- Over / under frequency and over current.

➤ **LOW VOLTAGE CIRCUIT BREAKERS**

- Low voltage circuit breakers shall be metal clad and shall be of the air break, horizontal draw out pattern 400 volts and rupturing capacity as mentioned in the drawing. Circuit breakers shall comply with VDE or BS 4752 & IEC 60439 and shall be complete with the auxiliary equipment described for high voltage circuit breakers. The circuit breakers closing mechanism shall be of the trip-free type and shall incorporate a mechanical "ON/OFF" indicator and mechanical interlock in order to prevent withdrawal, plugging or access to the breaker in the closed position.
- Contactors shall be robust in design and shall be capable of carrying full load for an indefinite period, and shall be provide with an arc-quenching device. Contacts shall have readily renewable tips. The live fixed contacts shall be fully shroud.

➤ **LOW VOLTAGE FUSED SWITCHES / ISOLATORS**

- Fused switches shall be of the heavy duty type complying with VDE No.0670 part 1/1.64 and shall be equipped with detachable neutral links and class Q1HRC fuses to VDE No.0670 part 4/3.67.
- Fused switches shall be of the triple pole and neutral type or heavy duty composites unit of the air break switch type and have not more than one fuse in any one pole, the fuse being contained in or mounted on the moving member or the switch. The neutral shall be either switch or taken through a removable link. A separate brass earth terminal shall be provide.
- Isolators shall be identical to fuse switches but the fuse links shall be replace by high conductivity copper link.

3.8 Earthing System:

- The Contractor shall Supply, installing, testing, and commission-earthing installation in accordance design of the system and all items shall be according to BS 7430, with the IEE Wiring regulations BS 7671. The system of PVC conduits and trunking, metallic sheaths of cables, cases and enclosures of switchgear and electrical apparatus shall be connect to the earth point, according to the current rules and regulations. The Contractor is remind that the resistance of the earth conductor from the earth-electrode to any point in the earthing system shall not exceed one ohms as per ANSI IEEE Standard 80.
- Codes of practice and highest prevailing engineering standards for the following main system component:
 - a. Extendible copper electrodes, (suggested length: 1.6~2.4 m),
 - b. Main earthing cable: copper bared as per BOQ and the length as required. And earthing cables for Gen. sets, hanger frame, fuel tank and any other equipment: insulated copper as per BOQ,

- Copper earthing bar, Earth pit with manhole cast iron cover plate complete as per standard, the cover of the manhole is preferred be clearly stamped with grounding sign.
- c. Ground Enhancement Material (Bentonite / (Salt & Coal) 50kg.
- d. Earthing busbar shall be protected fixed inside sealed box

3.9 Cables

- Cables shall be supplied by an approved manufacturer and where possible the same manufacturer shall be used for all cables and according to IEC 60228, IEC 61537, ISO, IEC 60227/IS 694, IEC 60502/151554 standards. In addition, the Calculations of the current rating of the cables should be according to IEC 60287.
 - (i) Rating :
 - The Contractor shall ensure that each cable is adequately rate for its duty under normal and possible fault conditions.
 - The rated voltage of the cable shall not less than the operating voltage and when assessing the rating and cross section of each cable the following factors shall be taken into account:
 - a) Maximum voltage drop permissible.
 - b) Type and magnitude of load.
 - c) Fault level and duration related to circuit protection relays and fuse gear.
 - d) Over current setting of relays and circuit breakers.
 - e) Route length and disposition of cables.
 - f) Ambient temperature.
 - g) Method of laying.
 - (ii) Type :
 - Cables complying with VDE or approve equivalent standards will be accepted provided all cables, which are supplied for a specified operating voltage, are to the same national standard. Standards specified in the following clauses indicated the type of cables used in the design: if the contractor wishes to use cables to alternative standard then details of current carrying capacity, de-rating factors ect, shall be submitted to the Engineer for approval.
 - a) XLPE/SWA/PVC:
 - Power cables specified as cross-linked polyethylene insulated steel wire armored and PVC sheathed are hereafter refer to as XLPE/SWA/PVC.
 - All such cables shall be terminate with mechanical glands, which shall be of a type as to provide adequate mechanical support by positively locking on the armor and shall at the same time give a high level of earth continuity.
 - b) PVC/SWA/PVC:
 - Power and control cables specified as PVC insulated and sheathed, galvanized single wire armored cable with an overall PVC sheath are hereinafter referred to as PVC/SWA/PVC.
 - c) MICC/PVC:
 - Certain control and miscellaneous circuits shall be carry out in mineral insulated copper clad cable with an overall extruded PVC sheath, hereinafter referred to as MICC/PVC cable.
 - For the purposes of core phase identification colored PVC core sleeves or colored PVC extension sleeves shall be use. Core sleeves and extension sleeves to be use on the core sizes for which they are intend.

3.10 System Accessories

Cable Tray

Perforated type Galvanized steel cable trays, cable tray covers, clamping bolts and other cable tray accessories such as coupler plates, bends, tees, reducers, vertical elbows in manufactured accordance with ASTM A653 SS, Grade 33, coating designation G90.

Hot-dip Galvanized Steel: Straight section and fitting side rails and rungs shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 for 14 gauge and heavier, ASTM A1008, Grade 33, Type 2 for 16 gauge and lighter, and shall be hot-dip galvanized after fabrication in accordance with ASTM A123.

Perforated cable trays must conform to IEC 61537 and EN ISO 1461 standard.

3.11 FUEL SYSTEM

3.11.1 Fuel Transfer Pumps

- Fuel oil shall be transferred to and from the main fuel tanks by electrically driven pumping units.
- The electrically driven pumps shall be of the self-primed, rotary type, having a suitable discharge capacity. directly driven and mounted on a common bedplate with its A.C., single phase, 50 cycles/sec, 220 volt, electric motor.
- The pump shall be provided with dry running protection in conjunction with the fuel level in the main storage tanks.
- The pump flash point and Viscosity, according to Imported Gasoil (Diesel) Guaranteed Specification – Yemen Petroleum Company YPC in the following table: -

Characteristic	Unit	Guaranteed Quality	Limit	Test Method
Flash Point	°C	62	min	D93
Kinematic Viscosity @ 40 °C	CST	2.0-5.0		D445

- The pump should have Nema-4X enclosure.
- The pump shall be complete with all piping and valves which shall be arranged to transfer the fuel oil from tankers to the main storage tanks and from main tanks to the fuel tanks of DG inside generating building.
- The fuel piping shall be of **black steel**. Piping outside the generating units buildings shall be laid down in trenches. Piping indoor shall be laid inside concrete ducts with Chaucer plate covers. Pipes shall be properly protected against corrosion. The joints shall be of the flanged and/or of the sleeve type with union couplings wherever necessary for easy dismantling.

3.11.2 Fuel Oil Storage Tanks

- Fuel oil storage tanks, outdoor type, CYLINDRICAL, the fuel tank capacity should be suitable liters powered by electric driven pump (s), fuel flow meter complete with bypass pipe work, valves and fittings to connect the above to engine.
- The fuel tank shall be minimum 6mm thick carbon steel approved per U.L. Standard 142 and meeting the requirements of N.F.P.A. 30.
- The tank shall be complete with steel platform and stand and shall be equipped with the following:
 - Level indicator.
 - Air vent, overflow pipe and drain pipe with cock.
 - Strainer on outlet.
 - Inspection opening with cover.
 - Turbine type flow meter on the outlet pipeline.
- The tanks shall be painted externally with aluminum paint.
- Access Steps and Ladders

3.12 DG built in fuel tank

The DG built in fuel tank capacity should not be less than below

DG built in fuel tank		
N.O	DG Capacity in KVA	build-in Fuel Tank Capacity in liter
1	990-1000	Not less than 500

3.13 Recommended Spare Parts for the Warranty

- Recommended Spare Parts for the Warranty period and continuous operating for one year by separate list.

3.14 Recommended Maintenance Spare Parts for the Whole Maintenance

- Recommended maintenance spare parts complete set one time during the whole maintenance period by separate list (include piston rings, main bearing, rod bearing, valve rotators and crankshaft seals turbocharger oil pump water pump and all other important parts).

3.15 Tools

- Recommended tools set of system tools by separate list.

3.16 Applicable standards

IEC 60364-1, IEC 60364-4-41, IEC 502, IEC 811, IEC60034-1, ISO3046, ISO8528, NEMA MG1-22, NEMA MG1-33, NFPA37, NFPA70.

3.17 Occupational Health and Safety

- Contractor shall implement all the Health, Safety and social requirements stated in the Environmental and Social Clauses ,EHS and ECOP.
- Contractor shall prepare and implement a Health and Safety Plan including the risks assessment, mitigation measures, monitoring plan.
- Contractor shall submit periodic safety reports and HSSE statistics according to the UNOPS HSSE management system and requirements.
- Contractor shall have a permit to work system.
- The contractor is responsible for safety at the construction or work site. The contractor is also responsible for preparation of a safety plan and for carrying out the safety plan.
- The contractor staff shall maintain conformance to the health and safety plan throughout the course of construction.
- Contractor inspectors shall consider safety a key element of their daily inspections.